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NATIONAL CULTURE: UNDERSTANDING THE IMPACT OF CROSS-CULTURE ON AIRLINE PILOTS' SAFETY PERFORMANCE IN THE MIDDLE-EAST AND NORTH AFRICA (MENA) REGION

by

Shareef Abdulla Kaddas Al-Romaithi

A Dissertation Submitted to the College of Aviation in Partial
Fulfillment of the Requirements for the Degree of
Doctor of Philosophy in Aviation

Embry-Riddle Aeronautical University
Daytona Beach, Florida
October 2014

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Shareef Abdulla Kaddas Al-Romaithi

This Dissertation was prepared under the direction of the candidate's Dissertation Committee Chair, Dr. Tim Brady, Professor, Daytona Beach Campus; and Dissertation Committee Members Dr. MaryJo O. Smith, Assistant Professor, Daytona Beach Campus; John V. Sabel, J.D., Adjunct Instructor, Daytona Beach Campus; and Dr. Antonio I. Cortés, External Member, and has been approved by the Dissertation Committee. It was submitted to the College of Aviation in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Aviation

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ABSTRACT

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Institution:	Embry-Riddle Aeronautical University
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The continuous expansion of Middle Eastern airlines has created a pilot shortage. Since the local pilot population in the Middle East is relatively small, airlines have been relying on foreign pilots to satisfy their operational requirements. Consequently, pilots with diverse cultural perspectives have been operating together. In order to manage this cultural diversity and ensure safe operations, airlines have been applying a number of training and operational strategies such as Crew Resource Management (CRM) with emphasis on adherence to Standard Operating Procedures (SOP). However, CRM was designed and implemented by North Americans as a solution for human factor intricacies among North American pilots, and thus, CRM is not culturally calibrated to accommodate pilots from other regions in the world.

The analyses of Flight Operational Quality Assurance (FOQA) information acquired from a Middle Eastern airline aided in understanding the influences of cultural diversity on airline operations. This analysis helped in understanding the impact of cross-culture among airline pilots on three relevant unsafe performance events: hard landings, unstable approaches, and pilot deviations.

The study was conducted using a descriptive comparative method to analyze the relationship between unsafe performance events and captain / first officer nationality combinations during flights where performance events were recorded. The flight data were retrieved from an unchanged flight data-recording environment yielding robust detailed data that was combined with administrative demographic data.

Tests of associations were used to understand the relationship between unsafe performance events and nationality combinations. These associations were illustrated through multi-dimensional chi-square tests. A comparison of cross-cultural and homogeneous flight deck crew combinations from unsafe performance events was examined. Additional analyses were conducted to predict group membership through discriminant analysis and multinomial logistic regression.

Several Spearman's *r* correlation tests were conducted to assess the influence of intervening demographic variables on the association between nationality combinations and unsafe performance events. While cause-and-effect relationships between variables could not be determined in this research design, association variations between variables were made evident. ANCOVA statistical tests were conducted to control for the effect of: age of captains / first officers, airport destinations, and eligibility to command the flight on the relationship between nationality combination and unsafe performance events.

The Spearman's rank correlation test indicated significant weak correlation between destination airport and unsafe performance events, as well as, eligibility to command the flight and unsafe performance events. A 7 by 7 multi-dimensional chi-square test indicated that there was a relationship between certain pilot nationality combinations and unsafe performance events categories for pilot deviations and all unsafe performance events together. Moreover, the discriminant analysis test results showed that there was a significant effect of some nationality combinations on unsafe performance events.

Results obtained from the analyses buttress the literature that certain cultural traits and beliefs influence pilots' behavior and attitudes and may jeopardize safety levels. CRM skills may be weakened as a result of heterogeneous nationality combinations. It is recommended to conduct further research on current CRM training concepts in order to improve its effectiveness among cross-cultural crewmembers.

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DEDICATION

I would like to dedicate this work to the late president of the UAE, H. H. Sheikh Zayed bin Sultan Al-Nahyan, whose visions and passion for education are an inspiration to this day.

"The true wealth of a nation lies in its youth, one that is equipped with education and knowledge and which provides the means for building the nation and strengthening its principles to achieve progress on all levels"

H. H. Sheikh Zayed bin Sultan Al-Nayhan

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First and most importantly, I would like to thank Allah for his blessings and for giving me the will to achieve my goals and complete my Ph.D. By his grace I was able to conclude my degree.

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I would like to express my appreciation to all my professors and classmates who made this degree enjoyable. I could not have done it without their support. Additionally, I would like to express my sincerest thanks to the College of Aviation and all the team members at Hunt library. Their hard work and continuous support made it possible for me to achieve my goals.

I especially thank all the team members at Air MENA who helped me in gathering the data and made this research possible. I would like to thank my family for their support throughout my career at Embry-Riddle. A big thank you to my niece, Ward, who was always there for me. Finally, I would like to thank my father, Abdulla Kaddas Al-Romaithi, who taught me how to challenge my self and follow me dreams.

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CHAPTER I

INTRODUCTION

The purpose of this dissertation is to determine if cross-cultural flight deck crew composition is related to increased error levels. Flight Operational Quality Assurance (FOQA) information was analyzed with special emphasis on pilots' national cultures. The data were retrieved from an airline in the United Arab Emirates (UAE). Principles of aircrew performances and aircraft operations, such as Crew Resource Management (CRM) and Standard Operating Procedures (SOP), have been taken into consideration in this study when defining errors and deviations committed by pilots.

The UAE

Stretched across the southeastern tip of the Arabian Peninsula, the UAE's geographical location is considered an economic passage between the West and East (Zoubir, 1999). Since the discovery of oil in the 1950s, the UAE has experienced an era of economic development transforming it into a prominent hub for international commerce, trade, and tourism (Zoubir, 1999). In 2000, the UAE was estimated to have 10% of the world oil reserves (Al Abed & Hellyer, 2001). Endowed with considerable oil reserves and being aware of declining natural resources, the UAE government has diversified its economic strengths through investments in various industries, such as air transportation (Verpermann, Wald, & Gleich, 2008).

Aviation in the UAE

The UAE has established itself as a global competitor in the aviation sector. Airlines in the UAE transported over 56 million passengers and 3 million tons of airfreight in 2009 (Oxford Economics, 2009). The aviation sector supports the UAE's economy by generating more than U.S. $39.47 billion, which is 14.7% of UAE's Gross Domestic Product (Jones, 2012). Furthermore, the aviation sector provides over 224,000 jobs in the UAE with an average annual salary of U.S. $86,000 (Oxford Economics, 2009).

In 2008, aircraft orders by operators in the UAE and other Middle Eastern countries were valued at $40 billion (Vespermann et al., 2008). These expansion strategies would enable Middle Eastern carriers to increase their network and flight frequencies across the globe. The wide body aircraft orders placed in 2008, as illustrated in Figure 1, show the expansion commitment among Middle Eastern carriers.

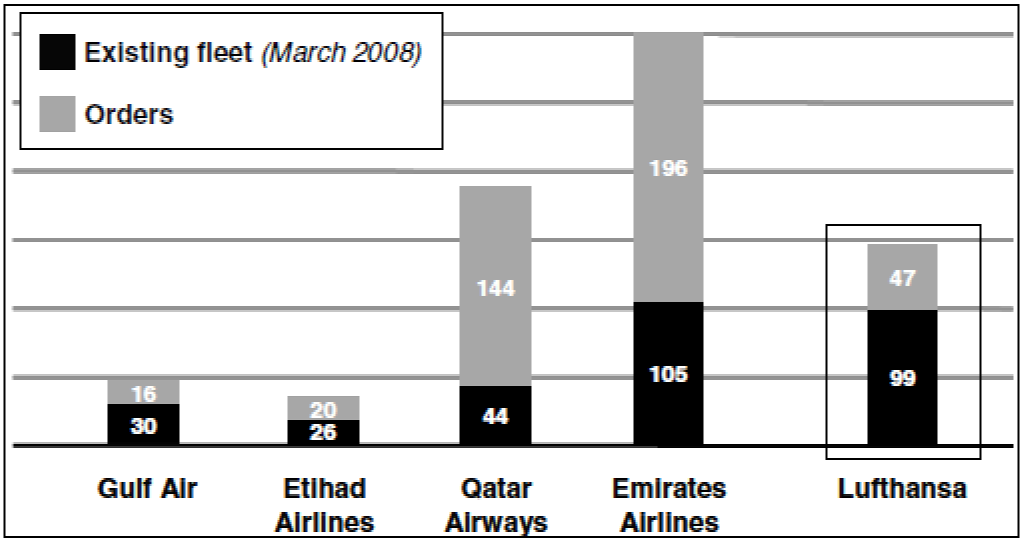

Figure 1. Wide body fleet expansion plans of Middle Eastern carriers. Adapted from "Aviation Growth in the Middle East - Impacts on Incumbent Players and Potential Strategic Reactions," by Vespermann et al., 2008, *Journal of Transport Geography, 16*(16), 388-394. Copyright 2008 by Elsevier.

General Civil Aviation Authority (GCAA). In parallel with the European Joint Aviation Requirements (JAR), the GCAA has been structured to govern and regulate aviation activities in the UAE (GCAA, 2013b). The GCAA is aimed at establishing and maintaining standardized safety performances among local operators (GCAA, 2013a). Required operational standards and safety levels are defined by the GCAA through published regulations that address minimum operational requirements and procedures (GCAA, 2013a).

Nationals versus Expatriates. As of July 2012, the population in the UAE reached 5,314,317 (Central Intelligence Agency, 2012). However, only 19% of the total population in the UAE are nationals, while 81% of the total population in the UAE is comprised of a wide array of nationalities, predominantly Asians, commonly referred to as expatriates (Central Intelligence Agency, 2012). NatWest International Personal Banking Quality of Life Index ranked the UAE as the third favorite place to live among expatriates due to its tax-free environment, job opportunities, and overall quality of life (Ferguson, 2013).

Expatriates account for most of the population in Middle Eastern countries, such as the UAE, comprising nearly 84% of the total population (United Nations [UN], 2005). In contrast, while expatriates dominate the Middle East, the majority of the European population is comprised of nationals. The highest percentage of expatriates in Europe is Luxembourg at 30%, followed by Switzerland at 20% (UN, 2005).

The critical imbalance between nationals and expatriates in the UAE has created a diverse work environment in all sectors. A comparison between nationals and expatriates in the capital city of Abu Dhabi is provided in Table 1. As of 2005, UAE nationals represented a mere 10.5% of the work force (Statistics Centre, 2011).

Table 1

Labor Force by Nationality

Indicator	1985	1995	2001	2005
Labor Force	297,406	532,881	676,547	815,311
Nationals	22,358	43,183	71,651	85,838
Expatriates	275,048	489,698	604,896	729,473

Note: Adapted from "Statistical Yearbook of Abu Dhabi 2011," by Statistics Centre - Abu Dhabi, 2011.

According to Qabbani and Shaheen (2011), the unemployment rate among UAE nationals reached 12.9% in 2011. A comparison across employment sectors revealed that UAE nationals are the least present in the transport sector, as illustrated in Figure 2. A 6.5% rate of nationals' employment indicates that the transport sector is dominated by a highly diverse group of expatriates (Al-Romaithi, 2006).

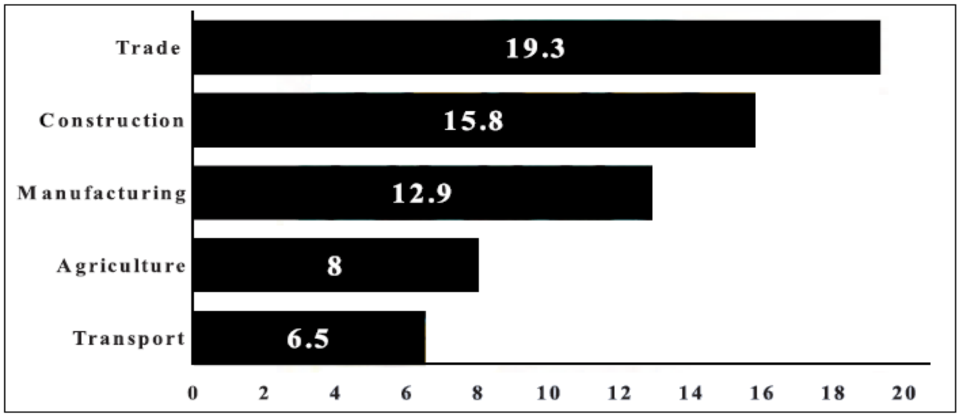

Figure 2. National employment by sector. Adapted from “Emiratization Efforts in the UAE: Impediments to a Serious Vision,” by National Bank of Dubai, 2005. Copyright 2005 by National Bank of Dubai.

Pilot Shortage in the UAE

Airlines in the UAE have transformed the country into a global nexus and an integral hub for international operations (Vespermann et al., 2008). However, due to the shortage of national pilots, carriers in the UAE have been relying on foreign pilots. According to Captain Khaled Al Ali, Director of Licensing at the GCAA, the total number of registered pilots in the UAE was 9,480 in 2012; 700 of these pilots were UAE nationals (A. Khaled, personal communication, October 21, 2012).

National pilots and aircraft ground engineers at Emirates Airlines represent approximately 12% of the airline’s total work force (International UAE, 2011). Furthermore, airline operators in the UAE are expanding rapidly and pilot training programs in the region are not providing airlines with the required number of qualified national pilots (Carbary, 2011). In order to meet its large order of 144 aircraft, Emirates Airlines planned to hire more than 700 pilots from several countries beginning in 2010 and extending for 18 months (Sambidge, 2010). By 2020, the number of pilots in the UAE is expected to increase by 75% (Glass, 2008).

The pilot shortage is not unique to the UAE. Boeing estimates 436,500 new pilots will be required by 2029 worldwide (Arnold, 2011). This situation may lead to a worldwide pilot shortage raising safety concerns among industry officials (Lowy, 2012). The high demand for pilots may jeopardize the ability to meet qualification standards. As John Allen, the Federal Aviation Administration's Director of Flight Services, stated, "if there is a shortage, airlines will hire pilots who are technically qualified but do not have the 'right stuff'" (Lowy, 2012, para. 11).

Commercial Aviation Safety

According to the International Civil Aviation Organization (ICAO) (2006), safety is defined as "the state in which the risk of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management" (p. 1-1). Aviation is a complex system that involves mechanical, human, and technological components that formulate the principal framework for operational integrity (Wells, 2001). In order to ensure optimum safety levels, safety programs must be developed to aid in identifying the hazards and risks that result in accidents and incidents. One particular area of interest is the realm of pilot error.

Pilot Error. Despite advancements in airline operations and training, 70% of worldwide aircraft accidents and incidents are attributed to pilot error (Kanki, Helmreich, & Anca, 2010). In order to mitigate the rate of pilot error, numerous training programs, such as CRM, have been developed and infused into daily airline operations (Helmreich, 2000a). However, studies such as Helmreich (2000a) have indicated that more than 50% of pilot errors were classified as intentional non-compliance.

The number of intentional non-compliance errors is alarming, making it imperative to identify and evaluate the driving factors behind these pilot behaviors and attitudes, as illustrated in Figure 3. Due to the differences in norms and beliefs among pilots, national cultural variation is of particular concern as operational standards may be influenced.

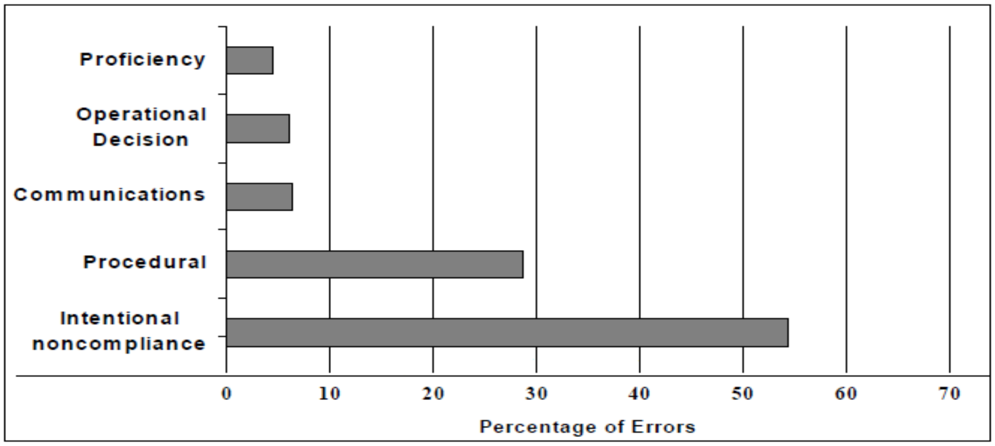

Figure 3. Distribution of error types. Adapted from "Culture and Error in Space: Implications from Analog Environments," by R. L. Helmreich, 2000a, *Aviation, Space, and Environmental Medicine*, *79*(9-11), 133-139. Copyright 2000 by the University of Texas at Austin.

The Middle East and North African Region (MENA)

The International Air Transport Association (IATA) has categorized aircraft accidents and incidents into various phases of flight. According to an IATA (2012) safety report for the MENA region, a total of 92 aircraft accidents occurred in 2011, 46 of which occurred during the landing phase. Judging by the high number of landing events compared to the other categories in Figure 4, landing can be viewed as the most critical phase of flight.

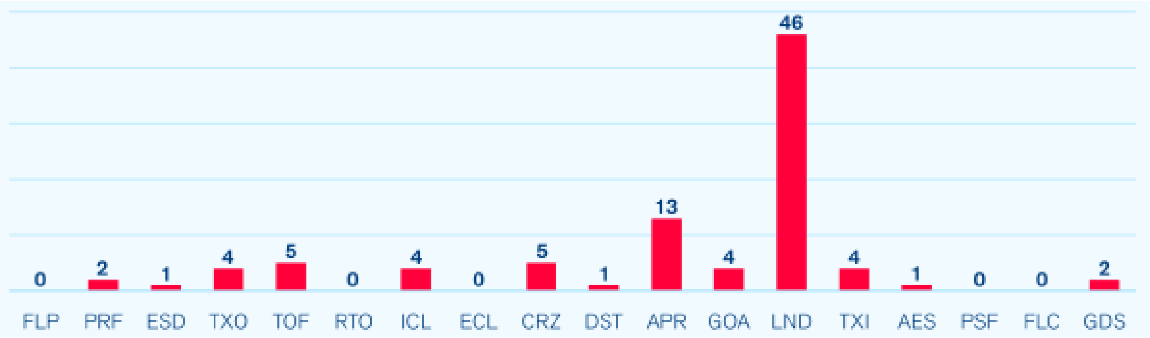

Figure 4. Accidents per phase of flight. Adapted from “Safety Report 2011,” by International Air Transport Association, 2012.

Among commercial international carriers, accidents that occurred in 2011 have been classified into different categories, such as runway excursion, hard landing, and tail strike as depicted in Figure 5. Gear-up landing / gear collapse (18%) and runway excursions (19%) contributed the highest percentage of occurrences in 2011 in the MENA region (IATA, 2012). The MENA region experienced higher rates of accidents in these two categories than other regions, as illustrated in Figures 6 and 7. Flight crew errors involved in the aforementioned accidents include lack of adherence to SOP, poor decision-making processes, and poor flying skills (IATA, 2012).

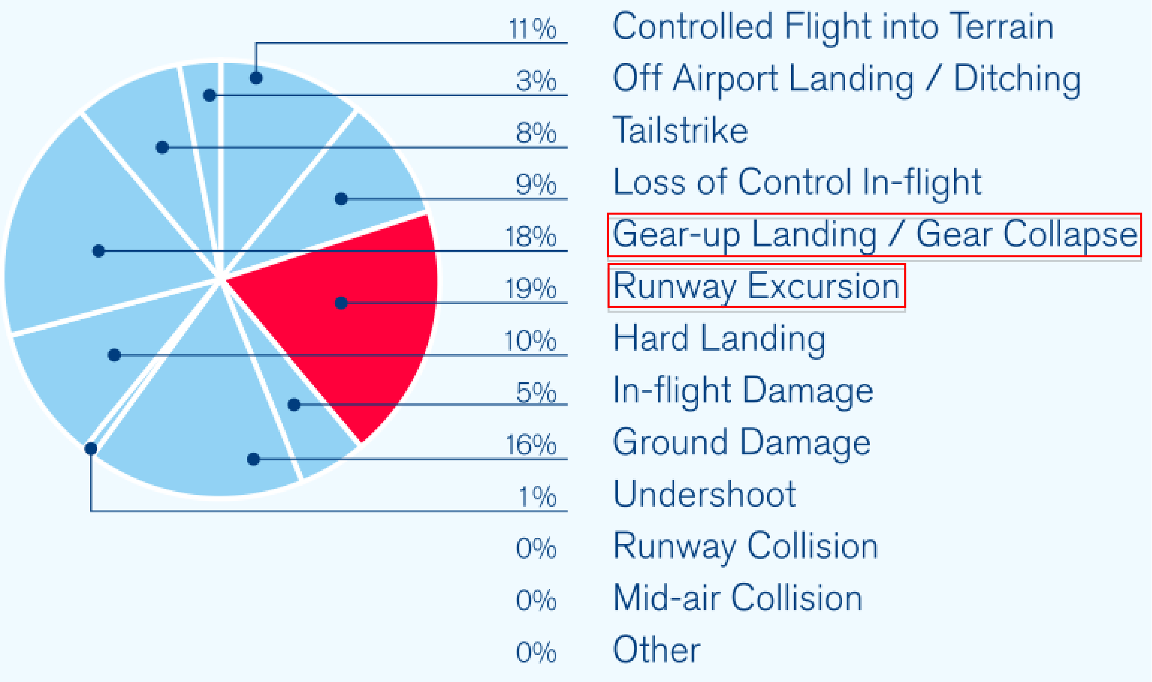

Figure 5. Categories of accidents in 2011. Adapted from “Safety Report 2011,” by International Air Transport Association, 2012.

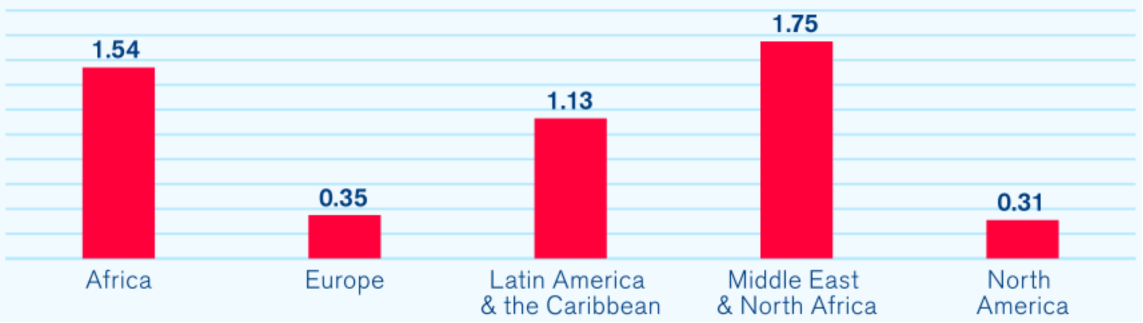

Figure 6. Rate[1] of gear-up / gear collapse by region. Adapted from “Safety Report 2011,” by International Air Transport Association, 2012.

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[1] Accidents per million sectors flown

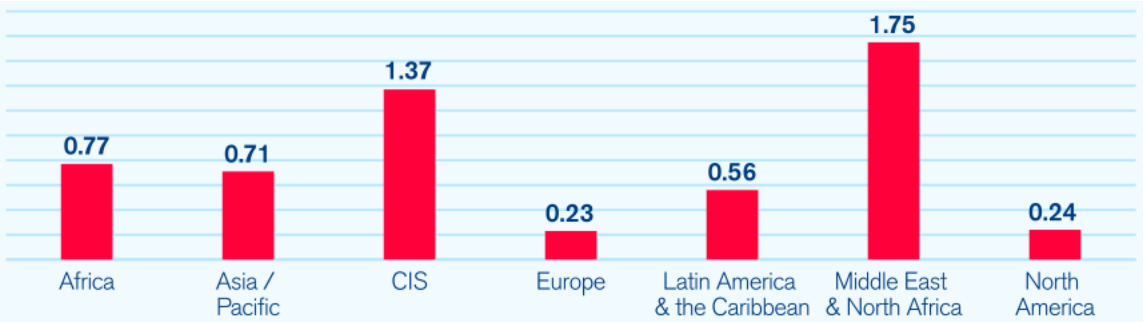
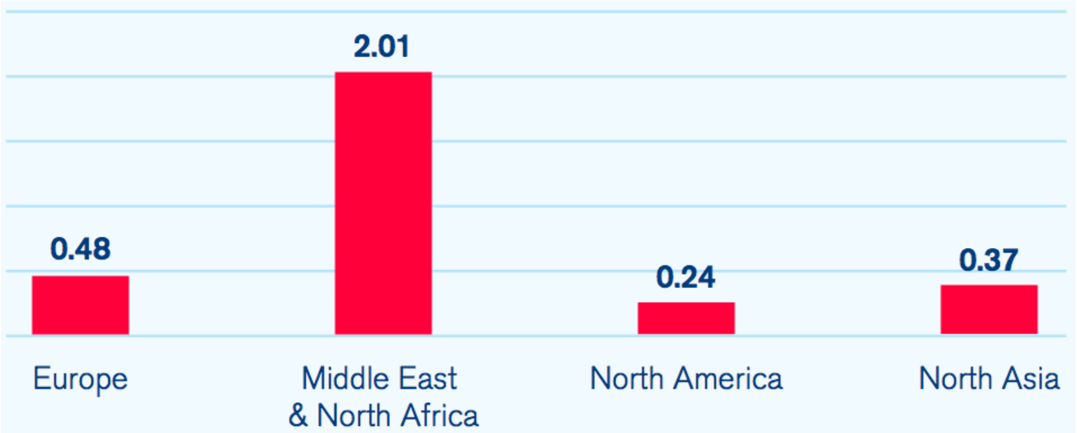


Figure 7. Rate[2] of runway excursion by region. Adapted from "Safety Report 2011," by International Air Transport Association, 2012.

In 2009, the number of accidents among commercial carriers in the MENA region decreased by 17% compared to previous years, though the MENA region experienced significantly higher rates of hard landings and tail strikes compared to other regions as depicted in Figures 8 and 9 (IATA, 2010). Contributing factors that led to these incidents included failure to execute a go-around after destabilization during the final approach phase and poor automation skills (IATA, 2010).



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[2] Accidents per million sectors flown

Figure 8. Rate[2] of hard landings by region. Adapted from "Safety Report 2009," by International Air Transport Association, 2010.

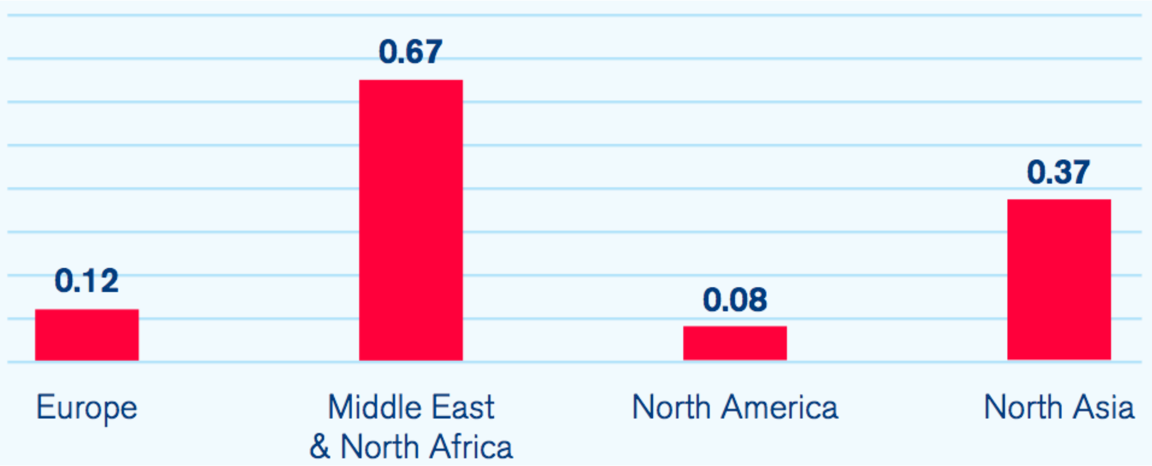

Figure 9. Rate[3]of tail strikes by region. Adapted from "Safety Report 2009," by International Air Transport Association, 2010.

The rates from Figures 8 and 9 are important as they link contributing factors with operational deficiencies present among pilots. These rates are associated with operational deficiencies due to pilots' poor automation skills and incorrect operational procedures during destabilized approaches (IATA, 2010). This linkage requires a deep understanding of operational requirements and mitigating actions that are developed through systematic and procedural approaches in standardization processes. Although the events that have occurred in the MENA region involved aircraft registered in the MENA region, pilots with different nationalities operated these aircraft. Thus, cross-cultural influences may have played a role in the aforementioned events.

Selected Airline

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[3] Accidents per million sectors flown

Due to the sensitivity of the data gathered and in order to protect the identity of the airline that provided the data, this study will refer to the selected airline as Air MENA. Since its inaugural flight, Air MENA has developed into a globally recognized airline serving 86 international destinations utilizing a highly advanced mixed fleet of Airbus and Boeing aircraft (Corporate Communications, 2012). The work force at Air Mena is comprised of 10,000 multi-national skilled employees (Corporate Communications, 2012).

Significance of the Study

Airline operations in the Middle East, and particularly in the UAE, are constantly expanding. According to ICAO (2013), airports in the UAE handled 212,074 departures for three local carriers in 2010. Since the employment rate of UAE nationals in the aviation sector is noticeably low, carriers are highly dependent on expatriate pilots. As a result, while interacting with crewmembers from various cultures, flight deck crew may not perform to their full potential during critical phases of the flight due to differences in attitudes and beliefs (Moran, Harris, & Moran, 2011). George’s (2010) study has revealed that human error contributes to more than half of the incidents and accidents experienced by airline operators. By analyzing the cultural differences present among airline pilots and the impact of these differences on operational safety, this dissertation aims to determine the need for a Cross-Cultural Awareness and Action Program (CCAAP) that would improve pilot safety performance.

Statement of the Problem

Airlines registered in the MENA region account for the highest ratio of accidents when compared to other regions. The low number of qualified national pilots in the

Middle East compels airlines registered in the MENA region to rely on cross-cultural flight crews. This reliance creates a vast cross-cultural environment on the flight deck of Middle Eastern airlines. Hiring pilots from various cultural backgrounds introduces various attitudes, behaviors, and beliefs into the organization that could inadvertently jeopardize operational safety and may result in flight deck mismanagement.

Purpose Statement

The purpose of this dissertation is to determine if cross-cultural flight deck crew composition is related to increased error levels. Data from an airline in the UAE was utilized to analyze the influence of cross-cultural pilots on operational safety.

The airline industry is highly diversified, extremely safety-sensitive, and technologically driven. Due to the complexities of air transportation, airlines have implemented fundamental training programs to attain and maintain safe operations including CRM, threat and error management (TEM), and SOP (Salas, Bowers, & Edens, 2001). Continuous improvements to these programs have been made as the industry strives to improve the safety of air travel. In order to understand the influence of cross-cultural crew environment on pilot performance, it is crucial to study these programs and explore their impact on daily operations (Salas, Bowers, & Edens, 2001).

Research Questions

One research question will be addressed in this study to identify possible relationships between cross-cultural crews and safety performance. The research question focuses on three flight events: Hard Landings, Unstable Approaches, and Pilot Deviations during various flight phases.

- To what extent can we predict an unsafe performance event based on the nationality combination of pilots?

Hypotheses

This dissertation aims to analyze six null hypotheses. Three hypotheses compare cross-cultural and homogeneous flight deck crews in terms of safety performance with regard to Hard Landings, Unstable Approaches, and Pilot Deviations during various flight phases. Three other hypotheses assess the influence of intervening demographic variables on the association between nationality combinations and unsafe performance events.

1. There was no significant effect of the covariate age on the relationship between nationality combinations of captains / first officers and unsafe performance events.
2. There was no significant effect of the covariate airport destination on the relationship between nationality combinations of captains / first officers and unsafe performance events.
3. There was no significant effect of the covariate eligibility to command the flight on the relationship between nationality combinations of captains / first officers and unsafe performance events.
4. There was no significant association between the frequency of homogeneous and heterogeneous cross-cultural nationality combinations of captains / first officers on unsafe performance events.
5. There was no significant association between the frequency of the nationality combinations of captains / first officers on unsafe performance events.

6. There was no significant association between cross-cultural (pilot nationality) group memberships on unsafe performance events.

Limitations

This dissertation analyzed a data set obtained from an airline in the UAE. The data provided are factual and objective, and the data do not explain why something happened, just that it did. These data were captured by the flight data monitoring system due to exceedances in preset operational limitations. Due to the sensitivity of the data gathered from the selected airline, the data was thoroughly de-identified and treated as proprietary. No information was revealed that would jeopardize the identity of the airline and pilots involved with the study. Data that specifically identify individuals or the airline have been omitted; these data include, but are not limited to, aircraft registration, staff numbers, and pilot names.

Delimitations and Assumptions

It was assumed that pilots operate at or above the minimum proficiency levels as mandated by the civil aviation authorities. As such, it was assumed that pilots employed by other airlines in the region attain the same minimum proficiency levels by undergoing similar training programs.

Despite the large number of airlines in the MENA region, data was retrieved from only one airline. However, the shortage of pilots was common among carriers in this region. These carriers depended on expatriate pilots for their recruitment processes. Hence, it was assumed that other airlines in the region had a similar cross-cultural environment.

Flight events involved in the gathered data are assumed to be normal flights without any instructors, examiners, or evaluators who may have influenced pilots' performances. Also, pilots with dual national heritage (Chinese-American) were included in only a single nationality category. These pilots were assumed to have behaved according to their primary national culture as defined by Helmreich (1999). For example, a Chinese-American would be considered an American.

Definitions of Terms

AQP	Advanced Qualification Program. A new training initiative that allows airlines to develop tailored training curriculums aimed at improving training and flight safety (Federal Aviation Administration [FAA], 2006a).
ASR	Air Safety Report. Safety reports used by pilots to file operational deviations under normal and abnormal flight conditions (Operations Manual Part A, 2012a, Chapter 11.6.2.).
CRM	Crew Resource Management. "The effective use of all available resources: human resources, hardware, and information" (FAA, 2004a, p. 2).
Cross-Culture	A flight deck crew composed of a captain and first officer from at least two different cultural backgrounds (Helmreich, 2000a).
Culture	"Shared values (what is important) and beliefs (how things work) that interact with an organization's structure and control systems to produce behavioral norms (the way we do things around here)" (Reason, 1998, p. 294).

Error	“An action or inaction that leads to a deviation from crew or organizational intentions or expectations” (Klinect, Wilhelm, & Helmreich, 1999, p. 3).
FOQA	Flight Operational Quality Assurance. A safety program that enables airlines to routinely collect flight data for analysis purposes. This program can help airlines reduce potential risks and minimize pilot errors (FAA, 2013).
Hazard	“Any existing or potential condition that can lead to injury, illness, or death; damage to or loss of a system, equipment, or property; or damage to the environment. A hazard is a condition that might cause an accident or incident” (FAA, 2010, Appendix 1, p. 6).
Individualism versus Collectivism	A cultural dimension that refers to two types of societies: an individualistic society where individuals are concerned with their own interests and collectivistic society where individuals are concerned with the interests of others over self interests (Hofstede, Hofstede, & Minkov, 2010).
Masculinity versus Femininity	A cultural dimension that refers to two types of societies: a masculine society where individuals are more assertive, competitive, and reward-oriented, and a feminine society where individuals are more modest, caring, and cooperative (Strauch, 2010).
National Culture	Attitudes, behaviors, and values based on heritage (Helmreich, 1999).

Risk	"The composite of predicted severity (how bad) and likelihood (how probable) of the potential effect of a hazard in its worst credible (reasonable or believable) system state" (FAA, 2010, Appendix 1, p. 8).
Organizational Culture	Attitudes, behaviors, and values that are influenced by different organizational groups (Stolzer, Halford, & Goglia, 2008).
Pilot Deviations	Actions or inactions by pilots that deviate from airline procedures and regulations (FAA, 2009).
Power Distance	A cultural dimension that measures hierarchal degrees in societies. Inequality between senior and junior crewmembers may be viewed differently in various societies; thus, attitudes and behaviors are influenced accordingly (Hofstede et al., 2010).
Professional Culture	Attitudes, behaviors, and values that are influenced by professions (Stolzer et al., 2008).
SHELL	Software-Hardware-Environment-Liveware-Liveware. Is a model that describes the operational relation between five human factors -related links: software, hardware, environment, liveware, and liveware (Stolzer et al., 2008).
Threats	"Events or errors that occur beyond the influence of the flight crew, increase operational complexity, and which must be managed to maintain margins of safety" (Bradley, 2010, p. 4).

Violation	“Deliberate - but not necessarily reprehensible - deviations from those practices deemed necessary to maintain the safe operation of a potentially hazardous system” (Reason, 2009, p. 195).
Uncertainty Avoidance	A cultural dimension that measures the degree of discomfort among individuals with regards to uncertainty and ambiguity (Strauch, 2010).

List of Acronyms

AAL	Above Aerodrome Level
AES	Arrival / Engine Shutdown
AIMS	Airline Information Management System
AQP	Advanced Qualification Program
APR	Approach
ASR	Air Safety Report
ATC	Air Traffic Control
C^3RM	Cross-Cultural Crew Resource Management
CAP	Cultural Action Program
CAT	Cultural Awareness Training
CCAAP	Cross-Cultural Awareness and Action Program
CIS	Commonwealth of Independent States
CMAQ	Cockpit Management Attitudes Questionnaire
CRM	Crew Resource Management
CRP	Culture Re-Qualification Program
CRZ	Cruise

DST	Descent
DV	Dependent Variable
ECL	En Route Climb
EFQM	European Foundation for Quality Management
ESD	Engine Start / Depart
FAA	Federal Aviation Administration
FDM	Flight Data Monitoring
FLC	Flight Close
FLP	Flight Planning
FMAQ	Flight Management Attitude Questionnaire
FMASS	Flight Management Attitudes and Safety Survey
FOQA	Flight Operational Quality Assurance
G	Gravity
GCAA	General Civil Aviation Authority
GDS	Ground Servicing
GOA	Go-Around
GSM	Global System for Mobile
IATA	International Airport Transport Association
ICAO	International Civil Aviation Organization
ICE	Integrated Culture Evaluation
ICL	Initial Climb
IDV	Individualism versus Collectivism
IPO	Input-Process-Output

IV	Independent Variable
JAR	Joint Aviation Requirements
LND	Landing
MENA	Middle East and North Africa
MAS	Masculinity versus Femininity
NBD	National Bank of Dubai
NDB	Non-Directional Beacon
NTSB	National Transportation Safety Board
PD	Power Distance
PRF	Pre-Flight
PSF	Post-Flight
RTO	Rejected Take-Off
SHELL	Software-Hardware-Environment-Liveware-Liveware
SMM	Safety Management Manual
SMS	Safety Management System
SOP	Standard Operating Procedures
SPSS	Statistical Package for the Social Sciences
TEM	Threat and Error Management
TOF	Take-Off
TXI	Taxi-In
TXO	Taxi-Out
UAE	United Arab Emirates
UAI	Uncertainty Avoidance Index

UN	United Nations
VLS	Lowest Selectable Speed
VREF	Landing Reference Speed
VOR	Very-High-Frequency Omni-Range Navigation Equipment

CHAPTER II

REVIEW OF THE RELEVANT LITERATURE

A genuine cross-cultural experience is ubiquitous in the daily operations of most organizations (Solomon & Schell, 2009). To achieve required operational standards in any organization, the organization must become culturally adept by understanding the different values, beliefs, and behaviors expressed by cross-cultural work forces (Solomon & Schell, 2009).

Human Factors in Aviation

Aviation pioneers have focused on enhancing aircraft technologies and aircraft design to increase operational safety and improve pilot efficiency (Roscoe, 1980). From World War I until the present day, the air transportation system has experienced remarkable changes that have resulted in operational improvements (Brady, 2000). The proliferation of new computerized aircraft systems has increased safety levels by reducing pilots' workload through the introduction of advanced flight instruments (Tsang & Vidulich, 2003). Moreover, safety levels have continued to improve as a result of enhanced aviation regulations in such areas as pilot training, licensing, and aircraft maintenance programs (Wells & Rodrigues, 2004).

Undoubtedly, the use of technological improvements has revolutionized air transportation by reducing accident rates and providing operational flexibility for pilots. Nevertheless, new types of accidents and incidents have emerged that have raised safety concerns with regard to pilot performance (Tsang & Vidulich, 2003). To gain a better understanding of various operational deficiencies, Tsang and Vidulich (2003) conducted several studies on pilots' interactions and behaviors. One of their studies revealed that accidents and incidents were a result of errors due to “interpersonal rather than technical deficiencies” (Tsang & Vidulich, 2003, p. 477). In order to mitigate these errors, a training program, known as CRM, has been implemented by airlines.

CRM: Improving Pilot Performance

In an effort to reduce pilot error and improve overall performance on the flight deck, a new training program was designed in 1980 to enable pilots to effectively utilize their resources (Helmreich, Merritt, & Wilhelm, 1999). As defined in Advisory Circular 120-51E, CRM is “the effective use of all available resources: human resources, hardware, and information” (FAA, 2004a, p. 2). To achieve efficiency and effectiveness from CRM training, operators incorporate comprehensive SOP in a teamwork-based curriculum (FAA, 2004a). Special emphasis is placed on skills and behaviors that enable crewmembers to be effective team members (FAA, 2004a).

Evolution of CRM

In the early 1980s, CRM training was focused on the negative behavior of subordinate crewmembers and encouraged captains to perform with a team-oriented attitude rather than with a dictatorial managerial style (Tsang & Vidulich, 2003). Certain interpersonal behaviors between pilots that promoted teamwork and cooperation were reinforced through class exercises (Merritt & Helmreich, 1997). Results from extensive studies provided impetus to the airlines’ training departments to review and evaluate their current training curricula (Merritt & Helmreich, 1997). As a result, CRM became an integral part of pilot training in the classroom and simulator (Kanki et al., 2010).

Second Generation CRM - 1986

Airline focus on CRM led to further developments in pilot training. Additional training elements, such as team building, situational awareness, and stress management strengthened the CRM program. The notion of synergy and teamwork ideologies was further reinforced by changing the name from cockpit resource management to crew resource management (Helmreich et al., 1999). However, training exercises at the time did not relate specifically to aviation activities, which may have negatively influenced the pilots' acceptance of the program (Kanki et al., 2010).

Third Generation CRM - 1993

A new CRM concept emerged that allowed further improvements in pilot performance. Aviation-related factors, such as organizational culture and human factors, were infused into the third generation of the training program (Helmreich et al., 1999). Moreover, CRM training was extended to check airmen, cabin crew, maintenance personnel, and dispatchers (Kanki et al., 2010). However, further developments in CRM were required to understand the factors behind human errors.

Fourth Generation CRM - 1994

Major changes were introduced to the fourth generation that allowed airlines to develop individualized training programs known as an Advanced Qualification Programs (AQP) (FAA, 2006a). Inclusion of AQP in an airline's training program provides a proficiency-based curriculum that targets pilot error (Tsang & Vidulich, 2003).

AQP. The FAA has developed a new training initiative that aims at improving airlines' training programs by allowing each individual airline to develop tailored curricula (FAA, 2006a). These curricula are based upon the proficiency levels of each airline’s pilots rather than mere compliance with required flight and ground training hours (FAA, 2006a). Through the implementation of an AQP, airlines are capable of improving proficiency levels through continuous evaluation of crew performance (FAA, 2006a). Seven characteristics distinguish AQP from other safety programs (Farrow, 2006):

1. Implementation of an AQP is voluntary;
2. An AQP requires utilization of innovative and evaluative methodologies;
3. An AQP may be integrated with an existing training program;
4. Qualification criteria will be based upon individual and team performance;
5. Data collection and analysis will be used to validate proficiency levels;
6. Training will be developed according to training requirements; and
7. An AQP will involve continuous development and maintenance to meet training requirements.

CRM: Transition to the Flight Deck. CRM training programs have undergone extensive changes as they have matured in various airlines’ training programs. Pilots’ behaviors and attitudes have evolved as well (Helmreich, Chidester, Foushee, Gregorich, & Wilhelm, 1990). However, the potential of CRM has not been fully realized. Certain pilots have continued to exhibit nonconformist attitudes toward the new training curricula. The pilots’ acceptance of changes and new training programs is highly important when seeking improvements in safety levels. Because of the cultural differences found in international airlines, these airlines have considered national culture training into their CRM programs to stress the importance of cultural harmony within their organization (Helmreich et al., 1999). International airlines with major cultural variations recognize the importance of cross-cultural training programs (Mjøs, 2004).

Input - Process - Outcome (IPO) Model. An input-process-outcome (IPO) model delineates the effectiveness of teamwork among crewmembers by providing a list of factors influencing crew performance at various stages (Tsang & Vidulich, 2003). These factors reflect crewmembers' characteristics as they are influenced by a set of attitudes, competencies, and skills (Salas, Wilson, Burke, & Burke, 2006). Since crewmembers' performance is group-based, their success depends on team coordination and overall standardization among members. Figure 10 provides a general model of inputs, processes, and outcomes upon which operational safety is dependent. The authors noted that factors such as pilots' professional culture, communication, and individual attitudes, are interlinked and affect overall safety levels (Kanki et al., 2010).

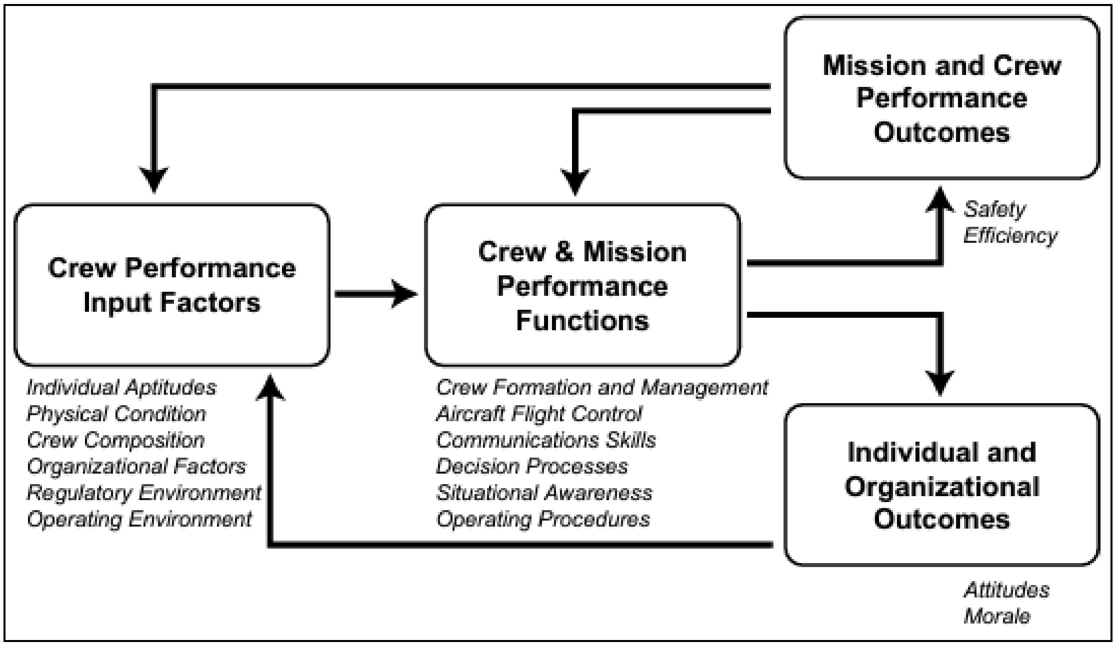


Figure 10. IPO Model. Adapted from "Crew Resource Management," by B. G. Kanki, R. L. Helmreich, & J. Anca, 2010. Copyright 2010 by Elsevier Inc.

Input Factors. The input segment is categorized into seven main components that reflect crewmembers’ attitudes and behaviors based upon group interactions. These attitudes and behaviors may impact crewmembers’ performance (Kanki et al., 2010):

1. Individual aptitudes: refers to the proficiency levels of crewmembers. Pilots and cabin crew must demonstrate certain levels of proficiency to meet airline and authority requirements.
2. Physical condition: refers to the physical and health status of crewmembers. Crewmembers must undergo rigid annual medical checks.
3. Crew composition: refers to the total number of crewmembers and their gender distribution. All flights require a minimum number of crewmembers; this number varies depending on the length of the flight. For example, flights exceeding 14 hours require four pilots (Operations Manual Part A, 2012e).
4. Organizational: refers to the policies that control operational variables, such as management-worker relations.
5. Regulatory: refers to the rules and operational limitations that formulate the regulatory influences in an organization. Regulatory examples include maximum duty hours and minimum crew compositions.
6. Cultural: refers to the quality of interaction between crewmembers that can be influenced by cross-culture as a result of variations in attitudes and behaviors.
7. Environmental: refers to the surrounding factors such as organizational, regulatory, and cultural influences to create a work environment deemed necessary for operational requirements.

Since these seven components are considered internal and external factors, they define multi-dimensional characteristics that have a pervasive effect on crewmembers' performance. Each component forms an important operational layer that conceptualizes crew proficiency levels and determines operational safety (Kanki et al., 2010).

Process Factors. During the process stage, crewmembers integrate their knowledge and skills to perform their duties according to predetermined standards. During this stage, many of the tasks performed are considered non-technical skills and include factors such as communications, decision-making process, workload management, teamwork, and situational awareness (Tsang & Vidulich, 2003). Though highly dependent on input factors, the process factors form the fundamentals required by crewmembers to achieve safe operations. Effective teamwork and cooperative skills form the foundation of process factors. Thus, the awareness of cultural differences among pilots on the flight deck is vital for effective usage of non-technical skills. There are six components involved in the process stage (Kanki et al., 2010):

1. Crew formation and management: refers to how workload is divided among crewmembers in a manageable and resourceful manner.
2. Aircraft flight control: refers to aircraft components, such as ailerons and elevators, which receive inputs from the pilots to perform certain tasks.
3. Communication skills: refers to the interaction between pilots and air traffic control, between captain and first officer, and between pilots and cabin crew.
4. Decision processes: refers to decisions and actions taken by crewmembers during normal or abnormal flight situations.

5. Situational awareness: refers to the crewmembers' ability to recognize and act upon operational requirements.
6. Operating procedures: refers to the standard procedures set forth by the airline. These procedures must ensure certain operational requirements.

Outcomes. Due to technical advancements in the commercial aviation sector, accident rates are already low, making it difficult to use accident rates as measures of effective outcomes. In order to achieve optimal outcomes, airlines must maintain, monitor, and promote safe operations through a hazard identification and risk assessment process. This process has been integrated with safety programs, such as FOQA, and is fundamental to the development of a safety management system (SMS) (Stolzer et al., 2008).

Fifth Generation CRM: Error Management - 1996

The underpinning notion of the fifth generation of CRM is that human error is inevitable and the consequences of these human errors can only be minimized (McCartney, 2005). Avoiding, trapping, or mitigating errors form the foundations of fifth generation CRM (Kanki et al., 2010). Error identification lies deep within an organization's IPO model. CRM provides an error management methodology that adopts a non-punitive approach to aid in identifying the nature and source of errors (Helmreich et al., 1999). Over time, CRM has been defined by the following characteristics; CRM:

1. Inculcates a comprehensive system of applying human factors concepts to improve crew performance;
2. Embraces all operational personnel;
3. Blends into all forms of aircrew training;

4. Concentrates on crewmembers' attitudes, behaviors, and impact on safety;
5. Uses the crew as the unit of training;
6. Requires the active participation of all crewmembers; and
7. Provides an opportunity for individuals and crews to examine their own behavior, and to make decisions on how to improve flight deck teamwork (FAA, 2004a, p. 6).

Sixth Generation: TEM - 2001

As CRM evolved through five generations, it became apparent to researchers and airline operators that identifying errors alone is not sufficient for a successful CRM program (Kanki et al., 2010). Recognizing and assessing threats became valuable components of CRM, which enhanced situational awareness and decision-making skills among crewmembers (Kanki et al., 2010).

Error versus Violation. Prior to adopting a non-punitive environment, an organization must clearly define and distinguish between error and violation. Error is defined as "an action or inaction that leads to a deviation from crew or organizational intentions or expectations" (Klinect et al., 1999, p. 3). Error can appear in three different forms: (a) initial and impromptu, (b) threat-related, and (c) as a component of the chain of errors (Klinect, 2005).

Violation is defined as "deliberate - but not necessarily reprehensible - deviations from those practices deemed necessary to maintain the safe operation of a potentially hazardous system" (Reason, 2009, p. 195). Reason (2009) classified violations as follows:

1. Routine Violations: Following a path with the least amount of effort provides convenience although it does not abide by the operator's requirements and SOPs. Designing simplified systems and procedures can eliminate these violations.
2. Exceptional Violations: In some circumstances, violations are inevitable due to present conditions. This type of violation is known as *system double-binds* and is highly dependent on surrounding conditions (Reason, 2009). For example, a crew may elect to commit a violation in order to rectify a particular situation despite the level of risks it may present.

Hazard. The FAA defines hazard as "any existing or potential condition that can lead to injury, illness, or death; damage to or loss of a system, equipment, or property; or damage to the environment. A hazard is a condition that might cause an accident or incident" (FAA, 2010, Appendix 1, p. 6). Examples of common hazards are pilot fatigue and improper use of checklists.

Various models aid in understanding and analyzing hazards. One of these models is the Software-Hardware-Environment-Liveware-Liveware (SHELL) model as depicted in Figure 11. This model provides systematic data pertaining to operations from a human factor perspective and encompasses the following elements: software, hardware, environment, liveware, and liveware (Stolzer et al., 2008). These elements are comprised of human factor interventions that identify various interactions occurring on the flight deck (Wise, Hopkin, & Garland, 2010).

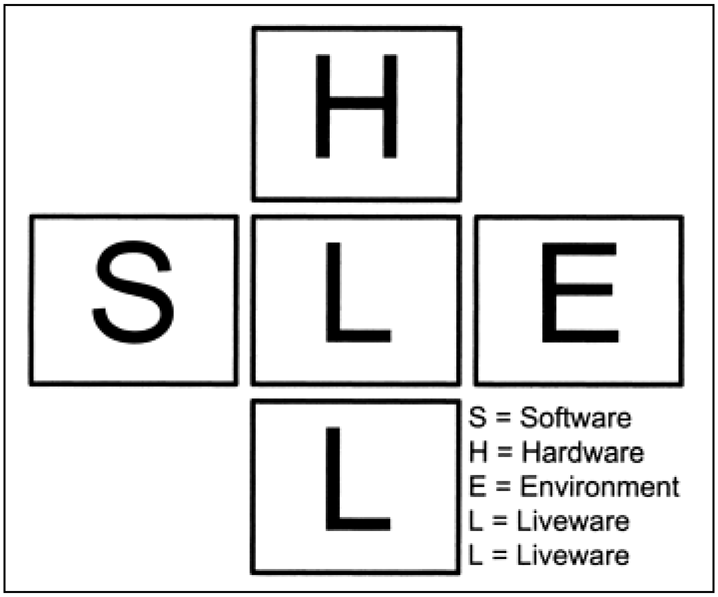


Figure 11. The SHELL model. Adapted from "Safety Management Systems in Aviation," by A. J. Stolzer, C. D. Halford, & J. J. Goglia, 2008. Copyright 2008 by Ashgate Publishing Company.

The model can be viewed as a relationship between the liveware, crewmembers, and every other element in the model. The four crucial relationships are described as follows (Stolzer et al., 2008):

1. Liveware and software: refers to the interaction between crewmembers and non-physical system components such as procedures, checklists, and manuals.
2. Liveware and hardware: refers to the relationship between crewmembers and all components of an aircraft such as the navigation instruments, yoke, and throttle controls.
3. Liveware and environment: refers to the relationship between crewmembers and the environmental factors that could affect crew performance such as oxygen requirements at higher altitudes and radiation levels.

4. Liveware and liveware: refers to the interaction between crewmembers and other individuals directly related to operational requirements such as cabin crewmembers, air traffic controllers, and ground engineers (Stolzer et al., 2008).

Risk. According to the FAA, risk is defined as "the composite of predicted severity (how bad) and likelihood (how probable) of the potential effect of a hazard in its worst credible (reasonable or believable) system state" (FAA, 2010, Appendix 1, p. 8). A pilot who continues flying the final approach despite the large cumulonimbus cell ahead faces a number of risks such as aircraft stall, poor aircraft performance, or possibly a crash.

Since human error is a leading factor for operational risk, exploring the sources of risks are vital for future safe operations. Threats and errors have been viewed as the main sources of risks in daily operations. The accumulation of threats and errors may lead to irreversible and undesirable outcomes. Figure 12 is a graphic illustration of the Swiss cheese model. Each cheese layer represents safeguards and defenses against organizational weaknesses and risks that are represented by holes in each layer (Reason, 1997). As the number of weaknesses and risks increases, the chance of an accident or incident becomes higher.

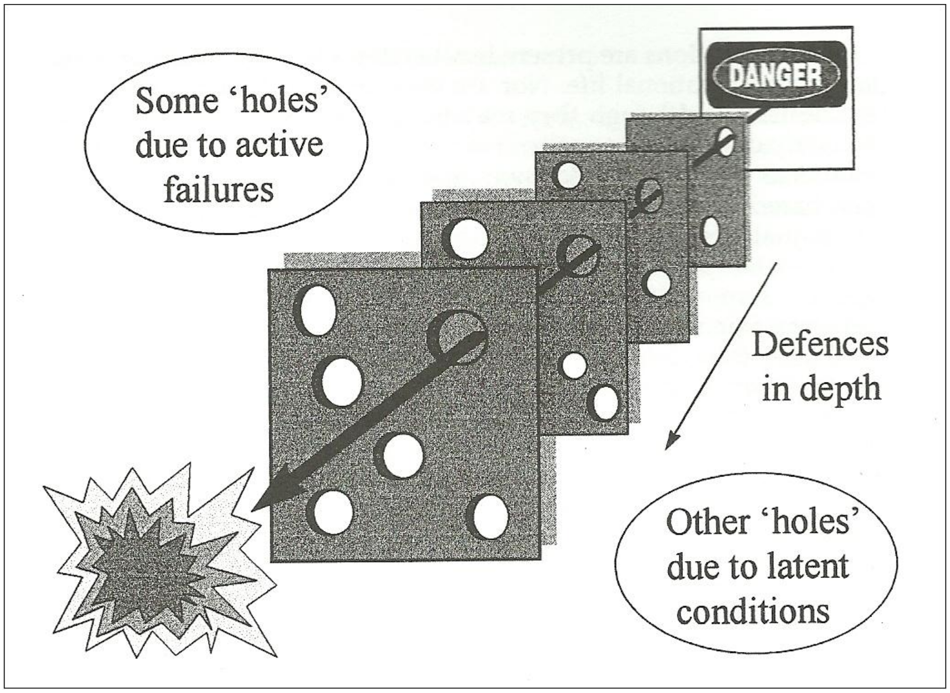


Figure 12. The Swiss cheese model. Adapted from "Managing the Risk of Organizational Accidents," by J. Reason, 1997. Copyright 1997 by Ashgate Publishing Company.

Although the Swiss cheese model has been widely used in professional training programs, its depiction of organizations and human interactions limits the model's use. The model does not address the complex relationship between latent conditions and active failures, which confines its graphical description to a linear fashion (Dekker, 2006b). The simplicity behind the model's graphical illustration fails to explain the chain of events that may have led to weakness in safety levels and eventually mishaps (Hollnagel & Woods, 2006).

Threats. Daily airline operations are faced with numerous threats that are defined as "events or errors that occur beyond the influence of the flight crew, increase operational complexity, and which must be managed to maintain margins of safety" (Bradley, 2010, p. 4). Early identification of threats can prevent breakdowns of safeguards and defenses. The two main types of threats are:

1. Internal Threats: Elements that occur on the flight deck and are directly related to pilots' behaviors and attitudes are considered internal threats. Examples of internal threats include lack of rest, fatigue/stress due to work overload, poor communication, or lack of cooperation between pilots due to cultural variations (Klinect, 2005).
2. External Threats: Elements that occur outside the flight deck environment, such as meteorological conditions, high terrain, air traffic control congestion, or engine failure are considered external threats (Klinect, 2005). External threats pose the highest level of operational risks during the most critical flight phases: takeoff and landing (Klinect et al., 1999).

Errors. An increase in the number of internal and/or external threats results in a higher risk of pilot error. James (2011) divides these errors into four categories:

1. Operational Decision Errors: This type of error is highly dependent on the decision-making, situational awareness, and workload capabilities of the pilots. For example, failure to perform a go-around during a destabilized approach is a serious error that could lead to irreversible consequences.
2. Communication Errors: Misinterpretation or omission of air traffic control calls may lead to the risk of undesirable altitude deviations and possibly a TCAS event. Also, communication errors between pilots, between pilots and cabin crew, and between pilots and ground staff may lead to incidents and accidents.
3. Procedural Errors: Performing SOP incorrectly during any phase of the flight may result in accidents or incidents.

4. Handling Errors: Undesired aircraft state caused by low proficiency levels and weak situational awareness.

TEM can be accomplished through an understanding of sequential threats and errors leading to operational deficiencies (Thomas, 2004). In order to identify these deficiencies, it is important for the leaders of organizations to understand the hazards, risks, and consequences these deficiencies pose to daily operations. Airline operations present a wide array of hazards and risks that could jeopardize operational safety.

Managing threats and errors is a critical process that involves a combination of experience and rigorous training (James, 2011). Once threats have been identified, pilots must perform proficiently to avoid errors. Avoiding error can be accomplished through strict adherence to SOP, the use of effective communication between crewmembers, adhering to an effective decision-making process, and maintaining high proficiency levels. If errors have been committed, they must be trapped before multiple errors accumulate and lead to consequential events (James, 2011). Trapping errors can be accomplished by continuous crosschecking and monitoring of aircraft systems, weather, and other related factors, such as communication. If errors have penetrated through the safeguards and system defenses, then the errors can be mitigated by changing the course of action, for example, executing a go-around or diverting to an alternative airport (James, 2011).

According to a study conducted by the University of Texas at Austin, threats and errors are more likely to occur during descent / approach / landing phases due to the high workload experienced by the pilots (Klinect et al., 1999). Table 2 provides the likelihood of threat and error occurrences per flight phase.

Table 2

Threat and Error in Various Flight Phases

Flight Phase	Threats	Errors
Pre-departure / Taxi	30%	25%
Takeoff / Climb	22%	22%
Cruise	10%	10%
Descent / Approach / Landing	36%	40%
Taxi / Park	2%	3%

Note. Adapted from "System Safety and Threat and Error Management: Line Operational Safety Audit (LOSA), "by R. L. Helmreich, J. Klinect, & J. Wilhelm. Copyright 2001a by the 12th Annual Symposium on Aviation Psychology in Columbus, Ohio.

As shown, more threats and errors occurred during the descent / approach / landing phases with a likelihood occurrence of 36% for threats and 40% for errors. Alternatively, the cruise and taxi / park phases of operations accounted for the lowest percentage of threats and errors.

Flight Operational Quality Assurance (FOQA)

According to Air MENA's operating manual, the commander is responsible for accomplishing a number of operational tasks that would ensure high levels of safety (Operations Manual Part A, 2012c). These responsibilities include adherence to SOPs, which involve limitations and parameters pertaining to the operation of an aircraft. Examples of operational limitations include: aircraft takeoff/landing weights, stabilized approach criteria, and aircraft attitude/speed.

With the aid of advanced aircraft data monitoring and recording systems, flights are continuously monitored. The continuous monitoring allows for the tracking of all aircraft systems in which an exceedance was detected during the course of the flight. These technologies have improved aviation safety by evolving the flight investigation techniques from a reactive approach to proactive and predictive approaches (Stolzer et al., 2008). These approaches form the basis of a safety program known as FOQA. According to ICAO, "FOQA is a proactive and non-punitive programme for gathering and analyzing data recorded during routine flights to improve flight crew performance, operating procedures, flight training, air traffic control procedures, air navigation services, or aircraft maintenance and design " (ICAO, 2006, p. 16-3). Although FOQA is a voluntary safety program for U.S. based airlines, once an airline decides to implement it, then the program is not voluntary for pilots (FAA, 2004b). In contrast, ICAO Annex 6 requires all airlines to implement FOQA programs (ICAO, 2006).

FOQA offers an objective approach toward flight data collection and analysis set forth by each airline known as Flight Data Monitoring (FDM) (Stolzer et al., 2008). Airlines develop policies, processes, and procedures upon which their daily operations are based. FDM systems are utilized to monitor standard levels and identify areas of operational risks (Flight Data Monitoring System, 2012). The primary function of the system is to monitor flight operations, record pilot deviations, and flag any flight deviations that exceed operational limitations and policies. This system provides each airline's safety department the capability to identify possible trends and mitigate risks experienced during flights as a result of deficiencies among pilots, communication skills with air traffic control (ATC), and/or weak SOPs (Flight Data Monitoring System, 2012).

The FDM system records and processes flagged pilot deviations, such as hard landings and unstable approaches, according to pre-selected parameters that are in accordance with the airline's SOPs (Flight Data Monitoring System, 2012). Flight events are categorized under three severity levels: minor, major, and critical. Depending on the extent of the deviation, a severity level would be assigned. For example, flying at a speed of 260 knots instead of the limit of 250 knots when the aircraft is below 5,000 feet would trigger a minor event since the exceedance level is not severe. On the other hand, flying an unstable approach due to an incorrect aircraft configuration below 1,000 feet would generate a major or critical event.

Pilot Deviations. According to the FAA (2009), pilot deviations are actions or inactions that disagree with SOPs and published regulations. Three areas of pilot deviations were analyzed: hard landings, unstable approaches, and general pilot deviations in various flight phases.

According to Air MENA, nine published stabilized approach criteria must be achieved by 1,000 feet in either instrument or visual metrological conditions; otherwise, a go-around must be conducted (Operations Manual Part A, 2012d, Chapter 8.3.20.17.2, pp. 117-118). Additional approach criteria include:

1. The airplane is on the correct path;
2. Pitch is within $+10^{o}$ and -0^{o};
3. Bank is no more than 7^{o};
4. Speed is within target speed +10 knots and Landing Reference Speed (VREF) / Lowest Selectable Speed (VLS), excluding minor deviations due to gusty conditions on final approach;
5. The airplane is in the correct and briefed landing configuration;

6. Sink rate is not more than 1,000 feet per minute, or a rate of descent appropriate to aircraft type and configuration, or as required by the approach procedure;
7. Power setting is appropriate for the airplane configuration and is not below the minimum power for approach as defined by the aircraft operating manual. Significant changes are only permitted for gust compensation;
8. All briefings and checklists have been completed; and
9. ILS approaches shall be flown within one dot of glide slope and localizer. During non-precision approaches the course deviation must stay within ½ dot or 2.5 degrees for very-high-frequency omni-range navigation equipment (VOR) approaches and 5 degrees for a non-directional beacon (NDB) approaches.

In terms of hard landings, the FDM system defines this event as excessive vertical loads exerted on the main landing gear (Flight Data Monitoring System, 2012). The unit used for this event is Gravity (G) and each aircraft type has different lateral load limits that are pre-defined in the FDM system. Hard landings may result in high loads on the main landing gear that could damage aircraft structures (Aigoin, 2012). Other negative outcomes associated with hard landings include pilot-induced oscillations, loss-of-control, and lateral excursions. By reviewing FDM systems, certain aircraft parameters associated with hard landings, such as aircraft weight, vertical speed, and vertical acceleration, could be identified (Aigoin, 2012). Besides unstable approaches and hard landings, additional pilot deviations will be reviewed, such as speed exceedances, excessive bank angles, and overweight landing.

Air Safety Reports (ASR)

Air MENA maintains a positive safety reporting culture where crewmembers report their errors and experiences through safety report forms. These forms are reviewed and analyzed by safety investigators at the safety department. Depending on the severity of events, recommendations are made to the Training and Flight Operations departments to provide additional training and implement required operational changes. A number of events require crewmembers to file a report, such as (Operations Manual Part A, 2012a, Chapter 11.6.2, pp. 16-18):

1. An emergency is declared;
2. A runway or taxiway incursion/excursion;
3. Go-around below 1,000 feet above ground level;
4. A bird strike or wildlife strike; or
5. Aircraft evacuation.

Unfortunately, the reporting system at Air MENA identifies the name and staff numbers of the involved crewmembers. Since the reports are identified among the departments, pilots may view this as a punitive system and feel that filing an ASR may jeopardize their jobs. A sample of an ASR is attached in Appendix B.

Non-Technical Skills

Since the 1980s, CRM has been studied from a developmental point of view, taking into consideration human error, hazards, risks, and TEM (Kanki et al., 2010). When analyzing pilots' behaviors and attitudes, it is necessary to explore their non-technical CRM skills. Non-technical skills are defined as "the cognitive and social skills of flight crewmembers on the flight deck, not directly related to aircraft control, system management, and standard operating procedures" (Flin et al., 2003, p. 96).

Non-technical skills include: communication, situational awareness, decision-making, leadership, and teamwork (Kanki et al., 2010). Incorporation of non-technical skills into CRM training is viewed as a positive move toward the understanding of attitudinal and behavioral implications by crewmembers (Powell & Hill, 2006). Incorporating CRM training as an error countermeasure alone will not result in behavioral changes on the flight deck (Helmreich & Wilhelm, 1998). Despite the remarkable evolution that CRM has undergone, it still lacks a crucial cultural dimension that provides a clear two-way communication between superiors and subordinates (Edkins & Pfister, 2003). When viewed from a cultural perspective, a first officer may be hesitant to point out an error to his/her captain out of respect. A study by Kanki et al., (2010) concluded that culture, and particularly national culture, impacts CRM training and impedes its transfer to the flight deck. Inclusion of non-technical skills in CRM training is a preliminary approach to understanding safety culture and its influence on pilots' performance (Edkins & Pfister, 2003). Presumably, pilots will become more aware of cultural influences by combining non-technical skills training with CRM training.

Culture

High risk organizations, such as airlines, nuclear power plants, hospitals, and maritime, are highly dependent on the reliability of human performances and the effectiveness of their interactions (Haber & Shurberg, 2002). High risk organizations involved in these industries have implemented multiple defense systems comprised of a combination of human input and computerized systems to reduce the chances of injuries and loss of human life (Powell & Hill, 2006). Nevertheless, between 80% and 90% of accidents and incidents are attributed to unsafe behaviors among employees (Cox, Jones, & Rycraft, 2004).

Unsafe behaviors are a result of weaknesses in several primary non-technical skills that include: communication, decision-making, leadership, and workload management (Mjøs, 2004). Studies have demonstrated that these non-technical skills are highly influenced by cultural variations among employees (Mjøs, 2004). Culture is defined as "the collective programming of the mind that distinguishes the members of one group or category of people from another" (Hofstede, 2001, p. 9).

A homogeneous culture is a culture "in which the shared meanings are similar and little variation in beliefs exists; that is, the culture has one dominant way of thinking and acting" (Hahn, 2010, para. 10). Because homogeneous cultures share similar beliefs and values, the degree of consensus among their societies is stronger than a cross-cultural society (Hahn, 2010).

Hahn defines cross-culture (heterogeneous) as a culture "in which numerous population groups have specific and distinct values and understandings" (2010, para. 10), and has numerous values and beliefs that shape the ideologies of a diverse society (Hahn, 2010). As such, cross-cultures tend to be less congruent than homogeneous cultures because they involve diversified attitudes and beliefs.

According to Barinaga (2007), homogeneous and cross-cultural work forces approach and perform organizational tasks differently. It has been shown that complex interactions among group members, such as pilots and ATC, are less effective in cross-cultural groups than in homogeneous groups (Barinaga, 2007). Variations in performances may be due to the differences in communication and behavioral skills that form the basis of non-technical skills (Barinaga, 2007).

Individuals and groups in organizations are influenced by the different values, beliefs, and norms that are entrenched in their behaviors and attitudes (Stolzer et al., 2008). Fostering a cross-cultural environment without an effective organizational safety culture that trains personnel to bridge cultural differences may lead to weaknesses and breakdowns of the organization's safeguards and defense systems (Haber & Shurberg, 2002).

Organizations often learn from one another when addressing safety measures (Drogoul, Kinnersly, Roelen, & Kirwan, 2007). However, it is crucial for organizations to have a clear understanding of their own safety requirements as these requirements vary depending on the type of operations involved (Drogoul et al., 2007). Airlines operate globally and their operations involve cross-cultural interactions among employees. Thus, behavior-based interventions provide effective strategies when designing regulations and standard operating procedures (Cox et al., 2004). These interventions explain human factor deficiencies that influence operational safety, one of which is culture (Cox et al., 2004).

Cross-Culture and Effectiveness of CRM. Airlines have adopted CRM training as a booster for non-technical skills among airline pilots (Salas et al., 2001). However, the notion that CRM is not influenced by culture is false (Wise et al., 2010). CRM was designed and implemented by North Americans as a solution for human factor intricacies among North American pilots, and thus, CRM is not culturally calibrated to accommodate pilots from other regions in the world (Wise et al., 2010). Traditional CRM programs had Western cultural “imprints” and thus clashed with values held by other national cultures (Helmreich & Merritt, 2000). For example, the concept that co-pilots should be assertive and question decisions made by captains has not transferred positively in many countries due to cultural attributes that restrict these behaviors between subordinates and superiors (Helmreich & Merritt, 2000).

Helmreich (2000b) stated that global airlines should adopt CRM training as an approach to manage and mitigate threat and error on the flight deck. Indeed, CRM programs are designed to train pilots for non-technical skills that would aid them in decision-making processes (Harris & Muir, 2005). However, there have been numerous controversies concerning CRM’s acceptance among airline pilots and its positive transfer from the classroom to the flight deck (Helmreich & Merritt, 2000). Salas, Wilson, Burke, and Burke (2006) conducted reviews on several studies that evaluated the effectiveness of CRM training. These studies focused on two underpinning questions that provided learning and behavioral evidence from CRM training (Salas, Wilson, Burke, & Burke, 2006, pp. 401-402):

1. Do trainees learn from CRM training?
2. Do trainees apply the learned CRM behaviors?

Inconsistencies in the results indicate that CRM is influenced by culture (Helmreich & Merritt, 2000). Performing tasks safely in a cross-cultural flight deck depends on effective utilization of automation systems and efficient communication skills, particularly during flight phases that involve high workload, such as approach and landing (Mjøs, 2004). Consequently, a culturally influenced flight deck environment has led to further implications in important operational facets including communication skills and crewmembers' effective interaction with the aircraft's automation systems (Yang, 2005; Sherman, Helmreich, & Merritt, 1997). A high number of the studies reviewed indicated positive and negative effects of CRM training (Salas, Wilson, Burke, & Burke, 2006).

Cross-Culture and Adaptation to Aircraft Automation. The end of the 1960s marked a new era for the airline industry, particularly with regard to aircraft technology (Wise et al., 2010). Supported by a strong economy and market expansions, air travel growth was at an all-time high (Wise et al., 2010). Recognizing the poor safety records, and human imperfections and errors, manufacturers developed advanced automated aircraft systems to meet industry standards (Edkins & Pfister, 2003). Safety levels improved considerably and transformed airlines into an advanced computerized type of operation (Wise et al., 2010). The decrease in accident rates was not only due to the introduction of automation, but also due to enhanced power plant reliability, better meteorological forecasting, higher fidelity simulators, tightened training standards, and other initiatives that all contributed to increased safety levels (Wise et al., 2010).

While safety records have improved since the introduction of automation on the flight deck, accidents attributed to human error have reached a plateau at approximately 70% since the 1970s (Hansman, 2001). The nature of error, however, has transferred from poor piloting skills to improper use of automation (Dekker, 2006b). Studies have shown that 50% of aircraft accidents and incidents are a result of flight deck design (Kinnersley & Roelen, 2007). Pilots did not adapt well to automated aircraft and, therefore, these advanced support systems have become traps (Kinnersley & Roelen, 2007). Hansman (2001) identified two causes behind pilots' difficulties in adaptation:

1. Flying habits are difficult to change. Transitioning from non-glass to glass flight decks can be demanding, particularly for experienced pilots with thousands of hours on conventional airplanes; and
2. All automated aircraft systems are displayed in English, where English is a second language for many pilots.

Further studies have revealed a third weak link between pilots and automation. Pilots tend to use 20% of the features in aircraft automation not only because of habitual restrictions and language barriers alone, but because of cross-cultural attributes and beliefs as well (Helmreich, 2008). Pilots' reliance on automation systems varies by pilot nationality (Sherman, Helmreich, & Merritt, 1997).

A study by the European Coordination Centre for Research and Documentation in Social Sciences revealed that different cultures interacted with aircraft automation in various ways (Sherman et al., 1997). Pilots from individualistic and egalitarian nations, such as the United States and Ireland, can manage the automation system without difficulties, but would rather manually fly the airplane (Strauch, 2010). Alternatively, pilots from hierarchical nations, such as China and Taiwan, manage the automation system with difficulties, but would rather rely on them, because they trust the system more than themselves (Sherman et al., 1997). Pilots from hierarchical nations also tend to strictly adhere to set procedures and rules; therefore, they depend on automation systems (Strauch, 2010). Unexpected deviations may confuse pilots from hierarchical nations and lead to poor decision-making (Sherman et al., 1997). A recent example of this complication is the crash of Asiana Flight 214 in San Francisco in July 2013, where the auto-throttle did not operate as expected and may have led to confusion on various auto-flight modes (Croft, 2013).

Misuse and disuse of automation systems are two primary causes that may degrade operational safety (Lee & See, 2004). Misuse refers to inappropriate reliance on, and usage of, the automation system while disuse refers to insufficient usage and distrust of the automation system (Lee & See, 2004). Misuse and disuse are both side effects of automation for cross-cultural crewmembers (Strauch, 2010)

Societies are often categorized according to certain traits and beliefs that differentiate them from one another (Hofstede, 2001). Hierarchical societies accept inequality and behave with a collectivist mindset (Moran et al., 2011). Individuals from these societies are often reticent and reserved, yet success-oriented (Moran et al., 2011). On the other hand, egalitarian societies are dominated by individualistic ideologies (Moran et al., 2011). Egalitarians are often short-term-oriented and can work in groups (Hofstede, 2001). The aforementioned differences between societies have a direct impact on pilots’ willingness to interact with automation systems (Sherman et al., 1997). Figure 13 lists some of the egalitarian and hierarchical societies.

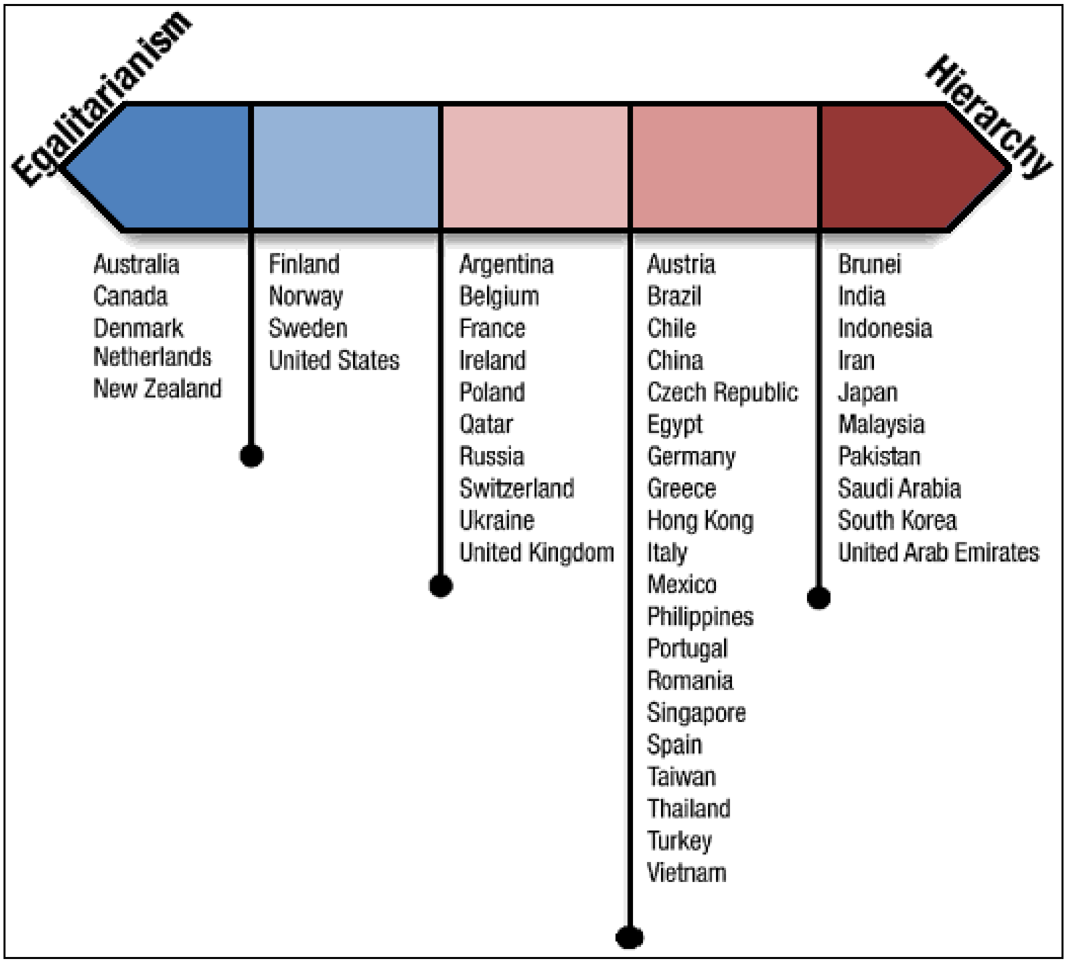


Figure 13. Egalitarian versus hierarchal societies. Adapted from “Managing Across Cultures,” by C. M. Solomon & M. S. Schell, 2009. Copyright 2009 by McGraw-Hill books.

Cross-Culture and Variations in Communication Styles. Communication is defined as a multi-dimensional process of exchanging information between individuals via verbal and non-verbal methods (Barak, 2011). Cross-cultural communication can present challenges and barriers due to differences in beliefs, values, and languages (Solomon & Schell, 2009). Language diversity plays a prominent role in creating operational challenges in a cross-cultural environment (Thomas, 2008). Ineffective communication due to language barriers may lead to poor situational awareness and lower confidence levels among crewmembers (Lichacz, 2008). Although English is the primary language in international businesses and organizations, it is often used as a second language, which creates a number of disadvantages (Thomas, 2008):

1. Mental exhaustion;
2. Fluency in a second language may create an impression of competency in other aspects;
3. First-language speakers tend to slow down their rate of speech and simplify their sentences in response to second-language speakers; and
4. Second-language speakers may pretend to understand first-language speakers to avoid embarrassment.

Cross-cultural communication is constrained by the cultural inputs provided by the speaker (Hofstede et al., 2010). These inputs are implemented unintentionally and are a byproduct of cultural influences (Solomon & Schell, 2009). In order to gain effective communication in a cross-culture environment, it is important to understand the different communication styles:

1. Direct versus indirect: the idea of speaking one's mind in a clear and concise manner is considered a direct style (Solomon & Schell, 2009). In contrast, the context of the message in an indirect communication relies on the tone of the voice and non-verbal communication (Solomon & Schell, 2009). Non-verbal communication may create additional barriers to cross-cultural communication due to uncommon body language, movements, gestures, and postures (Barak, 2011). Nevertheless, nonverbal communication provides a

higher level of trust (Barak, 2011). For example, a pat on the back is an indication of satisfaction and a job well done.

2. High context versus low context: individuals with a high context style tend to demand a comprehensive explanation with explicit details concerning the information being exchanged, whereas low context individuals expect only the information needed to complete a certain task (Yang, 2005). Any additional information may lead to confusion and time wasted (Yang, 2005). For example, pilots may provide long briefings that include irrelevant information, which may lead to confusion. On the other hand, a concise briefing that includes only information relevant to a certain procedure may be more efficient and lead to a better understanding.

Not surprisingly, members of a cross-cultural organization tend to adapt to variations in communication styles (Barak, 2011). More often than not, a positive work environment is maintained as a result of cross-cultural harmony (Barak, 2011). But to what extent would these members alter their communication styles? Communication differences may be perceived incorrectly and provoke an undesired work atmosphere (Barak, 2011).

A study conducted by Pekerti and Thomas (2003) examined communication behaviors between 48 Anglo-European New Zealanders and 48 Asians, primarily from China. Each New Zealander was paired with an Asian participant to rank crimes according to severity levels in 15 minutes. To complete the task, participants used communication styles adapted from their own culture to interact with other nationalities (Pekerti & Thomas, 2003). It was concluded that individuals in a cross-cultural interaction tend to exaggerate their cultural behaviors in an effort to clarify their intentions (Pekerti & Thomas, 2003).

Another study was conducted in 2003 to compare communication skills between three groups: American crewmembers, Chinese crewmembers, and cross-cultural crewmembers (Salas, Wilson, Burke, Wightman, & Howse, 2006). The evaluation of the three groups suggested that homogeneous members communicated better and made fewer errors than heterogeneous members (Salas, Wilson, Burke, Wightman, & Howse, 2006). Furthermore, Mjøs (2004) stated that cross-cultural interactions may negatively influence work performance, particularly when tasks are accomplished by means of effective communication, such as workload coordination and management.

Due to the existence of a cross-cultural work force on the flight deck with a multitude of linguistic abilities, ICAO has set the English language as the international language in aviation (Tiewtrakul & Fletcher, 2010). This standardization, known as Aviation English, involves specific phraseologies to simplify the communication process and eliminate potential errors between pilots, and between pilots and air traffic controllers (Alderson, 2009). According to the regulations outlined by the GCAA, “pilots who are required to use the radio telephone aboard an aircraft shall demonstrate the ability to speak and understand the English language” (GCAA, 2013b, p. 1-B-2).

As more international airlines are sharing the skies, Aviation English skills are becoming an integral part of a pilot’s life (Sharkey, 2012). Communication problems still degrade safety levels, despite English being the required language of operation (Tiewtrakul & Fletcher, 2010). Since cross-culture has a strong influence on communication skills, airlines with a diverse international pilot population must dedicate special attention toward standardizing their pilots by providing Aviation English training courses.

Safety Culture

Amid the rapid growth of economic globalization, industries have become dependent on cross-cultural work forces, and it is unrealistic for an organization to maintain homogeneous cultures within its work environment (Thomas, 2008). A dependency on a diverse work force has evolved the nature of the work force and created a complex environment in which an organization must perform (Wiegmann, Zhang, von Thaden, Sharma, & Gibbons, 2004). Toward this end, culture has been viewed as the primary influence of an individual's attitude and behavior that directly influences his/her performance (Griswold, 2013).

Organizations must understand cross-cultural concepts and recognize their influences on safety (Kelly & Patankar, 2004). "Lacking knowledge of what other cultures do, it is difficult to notice what one's own culture does not do" (Hutchins, Holder, & Pérez, 2002, p. 12). Understanding the differences between individuals' attitudes and behaviors when developing an organizational structure provides the foundation for a positive operational management (Hofstede et al., 2010).

Evaluating the types of pilot errors committed in a cross-cultural environment and examining potential training programs that may improve the performance of cross-cultural crewmembers are considered proactive interventions that form the basis of healthy safety cultures (Helmreich, 2008). The Health and Safety Commission in the United Kingdom defined safety culture as (Health and Safety Executive, 2009):

> The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management. Organizations 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 measures. (pp. 39-40)

Achieving a positive safety culture is a complex task. Commitment to high safety standards and effective operations must be initiated from the highest point of an organization's structure. Therefore, establishing and maintaining a positive safety culture begins with the organization's management (Kelly & Patankar, 2004). A positive safety culture requires the involvement and empowerment of employees as integral participants of the organization (Snyder, 2007).

The absence of a healthy safety culture may lead to subcultures within an organization (Gadd & Collins, 2002). The development of subcultures is a result of existing variations in risk levels and working conditions in an organization (Gadd & Collins, 2002). This development is not considered detrimental to operational safety; however, subcultures must be identified and engineered to satisfy organizational safety requirements (Antonsen, 2009). Kelly and Patankar (2004) stated that a positive safety culture enables organizations to establish:

1. Better communication among their employees;
2. Higher levels of assertiveness; and
3. Higher levels of employee-management trust. (p. 72)

"The assessment of safety culture may provide leading indicators of the level of safety that exists in an organization and may be used to benchmark organizational safety performance" (Mariscal, Herrero, & Otero, 2012, p. 1237). Three underpinning cultural groupings have been viewed as influential to airline operations: national, professional, and organizational (Helmreich, Wilhelm, Klinect, & Merritt, 2001). The following section describes these three cultural groupings and discusses how each cultural grouping can impact operational safety.

National Culture. Behaviors, attitudes, and values based on national heritage define national culture (Helmreich, 1999). National culture, like any other type of culture, forms a range of diversity within an organization. The diversity within an organization is influenced by complex socio-cultural factors; therefore, diverse organizations are hindered by stereotypical and inflexible attitudes (Moran et al., 2011). These attitudes weaken the organization's defense systems by affecting major operational components such as interaction and communication among team members (Moran et al., 2011).

Despite culture variations, pilots from across the globe are expected to aviate, communicate, and perform as an effective crewmember in any region of the world (Mumaw & Holder, 2002). However, airplanes are not manufactured to accommodate culture variations. Mumaw and Holder (2002) stated that individuals from various geographical regions interact and perform differently. Crewmembers with diverse national cultures communicate with various styles and behave according to certain attributes that have implications on operational safety (Helmreich, 2000b). Furthermore, situational awareness of cross-cultural crewmembers may be compromised due to ineffective communication as a result of language differences and behavior variations (Lichacz, 2008).

Given the objectives of this study, culture can be viewed as the actions performed or omitted by commercial pilots as a result of norms, values, and beliefs adopted from their cultural backgrounds. Examining the effects of national culture on flight deck behavior can be a challenging task. However, a four-dimensional culture model developed by Hofstede in the 1960s and 1970s forms a reliable methodology to assess cultural influences (Helmreich, 2000b). A dimension is defined by Hofstede et al., (2010) as “an aspect of a culture that can be measured relative to other cultures” (p. 31). The following four dimensions form the basis of their cultural model:

1. Power Distance (PD): Inequality between subordinates and superiors is viewed differently by various cultures. Consequently, societies accept and handle power distribution accordingly (Hofstede et al., 2010). In societies with high levels of PD, a subordinate does not question the decisions made by his/her superior and accepts the superior’s course of action (Helmreich, 2000b). This type of behavior on the flight deck is reflected by polarized relations between the subordinate and superior (Hofstede, 2001). This relationship leads to lack of assertiveness by subordinates. Brazil, Philippines, and Taiwan are examples of countries that have high PD scores.

   Organizations with high PD have centralized decision structures and authoritative management that creates inequality among the employees (Hofstede, 2001). Organizations with low PD refer to flat organizational structures with direct and open communication between managers and employees (Hofstede, 2001). Denmark, Norway, and the United States are examples of countries that have low PD scores.

The impact of PD on flight deck behavior was noted as one of the factors that led to the crash of a Japanese cargo aircraft in 1977 (Strauch, 2010). The crew composition of this flight consisted of one American captain, one Japanese first officer, and one Japanese flight engineer. Investigations revealed that the captain was intoxicated and blood tests showed a blood alcohol level of 0.29% (Strauch, 2010). The bus driver who transported the crewmembers to the airport noticed the captain's behavior and alerted his dispatcher. Also, the first officer and flight engineer noticed the captain's behavior and were aware of his intoxication. However, neither of the Japanese crew attempted to confront the captain (Strauch, 2010). Since Japan scores high on PD, the crew may have avoided confronting their superior because that would have caused humiliation and hierarchal degradation (Strauch, 2010).

2. Individualism versus Collectivism (IDV): This dimension refers to the degree to which certain goals are pursued to achieve personal interests compared to a group to which that individual belongs (Hofstede, 2001). Societies can be divided into two categories: individualistic and collectivistic (Strauch, 2010). In an individualistic society, individuals are inclined towards their own interests and taking care of themselves and immediate family/organization members (Hofstede et al., 2010). On the other hand, in a collectivistic society, the interest of group members is considered a priority over individual interests (Hofstede et al., 2010). Communication skills among members of a

collectivistic society are more easily achieved since they attain a sense of team orientation (Helmreich, 2000b).

An example of IDV was noted in the crash of Avianca flight 52 in 1990, from Medellin to John F. Kennedy airport in New York. The crew did not declare a mayday regarding their critical fuel situation, as they did not feel comfortable being positioned ahead of the other traffic (Salas, Wilson, Burke, Wightman, & Howse, 2006).

3. Masculinity versus Femininity (MAS): Members of a masculine society tend to be more assertive, ambitious, competitive, and reward-oriented (Strauch, 2010). In contrast, members of a feminine society are expected to behave with modesty and interpersonal concern (Hofstede et al., 2010). In a feminine society, men and women are expected to behave similarly with modest and tender attitudes (Hofstede et al., 2010). “Masculinity stands for a society in which social gender roles are clearly distinct: Men are supposed to be assertive, tough, and focused on material success; women are supposed to be more modest, tender, and concerned with the quality of life” (Hofstede, 2001, p. 297).
4. Uncertainty Avoidance Index (UAI): Societies tolerate future ambiguities and uncertainties differently (Strauch, 2010). An individual not having control of the future may develop a sense of distress and fear (Hofstede et al., 2010). Crewmembers with a high level of uncertainty will not deviate from procedures since they provide a sense of familiarity and comfort (Strauch, 2010). On the other hand, crewmembers from societies with low UAI are

more likely to be relaxed and deviate from procedures with no sense of alarm or discomfort (Hofstede et al., 2010).

This dimension is reflected in the investigation of a Colombian aircraft that crashed on approach to New York. Avianca Flight 52 flew from Medellin to John F. Kennedy airport and was piloted by two Colombian pilots who failed to inform air traffic control of their fuel emergency (Strauch, 2010). Despite their low fuel status, they failed to consider alternative airports, which may have been influenced by their high uncertainty levels and unfamiliarity of the area (Strauch, 2010). Appendix C - Table C1 lists the dimensional scores for different nationalities involved in this study.

Professional Culture. Every profession develops certain attitudes and behaviors that are expressed by members of the profession (Helmreich & Merritt, 2000). Pilot uniforms and airline badges are physical characteristics from which pilots develop a strong sense of professional culture (Helmreich, 2008). These characteristics may create negative cultural aspects reflected by a sense of invulnerability, or, positive culture aspects reflected by good work ethics (Helmreich & Merritt, 2003).

Negative professional culture poses a threat to operational safety as pilots fail to recognize their limitations while rejecting CRM concepts and ideologies (Helmreich & Wilhelm, 1998). An example of negative professional culture is a pilot who refuses assistance from a team member and prefers to work alone to maintain his/her high level of self-esteem and pride. Professional culture can lead to further safety implications due to disregarding health conditions, fatigue, and reluctance to admit error (Helmreich &

Merritt, 2003). Alternatively, a positive professional culture is reflected by a sense of pride and an overwhelming interest for the job.

Most pilots tend to have a high degree of pride for their profession and an affinity for their organizational position (Helmreich & Merritt, 2000). Pilots with a positive professional culture will demonstrate desirable leadership skills, establish clear communication, adhere to procedures, and obey regulations (Helmreich & Merritt, 2003).

Organizational Culture. Organizational culture is an ensemble of complex cultural elements, infusing myriad beliefs, norms, and attitudes shared and expressed by members of an organization (Wise et al., 2010). Organizational culture can be viewed as a socially constructed system in which members of its organization are distinguished from members of other organizations (Hofstede et al., 2010). Despite the presence of cultural differences, organizations tend to integrate their cultural diversity with common practices that shape the organizational culture by defining their own values and beliefs (Wise et al., 2010). Sexton and Klinect (2001) defined organizational culture as “the shared way members have learned to think, perceive, and behave in relation to organizational issues, tasks, and problems” (p. 7).

Organizations are structured in ways that directly impact the types of cultures existing within their boundaries (Daft, 2007). In order to achieve the desired operational requirements, organizations must encourage adaptability and responsiveness toward certain aspects, such as regulatory obligations, that necessitate the implementation of safety programs (Daft, 2007). These obligations can be achieved in various ways that dictate the type of organizational culture created (Haber & Shurberg, 2002). Management’s involvement and commitment to operational obligations are an integral factor in determining the organizational culture developed and the overall safety climate (Choudhry, Fang, & Mohamed, 2007).

Moreover, organizational culture impacts the safety performance of an organization by shaping its members' perceptions about the importance of safety (Hayward, 1997). Besides management's commitment to safety, an organization's communication style has a strong impact on members' attitudes toward safety (Helmreich, 1999). Hayward (1997) identified three types of organizational communication styles:

1. Pathological: Information is treated with political sensitivity and resembles power. As a result, communication becomes ineffective and creates undesirable outcomes (Hayward, 1997).
2. Bureaucratic: Minimal line of communication is provided between management and employees with a rigid relationship among team members (Daft, 2007). Bureaucratic organizations experience challenges when dealing with emergencies and change (Hayward, 1997).
3. Informative: An open line of communication between management and employees is established with a sense of equality (Daft, 2007). Members of an informative organization are empowered by partaking in decision-making processes (Hayward, 1997).

Cross-Cultural Management

Globalization has revolutionized international markets and transformed the methods of conducting business into unlimited boundaries of worldwide connectivity and cultural diversity in organizations (Dong & Liu, 2010). While the inclusion of cross-cultures in international organizations has been viewed as a positive change, it has led to undesirable states within organizations (Dong & Liu, 2010). The attitudes and behaviors of cross-cultural work forces may be influenced by globalization, particularly at high-risk industries, such as health care, maritime, nuclear power plants, and oil and gas (Youngdahl, Ramaswamy, & Dash, 2010).

Consequently, new organizational strategies have been created in order to develop and maintain high levels of safety standards among cross-cultural work forces (Dong & Liu, 2010). According to Dong and Liu (2010), a cross-cultural team within an organization may lead to internal conflicts between team members that may degrade operational safety and performance. The following sections discuss cross-cultural implications in four high-risk industries: nuclear power, maritime, health care, and oil and gas.

Nuclear Power Plant. Cross-cultural studies have become a focus and primary concern among high-risk industries, particularly after the Chernobyl accident in 1986 (Mariscal et al., 2012). The concept of safety culture emerged as a result of the Chernobyl accident (Meshkati, 1998). Reactor number four at the Ukrainian power plant exploded, releasing contaminants and fission products into the atmosphere (Zhang, Wiegmann, von Thaden, Sharma, & Mitchell, 2002). The contaminants spread over Scandinavian and West European countries, increasing the risk of cancer (Zhang et al., 2002). Although several events led to the Chernobyl accident, a poor safety culture was identified as a contributing factor (Zhang et al., 2002).

In light of an investigation of the Chernobyl disaster, several organizational deficiencies were identified as contributing factors to the accident. A review of the findings revealed major design flaws of the reactor that affected power level controls during critical operational phases (Schmid, 2011). Certain procedures led to power surges and rapid shut downs of the reactor (Schmid, 2011). Soviet nuclear scientists were aware of the reactor's design flaws and failed to act upon operational complaints with a complete disregard of any possibilities that the reactor may explode (Schmid, 2011).

The final report concluded that a poor safety culture at the Ukrainian power plant was due to ineffective communication between members of the organization that resulted in an unclear understanding of responsibilities and poor cooperation between work members (Schmid, 2011). Despite the unfortunate events at Chernobyl, beneficial operational concepts emerged to develop positive safety attitudes and behaviors, including improvements in leadership principles and values through effective communication styles (Mariscal et al., 2012).

The European Foundation for Quality Management (EFQM) conducted a study on positive safety attitudes and behaviors (Mariscal et al., 2012). Their study aimed at increasing efficiency and strengthening operational quality in private and public organizations (Mariscal et al., 2012). An EFQM model was developed to evaluate the operations of safety management at organizations through a self-assessment process (Mariscal et al., 2012).

Mariscal et al. (2012) discussed the use of the EFQM model to evaluate a Spanish nuclear power plant. The findings from the self-assessment highlighted required improvements in safety procedures and implementations. The following list includes some of the required improvements (Mariscal et al., 2012):

1. Safety roles must be defined for all work grades;

2. Dissemination of information and knowledge between senior and junior staff must improve to ensure continuity of effective operations;
3. Improvements in communications between management and workers to highlight nuclear safety; and
4. Reduce work overload to increase improvement opportunities.

Towards this end, findings from the Chernobyl accident and the EFQM model share a common operational requirement: communication. Lee and Harrison (2000) encapsulated the importance of communication by means of identifying roles and responsibilities through effective communication between members of an organization. Also, they found that establishing a shared perception of the importance of safety and developing a proactive attitude toward safety measures would shape a positive safety culture (Lee & Harrison, 2000).

Maritime. Cross-cultural conflicts are particularly visible in the maritime industry where a single ship may include a crew composition of multiple nationalities and cultures (Horck, 2008). Maritime operations require extensive teamwork efforts and good communication skills between team members on the ship and at port (Horck, 2008). With cross-cultural crewmembers, ship owners are faced with degraded quality of work due to poor communication skills between ship crewmembers and port officers that could lead to misunderstandings (Horck, 2008).

In 2007, a Hong Kong-registered vessel named Cosco Busan struck a pier in San Francisco (Coury, Ellingstad, & Kolly, 2010). According to the National Transportation Safety Board (NTSB) (2009), cross-culture was a primary contributor to the accident. The captain of the vessel, a Chinese national, and the Pilot who navigated the vessel to the harbor, an American national, both had more than 20 years of experience (Strauch, 2010). However, due to cultural and language differences between the captain and Pilot, a clear line of authority was lost and it was unclear who was in charge of the vessel (National Transportation Safety Board, 2009). The captain did not review or monitor the Pilot's navigation to the harbor; instead, he transferred his authority to the Pilot by relying on the Pilot's navigation (Strauch, 2010). By doing so, the captain neglected to observe the Pilot's navigational procedures and assumed the correct actions were taken. The following is a statement given by the captain during an interview (NTSB, 2009, pp. 67-68):

> Normally as a captain I would welcome the Pilot with my open arms, enthusiastic, and I would show my hospitality in offering him if he need any food or coffee or tea … it seems the Pilot coming on board was with cold face, doesn't want to talk. I don't know if he had a hard day before or because he was unhappy because I was a Chinese.

Certainly, culture played a major role in influencing the captain's behavior by delegating his authority to the Pilot when the captain was in charge of the vessel (Strauch, 2010). According to Hofstede (2001), Chinese society is hierarchal, which is influenced by formal authorities and scores high on PD. Although the captain was in charge of the vessel, he may have been intimidated by the Pilot's assertive attitude and behavior, which led him to believe that the Pilot was in charge (NTSB, 2009). Tension between the captain and the Pilot may have arisen because of language differences. The captain was not a native English speaker; therefore, he could have had difficulties interacting with the Pilot (NTSB, 2009).

Health Care. The medical industry is evolving into a diversified work force where demographic compositions of physicians and patients are continuously diversifying (Meeuwesen, Brink-Muinen, & Hofstede, 2009). According to Betancourt (2003), cross-culture between physicians may lead to stereotyping and discriminatory treatment of patients, resulting in patients' dissatisfaction and deteriorating health conditions. It has been deemed critical in the medical sector to train physicians in how to effectively communicate and interact in a cross-cultural environment (Betancourt & Cervantes, 2009).

Meeuwesen et al. (2009) conducted a study to analyze how physicians behaved with patients from nationalities different from their own. Patients' nationalities included ten European countries: Belgium, Estonia, Germany, Great Britain, The Netherlands, Poland, Romania, Spain, Sweden, and Switzerland. Their study was based on Hofstede's national dimensions and was categorized into four components (Meeuwesen et al., 2009):

1. Context variables: patients with a high PD index experienced normal medical encounters with their physicians and information shared by the physician was made in a professional manner. Patients from individualistic countries and with low PD experienced flexible relations with their physicians, but were given delayed diagnoses by following a wait-and-see approach. Furthermore, consultations in wealthier countries were longer and patients recovered more quickly.
2. Physicians' verbal behavior: physicians with a high PD index demonstrated a gregarious social behavior with affective communication skills. Physicians with a high UAI index focused primarily on psychosocial conversations with

their patients. Individualistic physicians conducted less counseling and asked few questions, while physicians with a high MAS index socialized more and deviated from the patient's health issues.

3. Patients' verbal behavior: patients with a low PD index communicated less formally with their physicians. On the other hand, patients with a low MAS index shared a lot of information with their physicians, focusing primarily on psychosocial conversations.
4. Communication styles: Physicians and patients with a high PD index behaved according to their expected roles and shared less information. On the contrary, physicians and patients with a low PD index demonstrated flexible communication styles. Physicians and patients with a high UAI experienced more eye contact during their conversation. Moreover, patients with a low MAS index conversed professionally with their physicians and asked numerous questions.

Physicians must recognize and acknowledge the influences of cross-culture on their practice to ensure fair treatments (Rothschild, 1998). Identifying cultural differences would aid physicians in developing a culturally-sensitive approach toward communicating and interacting with their patients (Rothschild, 1998). Effective communication between physicians and patients would lead to increased accuracy of diagnosis and improved physician-patient relations that are based on trust and positive sharing of information (Betancourt & Cervantes, 2009).

Oil and Gas. The nature of oil and gas operations is complex and involves challenges with technological changes and productivity requirements (Mearns & Yule, 2009). Due to the diversified work force in the oil and gas sector, companies must maintain a positive safety culture to ensure operational safety (Fitzgerald, 2005). More often than not, these sites are located in less-developed areas where local work forces are unfamiliar with appropriate health and safety measures (Mearns & Yule, 2009). In 2001, the government of Norway shared its concerns over degraded safety performances in the oil and gas sector and identified cross-culture as a primary challenge that must be investigated (Høivik, Moen, Mearns, & Haukelid, 2009).

One particular example of degraded safety performances in the oil and gas sector is the Piper Alpha accident in 1988 that caused the death of 167 men and billions of dollars in losses (Paté-Cornell, 1993). Piper Alpha received and distributed daily oil and gas productions to other platforms in the area. During the distribution stage to other platforms, a disturbance occurred that led to a flange leak (Paté-Cornell, 1993). Released vapors initiated several explosions that resulted in damages to oil lines, causing fire (Paté-Cornell, 1993).

One of the condensate pumps on Piper Alpha was undergoing maintenance procedures. In order to initiate the pump's overhaul procedures, the day shift crew removed the pressure safety valve and sealed it with a disk cover (Gordon, 1998). The crew failed to follow proper procedures and did not tag the seal properly. Furthermore, the day shift crew did not share information with the night shift crew with regard to the maintenance procedures that they had already started. The night shift crew started their work normally and pressurized the pipe under maintenance that may have led to the initial leak (Gordon, 1998). Clearly, a series of procedural flaws and communication failures led to the explosions on Piper Alpha (Gordon, 1998).

While the accident was a result of a number of events, investigations revealed that a combination of human errors and poor decisions were contributing factors (Ginn, 2004). The organization attained a negative safety culture because management prioritized productivity over safety and dedicated insufficient attention to maintenance and inspection procedures (Paté-Cornell, 1993).

Conclusions from the Piper Alpha accident emphasize the importance of organizational culture and its impact on operational safety (Fitzgerald, 2005). Numerous regulations and procedures have been put in place since the Piper Alpha accident to increase operational safety (Ginn, 2004). Management must demonstrate its commitment to high safety standards through a positive safety policy that allows open communication and provides continuous safety training programs (Haber & Shurberg, 2002).

Flight Management Attitudes and Safety Survey (FMASS). Bridging cross-cultural gaps and achieving coherency among crewmembers are of immense importance to operational safety and success. Several approaches have been utilized by organizations to identify the link between safety attitudes and pilot performance with regards to acceptance of CRM concepts in a cross-cultural work force (Merritt, 1998). Studies on safety-related attitudes began in the 1980s using a questionnaire known as the Cockpit Management Attitudes Questionnaire (CMAQ) (Sexton, Wilhelm, Helmreich, Merritt, & Klinect, 2001). CMAQ included limited questions that identified safety-related attitudes and behaviors among airline pilots (Sexton et al., 2001). Since then, researchers have made extensive progress in this field and updated the attitude questionnaire to incorporate Hofstede’s dimensions of national culture (Sexton et al., 2001). An updated version of CMAQ, known as Flight Management Attitude

Questionnaire (FMAQ), was designed to address national, professional, and organizational cultures and identify their effects on cross-cultural pilot performances (Sexton et al., 2001).

Further progress was achieved to link pilot attitudes with performance by associating essential FMAQ items with safety-related outcomes. The Flight Management Attitudes and Safety Survey (FMASS) was developed and included four scales with a set of questions related to each scale (Sexton et al., 2001):

1. Safety culture:
    a. The managers in the flight operations listen to us and care about our concerns.
    b. My suggestions about safety would be acted upon if I express them to management.
    c. Management will never compromise safety concerns for profitability.
    d. I am encouraged by my supervisors and coworkers to report any unsafe conditions I observe.
    e. I know the proper channels to report my safety concerns.
    f. I am satisfied with chief pilot and assistant chief pilot availability.
2. Job attitudes:
    a. I am proud to work for this organization.
    b. Pilot morale is high.
    c. Senior management (VP and above) at this airline are doing a good job.
    d. Working here is like being part of a large family.

    e. I like my job.
    f. Pilots trust senior management at this airline.

3. Teamwork:
    a. Teamwork with other cockpit crewmembers.
    b. Teamwork with gate agents.
    c. Teamwork with ramp personnel.
    d. Teamwork with flight attendants.
    e. Teamwork with dispatch.
    f. Teamwork with maintenance.
    g. Teamwork with crew scheduling.
4. Stress recognition:
    a. I am more likely to make judgment errors in abnormal or emergency situations.
    b. My decision-making ability is as good in emergencies as in routine flying conditions.
    c. I am less effective when stressed or fatigued.
    d. My performance is not adversely affected by working with an inexperienced or less capable crewmember.
    e. Personal problems can adversely affect performance.
    f. A truly professional crewmember can leave personal problems behind when flying. (p. 4).

Merritt (2000) recognized that a safe flight is contingent upon the pilots' behaviors and attitudes in a cross-cultural environment. Although the flight deck is governed by formidable procedures and regulations, pilots must perform in dynamic work settings and interact with diverse crewmembers that may alter their attitudes and behavior (Gross, 2006). The aforementioned FMASS scales will aid in understanding cross-cultural effects on operations and engineering a safety culture that would aid in steering the organization toward required operational standards (Mjøs, 2004). “Without an understanding of its own cultures, organizations cannot mount effective programs to optimize them” (Helmreich, 2008, p. 8).

Once a clear understanding of cross-culture is achieved, appropriate training programs must be implemented to synchronize interactions among cross-cultural crewmembers (Smith, Singal, & Lamb, 2007). Training programs and operational strategies must be developed in a manner that would add value to the organization by empowering employees and anchoring positive safety commitments by management (Mittal, 2012).

Summary

The review of the relevant literature demonstrated the evolution of CRM through six generations where new concepts have emerged to improve threat and error management (Kanki et al., 2010). Despite the improvements in CRM training, pilot error remains inevitable (McCartney, 2005). A study by Tsang and Vidulich (2003) revealed that the majority of aircraft accidents and incidents were a result of non-technical pilot errors. Improvements in non-technical skills among pilots involve an understanding of their attitudes and behaviors from a cultural perspective (Powell & Hill, 2006).

IPO. Several performance and training models have been implemented to aid in improving safety levels. One of these models is the IPO model that examines internal and external factors influencing crewmembers' performance during various operational phases. Crewmembers are evaluated on non-technical characteristics, such as culture, communication skills, and attitudes (Kanki et al., 2010). Besides non-technical characteristics, the IPO model examines organizational influences, such as policies, regulations, and managerial relations with employees. Implementing an IPO model provides a full evaluation of the organization where operational deficiencies are identified.

AQP. Operational deficiencies may be rectified through an AQP, where training curricula are tailored for crewmembers (FAA, 2006a). Implementation of an AQP is voluntary; however, it is recommended as it provides continuous improvements on operational requirements. These improvements are based upon analytical findings obtained from training data, which may provide proactive solutions to aid in improving training standards.

FOQA. Data collection and analysis can be accomplished through a FOQA program. Depending on each airlines' policies and procedures, data monitoring vary to accommodate regulatory and operational requirements. Implementation of a FOQA program helps in identifying pilot deviations that may pose risk to flight safety. These identifications provide possible operational trends and proactive solutions to mitigate risks. In order to obtain full analyses of present deficiencies, airlines promote a positive safety reporting culture. Through safety reports, crewmembers provide qualitative information that may aid in better understanding current deficiencies.

TEM. Identifying operational deficiencies and developing tailored training curricula are insufficient to meet operational requirements. It is also important to understand and assess operational threats and errors, as they mostly occur during critical flight phases, such as descent, approach, and landing. TEM concludes CRM's evolution to date; through the sixth generation culture has not been taken into account to accommodate cross-cultural crewmembers.

Culture. Wise et al. (2010) stated that culture influences CRM and affects its positive transfer to pilots. CRM training does not involve cultural aspects (Wise et al., 2010). In their review, Helmreich and Merritt (2000) concluded that CRM is only a tool used to optimize operations and improve safety levels. Additional studies have revealed that cross-culture can also impact pilots' adaptation to aircraft automation and impede communication skills among diverse crewmembers (Helmreich, 2008; Solomon & Schell, 2009).

Despite operating procedures set forth by the airlines, pilots with different cultures interact with aircraft automation in various ways. Misuse and disuse of aircraft systems may lead to poor team coordination on the flight deck that may lead to degraded operational safety. Such degradation of operational safety is not recognized by CRM.

Communication skills can also present challenges among cross-cultural crewmembers. Ineffective communication due to language diversity may lead to poor performance on the flight deck (Thomas, 2008). Mental exhaustion, misunderstanding, and tension among crewmembers are all possible consequences of language diversity. As a result, cross-cultural crewmembers tend to rely on SOP, checklists, and company policies without achieving a complete understanding amongst each other.

CRM training must be culturally calibrated by understanding pilots' attitudes, norms, and beliefs (Powell & Hill, 2006). Three distinct, yet intertwined, types of cultures influence airline operations: national, professional, and organizational cultures (Helmreich et al., 2001b). Inside these cultures are certain traits and beliefs that influence pilots' behaviors and attitudes, and which may jeopardize operational performance levels. Understanding the aforementioned types of cultures and how they influence operational safety form the basis of a proactive approach toward a positive safety culture.

Understanding the influence of national, professional, and organizational cultures on crewmembers is an important and complex task. Neglecting the impact of these cultures may lead to degraded operational performance and organizational implications. Taking a proactive stance and recognizing the effects of cross-culture on operations is an initial step toward mitigating and managing the effects of cross-culture. Air MENA is a cross-cultural organization with over 100 nationalities working together. Achieving cultural coherency at Air MENA is an important step that must be initiated with a positive managerial interaction.

Cultural coherency may be achieved by re-establishing CRM concepts. Integrating cross-cultural ideologies in CRM training would result in universally accepted training programs and would include CCAAP training. The addition of cross-cultural training would bridge the gaps among cross-cultural crewmembers to improve flight deck relations and flight operations.

CHAPTER III

METHODOLOGY

This chapter reviews the methodology utilized to analyze the relationship among pilot nationalities with respect to unsafe performance events related to Hard Landings, Unstable Approaches, and Pilot Deviations during various flight phases. A review of the pilot population at Air MENA revealed a culturally diverse work force with a considerable number of nationalities working together. Consequently, a detailed analysis of flight events was undertaken to examine the influence of culture combination of captain and first officer on performance. Flight events from May 2011 to January 2013 formed the basis of this study, which provided in-depth analysis of flight parameters, flight deviations, and pilots' errors.

Research Approach and Design

The research design used for this study was an archival design utilizing existing organizational records (Vogt, Gardner, & Haettele, 2012). A descriptive comparative method was adapted to analyze the relationship between unsafe performance events and captain / first officer nationality combinations during flights where performance events were recorded. The flight data were retrieved from an unchanged flight data-recording environment yielding robust detailed data that was combined with administrative demographic data.

Tests of associations were used to understand the relationship between unsafe performance events and nationality combinations. Tests of associations were aimed at determining the nature and degree of relationships between variables (Black, 1999). These associations were illustrated through multi-dimensional chi-square tests. A comparison of cross-cultural and homogeneous flight deck crew combinations from unsafe performance events was examined. Additional analyses were conducted to predict group membership through discriminant analysis and multinomial logistic regression. Several Spearman's *r* correlation tests were conducted to assess the influence of intervening demographic variables on the association between nationality combinations and unsafe performance events. While cause-and-effect relationships between variables could not be determined in this research design, association variations between variables were made evident.

The data used in this study were flight data events gathered from Air MENA. The unsafe performance events examined in this study were Hard Landings, Unstable Approaches, and Pilot Deviations that occurred during various flight phases.

Population/Sample

The population for the study was unsafe performance events for Air MENA between May 2011 and January 2013. These unsafe performance events were only pilot related events. All other events were eliminated from the data set. Purposive sampling ensured that data selection targeted crew based events that would aid in exploring the hypotheses (Babbie, 2010). The population contained 1,863 unsafe performance events from a total of 1,149 pilots: 536 captains and 613 first officers. The purposive sample contained 1,088 unsafe performance events that met the hypotheses: Harding Landings, Unstable Approaches, and Pilot Deviations and included 915 pilots: 428 captains and 487 first officers.

The Aerobytes program, a FDM software used at Air MENA, cannot determine whether several unsafe events took place on the same flight in the provided data.

Therefore, each unsafe performance event was allocated a unique event identification number and each event was treated as an independent incident for data analyses.

Some events were performed by the same captain / first officer combination on different flights. The data set contained 660 events (61%) with duplicated captain ID numbers; from the duplicated captain ID cases, less than 37% of captains were duplicated more than twice in the dataset. For first officer, 601 events (55%) contained first officer ID number duplications, and from the duplicated first officer ID cases, less than 29% of first officers were duplicated more than twice in the dataset. Figures 14 and 15 indicate the number of duplicated and un-duplicated unsafe performance events for captains and first officers.

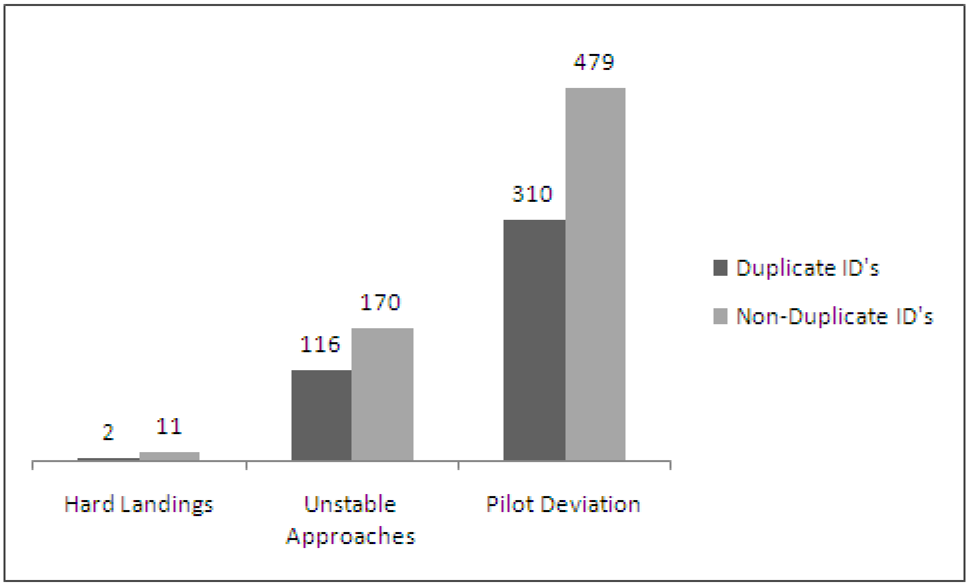


Figure 14. Number of duplicated and non-duplicated unsafe performance events by captains.

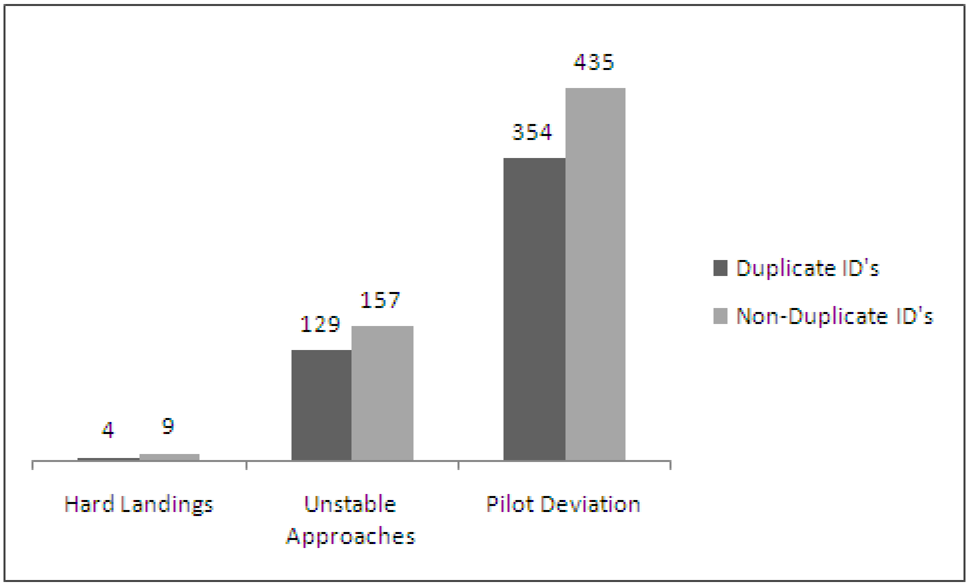


Figure 15. Number of duplicated and non-duplicated unsafe performance events by first officers.

All valid data on unsafe performance events were included; any corrupted data due to server inconsistencies were excluded. All pilots in the study had completed at least one mandatory operator proficiency check, ensuring that both captains and first officers were current on Air MENA's flight operating standards. Therefore, any unsafe performance events were not due to inconsistent or insufficient training of pilots.

The sample contained 97 different pilot nationalities. To reduce the number of pilot nationality combinations used in the data analyses, pilot nationalities were classified into 7 continent categories: Africa, Asia / Pacific, Commonwealth of Independent States (CIS), Europe, Latin America / the Caribbean, Middle-East / North Africa (MENA), and North America (IATA, 2012). Therefore, the number of captain / first officer nationalities (continents) combinations was reduced to 49.

Generalizability

While this study analyzed data gathered from one airline, it was crucial to assess its generalizability among other airlines in the MENA region. Three components were reviewed to ensure the study's generalizability:

1. Data Collection: The software used to gather data, Aerobytes, is used by 11 operators within the MENA region (Aerobytes, 2014).
2. Pilot Nationalities: The shortage of pilots in the MENA region is a strong indicator of an international recruitment process. According to Shaw-Smith (2013), Boeing estimates the need for 40,000 pilots in the MENA region between 2013 and 2032. The pilot training facilities in the region train approximately 130 pilots per facility per year (Shaw-Smith, 2013). This shortage is already reflecting on MENA operators; the second-largest airline operating out of Dubai International Airport has a work force from 85 countries (Gale, 2011).
3. Fleet: According to Anna Aero (2013), three major airlines in the MENA region have a total fleet of 285 aircraft that consist of Airbus and Boeing aircraft.

Sources of the Data

Flight data events were recorded by the Aerobytes FDM program and gathered from the safety department at Air MENA. The population data gathered included all unsafe performance events that were categorized by types of events and phases of events. The purposive sample of unsafe performance events included three categories to investigate the research hypotheses: Hard Landings, Unstable Approaches, and Pilot Deviations. Demographical data, such as age and nationality, were also collected from the administrative database of Air MENA. The nationality combinations of captain and first officer pilots in one event were the main predictor variables in the study, with unsafe performance events as the dependent variable.

The entire data set were compiled from Air MENA. In order to protect the identity of the pilots and the airline involved in the events, a thorough de-identification process was conducted. Identifying information such as pilot names, staff numbers, flight number, and aircraft registrations were omitted from the data set. The quantitative data included event name, departure airports, arrival airports, fleet, severity of the event, phase of the flight, pilots' age, and nationalities of captains and first officers.

Data Collection Device

The FOQA information was gathered from Aerobytes, which is the FDM software used by Air MENA. Quick Access Recorders and Flight Data Recorders are devices installed in every aircraft at Air MENA. These recording devices process the incoming data and download the data to the safety department's database via two methods (Flight Data Monitoring System, 2012):

1. Automatically using Global System for Mobile (GSM) communications. By securing a communication network between each aircraft and the server, flight data can be transmitted efficiently to the safety department. This process occurs automatically after every landing.
2. Manually using data collection cards.

Pilots' ages and nationalities were gathered from the Airline Information Management System (AIMS) database. The researcher integrated Aerobytes and AIMS data; for each flight event, the pilots' age and nationality were added. The final data were then converted to an Excel format and exported to Statistical Package for the Social Sciences (SPSS) for data cleaning, recoding, and analysis.

Measures

The data set contained variables that identified unsafe performance events, such as type, phase, and severity, as illustrated in Appendix C - Table C2. In order to remove non-pertinent undesirable flight events, data cleaning was performed on the data set, and the study's variables were re-coded for analysis. For the purpose of the current study, the variables used in data analyses were as follows:

1. *Fleet Type:* the aircraft type
2. *Departure Airport:* name of airport for flight departure
3. *Destination Airport:* name of arrival airport
4. *Flight Take-off Date*
5. *Flight Arrival Date*
6. *Status of the Event:* indicating that the unsafe performance event is one of the unsafe performance events being studied and should be included in the data analyses. Only valid events were included in the data analyses.
7. *Event Name:* the name of unsafe performance events, such as abnormal sink rate, approach speed high, and deviation above glide slope.
8. *Type:* of Unsafe Performance Event, such as Acceleration
9. *Phase:* of incident, such as landing and approach
10. *Severity:* of unsafe approach ranging from minor to major to critical
11. *Nationality of captain*
12. *Nationality of first officer*

13. *Age of captain*

14. *Age of first officer*

Treatment of the Data

The data collected from the Aerobytes FDM program were categorical; therefore, variables were created for the nominal data. The data were categorized and meaningful value labels were created.

Cleaning and re-coding of the data took place prior to data analyses. The data cleaning process began by eliminating all unsafe performance events that could not be categorized under one of the following unsafe performance events: Hard Landing, Unstable Approach, and Pilot Deviation. For the purpose of this study, unsafe performance events pertaining to the following categories were eliminated from data analyses: Turbulence, Long Landing, Short Landing, Technical, Go Around, Performance, Windshear, GPWS, CFIT, and TCAS. From a total of 1,863 unsafe performance events obtained from the Aerobytes FDM program, 775 events were excluded from data analyses and 1,088 events were included in the data analysis.

The variable, unsafe performance events, was categorized as: Hard Landings = 1, Unstable Approaches = 2, and Pilot Deviation = 3. Appendix C - Table C3 displays the unsafe performance events classified into the three events categories.

The sample was divided by rank: captain or first officer. The captain and first officer nationalities were recoded into one of the seven continents: 1 = Africa, 2 = Asia / Pacific, 3 = CIS, 4 = Europe, 5 = Latin America / the Caribbean, 6 = MENA, and 7 = North America. Appendix C - Table C4 displays a breakdown of nationalities within continent. For testing the research hypotheses, 49 nationality continent combinations between captain and first officer were generated in SPSS; there are seven continent nationalities for captains and seven continent nationalities for first officers. The 7 by 7 continent nationality combinations were used in chi-square analyses.

The continent nationality combinations included cross-cultural and homogeneous combinations, which were generated using 49 dummy variables in SPSS. When the nationality combination was true, the value was coded as 1 = yes; when the nationality combination was false, the value was coded as 0 = no. For example: nationality combination 1 was captain = Africa and first officer = Africa or nationality combination 2 was captain = Africa and first officer = Asia / Pacific.

In addition, a dichotomous variable 'nationality combination type' was generated to differentiate between the homogeneous nationality combinations and the heterogeneous cross-cultural nationality combinations of captain / first officer. For the seven homogeneous continent nationality combinations, such as Africa_ Africa, a value of 1 was assigned. For the 42 heterogeneous cross-cultural nationality combinations, a value of 2 was assigned.

The ratio variable, number of unsafe performance events committed per (continent) nationality combination of captain / first officer, was created. The total number of unsafe performance events was calculated for each of the (continent) nationality combinations. For example, the total number of unsafe performance events committed by the nationality combination of captain / first officer listed, such as Africa_Africa and Africa_CIS. This ratio was used in the analyses to show the nationality combination that had the largest ratio of unsafe performance events; descriptive data were used to identify which specific country nationality combination of captain / first officer committed most / least unsafe performance events, such as British_Africa.

Age of captains / first officers (measured in years) was a continuous variable and analyses were conducted to determine the association of age with unsafe performance events to identify its influence on the overall findings on nationality combinations. Additional recoding of the continuous variable age was conducted to determine which, if any, specific age category of captains / first officers was an intervening variable to the association between nationality combination and unsafe performance events. A categorical variable was generated for age that had three levels: younger age, average age, and older age. The average age category accounted for 68% and was created as the mean plus or minus one standard deviation. The younger age category included pilots whose age was less than 1 standard deviation from the mean, representing 16% of the sample. The older age category included pilots whose age was greater than 1 standard deviation above the mean, representing 16% of the sample.

Other variables used in data analyses were categorically recoded. Re-coding of the following nominal data is illustrated in Appendix C - Tables C2: fleet type, departure airport, event name, type, severity, and phase.

Destination airports and eligibility to command the flight were included in the analyses to eliminate their influence on the associations between nationality combinations of captain / first officer and unsafe performance events. There were 87 different destination airports in the dataset, coded from 1 to 87. Destination airports are categorized as illustrated in Appendix C - Table C5. Based on the destination airports recorded in the dataset, the eligibility of captain and first officer to command variable was created (Operations Manual Part A, 2012b).

1. Category A: Captains or first officers are eligible to command the flight; the category includes 52 airport destinations. Airports under Category A must satisfy all of the following requirements:
    - An approved instrument approach procedure;
    - At least one runway with no performance limited procedure for takeoff and / or landing;
    - Published circling minima not higher than 1,000ft above aerodrome level (AAL); and
    - Night operations capability.
2. Category B: Only captains are eligible to command the flight; the category includes 31 airport destinations. Airports under Category B do not satisfy the Category A requirements or require considerations such as:
    - Non-standard approach aids and or approach patterns;
    - Unusual local weather conditions;
    - Unusual characteristics or performance limitations; and
    - Any other relevant considerations including obstructions, physical layout, and lighting.
3. Category C: Only captains are eligible to command the flight and first officers must have received the same simulator training; the category includes four airports. Prior to operating to Category C airports, the captain must visit the

aerodromes as an observer and / or undertake instructions in a flight simulator. The operator should certify this instruction.

Assumption Checks. Assumption checks were performed on all of the variables in the data set to ensure that the data are not problematic for further data analyses. The data are nominal data; therefore, assumption checks for normal distribution and linearity of the data are not necessary. The following assumption checks were conducted:

1. Sample size was appropriate for the data analyses conducted in the study. The sample size was greater than 50 participants and is more than 8 times the number of independent variables (Brace, Kemp, & Snelgar, 2009).
2. Homoscedasticity: This assumption was not violated as indicated in the Normal P-P Plot of Regression Standardized Residual graph shown in Appendix D - Figure D1. As shown in the graph, the data was normally distributed. The Scatter plot shown in Appendix D - Figure D2 also indicated that this assumption was not violated, as there was pattern to the data.
3. Multicollinearity: This assumption was not violated as a linear relationship in the dependent variable was not indicated by the VIF Collinearity Statistics, where VIF level for all variables were less than 4. The table of coefficients is illustrated in Appendix C - Table C6.
4. Outliers: This assumption is not violated and it appears that 3.5% of the records are outliers. The Casewise Diagnostics Table in Appendix C - Table C7 shows that 96.5% of the records lie within 2 standard deviations above or below the mean. The remaining 3.5% of the records are considered outliers, because they are above 2 standard deviations. According to Rovai, Baker, and Ponton (2012),

since outliers are less than 5% of the data, they do not need to be removed from the data set, as they do not have an impact on the overall analysis.

5. The data met the criteria for conducting the chi-square test in that the variables were measured on a nominal level of measurement. Data were collected on more than two variables, the categorization of each of the variables was mutually exclusive, and every observation was independent of every other observation (Brace et al., 2009). The chi-square assumption that less than 20% of the cases have to have an expected frequency of less than 5 has been met by the data. The chi-square was useful as it calculated the expected frequencies for each data cell and compared the expected frequencies with observed frequencies (Tabachnick & Fidell, 2001). If the observed and expected frequencies were shown to be significantly different then, the results would show that the distributions of observations across the data cells were not due to randomness, but that there was a significant difference between nationality groups on unsafe performance. Given that existing variables were measured and not manipulated, a causal relationship between unsafe performance events and nationality combination could not be determined; instead only an association between the frequencies of groups could be established.

Therefore, the data met the criteria to conduct the descriptive and inferential statistical tests. These tests are discussed in the following sections. Assumption checks for the different descriptive and inferential tests are addressed and outlined below in the data analyses section.

Descriptive Statistics. Descriptive statistics were calculated to summarize the data in this study, providing an overview and understanding of what the data outcomes were as a whole. For nominal data, it is meaningless to calculate all measures of central tendency and variability; the data were not measured on a scale but rather in categories (Howitt & Cramer, 2011). Instead, descriptive analyses were restricted to reporting the mode, frequencies, and range.

Inferential Statistics. Inferential data analyses consisted of two parts. First, data analyses were performed to determine the effects of intervening variables on unsafe performance events using tests of correlations. Second, data analyses were conducted to answer the research hypotheses regarding the relationship between nationality combinations of captains / first officers and unsafe performance events.

Research Question and Hypotheses Testing. This study sought to answer the following research question: To what extent can we predict an unsafe performance event based on the nationality combination of pilots? In order to answer this question, six hypotheses were investigated. The purpose of hypothesis testing in research is to determine the likelihood that a population parameter is true.

H1. The null hypothesis was that there was no significant effect of the covariate age on the relationship between nationality combinations of captains / first officers and unsafe performance events. In order to determine the degree of relationship between unsafe performance events and age, a Spearman's *r* test was conducted. This test provided the measure of strength and direction of any potential relationships between unsafe performance events and these intervening variables. The Spearman's *r* correlation test was ideal for non-parametric variables (Brace et al., 2009). In addition, an

ANCOVA statistical test was conducted to control for the effect of age of captains / first officers on the relationship between nationality combination and unsafe performance events using the scaled variable, number of unsafe performance events per (continent) nationality combination, and unsafe performance event (Hard Landings, Unstable Approaches, and Pilot Deviation).

H2. The null hypothesis was that there was no significant effect of the covariate airport destination on the relationship between nationality combinations of captains / first officers and unsafe performance events. In order to determine the degree of relationship between unsafe performance events and destination airport, a Spearman's *r* test was conducted. In addition, an ANCOVA statistical test was conducted to control for the effect of airport destination on the relationship between nationality combination and unsafe performance events using the scaled variable, number of unsafe performance events per (continent) nationality combination, and unsafe performance event (Hard Landings, Unstable Approaches, and Pilot Deviation.

H3. The null hypothesis was that there was no significant effect of the covariate eligibility to command the flight on the relationship between nationality combinations of captains / first officers and unsafe performance events. In order to determine the degree of relationship between unsafe performance events and eligibility to command the flight, a Spearman's *r* test was conducted. In addition, an ANCOVA statistical test was conducted to control for the effect of eligibility to command the flight on the relationship between nationality combination and unsafe performance events using the scaled variable, number of unsafe performance events per (continent) nationality combination, and unsafe performance event (Hard Landings, Unstable Approaches, and Pilot Deviation).

H4. The null hypothesis was that there was no significant association between the frequency of homogeneous and the heterogeneous cross-cultural nationality combinations of captains / first officers on unsafe performance events. The association between nationality combinations of captains / first officers and unsafe performance events was investigated through a 2 by 3 multi-dimensional chi-square statistical test. The aim was to check whether the frequency of homogeneous nationality combinations differed from the frequency of heterogeneous cross-cultural nationality combinations of captains/first officers on unsafe performance events.

In SPSS, the type of nationality combination was coded as: 1 = homogeneous and 2 = heterogeneous. Unsafe performance events were coded as follows: 1 = Hard Landings, 2 = Unstable Approaches, and 3 = Pilot Deviation. The chi-square test was ideal for nominal data as it analyzed frequencies. The results on the chi-square alone could not explain the pattern of the results nor could they determine group membership. The unstandardized residuals provided insight for which combinations contribute to the over chi-square results.

H5. The null hypothesis was that there was no significant association between the frequency of the nationality combinations of captains / first officers on unsafe performance events. Using the 7 continent nationality combinations of captain and of first officer a 7 by 7 multi-dimensional chi-square was conducted.

H6. The null hypothesis was that there was no significant association between cross-cultural (pilot nationality) group memberships on unsafe performance events.

Discriminant analysis was used to predict category membership from the nationality combinations. This analysis was used to predict which of the 49 nationality combination categories were more likely to commit unsafe performance events.

Discriminant analysis was useful because it could be used in an attempt to predict category membership (Tabachnick & Fidell, 2001). The analysis looks to find the effect of the Independent Variable (IV) on the Dependent Variable (DV) and in finding a significant effect of one of the IVs then a partial prediction of participants DV could be made. In this case, discriminant analysis was used to predict which nationality combination membership was likely to commit an unsafe performance event.

In addition, a multinomial logistic regression was used to analyze relationships between a non-metric dependent variable and a dichotomous independent variable (Pampel, 2000). Multinomial logistic regression compared multiple groups through a combination of binary logistic regressions. The group comparisons were equivalent to the comparisons for a dummy-coded dependent variable.

A multinomial logistic regression was performed to identify which nationality combinations predicted unsafe performance events categories, an ideal test for nominal data. The main function of the regression was (a) to describe the relationship between nationality combinations and unsafe performance categories, and (b) to identify which combinations best predicted an unsafe performance outcome. As with the Discriminant Analysis, the 49 nationality combinations of captain and first officer were used as predictor variables, with the unsafe performance events categories as the dependent variable.

This statistical technique was useful as it computed the probability that pilots were a member of one of the three groups: Hard Landings, Unstable Approaches, or Pilot Deviation. This approach indicated the probability that a particular nationality combination had or had not committed an unsafe performance event on the flight. In SPSS, predicted group membership was compared to actual group membership to obtain a measure of classification accuracy (Brace et al., 2009).

The data used in this research fulfilled the requirements needed to conduct this statistical test, as multinomial logistic regression analysis requires that the dependent variable be non-metric; that is, nominal or dichotomous variables. The analysis also required that the IV be metric or dichotomous (Howitt & Cramer, 2011). Multinomial logistic regression does not make any assumptions of linearity, homogeneity of variance, and normality for the independent variables. In an event where the data does not satisfy these assumptions, this technique was preferred over discriminant analysis in order to predict group membership (Tabachnick & Fidell, 2001).

In SPSS, the overall test of relationship among the independent and dependent variables was based on the reduction in the likelihood values for a model that does and one that does not contain any independent variables. This technique was an extension of the chi-square analyses. Multinomial logistic regression is often referred to as a chi-square model, as it follows chi-square distribution (Hosmer, Lemeshow, & Sturdivant, 2013). The level of significance in the final chi-square model presented provides the evidence for the presence of a relationship between the different nationality combinations and the type of unsafe performance events.

While multinomial logistic regression indicated the strength of the relationship between IV and DV, the associations presented do not show the accuracy or errors associated with the chi-square model (Tabachnick & Fidell, 2001). The benchmark that was used to characterize a multinomial logistic regression model as useful was 25% improvement over the rate of accuracy achievable by chance alone (Pampel, 2000).

Summary

This research study analyzed the extent to which unsafe performance events can be predicted based upon pilot nationalities operating at a Middle Eastern airline. Six null hypotheses involving various operational conditions were investigated by using different statistical methods. Although the data were gathered from a single airline, the generalizability of the study was confirmed by reviewing the type of operations at other airlines in the region.

Aerobytes, a flight monitoring software used by Air MENA, was the source of data. Data collection was restricted for flight events between May 2011 and January 2013. This restriction was due to the validity of the data available during the collection period.

A descriptive comparative method was adapted to analyze the relationship between the combination of pilot nationalities and unsafe performance events. The study included 1,088 unsafe performance events and 915 pilots from 97 nationalities. Due to the complexity of the gathered data, pilot nationalities were coded into 7 continents: Africa, Asia / Pacific, CIS, Europe, Latin America / the Caribbean, MENA, and North America. Additional codes were generated to create categories for other variables, such as destination airports, fleet, and unsafe performance events.

Several statistical tests were used to analyze the null hypotheses. An ANCOVA was used to test for three covariates: pilots' age, airport destination, and eligibility to command the flight. The ANCOVA tests were an important phase as they reviewed the effect of the aforementioned covariates on the relationship between nationality combinations and unsafe performance events. In addition to ANCOVA, a Spearman's *r* test was used to test for the relationship between the covariates and unsafe performance events.

A 2 by 3 multi-dimensional chi-square statistical test was used to analyze the association between the frequency of homogeneous and heterogeneous cross-cultural nationality combinations. In order to test for the association between the frequencies of the nationality combinations of captains / first officers on unsafe performance events a 7 by 7 multi-dimensional chi-square statistical test was conducted. And finally, a discriminant analysis and logistic regression were utilized to test the association between cross-cultural (pilot nationality) group memberships on unsafe performance events.

CHAPTER IV

RESULTS

This study explored the relationship between nationality combinations of captains and first officers and unsafe performance events. The nationality combinations of pilots (continent combinations) at Air MENA were used in data analyses to determine the frequency of unsafe performance events (Hard Landings, Unstable Approaches, and Pilot Deviations) committed. The associations, and group membership with regard to these variables were explored, and confounding factors were investigated.

Descriptive Statistics

Flight data events were recorded by the Aerobytes FDM program and gathered from the safety department at Air MENA. The majority of events in the dataset had flights that had departed from or had their last destination as the Hub airport; 60% of flights were departures from the Hub, 37% of the flights were arrivals to the Hub.

Unsafe Performance Events. From a total of 1,088 unsafe performance events, there were a total of 13 Hard Landing incidents, 286 Unstable Approaches incidents, and 789 Pilot Deviation incidents. Unsafe performance events occurred in three flight phases: ‘Air’ (47%), ‘Landing & Approach’ (42%), and Ground (11%). All 13 Hard Landings occurred in the Landing & Approach phase of flight. Figure 16 indicates the type of unsafe performance for ‘Unstable Approach’ events. As shown, the most common type of event was ‘Late land flap (height AAL)’ (22%), followed by ‘Approach Speed High (<500ft)’ (16%) and ‘High rate of descent (<1000ft)’ (13%).

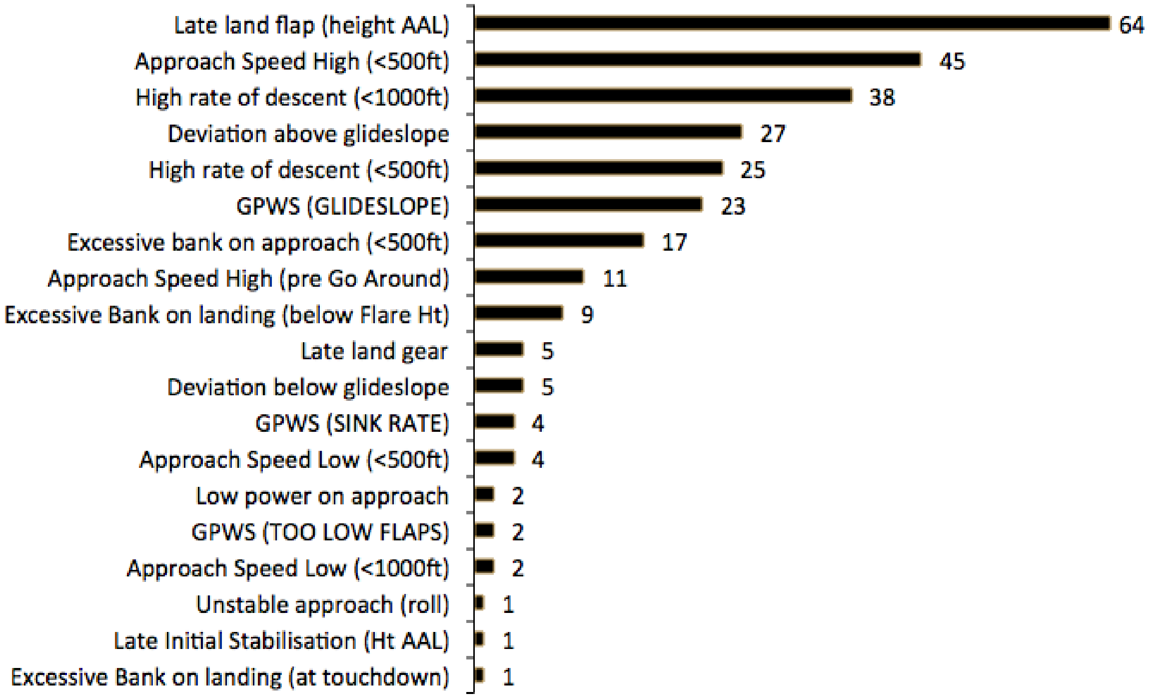


Figure 16. Frequency of unsafe performance events type for unstable approaches.

Figure 17 indicates the type of unsafe performance events for ‘Pilot Deviation.’ The most common type of event was ‘Dual Side Stick Input (Pitch)’ (29%), followed by ‘High-speed Below 5,000’ on Descent’ (9%) and ‘Dual Side Stick Input (Roll)’ (7%).

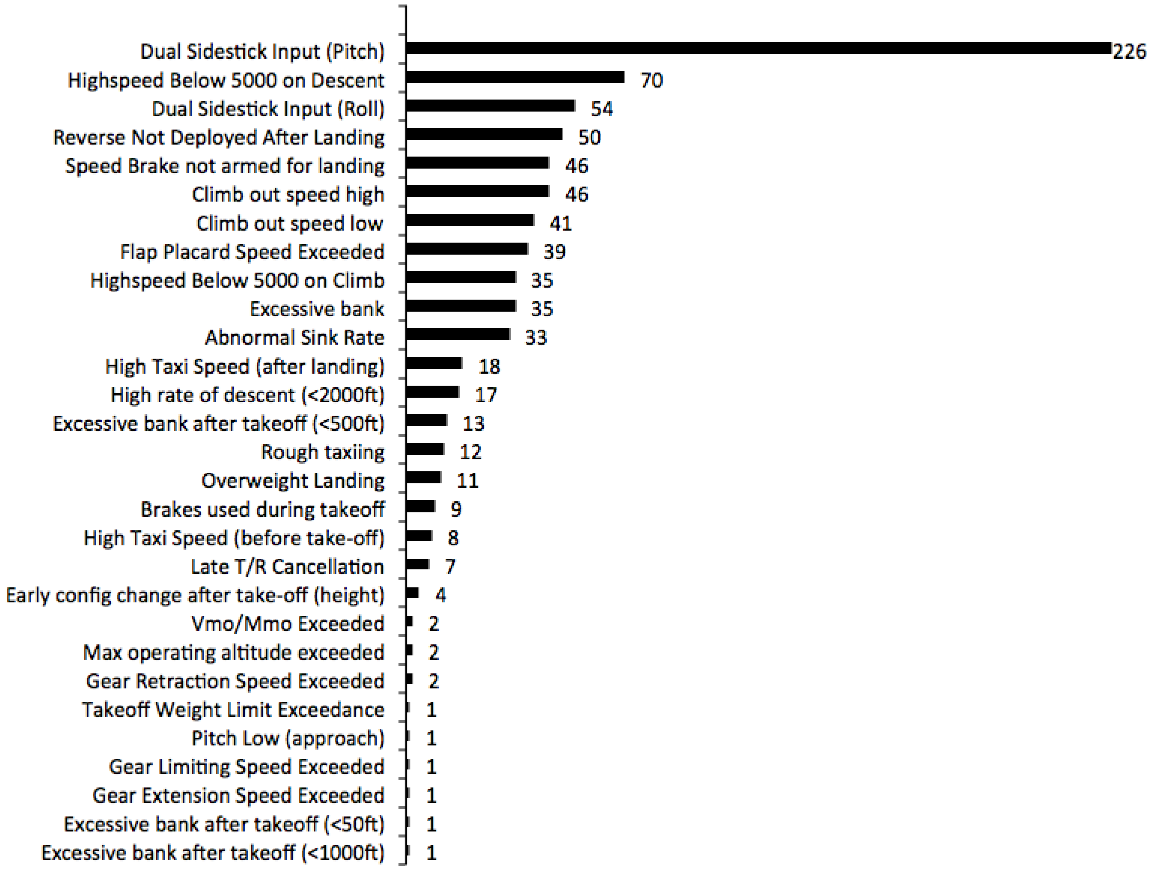


Figure 17. Frequency of unsafe performance events type for pilot deviations.

Events by Aircraft Type. The aircraft type where most unsafe performance events were committed was A320 (50%), of which 80% of these events were Pilot Deviation. The A330 had 28.1% of all unsafe performance events followed by the A340 (13.1%) and then the B777 (8%), as illustrated in Table 3.

Table 3

Unsafe Performance Events by Aircraft Type

	Event Name			
Aircraft Type	Hard Landings	Unstable Approaches	Pilot Deviation	Total
A320	3	106	435	544
A330	7	96	211	314
A340	1	34	108	143
B777	2	50	35	87
Total	13	286	789	1088

Hard landing events were committed on A330 (53.85%), A320 (23.07%), B777 (15.38%) and A340 (7.70%). For unstable approaches 37.1% of events were committed on the A320, 31.8% were committed on the A330, 17.5% were committed on the B777, and 13.6% were committed on the A340. For pilot deviation, 55.1% of the pilot deviations were committed on the A320, 26.4% were committed on the A330, 13.7% were committed on the A340, and 4.8% were committed on the B777.

Events by Severity. Figure 18 and Table 4 indicate the severity and type of events grouped into unsafe performance categories. The most frequent severity was Major (58.82%), followed by Critical (35.57%), and Minor (5.61%). The highest percentages of unsafe performance events were: 37.8% were pilot deviations of major severity, 32.0% were pilot deviations of critical severity, 19.9% were unstable approaches of major severity, 3.6% were unstable approaches of critical severity, 2.8% were unstable approaches of minor severity, and 1.2% were hard landings of major severity.

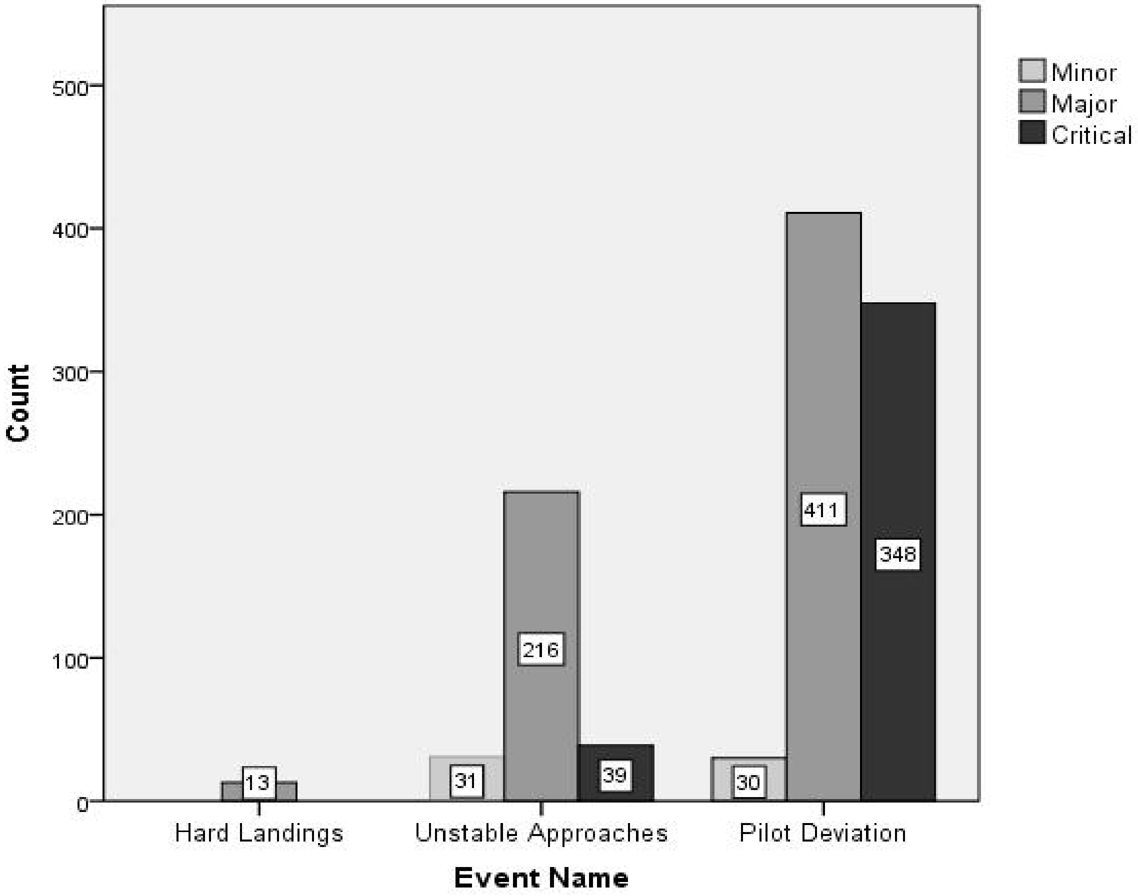


Figure 18. Frequency and severity levels of unsafe performance events.

Table 4

Type of Event by Severity Level

Type of Event	Severity of Event			
	Minor	Major	Critical	Total
Speed	38	196	60	294
Acceleration	0	13	0	13
Flight Path	8	130	19	157
Attitude	13	36	33	82
Power	1	8	0	9
Configuration	1	170	53	224
Warnings	0	87	222	309
Total	61	640	387	1088

Events by Airport. Hard Landing events occurred mostly at Amman airport (15.38%) and Kathmandu airport (15.38%) as the final destination airport; the remaining 69.24% of Hard Landing events occurred at Addis Ababa, Adelaide, Brisbane, Geneva, Hong Kong, Istanbul, Lahore, Shanghai, and Riyadh (7.69% each). The Hub airport accounted for 20.6% of the unstable approaches. The top five airports with the most unstable approaches, excluding the Hub airport, are: Seychelles (17%), Damascus (12%), John F. Kennedy (10%), Amman (7%), and Khartoum (6%). The Hub airport also accounted for 43.09% of the pilot deviations. The top five airports with the most pilot deviations, excluding the Hub airport, are: Kuwait and Lahore (22% each), Muscat (19%), Amman (18%), and Doha (17%).

Nationalities. The sample's demographics are split into nationalities. The captains' nationalities were from:

- Europe (38.14%),
    - British (8.64%), German (6.16%), French (5.33%), Italian (4.32%), Irish (1.84%), Greek (1.38%), Belgian and Cypriot (1.19% each), Austrian, Swiss, and Turkish (1.1% each), Croatian (0.92%), Spanish and Swedish (0.74% each), Bulgarian, Hungarian, Maltese, and Serbian & Montenegrin (0.46% each), Bosnian & Herzegovina (0.28%), and Dutch, Slovenian, and Yugoslavian (0.09% each).
- Asia / Pacific (21.42%),

    Malaysian (7.9%), Indian (2.11%), New Zealander (1.84%), South Korean (1.64%), Filipino (1.6%), Sri Lankan (1.2%), Singaporean

    (0.83%), Australian and Pakistani (0.73% each), Papua New Guinean and Taiwanese (0.64% each), Chinese and Thai (0.36% each), Bangladeshi and Bruneian (0.28% each), Indonesian (0.18%), and New Caledonia (0.1%).

- Middle-east & North Africa (15.81%),
    - Egyptian (3.58%), Emirati (3.13%), Jordanian and Omani (1.65% each), Tunisian (1.01%), Iraqi and Kuwaiti (0.83% each), Bahraini (0.74%), Algerian and Syrian (0.64% each), Moroccan (0.46%), Sudanese (0.37%), and Lebanese (0.28%).
- Latin America & the Caribbean (13.60%),
    - Mexican (2.39%), Peruvian (1.84%), Brazilian (1.75%), Jamaican and Salvadoran (1.65% each), Trinidadian & Tobago (1.56%), Costa Rican (0.83%), Chilean and Colombian (0.46% each), Bolivian and Venezuelan (0.37% each), and Guatemalan (0.27%).
- Africa (4.87%),
    - South African (1.56%), Seychellois (1.1%), Ethiopian (0.74%), Ugandan (0.55%), Mozambican (0.37%), Zimbabwe (0.28%), Kenyan (0.18%), and Motswana Plural Bats (0.09%).
- North America (5.33%), and
    - Canadian (3.4%), and American (1.93%).
- CIS (0.83%).
    - Moldovan (0.55%), Ukrainian (0.18%), and Russian (0.10%).

The First Officers' nationalities were from:

- Europe (34.72%),
    - British (7.74%), Spanish (6.08%), Italian (5.06%), Greek (3.68%), French (2.4%), Irish (1.57%), Hungarian (1.2%), Romanian (1.11%), Cypriot and Dutch (0.83% each), German (0.74%), Swedish (0.65%), Danish and Maltese (0.54% each), Belgian (0.46%), Turkish (0.37%), Finish and Portuguese (0.28% each), Slovakian (0.18%), and Bulgarian and Swiss (0.09% each).
- Asia / Pacific (22.84%),
    - Thai (3.41%), Malaysian (3.32%), Australian (2.77%), Pakistani (2.12%), Taiwanese (1.75%), Indian (1.57%), Sri Lankan, New Zealander, and Filipino (1.38% each), South Korean (1.1%), Singaporean (1.01%), Bangladeshi (0.46%), Bhutanese and Indonesian (0.28% each), Maldivian, Nepalese, and French Polynesian (0.18% each), and Papua New Guinean (0.09%).
- Middle-east & North Africa (27.07%),
    - Emirati (23.94%), Egyptian (0.65% each), Moroccan (0.55%), Lebanese (0.46%), Qatari (0.37%), Saudi Arabian and Sudanese (0.28% each), Tunisian (0.18%), and Algerian, Jordanian, Syrian, and Yemeni (0.09% each).

- Latin America & the Caribbean (8.83%),
    - Mexican (3.32%), Brazilian (1.66%), Jamaican (0.91%), Trinidadian & Tobago (0.74%), Salvadoran (0.65%), Colombian (0.55%), Peruvian (0.37%), Argentinean, Dominican, and Venezuelan (0.18% each), and Chilean (0.09%).
- Africa (4.14%), and
    - South African (1.93%), Seychellois (1.29%), Cote d Lvoire, Ethiopian, Mauritian, and Senegalese (0.18% each), and Malian and Uganda (0.10% each).
- North America (2.4%).
    - American (2.12%), and Canadian (0.28%),

As illustrated in Figure 19, the top 10 nationality combinations for Captain_First Officer (grouped into continents) is Europe_Europe (14%), followed by Europe_Middle-east & North Africa (10%).

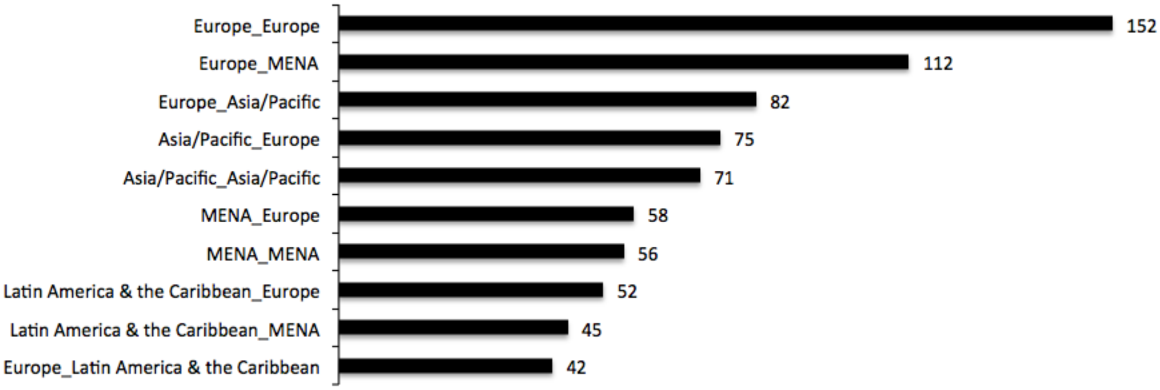


Figure 19. Top 10 nationality combinations for Captain_First Officer.

Table 5 indicates the descriptive information for nationality combinations, including the percent. No nationality combinations between captain and first officer existed for the following combinations: Africa_CIS, Asia / Pacific_CIS, CIS_Africa, CIS_CIS, CIS_Latin America & the Caribbean, CIS_North America, Europe_CIS, Latin America & the Caribbean_CIS, Middle-east & North Africa_CIS, North America_ CIS, and North America_North America.

Table 5

Distribution Among Pilot Nationality Combinations

	Captain Nationality Combinations							
First Officer Nationality Combinations	Africa	Asia / Pacific	CIS	Europe	Latin America & the Caribbean	MENA	North America	Total
Africa	0.3%	1.1%	---	1.7%	0.5%	0.2%	0.5%	4.2%
Asia / Pacific	1.3%	6.5%	0.1%	7.6%	2.8%	3.1%	1.5%	22.8%
CIS	---	---	---	---	---	---	---	---
Europe	1.8%	6.9%	0.2%	14.0%	4.8%	5.3%	1.7%	34.7%
Latin America & the Caribbean	0.3%	1.8%	---	3.0%	1.4%	1.1%	0.4%	8.8%
MENA	1.7%	3.7%	0.6%	10.3%	4.1%	5.2%	1.4%	27.0%
North America	0.1%	1.2%	---	0.7%	0.1%	0.3%	---	2.4%
Total	**5.5%**	**21.3%**	**0.8%**	**38.2%**	**13.6%**	**15.2%**	**5.3%**	**100%**

Pilots' Age. The age range for captains was between 29 and 64 years of age (mean age = 47, median and mode = 46, S.D. = 7.4). First officers' age ranged between 21 and 61 years (mean age = 36, median = 35, mode = 29, S.D. = 8). Three age categories were generated for both captains and first officers: younger age, average age, and older age. The average age category was created as the mean plus or minus one standard deviation. The younger age category included pilots whose age was less than 1 standard deviation below the mean, and the older age category included pilots whose age was greater than 1 standard deviation above the mean. Table 6 illustrates the frequency of age groups for captains (39 years and under, 40-54 years, and 55 years and over) and for first officers (28 years and under, 29-44 years, and 45 years and above).

Table 6

Frequency of Age Categories

Captains' Age Categories	Frequency	Percent
39 Years and under	192	17.6
40-54 Years	713	65.5
55 Years and over	183	16.8
Total	1088	100.0

First Officers' Age Categories	Frequency	Percent
28 Years and under	221	20.3
29-44 Years	705	64.8
45 Years and above	162	14.9
Total	1088	100.0

Nationality Combinations and Unsafe Performance Events

All Hard Landing events were due to ‘Abnormal Vertical G with Flap.’ Table 7 indicates the nationality combination of Captain_First Officer for ‘Hard Landing’ events. For Unstable Approach events, as indicated in Figure 20, the nationality combination with the largest percentage was Europe_Europe (13.64%); followed by the nationality combination of Europe_Middle-East & North Africa (9.44%), Europe_Asia/Pacific (9.44%), and Asia / Pacific_Europe (9.10%).

Table 7

Frequency of Hard Landing Events by Nationality combinations

Nationality Combination (Continent)	Frequency of Events	Percentage
Latin America & the Caribbean_Europe	3	23.08
Asia/Pacific_ Asia/Pacific	2	15.38
Europe_Europe	2	15.38
Europe_Middle-east & North Africa	2	15.38
Africa_Europe	1	7.69
Europe_Asia/Pacific	1	7.69
Europe_Latin America & the Caribbean	1	7.69
Middle-east & North Africa_Africa	1	7.69
Total	13	100.00

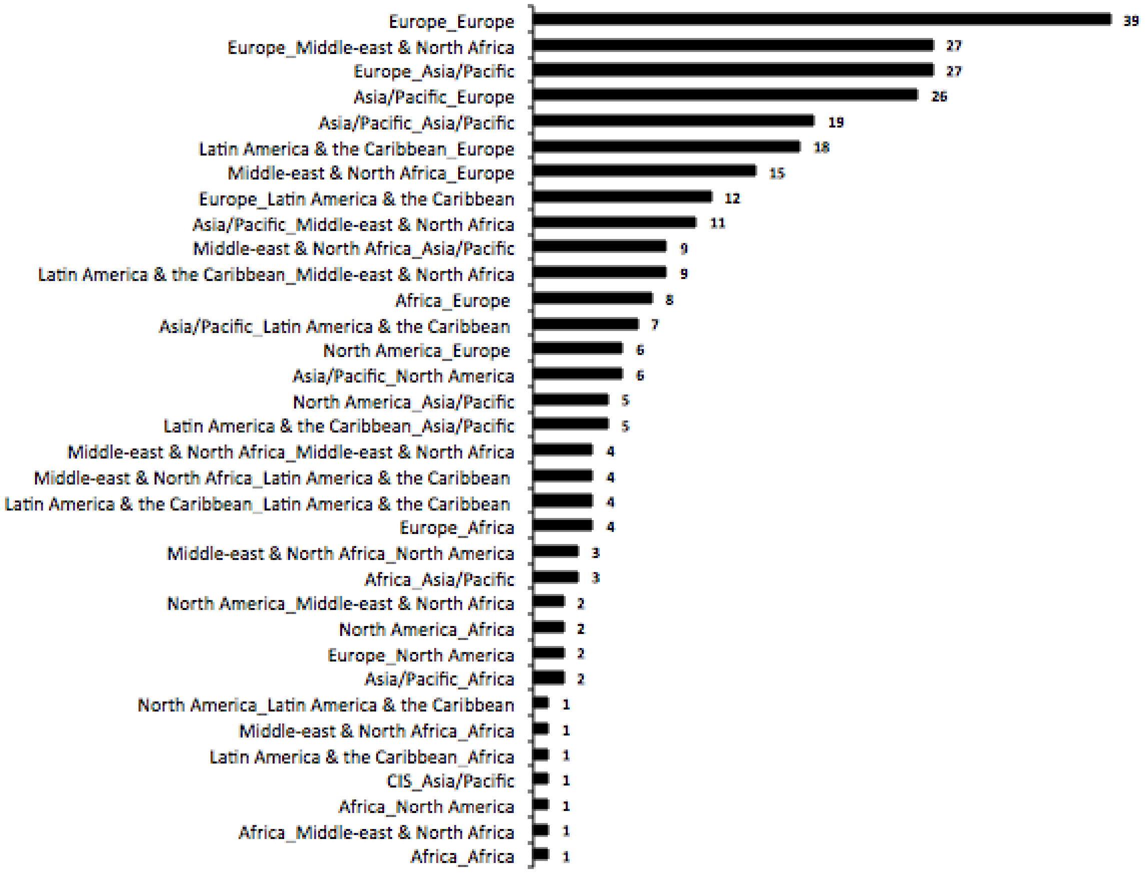


Figure 20. Frequency of unstable approaches for pilots nationality combinations.

Moreover, Figure 21 indicates that the most common nationality combination for Captain_First Officer where unsafe performance events took place for the Pilot Deviation events was Europe_Europe (14%); followed by ‘Europe_Middle-east & North Africa’ (11%) and ‘Europe_Asia /Pacific’ (7%).

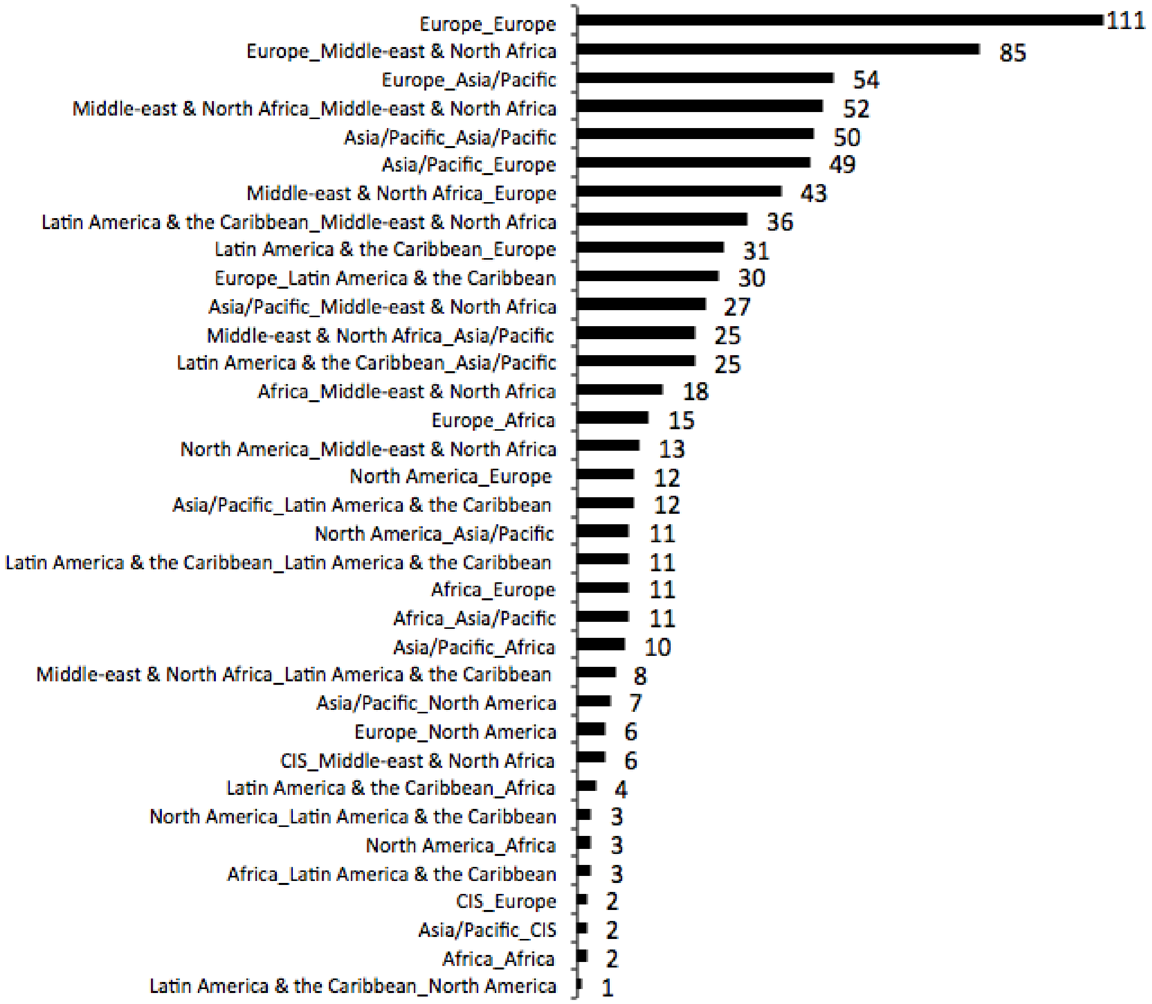


Figure 21. Frequency of pilot deviations for pilots nationality combinations.

Inferential Statistics

Hypothesis 1. The null hypothesis was that there was no significant effect of the covariate age on the relationship between nationality combinations of captains / first officers and unsafe performance events. A Spearman's rank correlation and an ANCOVA statistical test were conducted to test hypothesis 1.

A Spearman's rank correlation test was employed on the full dataset to determine the degree of relationship between unsafe performance events (Hard Landings, Unstable Approaches and Pilot Deviation) and age (three age categories) to test the null hypothesis. The findings showed that there was not a significant correlation between unsafe performance events and age of captains: $r_s(1088) = -.013$, $p = .665$, where $r_s^2 = .000169$. Therefore, the null hypothesis failed to be rejected. However, the findings showed that there was a significant but very weak correlation between unsafe performance events and age of first officers: $r_s(1088) = -.09$, $p = .003$, where $r_s^2 = .0081$. Therefore, the null hypothesis was rejected.

A between subjects ANCOVA was conducted on the full dataset to investigate the effect of nationality type (homogeneous or heterogeneous) on unsafe performance events while controlling for the variable: age of pilots. Prior to conducting the ANCOVA test, the following assumption checks were made (Brace et al., 2009):

1. A covariate should be chosen on the basis of existing theory and research.
2. A covariate should ideally be measured using a scale at ratio, interval, or ordinal level (if nominal, then the variable has to be a dichotomous variable).
3. Ideally, a covariate should be measured before the experimental manipulation takes place.
4. A covariate should be measured reliably.
5. The relationship between a covariate and the dependent variable must be linear.
6. There should be homogeneity of regression.

The findings showed that the data violated the homogeneity of regression assumption for first officers' age, $F(1, 1082) = 12.405$, $p < .000$. Therefore, the ANCOVA was not conducted.

Hypothesis 2. The null hypothesis was that there was no significant effect of the covariate airport destination on the relationship between nationality combinations of captains / first officers and unsafe performance events. A Spearman's rank correlation and an ANCOVA statistical tests were conducted.

A Spearman's rank correlation test was employed to determine the degree of relationship between unsafe performance events (Hard Landings, Unstable Approaches, and Pilot Deviation) and destination airport. The variable destination airport was recoded into a dichotomous variable where the Hub was recoded to 1 and all other destination airports were recoded to 0. This recoding enabled the data to meet the assumption checks. The Hub airport was 36.67% of the total number of destination airports. The findings showed that there was a significant weak correlation between destination airport and unsafe performance events $r_s(1088) = .219$, $p < 0.001$, where $r_s^2 = .048$. Therefore, the null hypothesis was rejected. Table 8 lists the frequency of unsafe performance events at the Hub airport versus spoke airports.

Table 8

Airport Destination by Unsafe Performance Event

Destination	Event Name			
	Hard Landings	Unstable Approaches	Pilot Deviation	Total
Spoke Destinations	13	227	449	689
Hub	0	59	340	399
Total	13	286	789	1088

A between subjects ANCOVA was conducted to investigate the effect of nationality type (homogeneous or heterogeneous) on unsafe performance events while controlling for the variable: destination airport (dichotomous variable). The findings showed that there was not a significant difference between unsafe performance events and nationality combinations when taking airport destination into account, $F(1, 1083) = 2.76$, $p = .097$. The null hypothesis failed to be rejected; therefore, there was no difference between unsafe performance events and nationality combinations when taking airport destination into account.

Hypothesis 3. The null hypothesis was there was no significant effect of the covariate eligibility to command the flight on the relationship between nationality combinations of captains / first officers and unsafe performance events. A Spearman's rank correlation and an ANCOVA statistical test were conducted.

A Spearman's rank correlation test was employed to determine the degree of relationship between unsafe performance events (Hard Landings, Unstable Approaches, and Pilot Deviation) and eligibility to command the flight. There was a significant weak correlation between eligibility to command the flight and unsafe performance events $r_s(1088) = -.304$, $p < 0.001$, where $r_s^2 = .092$. Therefore, the null hypothesis was rejected. Table 9 provides a distribution by event name for pilots' eligibility to land at the destination airport.

Table 9

Eligibility of Pilot to Land at Destination Airport

Eligibility of Pilot to Land at Destination Airport	Event Name			
	Hard Landings	Unstable Approaches	Pilot Deviation	Total
Captain or First Officer	6	156	654	816
Only Captain	4	98	115	217
Only Captain with Trained First Officer	3	32	20	55
Total	13	286	789	1088

A between subjects ANCOVA was conducted to investigate the effect of nationality type (homogeneous or heterogeneous) on unsafe performance events while controlling for the variable: eligibility to command the flight. The findings showed that the data did violate the assumption check of homogeneity of regression as the interaction between the dependent variable unsafe performance event and the covariate eligibility to command the flight significantly interacted $F(1, 1082) = 108.31$, $p < .000$. Therefore, the ANCOVA was not conducted.

Hypothesis 4. The null hypothesis was that there was no significant association between the frequency of homogeneous and the heterogeneous cross-cultural nationality combinations of captains / first officers on unsafe performance events. A 2 by 3 multi-dimensional chi-square test was employed on the full dataset to investigate whether there was an association between nationality combination type (homogeneous or heterogeneous) of captains / first officers and unsafe performance events. There was no significant association between nationality combination type and unsafe performance events, $\chi^2 = 3.032$, $df = 2$, $p = 0.22$. Therefore, the null hypothesis failed to be rejected, as shown in Table 10.

Table 10

Nationality Combinations by Unsafe Performance Events

Nationality Combinations	Event Name			
	Hard Landings	Unstable Approaches	Pilot Deviation	Total
Heterogeneous	9	219	561	789
Homogeneous	4	67	226	297
Total	13	286	787	1086

Hypothesis 5. The null hypothesis was that there was no significant association between the frequencies of the nationality combinations of captains / first officers on unsafe performance events. A 7 by 7 multi-dimensional chi-square test was conducted to investigate which nationality combinations were associated with each unsafe performance events category. The chi-square results were:

- Hard landings: $\chi^2 = 24.27$, $df = 16$, $p = .084$, failed to reject the null hypothesis,
- Unstable approaches: $\chi^2 = 27.71$, $df = 30$, $p = .586$, failed to reject the null hypothesis,
- Pilot deviations: $\chi^2 = 58.72$, $df = 30$, $p = .001$, rejected the null hypothesis, and
- Total: $\chi^2 = 54.12$, $df = 30$, $p = .004$, rejected the null hypothesis.

The unstandardized residuals provided below indicate the pilots' nationality combinations that most contributed to the chi-square result:

- Hard landings
    - Captain - Asia/Pacific with First Officer - Europe: Residual = -2.3
- Unstable Approaches
    - Captain - Europe with First Officer - MENA: Residual = 6.0
    - Captain - Europe with First Officer - Europe: Residual = -4.5
    - Captain - Latin America & the Caribbean with First Officer - Asia / Pacific: Residual = -3.9
    - Captain - Latin America & the Caribbean with First Officer - Europe: Residual = 3.5
    - Captain - Asia/Pacific with First Officer - North America: Residual = 3.0
    - Captain - MENA with First Officer - MENA: Residual = -2.8
    - Captain - Europe with First Officer - North America: Residual = -2.7
    - Captain - Africa with First Officer - Europe: Residual = 2.5
    - Captain - Asia/Pacific with First Officer - MENA: Residual = -2.4
    - Captain - Latin America & the Caribbean with First Officer - MENA: Residual = 2.0
- Pilot Deviations
    - Captain - Asia / Pacific with First Officer - MENA: Residual = -19.7
    - Captain - Asia / Pacific with First Officer - Asia / Pacific: Residual = 15.3
    - Captain - MENA with First Officer - MENA: Residual = 13.5
    - Captain - Europe with First Officer - Asia / Pacific: Residual = -13.3
    - Captain - Europe with First Officer - Europe: Residual = 11.9
    - Captain - Europe with First Officer - MENA: Residual = -5.6

  - Captain - MENA with First Officer - Africa: Residual = -5.5
  - Captain - Europe with First Officer - Latin America & the Caribbean: Residual = 4.4
  - Captain - Asia / Pacific with First Officer - North America: Residual = 4.2
  - Captain - Africa with First Officer - Europe: Residual = -3.8
  - Captain - MENA with First Officer - Asia / Pacific: Residual = -3.6
  - Captain - Asia / Pacific with First Officer - Africa: Residual = 3.3
  - Captain - MENA with First Officer - Latin America & the Caribbean: Residual = -2.9
  - Captain - MENA with First Officer - North America: Residual = -2.3
  - Captain - Europe with First Officer - Africa: Residual = 2.0
- Total
  - Captain - Asia / Pacific with First Officer - MENA: Residual = -22.3
  - Captain - Asia / Pacific with First Officer - Asia / Pacific: Residual = 18.2
  - Captain - Europe with First Officer - Asia / Pacific: Residual = -12.8
  - Captain - MENA with First Officer - MENA: Residual = 11.5
  - Captain - Europe with First Officer - Europe: Residual = 7.9
  - Captain - Asia / Pacific with First Officer - North America: Residual = 7.5
  - Captain - Europe with First Officer - Latin America & the Caribbean: Residual = 5.3
  - Captain - Asia / Pacific with First Officer - Europe: Residual = -5.2
  - Captain - Latin America & the Caribbean with First Officer - MENA: Residual = 5.1

  - Captain - MENA with First Officer - Africa: Residual = -5.0
  - Captain - Latin America & the Caribbean with First Officer - Asia / Pacific: Residual = -3.8
  - Captain - MENA with First Officer - Asia / Pacific: Residual = -3.7
  - Captain - CIS with First Officer - MENA: Residual = 3.6
  - Captain - Africa with First Officer - MENA: Residual = 2.8
  - Captain - North America with First Officer - Asia / Pacific: Residual = 2.8
  - Captain - MENA with First Officer - Latin America & the Caribbean: Residual = -2.6
  - Captain - North America with First Officer - Africa: Residual = 2.5
  - Captain - Latin America & the Caribbean with First Officer - North America: Residual = -2.5
  - Captain - Africa with First Officer - Latin America & the Caribbean: Residual = -2.3
  - Captain - Asia / Pacific with First Officer - Africa: Residual = 2.2
  - Captain - North America with First Officer - Europe: Residual = -2.1

There was a relationship between the above nationality combinations and unsafe performance events categories for pilot deviations and all unsafe performance events together. This result indicated that the observed frequencies in these nationality combinations were different than the expected rate of unsafe performance events for the nationality combinations.

Hypothesis 6. The null hypothesis was that there was no significant association between cross-cultural (pilot nationality) group memberships on unsafe performance events. A discriminant analysis was conducted to review the association between cross-cultural group memberships and unsafe performance events. “The rationale behind discriminant analysis is to make use of existing data pertaining to group membership and relevant predictor variables to create a formula that will accurately predict group membership” (George & Mallery, 2000, p. 316). The results showed that there was a significant effect of some nationality combinations on unsafe performance events. Table 11 lists the nationality combinations that have a significant association with unsafe performance events.

From the captain and first officer nationality combinations, the predicted group memberships for unsafe performance events are explained using Functions 1 and 2. The eigenvalues obtained for Functions 1 and 2 are 0.081 and 0.031, respectively, and the canonical correlation values for Functions 1 and 2 are .273 and .174 respectively.

The group memberships among the nationality combinations that committed unsafe events are defined by the inclusion of the pairs within the discriminant analysis functions. The null hypothesis was rejected; therefore, there was a significant association between unsafe performance events and cross-cultural (pilot nationality) group memberships. Table 12 indicates the classification results for the three unsafe performance events, describing the original group memberships versus the predicted group memberships. Overall, 73% of the original group cases were correctly classified; 100% of the pilot deviation events were correctly predicted, whereas only 7.7% of the hard landings, and 1.7% of the unstable approaches were correctly predicted. The only correctly predicted group memberships for hard landings and unstable approaches were for the nationality combinations that were found in Table 11. Figure 22 is a Territorial

Map for the Discriminant Functions indicating where the nationality combinations were more likely to appear.

Table 11

Nationality Combinations Associated with Unsafe Performance Events

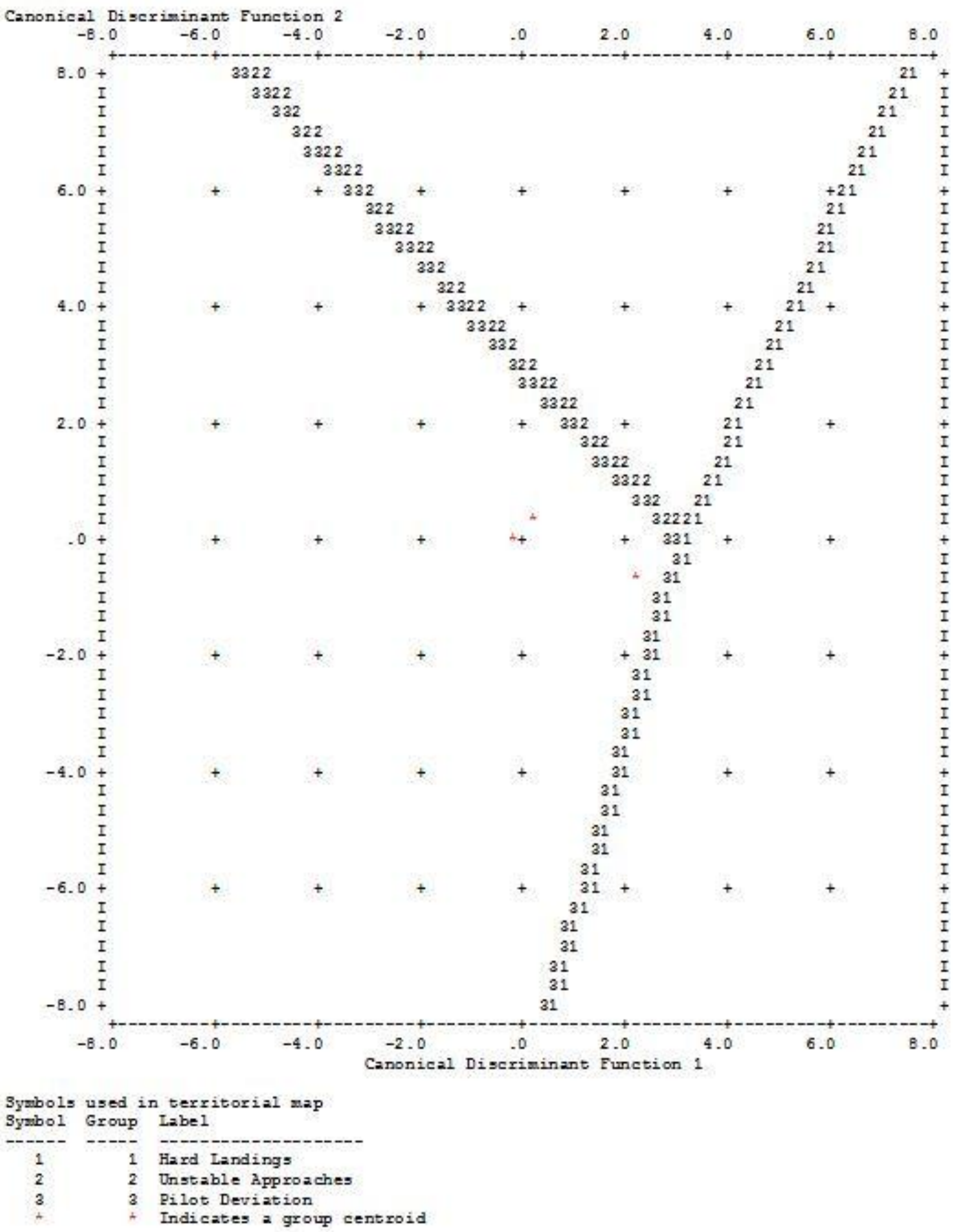
Captains	First Officers	Function 1	Function 2
MENA	Africa	2.27	.63
Latin America & the Caribbean	Europe	-.82	-2.11
MENA	MENA	3.36	8.67
MENA	North America	1.10	-.35
Asia / Pacific	MENA	.48	1.24
Africa	Europe	2.05	.06
Africa	MENA	1.72	-.79
Asia / Pacific	Latin America & the Caribbean	.99	2.54
Asia / Pacific	Asia / Pacific	3.36	8.67
Africa	North America	.78	.74
Asia / Pacific	Europe	.49	-.11
Europe	Asia / Pacific	2.28	-.17
Asia / Pacific	North America	6.76	-9.13
CIS	Asia / Pacific	-.73	-1.90
Europe	Europe	3.36	8.67
(Constant)		-.485	.001

Table 12

Discriminant Analysis Classification Results for Unsafe Performance Events

			Predicted Group Membership			
			Hard Landings	Unstable Approaches	Pilot Deviation	Total
Original Group Membership	Count	Hard Landings	1	0	12	13
		Unstable Approaches	1	5	280	286
		Pilot Deviation	0	0	787	787
	%	Hard Landings	7.7	.0	92.3	100.0
		Unstable Approaches	.3	1.7	97.9	100.0
		Pilot Deviation	.0	.0	100.0	100.0

a. 73.0% of original grouped cases correctly classified.



```
Canonical Discriminant Function 2
       -8.0      -6.0      -4.0      -2.0        .0       2.0       4.0       6.0       8.0
          +---------+---------+---------+---------+---------+---------+---------+---------+
     8.0 +            3322                                                             21  +
         I              3322                                                          21   I
         I                332                                                        21    I
         I                  322                                                     21     I
         I                   3322                                                  21      I
         I                     3322                                               21       I
     6.0 +          +         +  332    +         +         +         +         +21        +
         I                         322                                          21         I
         I                          3322                                       21          I
         I                            3322                                     21          I
         I                              332                                   21           I
         I                                322                                21            I
     4.0 +          +         +         +  3322   +         +         +     21  +          +
         I                                   3322                          21              I
         I                                     332                        21               I
         I                                       322                     21                I
         I                                        3322                  21                 I
         I                                          3322               21                  I
     2.0 +          +         +         +         +   332   +         21        +          +
         I                                              322           21                   I
         I                                               3322        21                    I
         I                                                 3322     21                     I
         I                                                   332   21                      I
         I                                         *           32221                       I
      .0 +          +         +         +        *+         +   331   +         +          +
         I                                                       31                        I
         I                                                   *  31                         I
         I                                                     31                          I
         I                                                     31                          I
         I                                                    31                           I
    -2.0 +          +         +         +         +         + 31      +         +          +
         I                                                   31                            I
         I                                                   31                            I
         I                                                  31                             I
         I                                                  31                             I
         I                                                 31                              I
    -4.0 +          +         +         +         +        31         +         +          +
         I                                                31                               I
         I                                                31                               I
         I                                               31                                I
         I                                               31                                I
         I                                              31                                 I
    -6.0 +          +         +         +         +     31  +         +         +          +
         I                                             31                                  I
         I                                            31                                   I
         I                                            31                                   I
         I                                           31                                    I
         I                                           31                                    I
    -8.0 +                                          31                                     +
          +---------+---------+---------+---------+---------+---------+---------+---------+
       -8.0      -6.0      -4.0      -2.0        .0       2.0       4.0       6.0       8.0
                                   Canonical Discriminant Function 1

Symbols used in territorial map
Symbol  Group  Label
------  -----  --------------------
   1        1  Hard Landings
   2        2  Unstable Approaches
   3        3  Pilot Deviation
   *        *  Indicates a group centroid
```

Figure 22. Discriminant functions territorial map.

A Logistic Regression analysis was conducted and, based on the regression model, the output predicted 100% of the 787 pilot deviation events, as seen in Table 13. This result supports the output obtained from the Discriminant Analysis and corroborates the association between unsafe performance events and cross-cultural (pilot nationality) group memberships. The null hypothesis was rejected; therefore, there was a significant association between unsafe performance events and cross-cultural (pilot nationality) group memberships.

Table 13

Logistic Regression Classification Results for Unsafe Performance Events

Observed	Predicted Group Membership			
	Hard Landings	Unstable Approaches	Pilot Deviation	Total
Hard Landings	1	0	12	13
Unstable Approaches	1	0	285	286
Pilot Deviation	0	0	787	787
Overall Percentage	0.2	0	99.8	100.0

CHAPTER V

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this dissertation was to determine if cross-cultural flight deck crew composition is related to increased error levels. Data from an airline in the UAE was utilized to analyze the influence of cross-cultural pilots on operational safety.

The airline industry is highly diversified, extremely safety-sensitive, and technologically driven. Due to the complexities of air transportation, airlines have implemented fundamental training programs to attain and maintain safe operations including CRM, TEM, and SOPs (Salas, Bowers, & Edens, 2001). Continuous improvements to these programs have been made as the industry strives to improve the safety of air travel. In order to understand the influence of cross-cultural crew environment on pilot performance, it is crucial to study these programs and explore their impact on daily operations (Salas, Bowers, & Edens, 2001). This section includes a summary of the results for the analyses conducted, followed by the conclusions and recommendations for future research and practices.

Discussion

The research design used for this study was an archival design utilizing existing organizational records (Vogt, Gardner, & Haettele, 2012). An investigation was conducted into the association between unsafe performance events and captain / first officer nationality combinations during a flight where performance events were recorded. The flight data were retrieved from an unchanged flight data-recording environment yielding robust detailed data that was combined with administrative demographic data.

Population and Sample. The population for the study was unsafe performance events for Air MENA between May 2011 and January 2013. These unsafe performance events were only pilot related events. All other events were eliminated from the data set. Purposive sampling ensured that data selection targeted crew based events that would aid in exploring the hypotheses (Babbie, 2010). The population contained 1,863 unsafe performance events from a total of 1,149 pilots: 536 captains and 613 first officers. The purposive sample contained 1,088 unsafe performance events that met the hypotheses: Harding Landings, Unstable Approaches, and Pilot Deviations and included 915 pilots: 428 captains and 487 first officers.

The Aerobytes program, the FDM software used at Air MENA, cannot provide the data to determine whether several unsafe events took place on the same flight in the provided data. Therefore, each unsafe performance event was allocated a unique event identification number and each event was treated as an independent incident for data analyses.

Some events were performed by the same captain / first officer combination on different flights. The data set contained 660 events (61%) with duplicated captain ID numbers. From the duplicated captain ID cases, less than 37% of captains were duplicated more than twice in the dataset. For first officer, 601 events (55%) contained first officer ID number duplications, and from the duplicated first officer ID cases, less than 29% of first officers were duplicated more than twice in the dataset.

Hypothesis Testing. This study sought to answer the following research question: To what extent can we predict an unsafe performance event based on the nationality combination of pilots? In order to answer this question, six hypotheses were investigated. The purpose of hypothesis testing in research is to determine the likelihood that a population parameter is true. The null hypothesis was the alternative hypothesis to what was proposed as true.

H1. The null hypothesis was that there was no significant effect of the covariate age on the relationship between nationality combinations of captains / first officers and unsafe performance events. In order to determine the degree of relationship between unsafe performance events and age, a Spearman's *r* test was conducted. This test provided the measure of strength and direction of any potential relationships between unsafe performance events and these intervening variables. The Spearman's *r* correlation test was ideal for non-parametric variables (Brace et al., 2009). The findings showed that there was not a significant correlation between unsafe performance events and age of captains. However, the findings showed that for the first officers' age, there was a very weak statistically significant relationship between nationality combinations of pilots and unsafe performance events. The relationship did not have practical significance, because it accounted for less than 1% of the variance. This effect may have been due to the wider age range of first officers, or the lowest age of the first officers group (21 years). Age is a proxy variable for experience. Due to the younger age of first officers in the data set (mean, median, and mode), the total experience level among pilots can be posited to be lower; therefore, the first officers were more susceptible to operational errors than 'older' captains who had more experience.

In addition, an ANCOVA statistical test was conducted to control for the effect of age of captains / first officers on the relationship between nationality combination and unsafe performance events using the scaled variable, number of unsafe performance events per (continent) nationality combination, and unsafe performance event. The findings showed that the data violated the homogeneity of regression assumption for first officers' age. Therefore, the ANCOVA was not conducted.

H2. The null hypothesis was that there was no significant effect of the covariate airport destination on the relationship between nationality combinations of captains / first officers and unsafe performance events. In order to determine the degree of relationship between unsafe performance events and destination airport, a Spearman's *r* test was conducted. A Spearman's rank test indicated a weak relationship between airport destination and unsafe performance events accounting for less than 5% of the variance, where 36.67% of the events occurred at the Hub (59 unstable approaches and 340 pilot deviations). The high number of events at the Hub may have occurred as a result of various factors not related to the cross-culture of the crewmembers, such as poor air traffic management, late night or early morning arrival times, training flights, and the relaxed flight deck environment when flying to their Hub that is developed as a result of familiarity of their base and the sense of 'arriving home.'

In addition, an ANCOVA statistical test was conducted to control for the effect of airport destination on the relationship between nationality combination and unsafe performance events using the scaled variable, number of unsafe performance events per (continent) nationality combination, and unsafe performance event (Hard Landings, Unstable Approaches, and Pilot Deviation). The findings showed that there was not a significant difference between unsafe performance events and nationality combinations when taking airport destination into account.

H3. The null hypothesis was that there was no significant effect of the covariate eligibility to command the flight on the relationship between nationality combinations of captains / first officers and unsafe performance events. In order to determine the degree of relationship between unsafe performance events and eligibility to command the flight, a Spearman's *r* test was conducted. There was a significant effect of the eligibility to command the flight on the relationship between nationality combinations and unsafe performance events that accounted for 9% of the variance. In fact, 75% of the events occurred when either the captain or first officer was eligible to command the flight: six hard landings, 156 unstable approaches, and 654 pilot deviations. These results may have occurred due to low first officer experience as discussed for H1, training flights conducted with cadet pilots or new joiners, ATC, other CRM skills (workload management, situational awareness, communication skills, teamwork, briefing, etc.) lapses, or the influence of national culture.

In addition, an ANCOVA statistical test was conducted to control for the effect of eligibility to command the flight on the relationship between nationality combination and unsafe performance events using the scaled variable, number of unsafe performance events per (continent) nationality combination, and unsafe performance event. The findings showed that the data violated the assumption check of homogeneity of regression. Therefore, the ANCOVA was not conducted.

H4. The null hypothesis was that there was no significant association between the frequency of homogeneous and the heterogeneous cross-cultural nationality combinations of captains / first officers on unsafe performance events. The association between nationality combinations of captains / first officers and unsafe performance events was investigated through a 2 by 3 multi-dimensional chi-square statistical test. The aim was to check whether the frequency of homogeneous nationality combinations differed from the frequency of heterogeneous cross-cultural nationality combinations of captains/first officers on unsafe performance events.

There was no significant association between the frequency of homogeneous and the heterogeneous cross-cultural nationality combinations of captains / first officers on unsafe performance events. However, heterogeneous crewmembers triggered 72.65% of the unsafe performance events: nine hard landings, 219 unstable approaches, and 561 pilot deviations.

H5. The null hypothesis was that there was no significant association between the frequencies of the nationality combinations of captains / first officers on unsafe performance events. Using the 7 continent nationality combinations of captain and first officer, a 7 by 7 multi-dimensional chi-square was conducted. There was no significant difference for hard landings or unstable approaches; there was a significant association for pilot deviations and all unsafe performance events in total. For the significant unsafe performance events, nationality combinations that included either the captain or first officer were from Asia / Pacific, Europe, and MENA. These nationality combinations appeared consistently among the top occurrences for unsafe performance events.

H6. The null hypothesis was that there was no significant association between cross-cultural (pilot nationality) group memberships on unsafe performance events. Discriminant analysis was used to predict category membership from the nationality combinations. This analysis was used to predict which of the 49 nationality combination categories were more likely to commit unsafe performance events. All of the pilot deviations were correctly predicted using 15 captain / first officer nationality combinations. Therefore, only pilot deviations were reliably predicted by the Discriminant Analysis and Logistic Regression.

The discriminant analysis and logistic regression showed that there was a significant effect of some cross-cultural group memberships on unsafe performance events. Nationality combinations of Asia / Pacific, Europe, and MENA appeared consistently, corroborating the findings from hypothesis 5.

Research Questions. One research question was addressed in this study to identify possible relationships between cross-cultural crewmembers and unsafe performance events.

- To what extent can we predict an unsafe performance event based on the nationality combination of pilots?

Only pilot deviations could be reliably predicted using the 15 captain / first officer nationality combinations. Hard landings had too few events (only 13 events). The nationality combinations for unstable approaches were not significantly correlated and were not included in the analyses. Therefore, unstable approaches could not be reliably predicted.

Conclusion

The results of this study indicated that captains' age does not have a statistically significant effect on unsafe performance events. However, the findings showed that there was a significant but weak relationship between unsafe performance events and age of first officers. This weak relationship may have been due to the younger age range among first officers, which equates to lower experience levels compared to captains.

Additionally, Air MENA facilitates a cadet pilot program where a majority of the cadets joining are below the age of 20 years. Upon completion of the cadet pilot program, these pilots are still in the range of 20 - 22 years old with approximately 250 hours of total flight time. This conclusion is supported by the fact that 50% of the unsafe performance events are committed on the narrow body fleet, the initial aircraft type for new first officers; 80% of the events are due to pilot deviations. The inexperience of these pilots illustrates that the lack of precise aircraft handling skills may lead to excessive deviations of aircraft controls. Moreover, their low experience levels may suggest that their CRM skills were less developed, and therefore; it was difficult to deal with crewmembers' cultural differences.

The results of this study indicated that there was a significant weak correlation between unsafe performance events and destination airport. The Hub accounted for 36.67% of the total number of destination airports where unsafe performance events occurred. This result supports the previous conclusions, as a majority of the 'low experienced' pilots tend to perform the landings at the Hub due to familiarity. The Hub is known for unstandardized air traffic management, where pilots are usually provided with extensive radar vectors in addition to altitude and speed constraints during the final phases of the flight. As a result, workload is increased during critical phases of the flight. If alternative approach procedures are not adequately briefed prior to commencing the descent phase, when ATC changes the expected approach, the pilot may not be prepared on multiple different levels (technical or non-technical), and therefore, could exceed an aircraft or SOP threshold.

As an international airline, Air MENA operates from its Hub that is centered between the Americas / Europe and Asia / Pacific. In order to optimize the network and improve the efficiency of connecting flights, the majority of the arrivals and departures are concentrated during two peak times: early mornings and late evenings. Early morning arrivals from the east provide connectivity to Europe and North America, and late evening arrivals from the west provide connectivity to the Indian Subcontinent, Asia, and the Pacific region. Figure 23 depicts the pattern of arrivals and departures at the Hub.

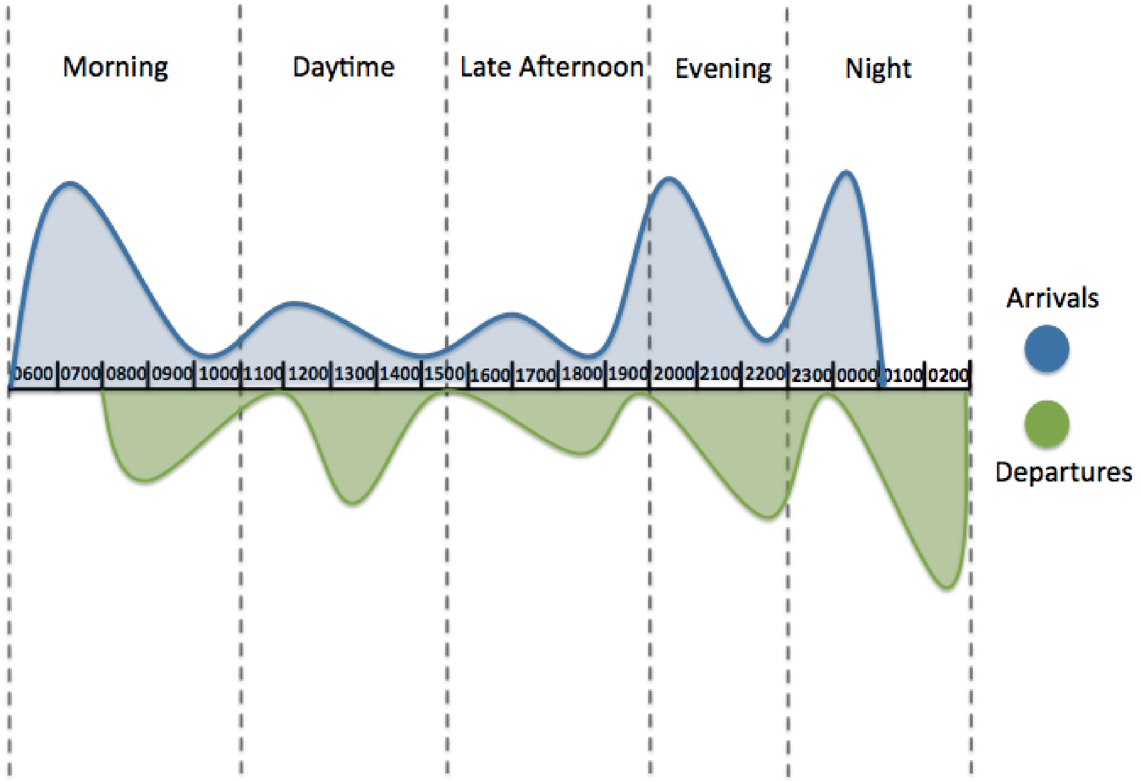


Figure 23. Arrival and departure patterns at hub.

During these peak times, the local airspace is highly congested with arriving and departing traffic that may have resulted in heavy workloads during critical phases of flight.   Moreover, the majority of the arrivals at the Hub are during the early hours of the morning, between 06:00 and 08:00. Since these flights are conducted throughout the night, fatigue could have contributed to low performance level resulting in an unsafe performance event.

The results of this study indicated that there was a significant relationship between unsafe performance events and eligibility to command the flight. In fact, 75% of the unsafe performance events occurred at destination airports where captains and first officers were eligible to command the flights. This result further indicates that the unsafe performance events were influenced by the national culture of the crew.

Although the 2 by 3 multi-dimensional chi-square test indicated that there was no significant association between unsafe performance events and nationality combinations, the frequency of events by nationality combination types varied considerably. In fact, heterogeneous nationality combinations accounted for 72.65% of the unsafe performance events. Heterogeneous pilot combinations accounted for nine hard landings, 219 unstable approaches, and 561 pilot deviations, compared to homogeneous nationality combinations that accounted for four hard landings, 67 unstable approaches, and 226 pilot deviations. Of the 15 nationality combinations that were significant, two were homogeneous and 13 were heterogeneous. The majority of these combinations presented nationalities with high PDI and IDV dimensions.

The aforementioned results buttress the literature that certain cultural traits and beliefs influence pilots’ behavior and attitudes and may jeopardize safety levels (Wise et al., 2010). Defense systems, such as checklists and SOPs, may be weakened as a result of heterogeneous nationality combinations. Additionally, heterogeneous nationality combinations may have experienced poor teamwork, communication skills, workload management, or SOP applications during critical phases of the flight. Consequently, cross-cultural crewmembers may have experienced mental exhaustion and tension as a result of misunderstanding, poor communication, excessive workload on one crewmember, or not paying attention to the flight controls.

The results of this study indicated that there were significant associations between unsafe performance events and the frequencies of nationality combinations of captains / first officers. Also, there was a significant association between unsafe performance events and cross-cultural group memberships. As explained in the literature, Hofstede's cultural dimensions expose the traits and attitudes for each national culture. Nationality combinations of Asia / Pacific, Europe, and MENA appeared consistently in the unsafe performance events. Aligning these nationality combinations with Hofstede's cultural dimensions reveals that Asia / Pacific and MENA score high in PDI, whereas Europe scores high in IDV. Nationality combinations with extreme PDI and IDV scores can jeopardize safety levels as a result of authoritarian characteristics and weak communication between crewmembers to avoid loss of 'face' and shame.

Nationalities with a high PDI dimension tend to be from Asian nations such as China, South Korea, and Japan. A recent example of an accident that involved nationality combinations with a high PDI dimension is Asiana Flight 214 in San Francisco in July 2013, where both South Korean pilots exerted high authoritarian behaviors (Croft, 2013). Whereas, nations with a low IDV score, such as Colombia, Brazil, and Guatemala, tend to fulfill obligations to family / team members rather than focusing on oneself. An example of an accident that involved a low IDV score is the crash of Avianca flight 52 in 1990, from Medellin to John F. Kennedy airport in New

York. The crew did not declare a mayday regarding their critical fuel situation, as they did not feel comfortable being positioned ahead of the other traffic (Salas, Wilson, Burke, Wightman, & Howse, 2006).

In summary, the analyses of the data gathered identified three significant aspects of the operations at Air MENA.

- A majority of the unsafe performance events occurred at the Hub where captains and first officers can command the flight. This result is a strong indication that these events were due to low experience levels by the first officers who have little experience in dealing with the CRM skills that can be highly influenced by national culture, along with aircraft handling and technical knowledge that are still being perfected.
- Heterogeneous nationality combinations resulted in more unsafe performance events than homogeneous nationality combinations. This result corroborates with the literature reviews' discussion of the cross-cultural implications and its effect on safety performance.
- Nationality combinations with high PDI and IDV scores significantly contributed to unsafe performance events in the data set; Table 14 lists the top three nationality combinations committing unsafe performance events by captains and first officers with high PDI or IDV. Their authoritarian characteristics and individualistic attitudes may jeopardize the overall safety of the flight. From the discriminant analysis group membership categories, captains and first officers from these three continents accounted for 46.67% and 66.67%, respectively, of the unsafe performance events.

Table 14

High PDI or IDV Dimensions by Nationality Combinations

	Asia / Pacific	Europe	MENA	Total
Captain	21.3%	38.2%	15.2%	74.7%
First Officer	22.8%	34.7%	27.0%	84.5%

Recommendations

Based on the results of this study, it was revealed that there is a significant association between unsafe performance events and first officers' age. Due to the first officers' young age range, their experience level is considered to be low. As cadet pilots, they graduate from flight school with approximately 250 hours, which may contribute to the association between first officers' age and unsafe performance events. Air MENA's cadet program should be reviewed to allow young cadets to gain more experience before operating on a jet aircraft.

Increasing the age requirement for cadets alone would not solve the issue; Air MENA should consider collaboration with neighboring operators with turboprop aircraft. Integrating turboprop operations into the cadet program would enable cadet pilots to gain more experience and improve their flying skills prior to operating on a jet aircraft. Allowing cadets to operate on turboprops would improve their transition to the jet aircraft by providing more hands-on-flying opportunities while being exposed to varying flight conditions, such as weather, terrain, ATC influences, language / accent barriers, etc.

The Hub airport contributed to 36.67% of the unsafe performance events. Coincidentally, captains and first officers are eligible to command the flight to the Hub airport. In addition to the fact that first officers have been at the controls, two other important factors must be taken into consideration. First, the Hub airport is known for having increased workload due to unstandardized air traffic management, particularly during peak hours by providing numerous radar vectors and altitude / speed constraints during critical phases of the flight. It is recommended that Air MENA collaborate with the Hub's Air Traffic Management to develop a structured and standardized arrival and departure procedures that would minimize ATC's instructions during critical phases of the flight. This standardization would reduce the workload on pilots and allow them to properly manage their flight. As a result, errors committed by pilots and ATC should be minimized.

Second, since Air MENA's arrivals are either early mornings or late evenings, pilots are exposed to continuous variations in flight schedules. Given the nature of Air MENA's global network, pilots are exposed to multiple time zone changes. It is recommended that Air MENA conduct a fatigue study to analyze the impact of flight schedules and time zone changes on pilots. Fatigue, coupled with low experience levels, poor ATC management, and cross-cultural crewmembers, may impact the overall safety of Air MENA's operations.

The pilot population at Air MENA during the study's time period included 97 nationalities, the majority of which speak English as a second language. In order to improve the communication skills among pilots, it is recommended that the GCAA increase the standards of required English skills to attain a commercial pilot license. This regulation improvement would facilitate better communication skills among pilots and avoid misunderstandings during critical phases of the flight.

Dissemination of information may aid in increasing awareness and safety levels among pilots. Unsafe performance events records may be presented to the pilots in a form of safety bulletins, quarterly / annual reports, or destination specific safety factors that pilots can review and brief before arrival at the given destination.

It is recommended that airlines adopt a new software that would function as a complete source for crewmembers' information that ranges from basic information, such as date of birth and nationality, to committed events, flight patterns, and training records. This software would provide airlines with an easier method of data collection that would aid in identifying trends and operational deficiencies through reliable analyses.

The current CRM syllabus at Air MENA encompasses the standard training elements with a focus on non-technical skills and TEM. Because CRM is not culturally calibrated, it is recommended to develop a seventh generation for CRM that would include CCAAP in its training curriculum. The seventh generation CRM, Cross-Cultural Crew Resource Management, or C^3RM, would provide the standard non-technical skills and TEM training, while integrating CCAAP throughout the curriculum. Figure 24 depicts a flow chart of the seventh generation CRM. A brief explanation of each element and the flow process are also depicted.

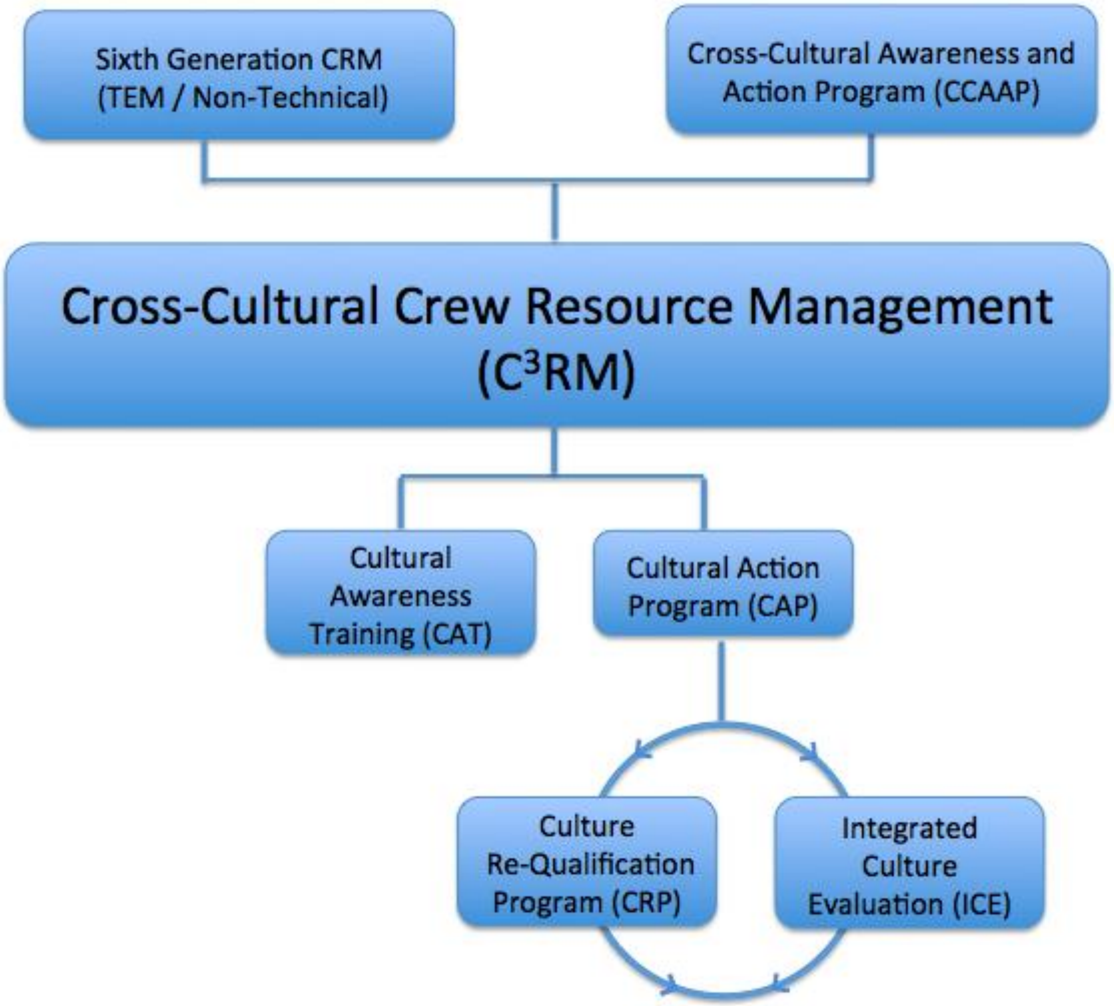


Figure 24. Seventh generation CRM.

The CCAAP includes two phases:

1. Cultural awareness training (CAT): The CAT program would incorporate national culture training based on Hofstede's national culture dimensions into the sixth generation CRM program. This training would aid in transferring cultural knowledge into daily airline operations.

2. Cultural action program (CAP): The CAP would involve the evaluation of integrated cultural awareness training into normal line operations and training.
    a. The line operations phase would be known as Integrated Culture Evaluation (ICE) and can be conducted in parallel with a Line Operations Safety Audit (LOSA). "A LOSA is a formal process that requires expert and highly trained observers to ride the jump seat during regularly scheduled flights to collect safety-related data on environmental conditions, operational complexity, and flight crew performance" (FAA, 2006b, p. 2).
    b. The training phase would be known as culture re-qualification program (CRP) that would be conducted in parallel with an AQP.

Recommendations for Future Research. Future research should examine the impact of additional covariates on the association between nationality combinations and unsafe performance events. This approach would aid in providing an in-depth analysis of the effects of external factors on the association between nationality combinations and unsafe performance events. The following is a list of possible covariates that may be explored further:

1. Flight Hours: obtaining the total number of flights hours before and after joining the airline, and at the time of the unsafe performance event(s) would depict a clear picture of the level of experience attained by each pilot involved in unsafe performance events. Also, categorizing these hours by fleet type would aid in conducting an in-depth analysis.

2. Training Records: obtaining training records for each pilot involved in unsafe performance events would provide viable quantitative and qualitative data that may be used for a more thorough analysis. Moreover, future research should also review the type of commercial licenses obtained (FAA or JAA), location of training, and if the pilot has instructor credentials.
3. Fleet: incorporating fleet type as a covariate would provide essential information about the level of operations conducted per fleet.
4. Arrival / Departure Times: reviewing arrival and departure times would aid in understanding flight schedules and how they may affect fatigue levels.
5. Repetition of events by pilots: identifying repeated unsafe performance events and pilots who are continuously conducting unsafe performance events would aid in identifying potential trends and operational deficiencies.

Future research may also conduct a FMAQ that is designed to address national, professional, and organizational cultures and identify their effects on cross-cultural pilot performances (Sexton et al., 2001). In addition to FMAQ, conducting interviews with pilots involved in unsafe performance events would provide important qualitative information that would not be possible to attain from FOQA data. Interaction with the human element involved in the study provides added value and strengthens the analyses. Depending on the availability of a LOSA program, LOSA records may be integrated in the analysis of FMAQ in order to identify possible operational deficiencies according to various factors, such as fleet type, airport, and phase of flight.

Reviewing training records would aid in identifying possible trends and deficiencies. Training records are a valuable source of information and should be explored in future research. This approach would allow the operators to develop operational defense systems through proactive and predictive safety strategies.

Collecting and managing pilots' information, such as flight time, flight schedules, and unsafe performance events, would aid in conducting more comprehensive analyses. This approach would take into account additional variables that may influence unsafe performance events. It is recommended that airlines incorporate such variables in future research.

Future research should analyze flights that do not involve unsafe performance events. This approach would allow a comprehensive analysis of nationality combinations with and without unsafe performance events, while exploring various covariates. Incorporation of flights without unsafe performance events would strengthen the analysis by narrowing the type of nationality combinations that are prone to committing unsafe performance events.

Finally, future research may also explore cross-cultural implications on cabin crew, ground engineers, and turn-around supervisors' safety performance levels. A research study that encompasses cabin crew and ground staff would provide a stronger picture of the overall operational status.

The safety of daily operations is often impacted by factors such as on-time performance targets that would impose the 'rush' factor on different crewmembers.

Having cross-cultural crew in the flight deck, cabin, and on the ground presents formidable challenges that many airlines face today.

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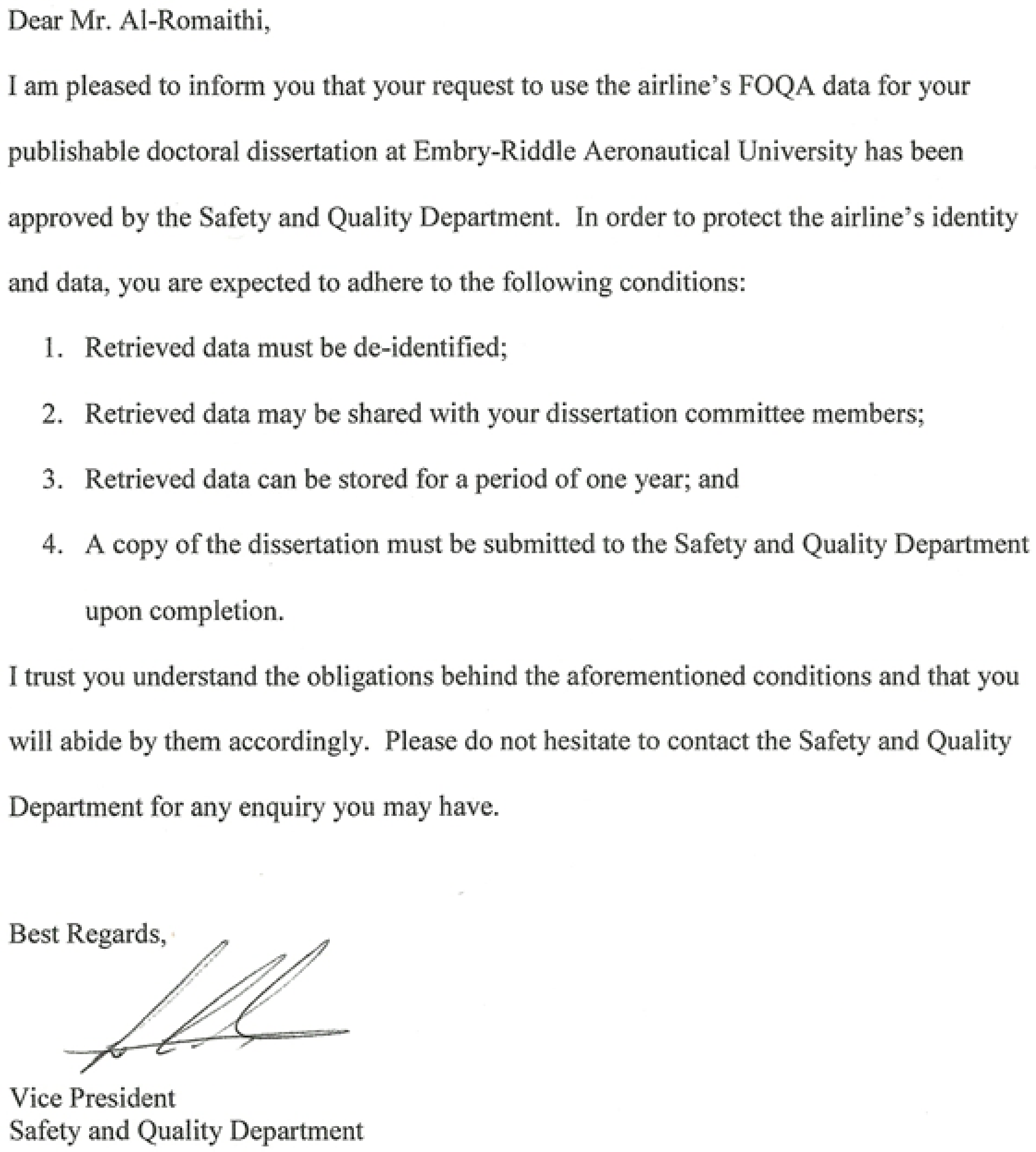
APPENDIX A

Permission to Conduct Research



Dear Mr. Al-Romaithi,

I am pleased to inform you that your request to use the airline's FOQA data for your publishable doctoral dissertation at Embry-Riddle Aeronautical University has been approved by the Safety and Quality Department. In order to protect the airline's identity and data, you are expected to adhere to the following conditions:

1. Retrieved data must be de-identified;
2. Retrieved data may be shared with your dissertation committee members;
3. Retrieved data can be stored for a period of one year; and
4. A copy of the dissertation must be submitted to the Safety and Quality Department upon completion.

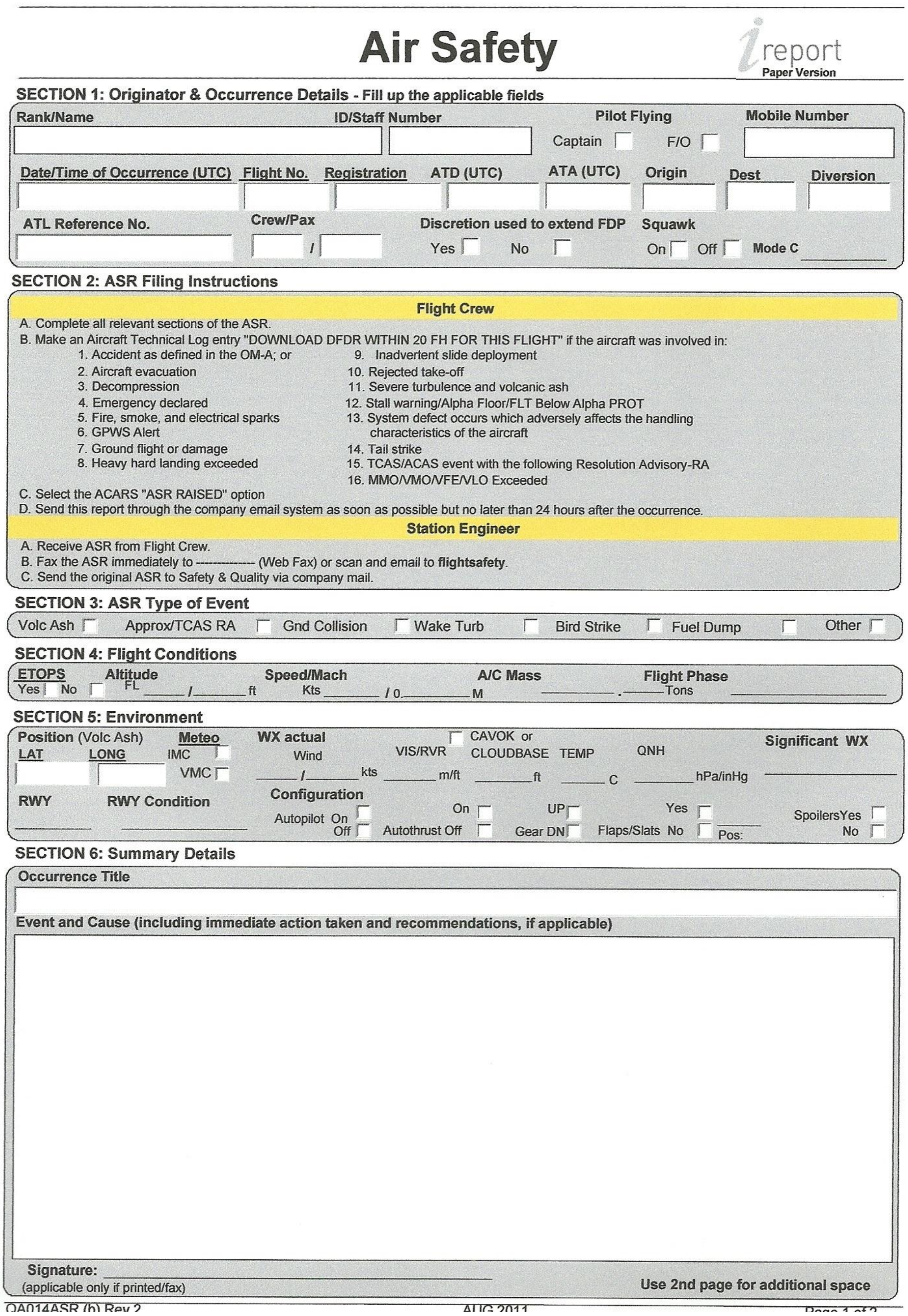
I trust you understand the obligations behind the aforementioned conditions and that you will abide by them accordingly. Please do not hesitate to contact the Safety and Quality Department for any enquiry you may have.

Best Regards,

Vice President
Safety and Quality Department

APPENDIX B

Air Safety Report (ASR)



Air Safety

ireport
Paper Version

SECTION 1: Originator & Occurrence Details - Fill up the applicable fields

Rank/Name **ID/Staff Number** **Pilot Flying** Captain ☐ F/O ☐ **Mobile Number**

Date/Time of Occurrence (UTC) **Flight No.** **Registration** **ATD (UTC)** **ATA (UTC)** **Origin** **Dest** **Diversion**

ATL Reference No. **Crew/Pax** / **Discretion used to extend FDP** Yes ☐ No ☐ **Squawk** On ☐ Off ☐ **Mode C** ____________

SECTION 2: ASR Filing Instructions

Flight Crew

A. Complete all relevant sections of the ASR.
B. Make an Aircraft Technical Log entry "DOWNLOAD DFDR WITHIN 20 FH FOR THIS FLIGHT" if the aircraft was involved in:

1. Accident as defined in the OM-A; or
2. Aircraft evacuation
3. Decompression
4. Emergency declared
5. Fire, smoke, and electrical sparks
6. GPWS Alert
7. Ground flight or damage
8. Heavy hard landing exceeded
9. Inadvertent slide deployment
10. Rejected take-off
11. Severe turbulence and volcanic ash
12. Stall warning/Alpha Floor/FLT Below Alpha PROT
13. System defect occurs which adversely affects the handling characteristics of the aircraft
14. Tail strike
15. TCAS/ACAS event with the following Resolution Advisory-RA
16. MMO/VMO/VFE/VLO Exceeded

C. Select the ACARS "ASR RAISED" option
D. Send this report through the company email system as soon as possible but no later than 24 hours after the occurrence.

Station Engineer

A. Receive ASR from Flight Crew.
B. Fax the ASR immediately to -------------- (Web Fax) or scan and email to **flightsafety**.
C. Send the original ASR to Safety & Quality via company mail.

SECTION 3: ASR Type of Event

Volc Ash ☐ Approx/TCAS RA ☐ Gnd Collision ☐ Wake Turb ☐ Bird Strike ☐ Fuel Dump ☐ Other ☐

SECTION 4: Flight Conditions

ETOPS Yes ☐ No ☐ **Altitude** FL ______ /________ ft **Speed/Mach** Kts ________ / 0.___________ M **A/C Mass** ___________ . ______Tons **Flight Phase** ________________________

SECTION 5: Environment

Position (Volc Ash) **LAT** **LONG** **Meteo** IMC ☐ VMC ☐ **WX actual** Wind ______ /_______ kts VIS/RVR _______ m/ft ☐ CAVOK or CLOUDBASE ________ ft TEMP ______ C QNH ________ hPa/inHg **Significant WX** ________________

RWY ___________ **RWY Condition** ________________ **Configuration** Autopilot On ☐ Off ☐ Autothrust On ☐ Off ☐ Gear UP ☐ DN ☐ Flaps/Slats Yes ☐ No ☐ Pos: ______ Spoilers Yes ☐ No ☐

SECTION 6: Summary Details

Occurrence Title

Event and Cause (including immediate action taken and recommendations, if applicable)

Signature: ____
(applicable only if printed/fax)

Use 2nd page for additional space

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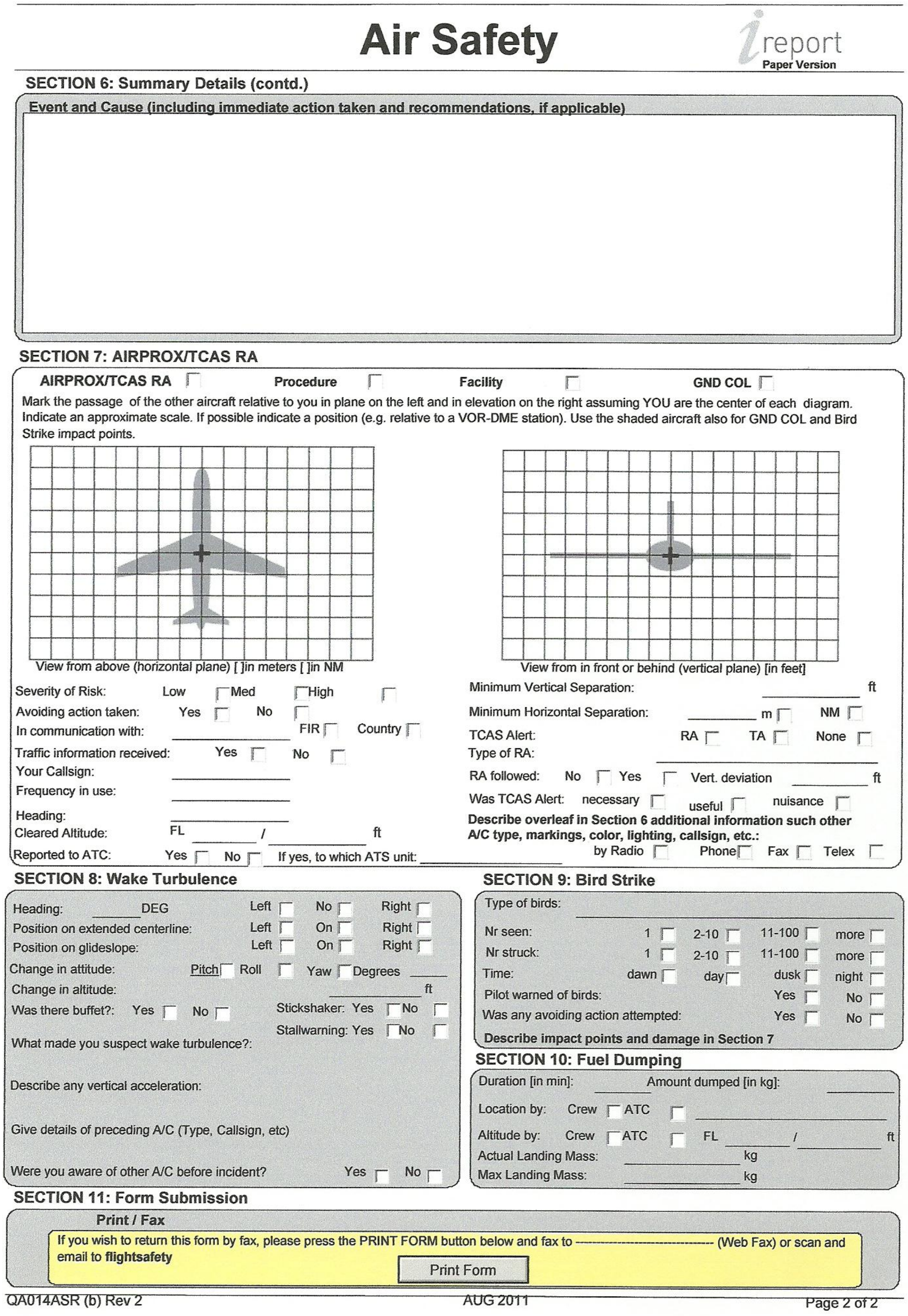

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SECTION 6: Summary Details (contd.)

Event and Cause (including immediate action taken and recommendations, if applicable)

SECTION 7: AIRPROX/TCAS RA

AIRPROX/TCAS RA ☐ **Procedure** ☐ **Facility** ☐ **GND COL** ☐

Mark the passage of the other aircraft relative to you in plane on the left and in elevation on the right assuming YOU are the center of each diagram. Indicate an approximate scale. If possible indicate a position (e.g. relative to a VOR-DME station). Use the shaded aircraft also for GND COL and Bird Strike impact points.

View from above (horizontal plane) [ ]in meters [ ]in NM

View from in front or behind (vertical plane) [in feet]

Severity of Risk: Low ☐ Med ☐ High ☐
Avoiding action taken: Yes ☐ No ☐
In communication with: ____________ FIR ☐ Country ☐
Traffic information received: Yes ☐ No ☐
Your Callsign: ____________
Frequency in use: ____________
Heading: ____________
Cleared Altitude: FL ________ / __________ ft
Reported to ATC: Yes ☐ No ☐ If yes, to which ATS unit: ______________

Minimum Vertical Separation: __________ ft
Minimum Horizontal Separation: ________ m ☐ NM ☐
TCAS Alert: RA ☐ TA ☐ None ☐
Type of RA: ______________
RA followed: No ☐ Yes ☐ Vert. deviation ________ ft
Was TCAS Alert: necessary ☐ useful ☐ nuisance ☐
Describe overleaf in Section 6 additional information such other A/C type, markings, color, lighting, callsign, etc.:
by Radio ☐ Phone ☐ Fax ☐ Telex ☐

SECTION 8: Wake Turbulence

Heading: ______ DEG Left ☐ No ☐ Right ☐
Position on extended centerline: Left ☐ On ☐ Right ☐
Position on glideslope: Left ☐ On ☐ Right ☐
Change in attitude: Pitch ☐ Roll ☐ Yaw ☐ Degrees ____
Change in altitude: __________ ft
Was there buffet?: Yes ☐ No ☐ Stickshaker: Yes ☐ No ☐
Stallwarning: Yes ☐ No ☐
What made you suspect wake turbulence?:
Describe any vertical acceleration:
Give details of preceding A/C (Type, Callsign, etc)
Were you aware of other A/C before incident? Yes ☐ No ☐

SECTION 9: Bird Strike

Type of birds: ______________
Nr seen: 1 ☐ 2-10 ☐ 11-100 ☐ more ☐
Nr struck: 1 ☐ 2-10 ☐ 11-100 ☐ more ☐
Time: dawn ☐ day ☐ dusk ☐ night ☐
Pilot warned of birds: Yes ☐ No ☐
Was any avoiding action attempted: Yes ☐ No ☐
Describe impact points and damage in Section 7

SECTION 10: Fuel Dumping

Duration [in min]: ________ Amount dumped [in kg]: ________
Location by: Crew ☐ ATC ☐ ______________
Altitude by: Crew ☐ ATC ☐ FL ________ / ________ ft
Actual Landing Mass: __________ kg
Max Landing Mass: __________ kg

SECTION 11: Form Submission

Print / Fax

If you wish to return this form by fax, please press the PRINT FORM button below and fax to ------------------------------ (Web Fax) or scan and email to **flightsafety**

Print Form

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APPENDIX C

Tables

Table C1

Hofstede's Cultural Dimension

Country	PDI	IDV	MAS	UA
ALGERIA	80	38	52	68
ARGENTINA	49	46	56	86
ARMENIA	66	37	45	85
AUSTRALIA	36	90	61	51
AUSTRIA	11	55	79	70
BAHRAIN	90	25	50	80
BANGLADESH	80	20	55	60
BELGIUM	65	75	54	91
BHUTAN	94	52	32	28
BOLIVIA	69	38	49	76
BOSNIA	73	33	40	80
BOTSWANA	60	35	40	50
BRAZIL	69	38	49	76
BRUNEI DARUSSALAM	104	26	50	36
BULGARIA	70	30	40	85
CANADA	39	80	52	48
CHILE	63	23	28	86
CHINA	80	20	66	30
COLOMBIA	67	13	64	80
COSTA RICA	35	15	21	86
COTE D IVOIRE	77	20	46	54
CROATIA	73	33	40	80
CYPRUS	66	37	45	85
DENMARK	18	74	16	23
DOMINICAN REP	65	30	65	45
EGYPT	80	38	52	68
EL SALVADOR	66	19	40	94
ETHIOPIA	70	20	65	55
FINLAND	33	63	26	59
FRANCE	68	71	43	86
FRENCH POLYNESIA	94	32	64	44
GERMANY	35	67	66	65
GREECE	60	35	57	112
GUATEMALA	95	6	37	101
HUNGARY	46	80	88	82
INDIA	77	48	56	40
INDONESIA	78	14	46	48
IRAN	58	41	43	59

Country	PDI	IDV	MAS	UA
IRAQ	95	30	70	85
IRELAND	28	70	68	35
ITALY	50	76	70	75
JAMAICA	45	39	68	13
JAPAN	45	39	68	13
JORDAN	80	38	52	68
Kenya	70	25	60	50
KOREA S.(REP. OF)	60	18	39	85
KUWAIT	90	25	40	80
LEBANON	75	40	65	50
MADAGASCAR	70	25	40	50
MALAYSIA	104	26	50	36
MALDIVES	77	48	56	40
MALI	77	20	46	54
MALTA	56	59	47	96
MAURITIUS	70	25	40	50
MEXICO	81	30	69	82
MOLDOVA	90	30	42	90
MOROCCO	70	25	53	68
MOZAMBIQUE	60	35	40	50
NEPAL	65	30	40	40
NETHERLANDS	38	80	14	53
NEW CALEDONIA	94	32	64	44
NEW ZEALAND	22	79	58	49
OMAN	95	25	60	80
PAKISTAN	55	14	50	70
PAPUA NEW GUINEA	94	32	64	44
PERU	64	16	42	87
PHILIPPINES	94	32	64	44
PORTUGAL	63	27	31	104
QATAR	95	25	60	80
ROMANIA	90	30	42	90
RUSSIAN FEDERATION	93	39	36	95
SAUDI ARABIA	95	25	60	80
SENEGAL	77	20	46	54
SERBIA & MONTENEGRO	86	25	43	92
SEYCHELLES	70	25	40	50
SINGAPORE	74	20	48	8
SLOVAKIA	104	52	110	51
SLOVENIA	71	27	19	88
SOUTH AFRICA	49	65	63	49

Country	PDI	IDV	MAS	UA
SPAIN	57	51	42	86
SRI LANKA	80	35	10	45
SUDAN	80	38	52	68
SWEDEN	31	71	5	29
SWITZERLAND	34	68	70	58
SYRIAN ARAB REP	80	38	52	68
TAIWAN	58	17	45	69
THAILAND	64	20	34	64
TRINIDAD AND TOBAGO	47	16	58	55
TUNISIA	80	38	52	68
TURKEY	66	37	45	85
UGANDA	70	20	65	55
UKRAINE	93	39	36	95
UNITED ARAB EMIRATES	90	25	50	80
UNITED KINGDOM	35	89	66	35
UNITED STATES	40	91	62	46
VENEZUELA	81	12	73	76
YEMEN	95	25	60	80
YUGOSLAVIA	86	25	43	92
ZAMBIA	60	35	40	50
ZIMBABWE	60	35	40	50

Table C2

List of Variables

Variable Name	Variable Components	Used in Analyses	Code
Event_ID	ID number of incident / event	No	No
Flight_No	Flight number	No	No
Fleet	Aircraft type, 5 categories: A320, A330, A340, and B777	Yes	5 categories from 1 - 5
Aircraft_Reg	Registration number of Aircraft	No	No
Depart_Airport	Departure airport, 181 airports	Yes	181 categories from 1 - 181
Destination	Destination / arrival airport, 181 airports	Yes	181 categories from 1 - 181
TO_Date	Takeoff Date (Day-Month_Year)	Yes	No
Arr_Date	Arrival Date (Day-Month_Year)	Yes	No
Peak_Time	Peak time (Day-Month_Year)	No	No
Status	Status of incident / event: indicating the validity of the event to be used in the data: Only valid events were included in the dataset.	Yes	No
Event_Name	Name of incident / event; 69 different events, with only 49 events relevant to the study: Abnormal Pitch (Low), Abnormal Sink Rate, Abnormal Vertical G with Flap, Approach Speed High (<500ft), Approach Speed High (pre Go Around), Approach Speed Low (<1000ft), Approach Speed Low (<500ft), Brakes used during takeoff, Climb out speed high, Climb out speed low, Deviation above glideslope, Deviation below glideslope, Dual Side Stick Input (Pitch), Dual Side Stick Input (Roll), Early	Yes	69 categories from 1 - 69

Variable Name	Variable Components	Used in Analyses	Code
	config change after takeoff (height), Excessive bank, Excessive bank after takeoff (<1000ft), Excessive bank after takeoff (<500ft), Excessive bank after takeoff (<50ft), Excessive bank on approach (<500ft), Excessive Bank on landing (at touchdown), Excessive Bank on landing (below Flare Ht), Flap Placard Speed Exceeded, Gear Extension Speed Exceeded, Gear Limiting Speed Exceeded, Gear Retraction Speed Exceeded, GPWS (GLIDESLOPE), GPWS (SINK RATE), GPWS (TOO LOW FLAPS), High rate of descent (<1000ft), High rate of descent (<500ft), Late Initial Stabilisation (Ht AAL), Late land flap (height AAL), Late land gear, Late T/R Cancellation, Low power on approach, Max operating altitude exceeded, Overweight Landing, Pitch Low (approach), Reverse Not Deployed After Landing, Rough taxiing, Speed Brake not armed for landing, Takeoff Weight Limit Exceedance, Unstable approach (roll), and Vmo/Mmo Exceeded.		
Value_Name	Specific kind of incident / event; 71 different categories: Airspeed - max vs Vapp below 500 ft, Airspeed - max vs Vapp pre-Go Around, Airspeed - max vs Vfe (2 secs), Airspeed - max vs Vle (2 secs), Airspeed - max vs Vlo ext (2 secs), Airspeed - max vs Vlo ret (2 secs), Airspeed - max vs Vref (500 to 50ft),	No	No

Variable Name	Variable Components	Used in Analyses	Code
	Airspeed - min vs Vapp below 500 ft, Airspeed - min vs Vls below 1000 ft, Airspeed - min vs Vls below 500 ft, Airspeed - min vs Vref (1000 to Flare), Airspeed - vs Max for Altitude (SOP), Airspeed - vs V2 (highest <1,000ft RAL, Airspeed - vs V2 (lowest <1,000ft RALT, Airspeed - vs V2 at 1st Config Change, Alpha Floor; Altitude - max vs ceiling, Brake Pedal – sum; Distance - until t/d from 50ft RALT, Distance - until t/d from flare ht, Flap - landing flap AAL, Flap - landing flap AAL (ignoring RALT), Fuel Flow – Min, Gear - down AAL, Groundspeed - max (5 secs); Groundspeed at T/R cancel, GS Dev - max (below 1000 ft), GS Dev - max (below 500ft), GS Dev - min (below 500ft), Height above rwy - config change, Lateral G - max abs, Longitudinal G - max abs, Mach - max vs Mmo, N1 - min (500ft to 50ft), No Reverse After Landing, Pilot Event, Pitch - min (1000 to 500ft), Pitch - most –ve, Rad Alt - min (Glideslope), Rad Alt - min (GPWS Active), Rad Alt - min (Sink Rate), Rad Alt - min (Terrain), Rad Alt - min (Too Low Flap), Rad Alt - min (Too Low Terrain), Radio Ht - min during Go Around, Roll – max, Roll - max (1500 to 1000ft), Roll - max (50 to 500ft), Roll - max (500 to 1000ft), Roll - max (500 to 50ft), Roll - max (at touchdown), Roll - max (below 50ft),		

Variable Name	Variable Components	Used in Analyses	Code
	Roll - max (below flare ht), Side Stick Product (Pitch), Side Stick Product (Roll), Sink Rate - max (1000 to 500ft), Sink Rate - max (2000 to 1000ft), Sink Rate - max (below 500ft), Spoilers - not armed, Stable Approach - Ht AAL (first stable), TCAS RA (duration), TCAS TA (duration), Tyre Speed - max vs limit, Vertical G – largest, Vertical G - largest with flap, Vertical G - most –ve, Vertical G - most +ve, Vertical Speed - max sink (10 secs), Weight vs Max Landing (specific a/c), Weight vs Max Takeoff, and Windshear Active.		
State_Name	Specific kind of value of incident / event; 16 different categories.	No	No
Type	Type of incident / event; 7 different categories: Speed, Acceleration, Flight Path, Attitude, Power, Configuration, and Warnings.	Yes	7 categories from 1 - 7
Phase	Phase incident / event took place; 5 different phases: Air, Entire Phase, Ground, Landing and Approach, Takeoff and Climb.	Yes	5 categories from 1 - 5
Severity	Severity of incident / event as a percentage, coded into three categories: Minor (less than 51), Major (between 51 and 74), and Critical (between 75 and 100).	Yes	3 categories from 1 - 3
Value	Speed of aircraft	No	No
Units	Units of Speed of aircraft	No	No
Capt1_ID	Captain ID number; this information is stored in a different secure data file to ensure anonymity and confidentiality.	No	No
CP1AGE	Age of captain in years	Yes	No

Variable Name	Variable Components	Used in Analyses	Code
CP1NAT	Nationality of captain	Yes	7 continents
Capt1Country	Country of captain	No	No
FO1_ID	First officer ID number; this information is stored in a different secure data file to ensure anonymity and confidentiality.	No	No
FO1AGE	Age of First Officer in years	Yes	No
FO1NAT	Nationality of first officer	Yes	7 continents
FO1Country	Country of first officer	No	No

Table C3

Categories of Unsafe Performance Events

Specific Incident	Minor Severity	Major Severity	Critical Severity	Total	% within Category
Unsafe Performance Event Category: Hard Landings					
Vertical G - largest with flap	0	13	0	13	100%
Unsafe Performance Event Category: Unstable Approaches					
Flap - landing flap AAL	0	61	2	63	22.0%
Sink Rate - max (1000 to 500ft)	0	38	0	38	13.3%
Airspeed - max vs Vref (500 to 50ft)	15	14	0	29	10.1%
GS Dev - max (below 500ft)	0	9	18	27	9.4%
Sink Rate - max (below 500ft)	0	25	0	25	8.7%
Rad Alt - min (Glideslope)	0	23	0	23	8.0%
Roll - max (500 to 50ft)	0	9	8	17	5.9%
Airspeed - max vs Vapp below 500 ft	7	9	0	16	5.6%
Airspeed - max vs Vapp pre-Go Around	0	11	0	11	3.8%
Roll - max (below flare ht)	0	2	7	9	3.1%
Gear - down AAL	0	5	0	5	1.7%
GS Dev - max (below 1000 ft)	4	0	1	5	1.7%
Rad Alt - min (Sink Rate)	0	4	0	4	1.4%
Airspeed - min vs Vapp below 500 ft	1	1	0	2	0.7%
Airspeed - min vs Vls below 500 ft	0	1	1	2	0.7%
N1 - min (500ft to 50ft)	1	1	0	2	0.7%
Rad Alt - min (Too Low Flap)	0	2	0	2	0.7%
Airspeed - min vs Vls below 1000 ft	0	0	1	1	0.3%
Airspeed - min vs Vref (1000 to Flare)	1	0	0	1	0.3%
Flap - landing flap AAL	0	1	0	1	0.3%
Roll - max (1500 to 1000ft)	1	0	0	1	0.3%
Roll - max (at touchdown)	0	0	1	1	0.3%
Stable Approach - Ht AAL	1	0	0	1	0.3%

Specific Incident	**Minor Severity**	**Major Severity**	**Critical Severity**	**Total**	**% within Category**
Unsafe Performance Event Category: Pilot Deviation					
Sidestick Product (Pitch)	0	53	173	226	28.6%
Airspeed - vs Max for Altitude (SOP)	4	44	57	105	13.3%
Sidestick Product (Roll)	0	5	49	54	6.8%
No Reverse After Landing	0	0	50	50	6.3%
Airspeed - vs V2	0	46	0	46	5.8%
Spoilers - not armed	0	46	0	46	5.8%
Airspeed - max vs Vfe (2 secs)	0	40	0	40	5.1%
Airspeed - vs V2	4	36	0	40	5.1%
Roll - max	9	15	11	35	4.4%
Vertical Speed - max sink (10 secs)	0	33	0	33	4.2%
Groundspeed - max (5 secs)	5	21	0	26	3.3%
Sink Rate - max (2000 to 1000ft)	0	17	0	17	2.2%
Roll - max (50 to 500ft)	0	7	6	13	1.6%
Weight vs Max Landing (specific a/c)	0	11	0	11	1.4%
Brake Pedal - sum	3	6	0	9	1.1%
Groundspeed at T/R cancel	0	7	0	7	0.9%
Lateral G - max abs	0	6	0	6	0.8%
Longitudinal G - max abs	1	5	0	6	0.8%
Height above rwy - config change	1	3	0	4	0.5%
Airspeed - max vs Vlo ext (2 secs)	0	3	0	3	0.4%
Pitch - most -ve	2	1	0	3	0.4%
Altitude - max vs ceiling	0	2	0	2	0.3%
Mach - max vs Mmo	0	1	1	2	0.3%
Airspeed - vs V2 at 1st Config Change	0	1	0	1	0.1%
Pitch - min (1000 to 500ft)	1	0	0	1	0.1%
Roll - max (500 to 1000ft)	0	1	0	1	0.1%
Roll - max (below 50ft)	0	1	0	1	0.1%
Weight vs Max Takeoff	0	0	1	1	0.1%
Total by Severity	61	640	387	1088	

Table C4

List of Continents by Nationalities

Continent	Code	Nationality
Africa	1	Motswana, Algerian, Ethiopian, Kenyan, Mozambican, Seychellois, Ugandan, South African, Zimbabwe, Mauritian, Cote D l'voire, Malian, and Senegalese.
Asia / Pacific	2	Australian, Bangladeshi, Indonesian, Indian, South Korean, Sri Lankan, Malaysian, New Zealander, Pakistani, Filipino, Papa New Guinea, Singaporean, Thai, Taiwanese, Bhutanese, Maldivian, Nepalese, French Polysian, Bruneian, Chinese, and New Caledonian.
CIS	3	Moldovan, Russian, and Ukrainian.
Europe	4	Belgian, Bulgarian, Swiss, Cypriot, German, Spanish, French, British, Greek, Hungarian, Irish, Italian, Maltese, Dutch, Portuguese, Swedish, Turkish, Danish, Finish, Romanian, Slovakian, Austrian, Bosnian & Herzegovin, Yugoslavian, Serbian & Montenegrin, Dutch, Maltese, and Croatian.

Continent	Code	Nationality
Latin American & the Caribbean	5	Bolivian, Brazilian, Chilean, Colombian, Costa Rican, Guatemalan, Jamaican, Mexican, Peruvian, Salvadorian, Trinidad & Tobago, Venezuelan, Argentinean, and Dominican.
Middle-East & North Africa	6	Emirati, Egyptian, Jordanian, Lebanese, Moroccan, Sudanese, Syrian, Tunisian, Qatari, Saudi Arabian, Yemeni, Bahraini, Iraqi, Kuwaiti, and Omani.
North America	7	Canadian and American

Table C5

Destination Airports by Category

Pilot Eligibility Category by Destination		
A	B	C
Abu Dhabi	Almaty	Addis Ababa
Ahmedabad	Amman (Queen Alia)	Kathmandu
Alexandria (Borg El Arab)	Astana	Peshawar
Amsterdam	Baghdad	Seychelles
Athens	Basrah	
Bahrain	Beirut	
Bangalore	Benghazi	
Bangkok	Calicut	
Beijing	Chicago	
Belgrade	Damascus	
Berlin Tegel	Djibouti	
Brisbane	Eldoret	
Brussels	Erbil	
Bucharest	Geneva	
Cairo	Guangzhou	
Cape Town	Hong Kong	
Casablanca	Islamabad	
Chengdu	Istanbul Sabiha Gokcen	
Chennai	Jakarta	
Cochin	Johannesburg	
Colombo	Karachi	
Copenhagen	Khartoum	
Dammam	Kuala Lumpur	
Delhi	Lagos	
Dhaka	Larnaca	
Doha	Manila	
Dublin	Mauritius	
Dusseldorf	Melbourne	
Frankfurt Hahn	Moscow Domodedovo	
Frankfurt Main	Mumbai	
Ho Chi Minh	N'Djamena	
Hyderabad	Nairobi	
Istanbul Ataturk	New York Kennedy Intl	
Jeddah	Sao Paulo	
Kuwait	Stuttgart	
Lahore	Tehran	
London Heathrow	Thessaloniki	

Pilot Eligibility Category by Destination		
A	B	C
Male	Thiruvananthapuram	
Manchester	Zurich	
Milan Malpensa		
Minsk -2		
Munich		
Muscat		
Nagoya		
Paris Charles-De-Gaulle		
Riyadh		
Rome		
Seoul		
Shanghai		
Singapore		
Stockholm		
Sydney		
Tokyo		
Tripoli		
Vienna		
Washington Dulles Intl		
Yangon		

Table C6

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	25.840	1.226		21.082	.000		
	V1NatCombination1_1 Continent Capt 1 FO 1	10.160	9.780	.029	1.039	.299	.987	1.014
	V2NatCombination1_2 Continent Capt 1 FO 2	-3.261	4.046	-.023	-.806	.420	.922	1.085
	V4NatCombination1_4 Continent Capt 1 FO 4	1.838	3.404	.016	.540	.589	.889	1.124
	V5NatCombination1_5 Continent Capt 1 FO 5	-5.674	6.970	-.023	-.814	.416	.974	1.027
	V6NatCombination1_6 Continent Capt 1 FO 6	-8.490	3.953	-.061	-2.148	.032	.918	1.090
	V7NatCombination1_7 Continent Capt 1 FO 7	14.160	16.851	.023	.840	.401	.995	1.005
	V8NatCombination2_1 Continent Capt 2 FO 1	3.293	4.509	.021	.730	.465	.937	1.067
	V9NatCombination2_2 Continent Capt 2 FO 2	4.027	2.215	.058	1.818	.069	.741	1.350
	V11NatCombination2_4Continent Capt 2 FO 4	3.199	2.067	.051	1.548	.122	.703	1.423
	V12NatCombination2_5Continent Capt 2 FO 5	5.118	3.643	.040	1.405	.160	.903	1.107
	V13NatCombination2_6Continent Capt 2 FO 6	-3.278	2.718	-.036	-1.206	.228	.827	1.209
	V14NatCombination2_7Continent Capt 2 FO 7	1.826	4.509	.011	.405	.686	.937	1.067
	V16NatCombination3_2Continent Capt 3 FO 2	-21.840	16.851	-.036	-1.296	.195	.995	1.005
	V18NatCombination3_4Continent Capt 3 FO 4	-4.840	11.947	-.011	-.405	.685	.991	1.009
	V20NatCombination3_6Continent Capt 3 FO 6	-5.674	6.970	-.023	-.814	.416	.974	1.027
	V22NatCombination4_1Continent Capt 4 FO 1	-4.068	3.787	-.031	-1.074	.283	.911	1.098
	V23NatCombination4_2Continent Capt 4 FO 2	.433	2.041	.007	.212	.832	.696	1.437

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
V26NatCombination4_5Continent Capt 4 FO 5	4.537	2.789	.049	1.627	.104	.836	1.197
V27NatCombination4_6Continent Capt 4 FO 6	-.939	1.908	-.017	-.492	.623	.653	1.531
V28NatCombination4_7Continent Capt 4 FO 7	-1.994	4.820	-.012	-.414	.679	.945	1.059
V29NatCombination5_1Continent Capt 5 FO 1	7.826	6.970	.031	1.123	.262	.974	1.027
V30NatCombination5_2Continent Capt 5 FO 2	.360	3.094	.003	.116	.907	.866	1.155
V32NatCombination5_4Continent Capt 5 FO 4	4.866	2.524	.059	1.928	.054	.800	1.251
V33NatCombination5_5Continent Capt 5 FO 5	-.340	4.147	-.002	-.082	.935	.925	1.081
V34NatCombination5_6Continent Capt 5 FO 6	-1.420	2.674	-.016	-.531	.595	.821	1.218
V35NatCombination5_7Continent Capt 5 FO 7	18.160	16.851	.030	1.078	.281	.995	1.005
V36NatCombination6_1Continent Capt 6 FO 1	-5.340	11.947	-.012	-.447	.655	.991	1.009
V37NatCombination6_2Continent Capt 6 FO 2	-.182	2.897	-.002	-.063	.950	.847	1.180
V38NatCombination6_3Continent Capt 6 FO 3	1.160	16.851	.002	.069	.945	.995	1.005
V39NatCombination6_4Continent Capt 6 FO 4	4.947	2.405	.064	2.058	.040	.779	1.283
V40NatCombination6_5Continent Capt 6 FO 5	10.215	4.147	.070	2.464	.014	.925	1.081
V41NatCombination6_6Continent Capt 6 FO 6	-4.110	2.447	-.052	-1.680	.093	.787	1.271
V42NatCombination6_7Continent Capt 6 FO 7	4.160	9.780	.012	.425	.671	.987	1.014
V43NatCombination7_1Continent Capt 7 FO 1	-15.440	7.615	-.056	-2.028	.043	.978	1.023
V44NatCombination7_2Continent Capt 7 FO 2	-5.507	4.147	-.038	-1.328	.184	.925	1.081
V46NatCombination7_4Continent Capt 7 FO 4	2.812	3.713	.022	.757	.449	.907	1.103

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
V47NatCombination7_5Continent Capt 7 FO 5	-3.269	6.469	-.014	-.505	.613	.969	1.032
V48NatCombination7_6Continent Capt 7 FO 6	-2.785	4.147	-.019	-.672	.502	.925	1.081

a. Dependent Variable: Event_name_New Name of event / Incident

Table C7

Casewise Diagnostics

Case Number	Std. Residual	Event_name_New Name of event / Incident	Predicted Value	Residual
6	2.236	62	24.42	37.580
22	2.029	59	24.90	34.098
205	2.029	59	24.90	34.098
290	2.162	62	25.66	36.341
318	2.236	62	24.42	37.580
354	2.207	62	24.90	37.098
359	2.126	62	26.27	35.726
380	2.346	62	22.58	39.421
459	2.347	62	22.56	39.437
476	2.139	59	23.06	35.944
537	2.215	59	21.77	37.227
591	2.126	62	26.27	35.726
611	2.218	59	21.73	37.270
626	2.152	62	25.84	36.160
668	2.509	68	25.84	42.160
693	2.029	59	24.90	34.098
708	2.396	62	21.73	40.270
773	2.207	62	24.90	37.098

Case Number	Std. Residual	Event_name_New Name of event / Incident	Predicted Value	Residual
788	2.270	62	23.85	38.154
802	2.162	62	25.66	36.341
808	2.011	60	26.20	33.800
813	2.033	60	25.84	34.160
820	2.317	62	23.06	38.944
825	2.478	59	17.35	41.650
897	2.249	64	26.20	37.800
927	2.311	59	20.17	38.833
948	2.029	59	24.90	34.098
1010	2.378	69	29.04	39.961
1014	2.152	62	25.84	36.160
1040	2.033	60	25.84	34.160
1100	2.396	62	21.73	40.270
1147	2.207	62	24.90	37.098
1210	2.207	62	24.90	37.098
1287	2.624	69	24.90	44.098
1295	2.042	62	27.68	34.321
1299	2.007	60	26.27	33.726
1308	2.162	62	25.66	36.341
1314	2.396	62	21.73	40.270

APPENDIX D

Figures

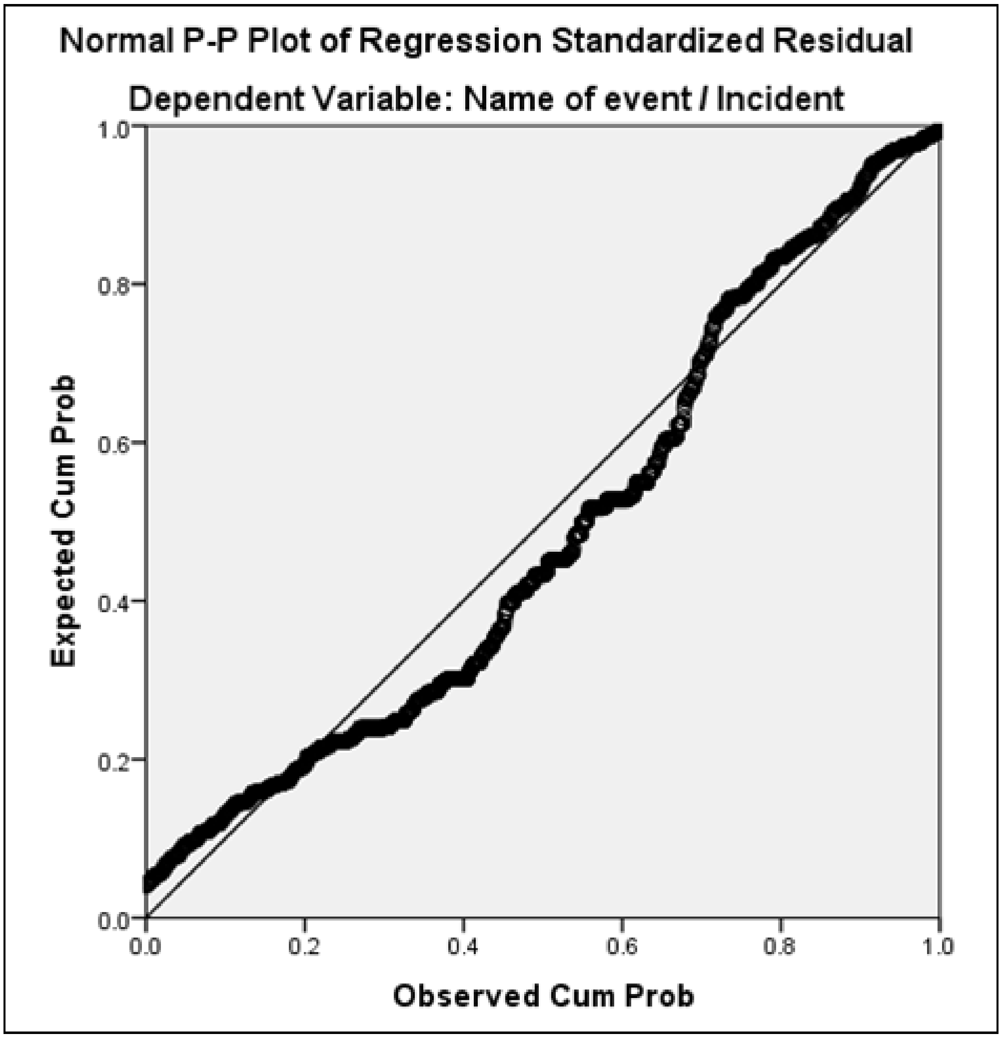

Figure D1. Normal P-P Plot of Regression Residual.

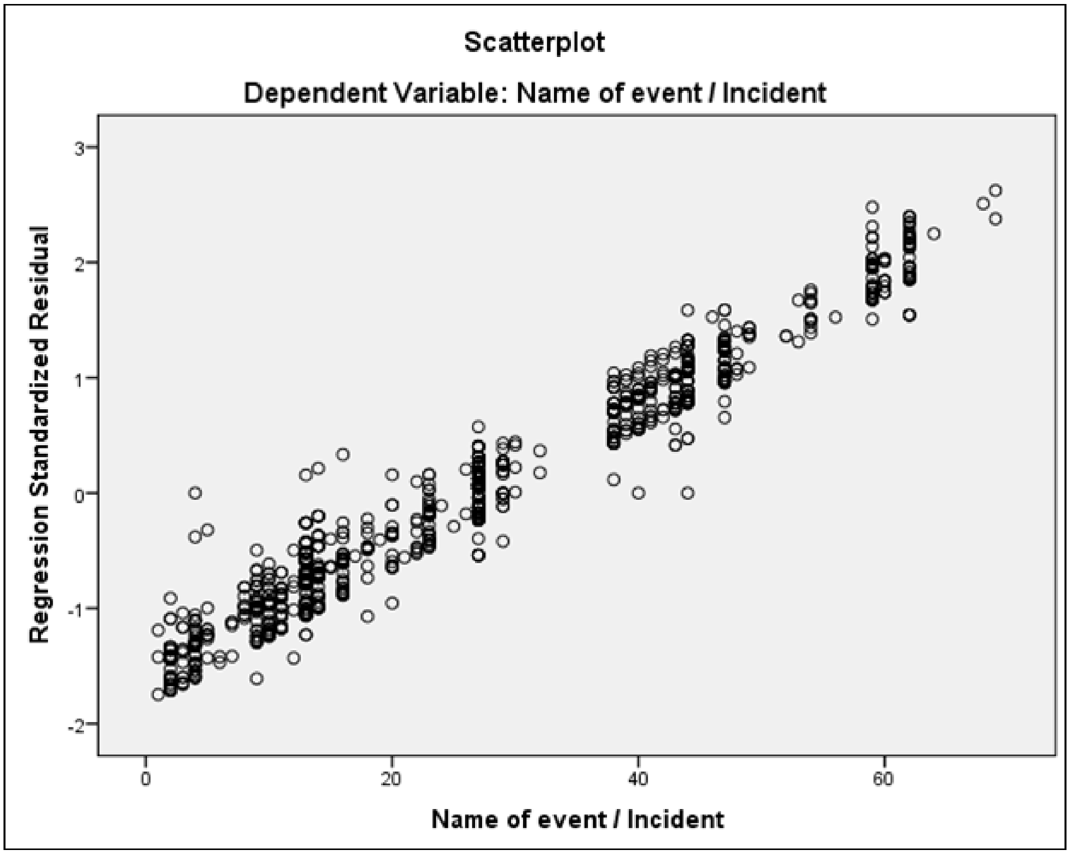

Figure D2. Scatterplot.