7-2010

The Taiwan Civil Aviation Safety Reporting (TACARE) System in Aircraft Maintenance: An Evaluation of the Acceptance of Voluntary Incident Reporting Programs for Maintenance Personnel in Taiwan

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THE TAIWAN CIVIL AVIATION SAFETY REPORTING (TACARE) SYSTEM IN AIRCRAFT MAINTENANCE: AN EVALUATION OF THE ACCEPTANCE OF VOLUNTARY INCIDENT REPORTING PROGRAMS FOR MAINTENANCE PERSONNEL IN TAIWAN

by

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A Thesis Submitted
to the Department of Applied Aviation Sciences
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Aeronautics

Embry-Riddle Aeronautical University
Daytona Beach, Florida
July 2010

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This Thesis was prepared under the direction of the candidate's thesis advisor, Dr. Donald S. Metscher, Associate Professor, Daytona Beach Campus, and has been approved by the Thesis Committee. It was submitted to the Department of Applied Aviation Sciences in partial fulfillment of the requirements for the Degree of Master of Aeronautical Science.

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ACKNOWLEDGMENTS

First, I would like to deeply acknowledge, and express my appreciation, to the Lord God for guiding me, protecting me, and illuminating me in each day of my life. I would like to manifest my sincere and deep gratitude to my parents, Chia-Ning Chen and Yin Ming, who have done the impossible to support my dreams and education at Embry-Riddle Aeronautical University. I would like to thank my girlfriend Karen Chu and all my world-wide friends for their provided support.

I also manifest a special thanks to Dr. Donald S. Metscher, without whom this project would not have been realized. I extend this appreciation to Dr. James Ramsay and Captain Roger Mason for the time and wisdom they contributed to this project. I also want to express my gratitude to Dr. Thomas R. Weitzel and Dr. Douglas Farrow for their kindness assistance with their expertise. I thank the program chair Dr. Marvin Smith, the faculty members, and all the Embry-Riddle Aeronautical University collaborators, whose hard work has helped my academic life to be successful.

ABSTRACT

Researcher: Yi-Fan (Tom) Chen

Title: The TAiwan Civil Aviation safety REporting (TACARE) System in Aircraft Maintenance: An Evaluation Of The Acceptance Of Voluntary Incident Reporting Programs For Maintenance Personnel In Taiwan

Institution: Embry-Riddle Aeronautical University

Degree: Master of Science in Aeronautics

Year: 2010

The purpose of this research was to examine the effectiveness of the TAiwan Civil Aviation safety REporting (TACARE) system for maintenance personnel to improve aircraft safety. The research evaluated what are the issues that affect the participation of the TACARE system. The understandings of the safety culture for maintenance personnel in Taiwan were also analyzed. The research was conducted with a mixed method. The survey and interview were developed to sample the acceptance and opinions regarding the TACARE system for the maintenance personnel in Taiwan. Statistical analysis of the data from 605 survey respondents and 9 interviewees concluded the maintenance personnel in Taiwan lacked the necessary knowledge of voluntary safety reporting. The results yielded the agreement with importance of promoting voluntary safety reporting programs in Taiwanese aircraft maintenance industry.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

A&P	Airframe and Powerplant
AQP	Advanced Quality Program
ASAP	Aviation Safety Action Program
ASC	Aviation Safety Council
ASIAS	Aviation Safety Information Analysis and Sharing
ASRS	Aviation Safety Reporting System
CAA	Civil Aviation Administration
CAST	Commercial Aviation Safety Team
CFR	Code of Federal Regulation
CRM	Crew Resource Management
EGAT	Evergreen Aviation Technologies Corp.
EGAS	Evergreen Airline Services Corp.
ERC	Event Review Committee
FAA	Federal Aviation Administration
FOQA	Flight Operational Quality Assurance
HFACS	Human Factors Analysis and Classification System
IATA	International Air Transportation Association
IC	Individualism – Collectivism
ICAO	International Civil Aviation Organization
IEP	Internal Evaluation Program
IOSA	IATA Operational Safety Audit
JTSB	Japan Transportation Safety Board

LOSA	Line Operational Safety Audit
ME	Maintenance Extension
MEI	Maintenance Error Investigation
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MRM	Maintenance Resource Management
MRO	Maintenance, Repair, and Overhaul
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NTSB	National Transportation Safety Board
UA	Uncertainty Avoidance
PD	Power Distance
QA	Quality Assurance
QMS	Quality Management System
SMS	Safety Management System
SOP	Standard Operation Procedure
SPSS	Statistical Package for the Social Sciences
SRM	Safety Risk Management
TACARE	TAiwan Civil Aviation safety Reporting
TIAS	Taoyuan International Airport Services Co. Ltd.
TWA	Trans World Airlines
U.S.	United Sates
VDRP	Voluntary Disclosure Reporting Program

Chapter I

INTRODUCTION

Safety has always been a concern in the inherently high-risk aviation industry. In the Bird Triangle theory, Figure 1 shows that accidents have been rare. However, there have been many errors and incidents that preceded these infrequent major accidents. For every major accident, there were 15 minor accidents and 300 incidents. The goal of voluntary reporting is to prevent a tragic fatal accident by means of gathering, analyzing, and propagating these 300 incidents and even more safety related issues through the reports and share them with the entire aviation community (McVenes & Chidester, 2005).

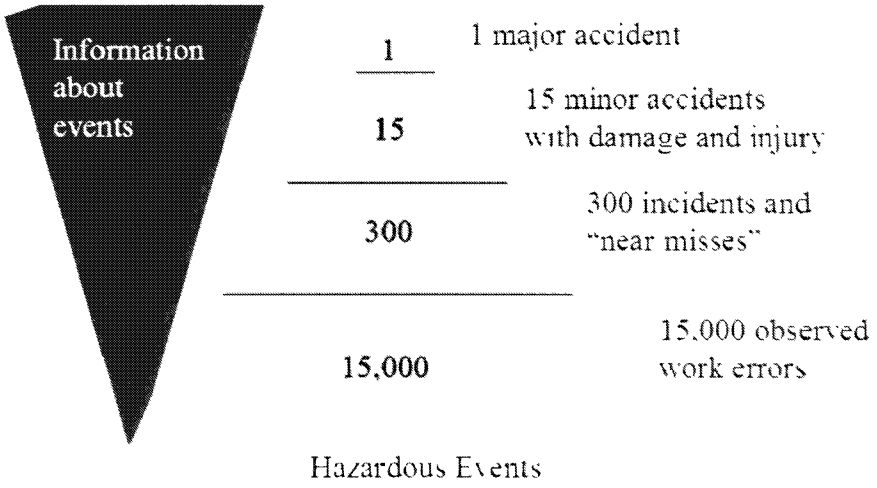

Figure 1. The Bird Triangle (Adapted from McVenes & Chidester, 2005).

"While fatal accidents are extremely rare and incidents of injury and minor damage occur occasionally, near-misses and work errors can take place on a daily basis" (McVenes & Chidester, 2005. p. 305). Most of these were unobserved and unreported, but they are still environmental threats or operating errors. However, they can lead to a fatal accident under the right circumstances. If those errors can be significantly reduced,

then the accident rate can also be reduced.

Before voluntary safety programs were implemented, information about hazards and safety problems became available only after an accident occurred. This reactive method has become inadequate for further safety improvements in the aviation industry. Voluntary safety reporting programs have enabled the airline industry to detect hazards and vulnerabilities in the air transportation system. Reports gathered from front-line employees have increased the possibility of seeing not only *what* happened, but also *why* it happened (Yeh, 2009). According to the statistical data from the Federal Aviation Administration (FAA), voluntary incident reporting programs, such as the Aviation Safety Reporting System (ASRS) and the Aviation Safety Action Program (ASAP), have discovered 90% of the problems which are previously unknown to the air carrier industry or the FAA (Farrow, 2009). As a result, safety recommendations have been generated from the information in those incident reports and helped to reduce the accident rate. The mean to enhance aviation safety has now transformed from accident investigations (reactive) to voluntary reporting (proactive and predictive).

Background of the Problem

Human errors have become the primary threat to aviation safety. Human factors have been involved with approximately 80% of jet aircraft accidents. Meanwhile, maintenance errors have contributed to 15% of commercial jet aircraft accidents (Boeing Company, n.d.). In addition to the flight crew, maintenance has become the second highest contributor to aircraft accidents. Frequently, maintenance mistakes and errors are almost undetectable and uncorrectable until the next inspection, or problems are

experienced later during the flight (Patankar & Taylor, 2004a). Therefore, most of the safety issues remained unseen by others until an accident or incident occurs.

Human errors in maintenance not only lead to fatal accidents, but also add costs to air carrier operations. According to one study, 20-30% of in-flight engine shutdowns and 50% of delays and cancellations are caused by human errors. Meanwhile, 48,800 non-airworthy aircraft are dispatched each year as a result of maintenance errors. The cost of flight cancellations and delays is steep. The cancellation of a commercial flight can cost an airline $50,000. The average cost for the aircraft to return to the gate is $15,000, and the average ground damage incident costs $70,000. One airline estimates $100 million a year is lost, and the total lost revenue from ramp accidents is $2.5 billion annually (Boquet, 2009).

The voluntary reporting systems for aircraft maintenance, such as the Aviation Safety Reporting System (ASRS) and the Aviation Safety Action Program (ASAP), have been successful in the United States. They accumulate two thousand reports from aircraft maintenance personnel every year (FAA, 2009). These safety programs for aircraft maintenance are considered effective tools to enhance aviation safety. On the contrary, Taiwan's Aviation Safety Council (ASC), which is similar to the National Transportation Safety Board (NTSB), has suffered from insufficient incident reports in its voluntary safety reporting system, known as the TAiwan Civil Aviation safety REporting (TACARE) system.

Statement of the Problem

The purpose of this study was to evaluate the effectiveness and acceptance of the TACARE system for maintenance personnel in Taiwan. Taiwan's ASC established a voluntary reporting program for its civil aviators in 1999, known as the TACARE system. To date, this system has accumulated a minimal number of incident reports from maintenance personnel. Accordingly, this study has been designed to address the need for voluntary incident reports concerning civil aircraft maintenance in Taiwan.

Significance of the Problem

Statistics of the Civil Aeronautics Administration (CAA, n.d.) in Taiwan show there are 2,210 certified mechanics in Taiwan. However, only a small number of them from air carriers and maintenance facilities participate in the TACARE system. This study examined the safety culture among Taiwanese maintenance personnel, and identified factors affecting the TACARE system.

Maintenance personnel's perceptions contribute to the effectiveness of the voluntary safety reporting system, TACARE. Certain cultural personalities of the Taiwanese maintenance personnel, company policies, and aviation regulations have been major influences in an effective aviation safety reporting system. To improve the acceptance of voluntary reporting programs in the Taiwanese aviation industry, the effectiveness of the U.S. voluntary aviation safety reporting system (such as ASRS and ASAP) was compared to the TACARE system.

Delimitations

This study discussed the importance of establishing voluntary safety reporting programs and integrating the concept of just culture among the maintenance personnel in Taiwan. Due to the sensitive nature of the data that have been received in the programs, de-identified examples have been utilized to illustrate different factors that may have been encountered in the real environment of the Taiwan aviation industry. The existing TACARE program has been addressed in the current study to evaluate the acceptance of voluntary reporting, but this research does not conduct a cost-effective analysis of the system.

Definition of Terms

Aviation Safety Council (ASC): An independent investigation agency in Taiwan. Its function is the same as the National Transportation Safety Board (NTSB) in the United States (U.S.). The ASC is the agency in charge of the voluntary reporting system, TAiwan Confidential Aviation safety REporting system (TACARE).

Aviation Safety Action Program (ASAP): One of the United States Federal Aviation Administration's voluntary safety programs. This is a self disclosure program utilized by air carrier and repair station employees.

Effectiveness: The degree to which implementing the voluntary safety programs in the Taiwan air carrier industry yields desired safety outcomes.

Event Review Committee (ERC): The ERC is responsible for reviewing and analyzing all ASAP reports that are submitted. It is also in charge of deciding what reports qualify for ASAP, identifying problems and risks from the reports, and providing solutions for those

problems and risks (FAA, 2002).

TAiwan Confidential Aviation safety REporting system (TACARE): A voluntary reporting system in Taiwan designed to invite flight crews, maintenance personnel, air traffic controllers, and the general public to report irregular events and hazards in the course of normal flight operations.

Safety Management System (SMS): A process-driven and proactive program that continuously collects and analyzes sizable volumes of data, providing a principled basis for the definition of activities and the allocation of resources to address safety concerns in a proactive manner (Galotti, Rao, & Maurino, 2006).

Just Culture: People recognize that although punishment serves little purpose from a safety perspective, punitive action may be necessary in some circumstances, and there is a need to define the line between acceptable and unacceptable actions.

Major Accident: An accident in which a 14 CFR 121 aircraft was destroyed, there were multiple fatalities, or there was one fatality and a 14 CFR 121 aircraft was substantially damaged (NTSB, 2010).

Incident: An occurrence, other than an accident, associated with the operation of an aircraft that affects or could affect the safety of operations (NTSB, 2010).

Chapter II

REVIEW OF THE RELEVANT LITERATURE

Accidents in commercial aviation have traditionally been viewed and treated as events where lessons could be learned to improve future safety. However, these lessons have often been learned with an unacceptable price – the loss of life. Today, even though the safety of aviation has been improved dramatically, maintenance errors have still caused several fatal accidents and incidents in recent years. Those accidents and other incidents raise public concerns on the airworthiness of the aircraft.

Maintenance Related Accidents

In the U.S., the most recent, catastrophic accident that involved maintenance problems was Alaska Airlines Flight 261 on January 31, 2000. Due to the malfunction of the jackscrew of the vertical tail trim system, the MD-83 jet plunged uncontrollably into the Pacific Ocean about 2.7 miles north of Anacapa Island, California (NTSB, 2002). A series of factors contributed to the failure of the jackscrew. Inadequate lubrication of the jackscrew which was caused by the extension of the lubrication interval was the main cause of the accident. However, the airline also failed to address several related problems, such as (a) imprecise procedures, (b) poor training, and (c) lack of supervision. The continuous negligence of improper maintenance actions resulted in the loss of 88 lives.

In Taiwan, there was one fatal accident and one incident which involved maintenance errors in the last 10 years. One of most serious accidents in Taiwan's aviation history was China Airlines Flight 611. On May 25, 2002, due to improper repairs and inspection from a previous accident, in which the airplane had a tail strike 20 years

earlier, the Boeing 747-200 airplane broke up over the Taiwan Strait while cruising at 35,000 feet (ASC, 2002). This was due to an improper repair which did not follow the correct instructions from the manufacturer. As a result of this, and over 20 years of wear on the aircraft, a structure failure in the tail section occurred. The aircraft disintegrated in the air and resulted in the loss of 225 people on board. In 2006, the 84-year-old former China Airlines engineer conducting this repair was being prosecuted for negligent homicide (United Daily News, 2006).

Another incident that recently occurred also involved maintenance errors. On August 20, 2007, a Boeing 737-800 operated by China Airlines landed and taxied into the apron at Naha Airport. Due to the detached downstop assembly from the slat track, when the slat was retracted, the component punctured a hole in the fuel tank. Fuel that was leaking from the fuel tank caught fire and the aircraft was engulfed in flames (JTSB, 2009). The aircraft was badly damaged and destroyed by fire. Fortunately, all 165 people on board were evacuated from the aircraft and there were no fatalities or injuries. Due to the design fault of the assembly, the assembly was not able to be maintained and repaired properly. Neither the manufacturer nor the airlines had addressed this issue sufficiently. Also, both the maintainer and supervisor who perform the maintenance on the assembly did not report any difficulty on that task.

From ASC statistics, there have been five fatal accidents involving Taiwanese air carriers from 1998 to 2007. As previously mentioned, one resulted from maintenance errors; hence, maintenance errors were causal in 20% of Taiwan's fatal aircraft accidents during the 10-year period. This figure does not include incidents or near-misses. Countless maintenance problems have cost human lives and revenue, yet the safety

standards in maintenance are not followed. Therefore, human errors in aircraft maintenance need to be addressed in order to prevent more accidents.

Human Factors in Aircraft Maintenance

Human factors in aviation has traditionally concentrated on aircrew and air traffic control errors, but the increasing number of maintenance and inspection errors has contributed to the rise of human factors research and interventions in this area. James T. Reason's Swiss Cheese Model (1997; Figure 2) demonstrated that a series of inadequate maintenance actions will result in a fatal accident. Consequently, the study of maintenance errors as precursors to incidents and accidents has become essential.

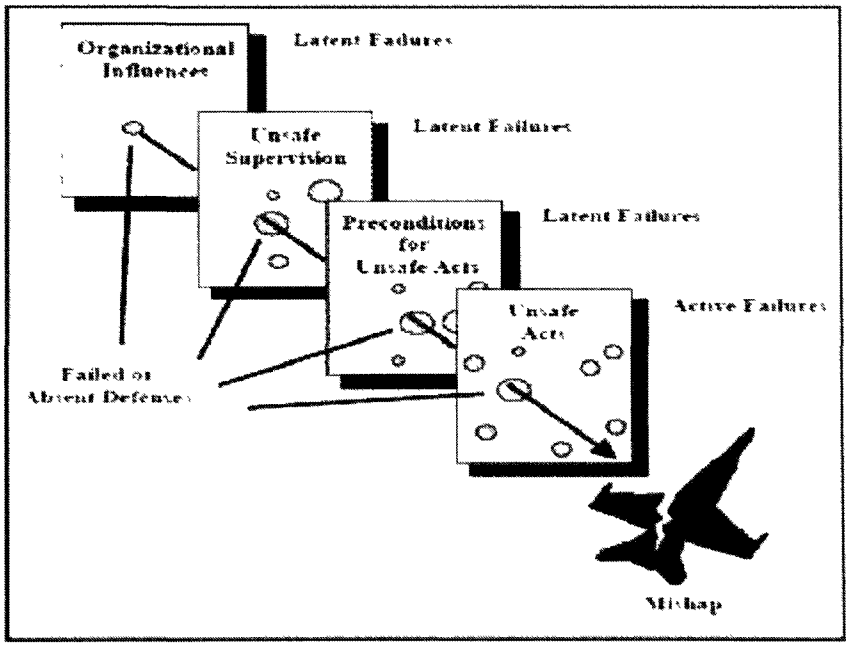

Figure 2. The Swiss Cheese Model of Accident Causation (Adapted from Reason, 1997).

Since the objective of voluntary incident reporting is to analyze and prevent incidents and accidents, it is critical for voluntary safety programs to conduct continuous

reviewing processes to identify potential hazards to flight safety. Human error models and taxonomies have facilitated the identification of human factors problem areas as well as provided a basis for the development of tailored intervention strategies. For maintenance errors, two major models to identify and analyze the problem are the Human Factors Analysis and Classification System (HFACS) and Dupont's Dirty Dozen.

Human Factors Analysis and Classification System (HFACS)

The Swiss Cheese model of accident causation is a model used in the risk analysis and management of human systems. It was originally set out by James T. Reason in 1990. Drawing upon Reason's (1990) concept of latent and active failures, the HFACS describes four levels of failure: (a) unsafe acts, (b) preconditions for unsafe acts, (c) unsafe supervision, and (d) organizational influences (Wiegmann & Shappell, 2003).

Unsafe acts can be classified into two categories: errors and violations (Reason, 1990). Errors represent the mental or physical activities of individuals that fail to achieve their intended outcome. Violations, on the other hand, refer to the willful disregard for the rules and regulations that govern the safety of flight. The categories of errors and violations expand further to include three basic error types: (a) skill-based, (b) decision, and (c) perceptual and two forms of violations: routine and exceptional (Wiegmann & Shappell, 2003). Unsafe acts can be directly linked to nearly 80 % of all aviation accidents (Boeing, n.d.). One of the most noticeable problems is simply "human error." Those errors in operations are mostly caused by latent conditions in the organization.

Within the preconditions level, there are three contributing factors: (a) condition of operators, (b) personal factors, and (c) environmental factors. The condition of

operators does influence performance on the job. In this category, there are three types of conditions: (a) adverse mental states, (b) adverse physiological states, and (c) physical/mental limitations. Those factors affect human performance (i.e., fatigue and disorientation). Personal factors refer to preconditions for unsafe acts that are created by people, such as communication skills. They have been divided into two general categories: Crew Resource Management (CRM) and personal readiness. Environmental factors (i.e., noise and automation) can also contribute to the substandard conditions of operators and hence to unsafe acts. They can be identified within two categories: physical and technological (Wiegmann & Shappell, 2003).

Reason (1990) also traced the causal chain of events back up the supervisory chain of command. HFACS has identified four categories of unsafe supervision: (a) Inadequate Supervision refers to the failure of supervisor to provide guidance, training opportunities, leadership, and motivation, as well as the proper role model to be emulated; (b) Planned Inappropriate Operations means that individuals are put at unacceptable risk, crew rest is jeopardized, and ultimately performance is adversely affected; (c) Failed to Correct a Known Problem refers to those instances when deficiencies among individuals, equipment, training or other related safety areas are "known" to the supervisor, yet are allowed to continue unabated; and (d) Supervisory Violations are reserved for those instances when existing rules and regulations are willfully disregarded by supervisors (Wiegmann & Shappell, 2003). A typical example in this level is the accident of Alaska 261, which was caused by inappropriate inspection.

For Organizational Influences, decisions of upper-level management directly affect supervisory practices, as well as the conditions and actions of operators. The most

elusive of latent failures revolve around issues related to (a) Resource Management, (b) Organizational Climate, and (c) Operational Process. Resource Management encompasses the realm of corporate-level decision making regarding the allocation and maintenance of organizational assets such as human resources and equipment. Organizational Climate is defined as the situation-based consistencies in the organization's treatment of individuals. Operational Process refers to corporate decisions and rules that govern the activities within an organization, including the establishment and use of standardized operating procedures and formal methods for maintaining oversight between the workforce and management (Wiegmann & Shappell, 2003). One of the organizational influences is the chain of command in the military, which often causes accidents by following superior's orders unquestionably.

HFACS framework bridges the gap between theory and practice by providing investigators with a comprehensive, user-friendly tool for identifying and classifying the human causes of aviation accidents. The ultimate goal is to reduce the aviation accident rate through systematic, data-driven investment.

Human Factors Analysis and Classification System – Maintenance Extension

Similar to the original Reason's Swiss Cheese model (1997), the HFACS – Maintenance Extension (ME) consists of four error categories: (a) Management Conditions, (b) Maintainer Conditions, (c) Working Conditions, and (d) Maintainer Acts. Management Conditions that cause active failures includes both organizational and supervisory. Maintainer Conditions that can contribute to an active failure include medical, crew coordination, and readiness. Working Conditions that can contribute to an

active failure include environmental, equipment, and workspace. Management, Maintainer, and Working Conditions are latent factors that can impact a maintainer's performance and can contribute to an active failure, an unsafe Maintainer Act. Unsafe Maintainer Acts (errors and violations) may lead directly to a mishap (Schmidt, Lawson, & Figlock, n.d.).

HFACS-ME is effective in capturing the nature of and relationships among latent conditions and active failures. It captures factors leading to maintenance error from a systematic approach. The insights gained provide a solid perspective for the development of potential intervention strategies (Schmidt et al., n.d.).

The Dirty Dozen

Besides the HFACS, the Dirty Dozen illustrates the contributing factors for human behaviors. In 1993, Transport Canada developed a series of training courses for mechanics, which would serve to reduce maintenance errors with Dr. Gordon Dupont. In close collaboration with the aviation industry, Transport Canada and Dr. Dupont subsequently identified 12 issues in maintenance errors, known as the Dupont's Dirty Dozen (1997). The following illustrates those 12 factors in detail (Dupont, 2009):

1. Lack of communication – It is simply the failure to exchange information. In good communication, the mental pictures must match.

2. Complacency – This is where someone becomes so self-satisfied that a person can lose awareness of dangers. It is also called overconfidence as people become more proficient at what they do.

3. Lack of knowledge – With constantly changing technology, this contributor to an error is more common than people think. It also refers to a lack of training to perform certain tasks.

4. Distraction – It is anything that takes someone's mind off the job at hand even for an instant. Any distraction can cause people to think further ahead than they should.

5. Lack of teamwork – The larger an organization becomes, the more common this contributing factor is. Because teamwork is constantly evolving and changing, it is hard to gain and very easy to lose.

6. Fatigue – It is insidious, and the person fails to realize just how much his/her judgment is impaired until it is too late.

7. Lack of resources – Using improper equipment to safely carry out a task has caused many fatal accidents.

8. Pressure – To be on time is ever-present in the aviation industry. Often, technicians have to rush to finish jobs.

9. Lack of assertiveness – In failing to speak up when things do not seem right has resulted in many fatal accidents. Assertiveness also calls for listening to the views of others before making a decision.

10. Stress – It is the subconscious response to the demands placed upon a person. Everyone experiences stresses at work. It is not all bad until it becomes excessive, and people become distressed.

11. Lack of awareness – It occurs when there is a lack of alertness and vigilance in observing. This usually occurs with very experienced persons who fail to reason out possible consequences to what may normally be a good practice.

12. Norms – It is the short term for "normal," or the way things actually are done around an organization. Norms are unwritten rules followed or tolerated by the majority of a group. Negative norms are those that detract from an established safety standard.

Since the development of the Dirty Dozen, maintenance personnel at most of the air carriers have routinely received training to recognize the Dirty Dozen and prevent their occurrence. However, the Dirty Dozen puts more emphasis individual performance rather than the entire organization. It only can identify the causes of maintainer's unsafe acts and preconditions.

Voluntary Incident Reporting

International Civil Aviation Organization (ICAO) Annex 13 (2001) Chapter 8 Section 8.2 recommends that "A State should establish a voluntary incident reporting system to facilitate the collection of information that may not be captured by a mandatory incident reporting system." Section 8.3 (p. 8-1) expounds that "A voluntary incident reporting system shall be non-punitive and afford protection to the sources of the information." The FAA also characterizes voluntary incident reporting as follows: (a) involve partnership and trust between regulator and regulated, (b) require some form of data collection, analysis and corrective action, and (c) program oversight from a single authority that specializes in voluntary programs (Farrow, 2010).

The main idea of reporting is to contribute to organizational learning. It is to help prevent recurrence by making systemic changes that aim to address some of the basic circumstances in which work went awry (Dekker, 2007). In aviation maintenance, safety is dependent on technical reliability of the hardware and human reliability of the maintenance personnel. Voluntary incident reporting programs acknowledge the complexity of this human-machine interface as well as the human relationships involved and provide a mean to address errors that impact the overall safety of aviation maintenance (FAA, 2009). Voluntary incident reporting programs have become valuable sources to study the human factors concerning aviation safety, especially maintenance where the problems often cannot be seen through inspections or self audits.

Aviation Safety Reporting System

In 1974, Trans World Airlines (TWA) Flight 514 had an accident in which the aircraft descended below the minimum safe attitude specified for the area in which it was flying and crashed into a Virginia mountain top. Only 6 weeks before the TWA crash, a United Airlines crew had narrowly escaped the same fate utilizing the same approach and location. The problem with approach procedure and the differences in its interpretation between pilots and controllers were brought into United's internal reporting system called Flight Safety Awareness Program. If this incident report had been shared industry wide, the TWA accident may have been prevented (NASA, 1986).

After TWA Flight 514's fatal accident, the Federal Aviation Administration (FAA) instituted the voluntary ASRS program on April 30, 1975, designed to encourage the identification and reporting of deficiencies and discrepancies in the system (FAA, 1997). The U.S. was one of the first nations to develop a voluntary incident reporting program. ASRS was established under a Memorandum of Agreement (MOA) between the FAA and the National Aeronautics and Space Administration (NASA). This cooperative safety reporting program invites pilots, controllers, flight attendants, maintenance personnel, and other users of the National Airspace System (NAS), or any other person, to report to NASA actual or potential discrepancies and deficiencies involving the safety of aviation operations. Based on information obtained from this program, the FAA will take corrective action as necessary to remedy defects or deficiencies in the NAS. The reports may also provide data for improving the current system and planning for a future system (FAA, 1997).

One of the most critical aspects for a successful incident reporting system is the protection of the participating parties. Incidents would not be reported by individuals unless they were protected from disciplinary and regulatory punishment. As a result, Title 14 of the Code of Federal Regulation (CFR) Part 91.25 prohibits the use of any reports submitted to NASA under ASRS in any disciplinary action, except information concerning criminal offenses. In addition to the protection provided by Part 91.25, ASRS has established a comprehensive immunity program that provides total confidentiality for the reporting parties (FAA, 1997). The ASRS, however, has limitations concerning immunity. Immunity can be provided to a reporter when: (a) the contributor has filed an ASRS form within 10 days of the incident, (b) the reporter could not have been involved in a reckless operation, gross negligence, or willful misconduct, and (c) the violation did not result in an accident (NASA, 1986).

Since 1975, the ASRS has accepted over 500,000 reports and received approximately 47,000 reports each year; 60% of reports were filed from ASAP reports (Farrow, 2010). The ASRS has collected the data and contributed to the enhancement and improvement of aviation safety throughout the U.S. It also has been internationally recognized as a strong contributor to aviation safety. With the success of the ASRS, the FAA has introduced several voluntary safety programs that have proved to be effective afterward.

Aviation Safety Action Program

The ASAP was developed to further analyze the individual carriers' operations. Similar to its NASA counterpart, ASAP provides a platform whereby employees of

participating air carriers and repair station certificate holders can identify and report safety issues to management and to the FAA for resolution. These programs are designed to encourage participation from various employee groups, such as flight crewmembers, mechanics, flight attendants, and dispatchers (FAA, 2002).

The objective of the ASAP has been to encourage air carrier and repair station employees to voluntarily report safety information that may be critical to identifying potential precursors to accidents (FAA, 2002). Four challenges in implementing the ASAP have been (a) recognizing contributing factors, (b) analyzing a high volume of data, (c) following through on actions beyond correcting individuals, and (d) providing operational feedback and publications (Chidester, 2003).

To date, there have been 151 programs for pilots, maintenance personnel, dispatchers, and flight attendants across 69 operators. Those programs receive 45,000 reports annually. Among them, there are 42 maintenance ASAPs, which receives about 2,000 reports from maintenance personnel in the U.S every year. In contrast with ASAP, ASRS has been the all-inclusive reporting program. Anyone involved in U.S. aviation can report into the program or extract information out of the program. On the other hand, the ASAP has been action-oriented. Individual and organizational concerns and events can be tightly monitored and controlled because only one organizational entity has been involved (Farrow, 2010).

An ASAP program is dependent on employee-management trust. The ASAP Memorandum of Understanding (MOU) establishes the basic agreement between employees, management, and the regulator. The MOU establishes corporate commitment and serves as a foundational reference in the event of challenging cases. This document

needs to be co-developed by the company and employee representatives. The MOU include the voluntary disclosure policy to encourage employees of air carriers participating in the programs to disclose information which may include possible violations of Title 14 CFR Part 91.25 without fear of punitive enforcement sanctions or company disciplinary action. Events report under a program that involves an apparent violation of the regulations on the part of air carriers is handled under the MOU (FAA, 2002).

Since ASAP's goal is to analyze and prevent incidents and accidents, it is critical to conduct continuous reviewing processes to identify potential hazards to flight safety. This is accomplished with an Event Review Committee (ERC). The ERC may share and exchange information and identify actual or potential safety problems from the information contained in the reports. The ERC is usually comprised of a management representative from the certificate holder, a representative from the employee labor association (if applicable), and a specially qualified FAA inspector (FAA, 2002). Its principal function has been to conduct scheduled meetings to evaluate each ASAP report on a case-by-case basis. The ERC must achieve consensus on every event. The methods that the ERC utilize to determine whether to include or exclude an ASAP report is detailed in Figure 3. These meetings identify the hazards and assured that every corrective action is implemented to mitigate the reported hazard.

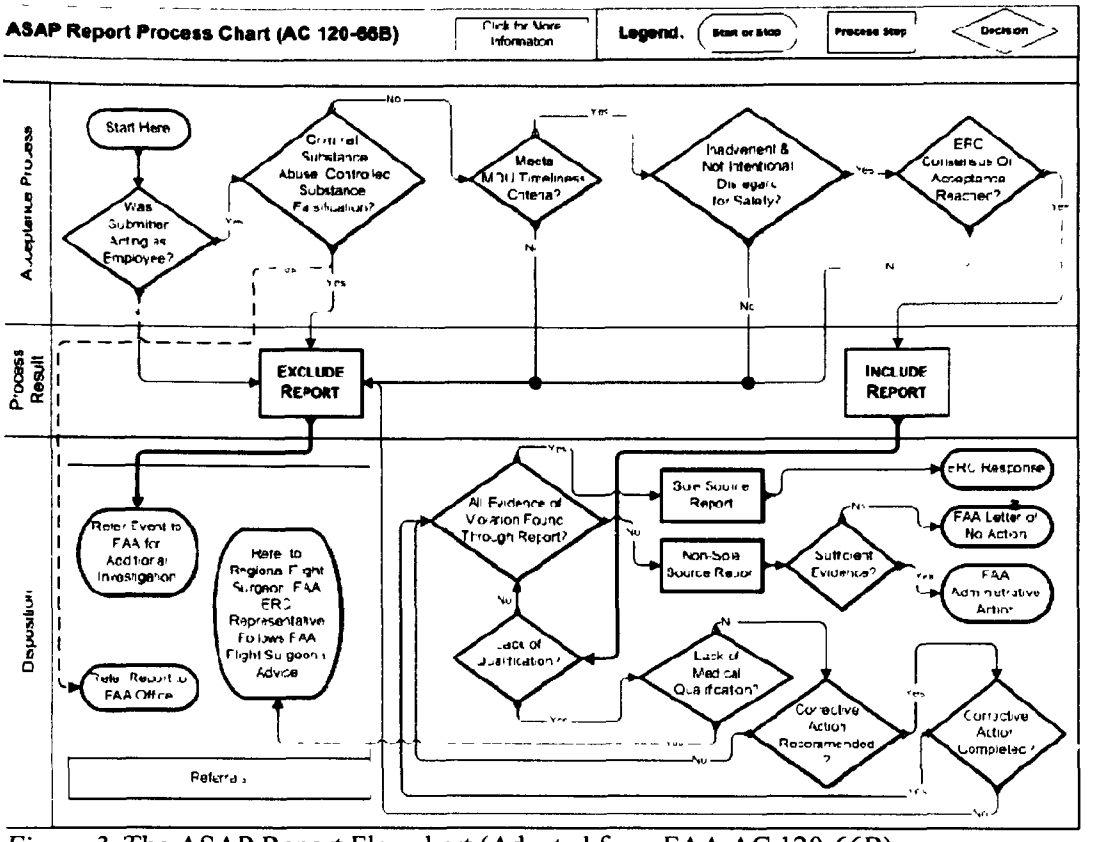

Figure 3. The ASAP Report Flowchart (Adapted from FAA AC 120-66B).

Similar to other confidential and voluntary safety reporting programs, ASAP provides incentives to employees to report safety events and alleged violations. The incident must be unintentional and has to be reported in a timely manner (e.g. 24 hours). It does not appear to involve an intentional disregard for safety, which involves (a) criminal activity, (b) substance abuse, (c) controlled substances, (d) alcohol, and (e) intentional falsification.

The ASAP incident reports have been categorized as sole-source and non-sole-source reports. The FAA (2002) has defined a sole-source report as a report in which all evidence of the event has been discovered by the single report. Upon acceptance into the ASAP database, the participants in a sole-source event would receive

either a response from the ASAP ERC or an FAA Letter of No Action, where a 14 CFR violation has been identified. No FAA action would be applied if the reports were sole-source reports (Farrow, 2010). A non-sole-source report has been defined as a report in which the event was not reported by only one of the individual reporting parties. Non-sole-source reports involving possible 14 CFR violations have resulted in the FAA issuing a Letter of Corrections (FAA, 2002). The reports have usually been archived in a database for future references in a two year period.

Typically, about 70% of the ASAP reports cause a procedural change at the task level. For example, task cards or job cards are changed using an existing or a new document change process. About 25% of the time, the ASAP reports cause a change across the organization. This means the document change process itself might be changed, impacting all future document change requests. About 5% of the time, the ASAP reports cause an industry-wide change. For example, the report may result in a Service Bulletin or an Airworthiness Directive that impacts other organizations (FAA, 2009). ASAP has proven to be a successful safety program for each individual air carrier.

Aviation Safety Information Analysis and Sharing (ASIAS) system

From the birth of proactive safety programs, there has been the assumption that information gained from one operator in one program would be integrated with others. The result would be a greater understanding of the issues and risks under study (Stolzer, Halford, & Goglia, 2008). With the vision for industry wide collaboration and the legal protection of information in place, the FAA and the aviation community have initiated a safety analysis and data sharing collaboration to proactively analyze broad and extensive

data to advance aviation safety, known as the Aviation Safety Information Analysis and Sharing (ASIAS).

The initiative leverages internal FAA datasets, airline safety data, publicly available data, manufacturers' data and other data. The airline safety data is being safeguarded by the MITRE Corporation, in a de-identified manner to foster broad participation and engagement (CAST, n.d.). The contractor, known as the MITRE Corporation, serves as a neutral third party to perform the data collection and analysis processes. ASIAS fuses various aviation data sources in order to proactively identify safety trends and to assess the impact of changes in the aviation operating environment. It is designed to address the following issues in the past: (a) fragmentation of safety data and information, (b) difficult access problems, (c) lack of data standards, (d) data quality deficiencies, (e) lack of analytical tools and methodologies, and (f) need to develop diagnostic and prognostic analytical (Pardee, 2008). The two components of this activity are the *Analysis* of aggregate data and the *Sharing* of information.

The resources of ASIAS include both public and non-public aviation data. Public data sources include, but are not limited to, air traffic management data related to traffic, weather, and procedures. Non-public sources include de-identified data from aircraft operators, including digital flight data and safety reports submitted by flight crews. Future plans include the addition of de-identified reports from maintenance and dispatch personnel, flight attendants, and air traffic controllers. Governance agreements with participating operators and owners of specific databases provide ASIAS analysts with access to safety data without having to archive sensitive proprietary information centrally (CAST, n.d.).

ASIAS has been developed and collaborated with 13 major air carriers, such as American, Delta, and Continental. It establishes key safety benchmarks so that individual operators may assess their own safety performance against the industry as a whole. A partnership between the industry and the regulator is also established, which is the Civil Aviation Safety Team (CAST). The CAST and ASIAS are closely cooperating with each other to implement the preventive or corrective actions in the industry from the results of those analyses (CAST, n.d.). With the efforts of ASIAS and CAST, an industry-wide consensus is built to support the Safety Management System (SMS).

Safety Management System (SMS)

SMS is an organized approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures. ICAO's Standards and Recommended Practices require that States establish a "safety program" to achieve an acceptable level of safety in aviation operations. The acceptable level of safety shall be established by the State(s) concerned (ICAO, 2006). ICAO initiated provisions of the Safety Management System (SMS) in November, 2006. Air carriers, airdrome operators, and maintenance organizations around the world are required to implement SMS (Galotti, Rao, & Maurino, 2006).

The performance-based approaches to the management of safety have been demonstrated by SMS. The brief definition of SMS can be described as "a dynamic risk management system based on quality management system (QMS) principles in a structure scaled appropriately to the operational risk, applied in a safety culture environment" (Stolzer et al., 2008, p. 18-19). Any SMS-type system has also been regarded as a dynamic risk management system. Using the Risk Matrix, shown in Figure

4, the approach allows the employees and management to consider the risks of not implementing a particular safety intervention — the cost of the intervention could be measured against the cost of the event (the likelihood of occurrence of the event and the severity of the event). The assessment provides a guideline for mitigating actions and allowable timelines for corrective and preventive actions (Stolzer et al., 2008). The organization is able to allocate its resources to eliminate the highest risk index first. Through this process, risks can be managed within an acceptable parameter in the most cost effective way.

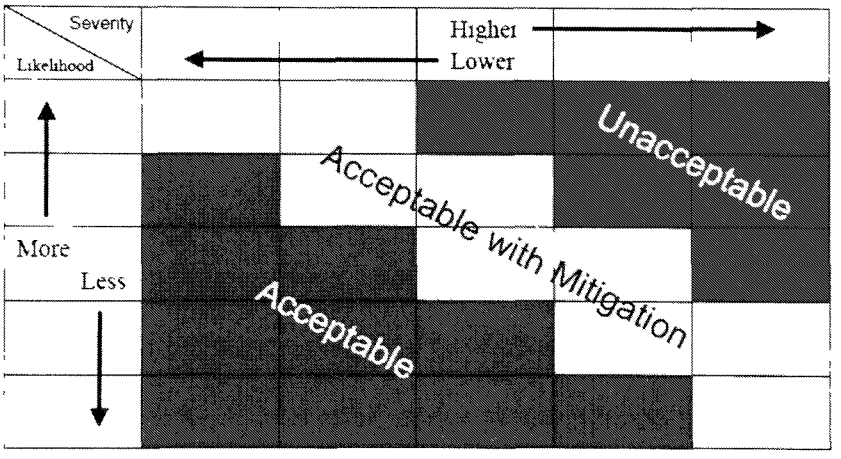

Figure 4 Risk Matrix (Adapted from Stolzer et al., 2008)

In FAA Advisory Circular (AC) 120-92, the SMS is structured upon four basic components of safety management: (a) safety policy, (b) safety risk management (SRM), (c) safety assurance, and (d) safety promotion (FAA, 2006). Thus, an SMS is functioning effectively when all four structural elements exist and are being executed. The four principles are also known as "Four Pillars" in FAA AC 120-92. Figure 5 shows how the Four Pillars act as the foundation of SMS and support the success of a SMS. With the

Four Pillars, an SMS can be applied in building a healthy safety culture (Stolzer et al., 2008).

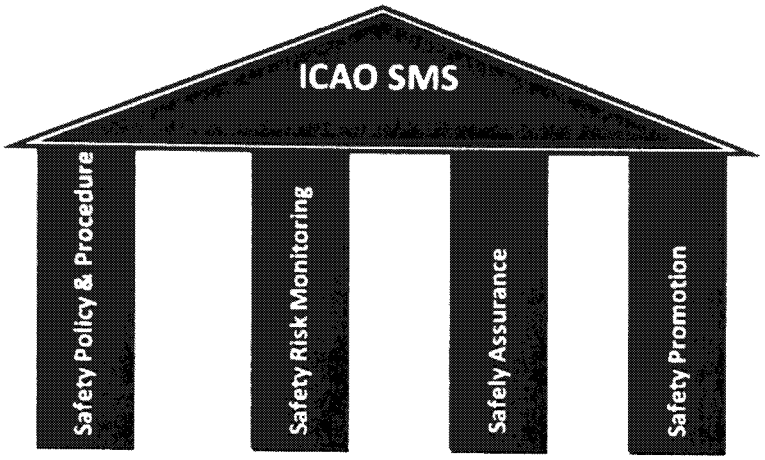

Figure 5. Four Pillars of SMS. (Adapted from Stolzer et al., 2008)

Safety Policy

An SMS must first define its policies, procedures, and organizational structures, which describe responsibility, authority, accountability, and expectations (Stolzer et al., 2008). Under the broad umbrella of the SMS program, the aviation organization could make a commitment to the employees across the company that the voluntary safety reporting will be carefully considered using the SRM approach and appropriate feedback will be provided to all reports. Organizational safety culture will be assessed regularly and specific improvement efforts will be implemented; employee and management evaluation and reward systems will incorporate adequate support for SMS (FAA, 2009).

The main idea is that in companies where management is truly committed to enhancing safety as a core business activity, employees will not be afraid of pointing out their safety deficiencies. This requires a change in the way that people think about safety. It is often referred to as a collective perception and culture. Although culture cannot be

regulated or implemented in the way that more concrete systems and regulations may be, management philosophy can be conveyed by unambiguous terms throughout an organization (Galotti et al., 2006). With the safety policy in place, it would create an environment which favors the improvement of safety.

Safety Risk Management (SRM)

A formal system of hazard identification and SRM is essential in controlling risk to acceptable levels. The SRM component of the SMS is based upon the system safety process model (FAA, 2008). The SRM process provides objective means of assessing safety risks. It is the core function of SMS, which is to identify and control hazards. This process could be incorporated in the voluntary safety reporting programs so that all recommendations coming from the incident reports consider the risk aspects, severity and likelihood, prior to making recommendations. Subsequently, if the recommendation for a particular change is not accepted by the company management, a corresponding SRM rationale could be provided by the management.

Figure 6 shows the basic flow of information through an SMS Risk Control Process, which explains the task loop to control risks in detail. The process and information flow is designed to identify latent or unrecognized unsafe conditions and analyze them for impact on the organization so that actions can be taken to adequately control those conditions. Most importantly, this SRM process requires information to be obtained from all kinds of sources, such as audits and voluntary safety programs. In order to assess and manage risks, it is essential for SMS to collect data and go through the SRM process continuously.

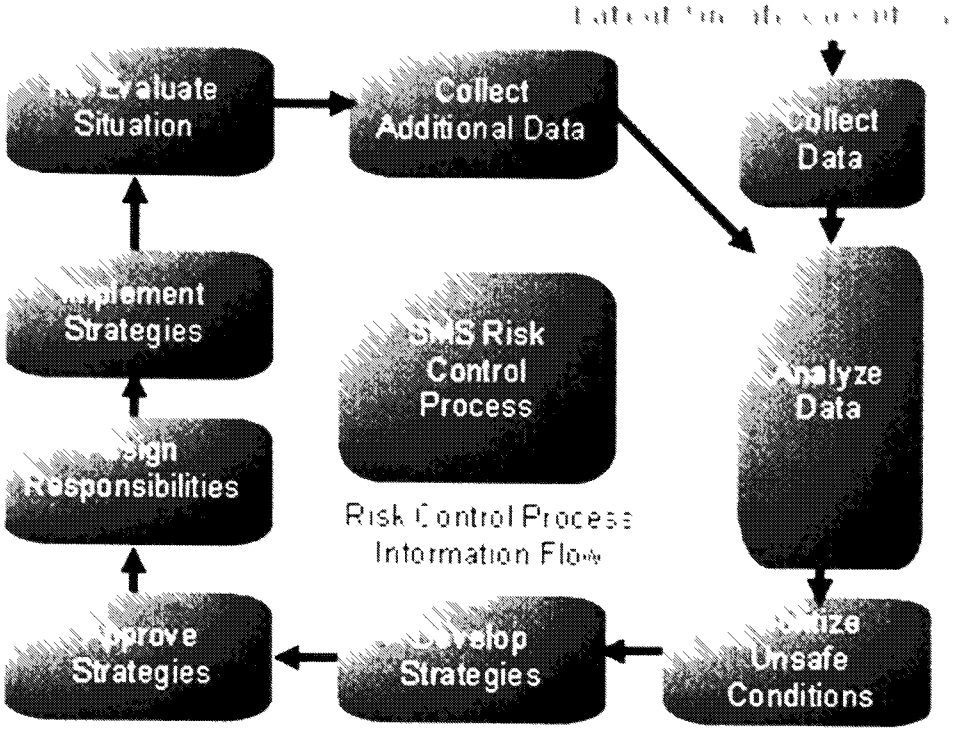

Figure 6 Risk Control Process of SMS. (Adapted from Stolzer et al., 2008)

Safety Assurance

Once SRM is implemented, the operator must ensure it is continuously practiced and continue to be effective in a changing environment. The safety assurance function provides for this using quality management concepts and processes. The safety risk management and safety assurance processes are integrated in the SMS. The safety risk management process provides for initial identification of hazards and assessment of risk. Organizational risk controls are developed and, once they are determined to be capable of bringing the risk to an acceptable level, they are employed operationally. The safety assurance function takes over at this point to ensure that the risk controls are being practiced and they continue to achieve their intended objectives. This system also

provides for assessment of the need for new controls because of changes in the operational environment (FAA, 2008). Tracking the changes accomplished as a direct result of those voluntary safety programs would be the best way to meet this SMS requirement. Such actions should document the evidence of organizational change as well as emphasis on systematic solutions and the shift toward a safety culture (FAA, 2009).

Safety Promotion

The safety promotion pillar has had as an objective to create a safety culture, which would begin at the top of the organization with the incorporation of policies and procedures that could cultivate a reporting culture and a Just Culture. To support a reporting culture, the organization must cultivate the willingness of its employees to contribute to the organization's understanding of its operation. Since the most valuable reports have evolved to self-disclosure of mistakes, the organization must make the commitment to act in a non-punitive manner when those mistakes were not the result of careless or reckless behavior. An SMS can provide a company with mechanisms for allowing employees to submit reports on safety deficiencies without fear of reprisal. It should also generate robust mechanisms to disseminate information to its workforce. As a result, each employee could have timely access to safety-related information, since the data would have no value unless an organization could learn from it in time to avoid a mistake. An SMS should be a closed-loop system, in which an audit trail can exist whereby a discovery in the risk assessment and analysis process may lead to causal analysis that would be used in a preventive and corrective action process to modify the operations and reduce risks (Stolzer, et al., 2008).

Implementation

SMS has not only been assisting the FAA in maintaining the voluntary reporting programs that have been operated effectively and efficiently in the U.S., but have also been conducted in other countries. Transport Canada committed to the implementation of the SMS in aviation organizations in 2005. Europe and New Zealand have moved forward with the SMS more quickly than the U.S. (Stolzer et al., 2008). Taiwan also has mandated Taiwanese air carriers to implement the SMS as of January 1, 2009 (CAA, AC 120-32B, 2007). Although Taiwanese aviation authorities have put the SMS into practice, one of its fundamental elements, safety culture, has experienced difficulty for acceptance of the program in the Taiwan aviation industry due to the nature of the national culture. The question now is how to get the maintenance organizations in Taiwan to comply with ICAO's requirement for safety programs.

Safety Culture

Culture is defined as the values, belief, and norms shared of a group of people that influence the way they behave (FAA, 2008). Human beings are all influenced by cultural issues. The various cultures set boundaries for acceptable behavior and provide a framework for decision making. A safety culture is the "engine" that continues to drive the organization towards the goal of maximum attainable safety. It can be divided into two parts. The first comprises the beliefs, attitude, and values (often unspoken) of an organization's membership regarding the pursuit of safety. The second is concrete and embraces the structures, practices, controls, and policies that an organization possesses and employs to achieve greater safety (Reason & Hobbs, 2003). Safety culture is

regarded as a fusion of the following elements:

1. Just Culture: A concept that people are encouraged, and even rewarded, for providing essential safety-related information. There is a clear line that differentiates between acceptable and unacceptable behavior (Stolzer et al., 2008).
2. Reporting Culture: Aims to create a comfortable environment for people to acknowledge any safety deficiency in the organization. The information would be de-identified and protected by separated authority. People are prepared and easy to report their errors and experiences (Reason & Hobbs, 2003).
3. Learning Culture: Is used to guide continuous and wide-reaching system improvements rather than mere local fixes. Under learning culture, people have the willingness and the competence to draw conclusions from safety information systems and the will to implement major reforms (Reason & Hobbs, 2003).

These subcomponents of a safety culture (a Just Culture, a reporting culture, and a learning culture) would need to work together to create an informed culture, which in most respects, has been regarded as a key element to a safety culture (Stolzer et al., 2008). It lets everybody have the knowledge about the human, technical, organizational and environmental factors that determine the safety of the system as a whole. People would know where the "edge" is without having to fall over it.

Organizational psychologists tell us that there are three distinct cultural environments that we need to understand: (a) national culture encompasses the value of

particular nations, (b) organizational/corporate culture differentiates the behavior found in various organizations, and (c) professional behavior differentiates the behavior found in different professional groups (Stolzer et al., 2008).

Voluntary safety programs are generally impeded by many difficulties, such as trustiness of confidentiality, punishment, and personal identity, etc. Establishing a safety culture in the organization is essential for safety improvements. If people do not trust the organization that is operating the reporting system, the systems will not succeed. As the China Airlines Flight 611 case shows, Taiwan's aviation industry strongly addresses the punishment and blame culture. Because of the traditions in Chinese culture, it is hard to establish a Just Culture, the most important foundation in safety culture (Stolzer et al., 2008).

Social Culture

China is one of the oldest civilizations in mankind's history. In Chinese history, people lived in union and were governed by emperors. Even though there have not been emperors in China during the past 100 years, certain perspectives of Chinese culture persist (Lee & Weitzel, 2005). The dimensions of social culture were first defined by Gerard Hendrik Hofstede (1978). His study demonstrates that there are national and regional cultural groupings that affect the behavior of societies and organizations. Mainly, there are four dimensions of culture differences, which include (a) power distance (PD), (b) individualism-collectivism (IC), (c) uncertainty avoidance (UA), and (d) masculinity.

PD is defined as how the less powerful members of institutions and organizations expect and accept that power is distributed unequally. Low PD accepts power relations

that are more consultative or democratic. People relate to one another more as equals regardless of formal positions. Subordinates are more comfortable with and demand the right to contribute to and critique the decision making of those in power. On the contrary, high PD means less powerful accept power relations that are more autocratic and paternalistic. Subordinates acknowledge the power of others simply based on where they are situated in certain formal, hierarchical positions (Hofstede, 2001). As a result, the low or high PD alters the chain of command in an organization. In high PD, superiors have the full authority and may become "error-free." Inadequate decision making and "no questions asked" philosophy could end up with a disaster. In low PD, people tend to become reckless about superiors' instructions.

In Chinese culture, there is a high PD. Authoritarianism is a characteristic based on 5,000 years of dictatorship. It has a large amount of influence within society. Figures of authority, such as professors, managers, and airline captains, are treated with a great amount of respect by their subordinates. Chinese subordinates treat their superiors with high respect, regardless of the environment and conditions. This relationship between superiors and subordinates routinely exists beyond the working environment. An example is that eye contact with figures of authorities is acceptable and is encouraged for subordinates in the Western cultures. In contrast, Chinese cultures consider that a subordinate making an eye contact with a figure of authority is disrespectful; therefore, the action is strongly discouraged and avoided. In addition, there has been a common belief that a figure of authority is error-free. This belief has led figures of authorities not to allow challenges or questions. Superiors will not admit their errors, and the primary result is that they might have fear of losing jobs. As a result, the responsibility of the

subordinate is to preserve the superiors' face, which is regarded as one's dignity and prestige, thereby maintaining the harmony of the group (Lee & Weitzel, 2005).

As for IC, individualism is contrasted with collectivism, and refers to the extent to which people are expected to stand up for themselves and to choose their own affiliations, or alternatively act predominantly as a member of a group or organization. Asian and Latin American cultures rank among the most collectivist in this category, while Anglo countries such as the United States, Great Britain and Australia are the most individualistic cultures (Hofstede, 2001). People in an individualist culture may become over-confident of themselves and take risky actions. On the other hand, people in a collectivist culture rarely express their individual opinions during social activities, such as conferences and lectures. This may become a latent risk in aviation safety when people fail to report a problem (Lee & Weitzel, 2005).

Chinese culture is characterized by its strong emphasis on collectivism, and the principle of individualism in most western cultures dislikes that in the Chinese culture. In general, Chinese consider the implications of their behavior in a framework of concern extending beyond their immediate family. Thus, people in a collectivist culture often behave in relation to their family or organization. As a result, this characteristic of Chinese culture has led Chinese children to be taught to listen and not to speak at a young age and speak only when spoken to. Nevertheless, human society is formed as a group and can function well, but it relies heavily on individual performance. One of the main components to maintain the function of the society is the harmony of the group, which is usually the priority concern. Therefore, they are not dependent upon themselves, but the society. This may become a latent risk in aviation safety (Lee & Weitzel, 2005).

UA reflects the extent to which members of a society attempt to cope with anxiety by minimizing uncertainty. Cultures that scored high in UA prefer rules (e.g. about religion and food) and structured circumstances, and employees tend to remain longer with their present employer. Mediterranean cultures, Latin America, and Japan rank the highest in this category (Hofstede, 2001). Therefore, these uncertainties often cause misunderstandings between people, and may lead to miscommunication and lack of communication at work.

The social pressure in Chinese culture leads to UA and also evolves into a "shame" culture. The Chinese are more sensitive to pressure from society rather than an individual's internal pressure and feelings. The society is heavily ruled and structured in both written and unwritten ways. In contrast, many other cultures emphasize honor systems or codes of honor. The measurements are commonly based on one's feelings of guilt and have to be conducted in accordance with one's own judgment. The honor system, however, cannot be applied to the Chinese culture. As a result, most Chinese grow up and are affected by social pressure. In general, the honor system in Chinese is determined by one's belief system (Lee & Weitzel, 2005).

Masculinity versus its opposite, femininity, refers to the distribution of roles between the genders which is another fundamental issue for any society to which a range of solutions are found. Masculine cultures value competitiveness, assertiveness, ambition, and the accumulation of wealth and material possessions, whereas feminine cultures place more value on relationships and quality of life (Hofstede, 2001). Due to the difference on valuing daily life, this characteristic in the culture may lead a person to

become aggressive or passive at work. Consequently, that may result in a lack of assertiveness, leadership, and situational awareness.

Based on 5,000 years of empire history, males usually rule the society, and females are less empowered. The rights for males and females are imbalanced. Although the situation has changed dramatically since democracy was introduced, males are still more career motivated than females. That affects their jobs, especially in the aviation industry, which is considered a highly technical field.

Just Culture

Voluntary incident reporting usually involves the air carriers, authorities, and employees. Getting people to report is about building trust. Trust that the information provided in good faith will not be used against those who reported it. Keeping up the reporting rate is also about trust, but it is even more about involvement, participation, and empowerment (Dekker, 2007). Therefore, a Just Culture needs to be established within an organization in order to set a comfortable climate (confidential and non-punitive cultures) for the voluntary incident reporting program.

The foundation of the Four Pillars of SMS, present in all the voluntary safety programs, cannot stand without the support of a Just Culture. These programs cannot be run effectively without a Just Culture as a basis for establishing a reporting climate. Just Culture has promoted an atmosphere of mutual trust that would encourage voluntary reporting. When an employee has been motivated to report work errors (other than intentional, reckless, or the result of an accident), the organization has benefited from a safety point of view. Not all employees have embraced the idea of voluntary reporting.

Dekker (2007) pointed out that "the main reason has been that reporting could be risky. Many things can be unclear:

1. How exactly will the supervisor, the manager, the organization respond?
2. What are the rights and obligations of the reporter?
3. Will the reported information stay inside of [*sic*] the organization? Or will other parties (media and prosecutor) have access to it? " (p. 41).

The reporting individual may have no faith that anything meaningful would be done with what he or she reported. This issue may be more significant in Asian countries with a solid Chinese culture. Therefore, the aviation industry in Taiwan is experiencing the hardship of building a Just Culture and transitioning from less willingness for reporting to a voluntary safety reporting program.

Getting people to report has been difficult. Keeping up the reporting rate once the system has been instituted is equally challenging. An effective reporting culture depends on how the organization can handle blame and punishment. Reason (1997) has defined Just Culture as "an atmosphere of trust in which people are encouraged, even rewarded, for providing essential safety-related information, but in which they are also clear about where the line must be drawn between acceptable and unacceptable behavior," (p. 195); Just Culture has been the ultimate concept underpinning the maintenance and effectiveness of a voluntary reporting system. Just Culture has also been a tool for improving safety by knowing how to reconcile accountability for failure with learning from that failure – with the aim of continuing to make progress on safety (Dekker, 2007).

Figure 7 shows that, in Just Culture, it is unacceptable to punish all errors and unsafe acts regardless of their origins and circumstances. It is, however, equally

unacceptable to give blanket immunity from sanctions for all actions that could contribute to organizational accidents/incidents. One of the difficulties of managing the application of Just Culture is focused in discriminating between truly "bad behavior," and the vast majority of unsafe acts to which the attribution of blame has been neither appropriate nor useful (Reason, 1997).

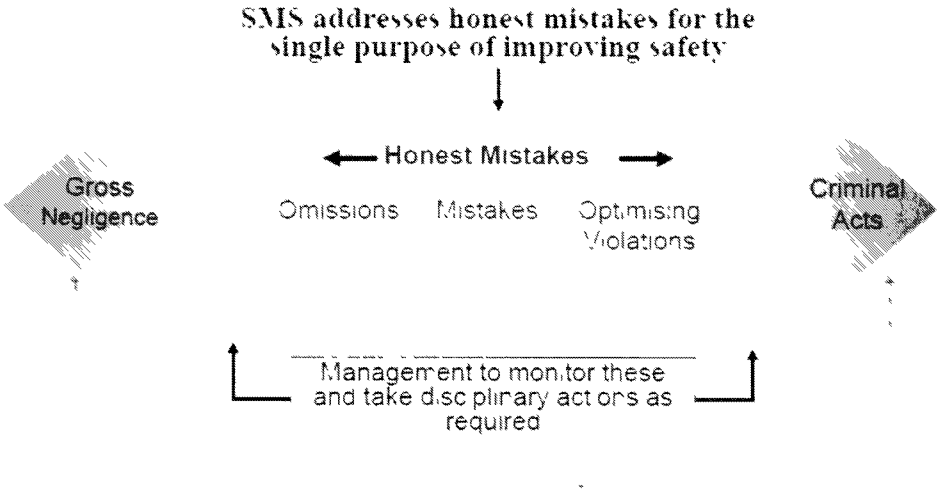

Figure 7. The Concepts of Just Culture (Adapted from Cioponea, 2007, slide 3).

The Just Culture Community (2006) categorized the four evils of human behaviors (human errors, negligent conduct, reckless conduct, and knowing violations) to assist the industry in determining whether behaviors can be assigned a degree of risk, or not. Nevertheless, it also illustrated that knowing violations may fall into either at-risk or reckless behavior based on the individual's perception. Psychological and legal issues should be taken into consideration when making the judgment.

Dekker (2007) pointed out that engineering a Just Culture relies upon the following three central questions:

1. Who in the organization or society gets to draw the line between acceptable and unacceptable behavior?
2. What and where should the role of domain expertise be in judging whether behavior is acceptable or unacceptable?
3. How protected against judicial interference are safety data (either the safety data from incidents inside of [*sic*] the organization or the safety data that come from formal accident investigation)? (p. 119)

These questions are difficult to answer definitely, since influences from countries, organizations, and professions may lead to multiple avenues of approach toward establishing a Just Culture. Although establishing a Just Culture within any voluntary safety programs might have difficulties and depend upon differences of national culture, Just Culture appears to some as two separate concepts – "Justice" and "Culture." Although the concepts of justice and culture have basically been fixed and are not malleable, a relationship between them could be fashioned to meet any particular needed mindset. Dekker (2007) introduced four steps regarding how to build a Just Culture. These steps illustrated in Figure 8 demonstrate how airlines and aviation authorities can implement Just Culture to establish a level of trust that would be necessary to enhance the effectiveness of voluntary safety reporting programs. The ultimate goal of adopting Just Culture in many Eastern countries could eliminate cultural discrepancies and its influences.

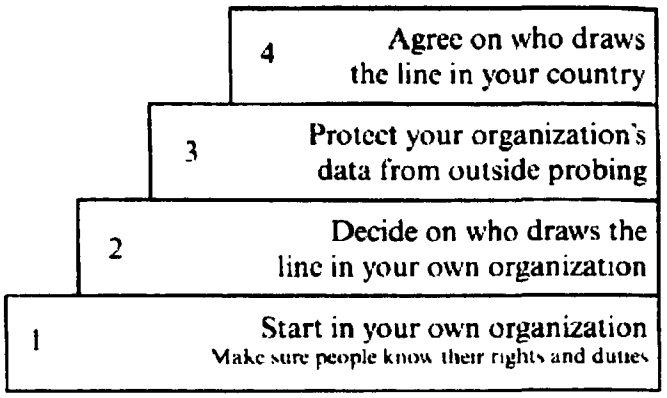

Figure 8. Approaches to Build a Just Culture (Adapted from Dekker, 2007, p. 138).

The fourth step (agree on who draws the line in each country), utilized for establishing an effective safety reporting program/system, however, needs to be implemented by agreement between the aviation authority, the airline, and the union. Since most Asian countries such as Taiwan do not have regulations addressing immunity, the fear of disciplinary actions from the governmental authority and from the airline may reduce the employees' trust in a safety reporting program and his/her willingness to participation in reporting. Without the immunity agreement, building a thoroughly Just Culture cannot be achieved.

The importance of securing the free flow of information to determine the cause of incidents affects the prevention of future accidents and incidents. What people should focus on is determining contributing factors and producing preventive methods, instead of a criminal punishment to employees.

Maintenance Resource Management

Following Crew Resource Management (CRM), the first generation of Maintenance Resource Management (MRM) was developed in 1989 after the Aloha Airlines accident (Patankar & Taylor, 2004b). MRM is a general process for improving communication, effectiveness and safety in aircraft maintenance operations. As much as CRM was created to address safety and teamwork issues in the cockpit, the Federal Aviation Administration (FAA), in conjunction with industry partners, developed MRM to address teamwork deficiencies within the aviation maintenance environment (FAA, 2000).

MRM is often referred to as a training program, but MRM is much more than training. It is a tool to provide individuals and groups with the skills and processes to manage errors that are within their control, such as communication, decision-making, situation awareness, workload management, and team building. Part of MRM is training, but part of it must be the application and management of the attitude, skills, and knowledge that training and behavior can provide (Patankar & Taylor, 2004b).

Today, the fourth generation of MRM programs have taken root. It is characterized by a commitment to long-term communication and behavioral change in maintenance. The emergence of MRM should be more than awareness training or coping skills. It is the conscious process of increasing trust among maintainers, their managers, and their regulators that enable them to learn from present behaviors in order to improve quality and efficiency. It is the process of cultural change (Patankar & Taylor, 2004b).

The fourth generation MRM programs are being designed and implemented from a systematic perspective. The airline operators are aware of the interpersonal trust issues

that impede self-disclosure, and they are striving to incorporate a Maintenance Error Investigation module in their training so that the participants understand the procedure of such investigation (Patankar & Taylor, 2004b). In other words, today's MRM has applied incident reports as part of training material. To reduce maintenance errors, an air carrier must have a safety program similar to the ASRS and ASAP to gain more knowledge from voluntary incident reports while MRM is being implemented into the maintenance organization.

Taiwanese Civil Aviation Authorities

In Taiwan, the civil aviation authorities are almost equivalent to the authorities in the U.S. The Taiwanese Civil Aeronautics Administration (CAA) is the regulatory and administration agency, which is the same as the FAA. Regulations and documentation also follow the same safety standards compared to the U.S. The CAA also has a mandatory reporting system for aviation occurrences. Meanwhile, the Aviation Safety Council (ASC) serves as an independent investigation agency which is similar to the functions of NTSB. It provides a voluntary incident reporting program, known as the TACARE system.

Civil Aeronautics Administration

The Civil Aviation Act in Taiwan was passed on May 30, 1953. This Act was enacted to ensure aviation safety, a sound civil aviation system, compliance with international civil aviation standards, and promote the development of civil aviation (CAA, 2009). Following the guideline from the Organization Act, the Civil Aeronautics

Administration (CAA) was established under the Ministry of Transportation and Communications (MOTC) to administer affairs relating to civil aviation.

The Taiwanese CAA has the same functions as the FAA, which are promoting and regulating civil aviation. The mission statement of the CAA illustrates three objectives: (a) meet the travel and transport demand of the public, (b) promote the development of aviation industry, and (c) build an environment of co-existence and co-prosperity. The actions toward these missions are (a) implementing flight safety systems, (b) expanding civil aviation activities, (c) promoting airport construction, (d) enhancing service quality, and (e) fostering civil aviation elites (CAA, 2009).

To insure the airworthiness of the aircraft, the CAA provides mandatory oversight function in aircraft maintenance, which includes the rules governing (a) classification of ratings, (b) inspection procedures manuals, (c) maintenance records, (d) maintenance facilities, (e) equipment, (f) parts and qualification of personnel, (g) the establishment of maintenance and quality assurance systems, and (h) application for certification, revision of ratings, issuance, cancellation and renewal. To comply with the Civil Aviation Regulations, the owner or operator of an aircraft with an airworthiness certificate shall maintain the aircraft in accordance to regulations. A repair station that performs the maintenance applies to the CAA for certification, and then a certificate will be issued upon certification. The CAA shall send its personnel to inspect the repair station with regard to personnel, facilities and operations. Those being inspected shall not refuse, avoid or obstruct such inspections. If the maintenance status does not meet airworthiness and safety requirements, the aircraft shall be grounded and its airworthiness certificate be revoked (CAA, 2009).

In addition to the regulatory certification and inspection, similar to other countries, the Civil Aeronautics Administration (CAA) in Taiwan has a mandatory flight occurrence reporting system. Most information received by the system fall into the category of serious aviation occurrences.

Aviation Safety Council

On February 16, 1998, China Airlines flight 676, an Airbus A300-600R crashed while conducting a go-around from Runway 5L at Taipei/Taiwan Taoyuan (previously Chang Kai-Shek) International Airport (CAA, 2000). Following that accident, the ASC was established in May 1998 to be an independent government agency in aviation accident investigation, with the purpose of analyzing causal factors and proposing flight safety recommendations.

Based on Taiwan's Civil Aviation Regulation, Articles 84 and 87, the birth of ASC was officially declared on May 25, 1998 as an independent council, reporting directly to the Premier's office. ASC perform its duties by making findings as to the causes and contributing factors through rigorous and systematic air accident investigations, and then propose safety recommendations. The Aviation Occurrence Investigation Act was also proposed and implemented to address the rules of accident investigation. The sole objective of the accident investigations is to improve Taiwan's aviation safety, instead of apportioning blame or responsibilities, which is in full compliance with ICAO Annex 13 (ASC, n.d.b).

ASC consists of seven board members, including a chairman, whom are all appointed by the Premier. Regular meetings take place once a month, and additional ones

can be called upon by the chairman when deemed necessary. The main structure of ASC is comprised of the (a) Occurrence Investigation Division, (b) Flight Safety Division, (c) Investigation Laboratory, and (d) Legal and Administrative Division. The Managing Director is assigned by the chairman and takes full responsibility for the office operations (ASC, n.d.b). The organization chart is shown in Figure 9.

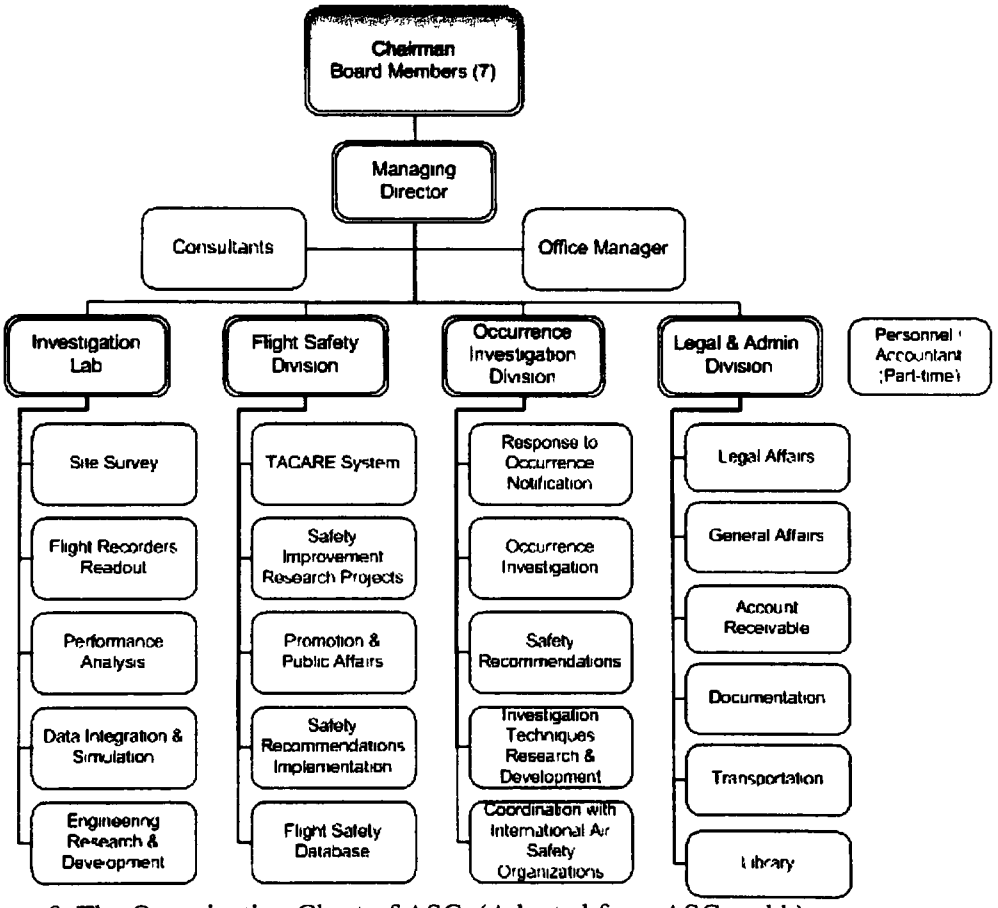

Figure 9. The Organization Chart of ASC. (Adapted from ASC, n.d.b)

One of the key function of the ASC lies in the flight safety division. It conducts research regarding aviation occurrence prevention and safety recommendation implementation, including the following: (a) established flight safety data base for safety

trend analysis, (b) safety recommendations implementation, (c) safety research, (d) TAiwan Confidential Aviation safety REporting (TACARE) system, (e) establishing, maintaining and developing of the information system, and (f) promote ASC.

TAiwan Confidential Aviation Safety REporting

In June 1999, the feasibility study of the reporting system in Taiwan was conducted by Nation Cheng Kung University. Based on the recommendations of the study, a system with the concept of voluntary, confidential, and non-punitive that provides a channel to collect aviation safety information was launched in the same year by the flight safety division in ASC. Safety information gained through reports will be published via TACARE Newsletters. Since the system was established, 17 recommendations concluded from significant reports have been provided to the CAA for further improvement (TACARE, n.d.)

In TACARE's introduction (n.d.), it states:

> To encourage the reporting of actual or potential threats involving the safety of aviation operations, TACARE invites flight crew, maintenance personnel, air traffic controllers, flight attendants, or any other person to report to the system. TACARE provides an independent reporting channel for all personnel in the aviation community based on the concept of being "confidential, voluntary and non-punitive. Under such ideology, TACARE hopes to elevate Taiwan's aviation safety by obtaining, distributing and analyzing safety-related reports, and keeping the identity of the reporter confidential at all times. (¶2)

TACARE has provided five channels for users to submit a report: phone, fax, email, website, and traditional mail. The users can report any concern, event, and unsafe conditions to TACARE, unless that information would be related to accidents, serious incidents (aviation occurrence), and criminal offenses, which should be filed directly to

the ASC, the CAA, and the law enforcement agency. Upon receiving reports, the TACARE working group would follow the processes shown in Figure 10. The de-identification process would be conducted within 72 hours after the contents of the report have been confirmed. Thereby, the confidentiality and anonymity of the reporters and the parties involved can be ensured (TACARE, n.d.).

Figure 10. The Processes of TACARE (Adapted from TACARE, n.d.).

Once the report has been received and de-identified, the analysts would start categorizing and analyzing the information. If the reported information can be considered significant enough to improve flight safety, it would be forwarded to the CAA and operators in a de-identified form. The information would also be provided to the public

through the *Newsletters* (similar to CALLBACK in NASA ASRS) and the TACARE website (TACARE, n.d.).

Each working group member has signed the *Non-disclosure Agreement* (TACARE, n.d.). Nevertheless, the Non-disclosure Agreement has not been stated in the Taiwanese Aviation Regulation; thus, the level of TACARE's confidentiality has been questioned. Although there has been no breach of confidentiality and punishment against the reporter since TACARE has been established, the ASC has determined that TACARE's immunity policy has been an issue of system operations. Even though the ASC has dedicated itself to improving the effectiveness of the TACARE, to date, there are only three incident reports from ground services personnel and no reports from maintenance personnel. Compared to ASRS and ASAP in the U.S., the TACARE system is insufficient to reduce the maintenance errors and improve aircraft safety.

Research Questions

The review of the literature associated with the TACARE problem resulted in three research questions:

1. "What is the understanding of safety for maintenance personnel in Taiwan"?
2. "How would the Taiwanese maintenance personnel accept the concept of voluntary safety reporting program"?
3. "How does a U.S. voluntary safety program for aircraft maintenance operations implement into Asian culture"?

Chapter III

METHODOLOGY

Very little research has been conducted to study the safety of aircraft maintenance in Taiwan recently. Since the perspectives of maintenance personnel toward TACARE were unknown previously, this research used a mixed method design to obtain that data. The data collection instruments were developed by the researcher and targeted both qualitative and quantitative research methods. This design provided quantifiable results and added validity to the research questions.

A questionnaire and a set of interview topics were designed and administrated to evaluate the effectiveness and acceptance of voluntary incident reporting programs for maintenance personnel in Taiwan. Safety and voluntary reporting are sensitive issues, thus all the personal information from interviewees and survey takers were de-identified. The interviews and surveys remained confidential, and none of the participants' personal information was revealed in public.

Mixed Method

The mixed method research designs combined both quantitative and qualitative approaches by mixing the data from both of their data in a single study (Gay, Mills, & Airasian, 2006). By interpreting the data from quantitative and qualitative research methods, researchers are able to have a broader view of the research and then verify the outcomes. The utilization of mixed methods has increased in recent years, but the method is still considered new in research design. Since mixed methods produce high validity of the collected data, there are more applications in different research fields, especially in

aviation, which requires highly accurate results.

There are a number of different strategies for mixed methods. Creswell (2003) classifies them in six main categories: (a) sequential explanatory strategy, (b) sequential exploratory strategy, (c) sequential transformative strategy, (d) concurrent triangulation strategy, (e) concurrent nested strategy, and (f) concurrent transformative strategy. Because of the nature of unknown outcomes in this research, the instruments in this study utilized a sequential explanatory strategy. Quantitative data were collected and analyzed first. Based on the results of quantitative data, the qualitative method was conducted to gather more detailed information. This strategy gathered information from perspectives at different levels.

A sequential explanatory model is identified by its use of one data collecting process. It is considered the most straightforward among those mixed method approaches. As Figure 11 shows, the procedures of qualitative and quantitative designs are working sequentially. It is characterized by the collection and analysis of quantitative data followed by the collection and analysis of qualitative data. The two methods are integrated during the interpretation phase of the study.

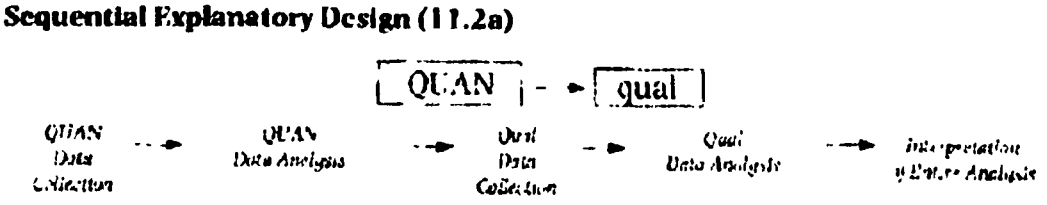

Figure 11. Sequential Explanatory Strategy (Adapted from Creswell, 2003)

The purpose of the sequential explanatory strategy typically is to use qualitative results to assist in explaining and interpreting the findings of primarily quantitative research. It can be especially helpful when unexpected results arise from quantitative data. The qualitative data can be used to examine these surprising results in more detail. The strategy is also easy to implement because the steps fall into clear and separated stages. The design feature makes it easy to describe and report (Creswell, 2003). Based on the strengths of the sequential explanatory strategy, this study starts with quantitative research through general surveys and follows with qualitative research through individual interviews.

The Survey

The quantitative research with surveys was performed through a random sampling from the entire population of Taiwanese maintenance personnel from (a) maintenance and engineering departments in the airlines; (b) Maintenance, Repair, and Overhaul (MRO) facilities; and (c) ground services companies. The 4-page survey consisted of a cover letter and 24 questions, 15 multiple choice, and 9 Likert-type-scale questions. The cover letter included (a) a basic introduction about the research, (b) the terms and conditions of this research, and (c) the contact information of the researcher. The English version of the survey is shown in Appendix A.

The first section of the survey instrument (Questions 1-2) included inquiries related to the knowledge of voluntary safety reporting programs and the term – Just Culture. Question 1 was designed to examine maintainers' familiarity and utilization of the voluntary safety programs in the U.S. and worldwide. Question 2 and 2A were

designed to study whether the maintainers in Taiwan have knowledge of Just Culture.

The second section of the survey (Questions 3-6) were comprised of inquiries about the TACARE system. Question 3 was designed to examine maintainers' familiarity with TACARE. Questions 4 and 5 were designed to study the utilization of TACARE on the part of mechanics and their reasons why they would choose not to utilize TACARE. Question 6 was designed to measure the maintainers' beliefs regarding the responsibility of TACARE.

The third section of the survey instrument (Questions 6 through 14) were comprised of 9 statements, upon which participants could express their opinions by choosing the appropriate answers from the 4-point Likert-type-scale. These questions were designed to examine the maintainers' acceptance of those concepts underlying voluntary safety reporting programs. The responses to these questions were subsequently utilized to evaluate the factors that influence the effectiveness of the TACARE program. The most important characteristic of this section was the 4- point Likert-type-scale. The Likert scale is generally developed as a 5-point scale and has been popular in many research studies. Because of the tendency to not choose sides in Chinese culture, the neutral choice may compromise this study. As a result, the 4-point Likert-type-scale was deemed more desirable in that it eliminated the neutral choice and forced either an agreement or a disagreement with the statement.

The last section of the survey (Questions 16-24) had 10 demographic Questions. Questions 16 to 19 included gender, nationality, age, and experience. Questions 20 and 21 were about the respondents' primary training source and certificates. Questions 22 and 23 determined the position of the individual maintainer in the organization. Question 24

was an inquiry about whether the participant is willing to receive an electronic copy of the result. The background of the participants played an important role in exploring the possibility of their acceptance of the TACARE system. These 10 Questions were utilized to discover the different influences in the population. The survey was designed to be completed in 10 minutes, with a blank space provided for participants to add comments.

The Interview

The qualitative research with interviews was conducted after the initial analysis of those returned surveys. The interviews were designed to be a case study of one maintenance organization in Taiwan. They were conducted to obtain more in-depth information from the selected participants building upon the survey questions. A list of semi-structured questionnaires was established as a basic outline for interviews. Other participants' comments besides the questions were also included. Since the participants were all based in Taiwan, the interviews were performed verbally via international phone calls and the internet communication software – Skype. Interviewees included certified mechanics, experienced supervisors, and managers in the MRO facility in Taiwan. The interviewees were selected from convenience samples. All of the personal information remained confidential in this research.

A brief set of semi-structured interview questions was intended to produce qualitative responses from them. All questions were framed in the open-ended format to obtain the greatest amount of information. Questions 1 and 2 were designed to gather information related to the incentives and other factors that contributed to the participants' willingness or ultimate decision to utilize the TACARE system. Question 1 inquired

about interviewees' knowledge of the TACARE system. Question 2 inquired into the participants' opinions regarding the influences of the TACARE system and the safety culture among maintenance personnel in Taiwan. Questions 3 and 4 were designed to gather information concerning the benefits that the company had gained from the company's internal voluntary safety reporting program and the SMS. Question 5 was designed to obtain participants' opinions of challenges, advantages, and disadvantages related to having a voluntary reporting program. Questions 6 to 8 were utilized to examine the existence of Just Culture and to discover what best practices could be employed to improve the level of Just Culture and voluntary safety reporting programs. Finally, Question 9 was designed to solicit any relevant comment about aircraft maintenance safety in Taiwan.

The 4-page interview instrument included (a) a cover letter with brief introduction, (b) interview topics, and (c) demographic inquiries. The instrument was designed to optimize each participant's response on all topics. A blank space was provided after each question to allow the interviewees and interviewer sufficient area for written comments. The interview was designed to be completed within 15 minutes, while still giving participants enough time to answer all questions. All interviewees were advised by e-mail in advance that all participants would be anonymous, and all responses would be de-identified. The English version of the interview instrument was included in Appendix C.

Instruments Review

Designs of the English version of the interview and survey instruments were completed in January, 2010. Upon completion, the instruments were reviewed and approved by the thesis's advisor – Dr. Donald S. Metscher and readers – Dr. James D. Ramsay, and Captain Roger A. Mason. Although the interview questions and the survey were originally developed in English, it required translation into Chinese for the intended participants, as most of them were native Taiwanese.

The instruments were translated into Chinese not only word-by- word, but also using aviation terminology to fit their working vocabulary. The problem of translating the English instruments into Chinese was that some aviation terms could not be translated into Chinese words directly. Some of the professional terms, such as Just Culture, had no single agreed-upon word to express it in Chinese. Therefore, the researcher decided to follow the translation of those aviation safety terms, which are used in the publications of ASC in Taiwan.

The Chinese versions of the instruments were completed right after the completion of the English versions and then reviewed by Mr. Luke Lu – Chief Executive Officer of Formosa Aerospace Corporation, Mr. Chia-Ning Chen – the researcher's father and Aviation Journalist of United Daily News, and Mr. Michael Chen – former Master of Science in Aeronautics student at Embry-Riddle Aeronautical University and Project Manager in C-Media Electronics, Inc. This procedure was to ensure that participants understood the questions clearly and allowed for more accurate answers to the research questions. It also ensured the highest possible return rate and completeness of response.

Both the English and Chinese versions were ultimately revised in February 3, 2010. The Chinese versions of the survey and interview are included in Appendix B and D.

Administration of the Instrument

Unlike the U.S., Taiwanese mechanics, supervisors, and managers in aircraft maintenance business had been reluctant to voluntarily participate in interview or survey studies. Therefore, the researcher expected to encounter significant challenges during the actual administration of the instrument. The method to administer the research instruments was recommended by Mr. Cha-Ning Chen (researcher's father). Since he had deep connections with Taiwanese airline business, his contacts in the Public Relations (PR) department of each company were employed to initiate the communication. After that, the researcher was able to make contacts with most of the major companies in Taiwanese commercial aviation industry. Those companies included (a) China Airlines, (b) Taoyuan International Airport Services Co. Ltd. (TIAS), (c) Evergreen Group – Evergreen Aviation Technologies Corp. (EGAT) and Evergreen Airline Services Corp. (EGAS), and (d) TransAsia Airways. Through e-mail communications with the public relations departments in those companies, the researcher was able to finalize the content of the instruments and the distribution method.

After the final revision of the survey, it was sent to Mr. Chia-Ning Chen through e-mail. Depending on each company's preference, the survey was prepared in both paper copies and electronic forms. Following the instructions of each company, the survey forms were distributed on February 5, 2010.

The interview was designed to gather descriptive data, which could not be fully obtained by the surveys. The interview was designed to be conducted after the returns of the surveys as a case study of one company. The researcher had decided to perform the interviews with participants from EGAT. The interviewees were selected by the company's convenience and each individual employee's willingness to contribute further in this research, and then the interview questions were emailed to each individual interviewee in advance.

Distribution of the Instrument

Both language versions of the survey in electronic files were provided to the contact person of each company. After their assessments, only the Chinese version of the survey was needed. With the approval from the contact person in each company, the survey forms were distributed to the associated departments in those companies by Mr. Chia-Ning Chen on February 5, 2010.

A total number of 630 forms were distributed. With the help from Ms. Katherine Ko – Manager of PR in Evergreen Group, there were 266 paper forms for both EGAT and EGAS. As for China Airlines, with the help of Ms. Amy Sun – Manager of PR and Mr. Jerry Wang – Manager of Quality Assurance (QA), there were 200 paper forms and another 14 electronic forms distributed in the company's maintenance and engineering department. In addition, through personal contacts, there were 100 paper forms for TransAsia Airways and 50 for TIAS. The period of the surveys' distribution and returning was designed to end on March 5, 2010.

Based on the information from the initial analysis of those returned surveys, a final revision on the semi-structured interview questions was made to adjust the measurement toward the understandings of participants. The interview period with the participants was started on March 15, 2010, and each interviewee was contacted via e-mail by the researcher. There were 9 interviewees in this case study from EGAT. Due to the difficulties in communication (e.g., differences in time zone and interviewee's duty hours), each interviewee was able to choose to answer the questions in written form via e-mail or schedule a convenient time with researcher for telephone interview.

Treatment of Data

The data for this thesis were collected to evaluate the safety culture of aircraft maintenance in Taiwan, and there were information from interviews and surveys. The demographic data both from interviews and surveys were classified to understand differences between groups. The answers from interviews were categorized to determine the outcomes. The data from the surveys were analyzed and charted using the Statistical Package for the Social Sciences (SPSS), and measured using non parametric inferential statistical methods. The quantitative data in the surveys were treated as ordinal data for test of significance and correlation. Finally, there was a comparison of outcomes from interviews and surveys to assess the final results of this thesis.

Chapter IV

RESULTS

In this research, there are both quantitative and qualitative data. The distribution of the survey (Appendixes A and B) was from February 5 to March 5, 2010. A total of 630 surveys were administered, and 605 surveys were returned for a participation rate of 96.03%. Conversely, the interview (Appendixes C and D) was conducted from March 29 to April 9, 2010, and there were nine interviewees. The results from both are presented and discussed in the following section.

Survey

The participants of this study were from the aircraft maintenance personnel in airlines, MRO facilities, and ground service companies in Taiwan. The participants were classified by their airlines or other affiliation with which participants were employed and according to their job specifications in the airlines. The participants' companies were (a) China Airlines, (b) Taoyuan International Airport Services Co. Ltd. (TIAS), (c) Evergreen Group – Evergreen Aviation Technologies Corp. (EGAT) and Evergreen Airline Services Corp. (EGAS), and (d) TransAsia Airways. Figure 12 showed that the Evergreen Group (EVA) dominated the majority of participants (43.97%). China Airlines included 32.40% of the participants. TransAsia Airways and TIAS comprised 16.03% and 7.6% of total participants, respectively.

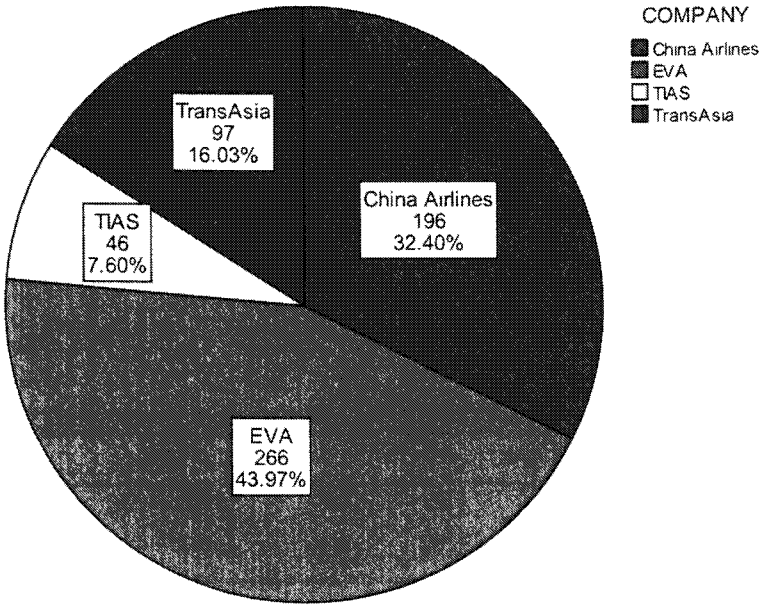

Figure 12. The Pie Chart of Participation

Multiple Choice Questions

The purposes of survey questions 1 through 6 were to obtain participants' attitude and knowledge regarding voluntary safety programs. These questions had multiple choice answers; thus, the choices of answers were required to be coded for statistical analysis. The data were coded as follows: (a) 1 = Option "a", (b) 2 = Option "b", (c) 3 = Option "c", and (d) 4 = Option "d", and continuing in this manner.

Question 1 was designed to determine the participants' knowledge of the voluntary safety programs in the U.S. and worldwide. The participants were able to choose any program(s) by simply knowing of the particular program or general knowledge of the programs. The results in Table 1 show that 55.5% of participants had heard of SMS. Following that, 46.4% of participants had known about ASRS and International Air Transportation Association Operational Safety Audit (IOSA). Flight

Operational Quality Assurance (FOQA) was known by 27.1% of participants. ASAP, Advanced Qualification Program (AQP), Line Operational Safety Audit (LOSA), Voluntary Disclosure Reporting Program (VDRP), and Internal Evaluation Program (IEP) collectively were known by less than 15% of participants.

Table 1

Familiarization with Voluntary Safety Programs.

	ASRS	ASAP	FOQA	AQP	LOSA	VDRP	IEP	SMS	IOSA
Cases	281	90	164	32	69	68	52	336	281
Percent	46.4	14.9	27.1	5.3	11.4	11.2	8.6	55.5	46.4

Question 2 involved the familiarization of the Just Culture (Table 2). There were four participants who did not answer this question. A total of 601 participants' responses were valid, and only 18.3% had heard about the term Just Culture.

Table 2

Just Culture Familiarization.

	Frequency	Percent
Yes	110	18.3
No	491	81.7
Total	601	100.0
Missing	4	

Question 2-A presented the level of understanding about the concepts of Just Culture. The results are shown in Table 3. Among 110 participants who had heard about Just Culture, 80 respondents believed they understood the concepts of Just Culture. Therefore, only 13.2% of the total participants were educated concerning Just Culture.

Table 3

Understanding of Just Culture.

	Frequency	Percent	Valid Percent
Yes	80	13.2	72.7
No	30	5.0	27.3
Total Respondent	110	18.2	100.0
Total Participant	605	100.0	

There were 601 participants out of 605 who answered Question 3. The results in Table 4 show that 61.7% of respondents were familiar with TACARE, but they had never utilized it before. Only 3.6% of participants (n = 22) who had known of it and utilized it before. There were 33.8% of participants who were not aware of the existence of TACARE and another 4.5% of participants (n=27) showed no interests in TACARE.

Table 4

TACARE Familiarization.

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes, and I have used it	22	3.6	3.7	3.7
Yes, but I have not used it	349	57.7	58.1	61.7
No, I am not aware of TACARE	203	33.6	33.8	95.5
No, it is no importance to me	27	4.5	4.5	100.0
Total Respondent	601	99.3	100.0	
Missing	4	.7		
Total Participants	605	100.0		

As illustrated in Table 5, the results of Question 4 show the willingness of reporting in Taiwan. More than 90% of participants suggested that it is important to

submit reports to the TACARE system and only 9.1% of participants said they would not submit reports to TACARE.

Table 5

TACARE Participation.

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	545	90.1	90.8	90.8
No	55	9.1	9.2	100.0
Total Respondents	600	99.2	100.0	
Missing	5	.8		
Total Participants	605	100.0		

Question 5 consisted of two parts: 5-A and 5-B. Question 5-A examined participants' belief in the responsibility of reporting (Table 6). Among participants believing in the importance of TACARE, 73.9% of them believed that it is everyone's responsibility to file a report when a safety problem was spotted. Fewer respondents (9.6% and 10.1%) indicated that a safety problem can only be reported by supervisor or inspector.

Table 6

TACARE Reporters (Question 5-A).

	Frequency	Percent
Supervisor	54	9.6
Mechanic/Operator	36	6.4
Inspector	57	10.1
Anyone	416	73.9

Question 5-B inquired into the possible factors that caused participants not to submit a safety report to TACARE. There were five statements and one open-ended option for participants to choose. The statements were listed as: (a) the probability of disciplinary action(s) from my company, (b) the lack of confidence on the immunity of TACARE system, (c) my unfamiliarity with the TACARE reporting procedures, (d) I do not believe a submission of a TACARE report would not improve flight safety, and (e) the company has its own reporting procedure, so TACARE is irrelevant. The participants were allowed to choose multiple answers related to their concerns with reporting to TACARE. Figure 13 shows the number of respondents for each statement. Statement "c" had the highest count of 143 respondents, which suggested the lack of knowledge on the reporting procedures.

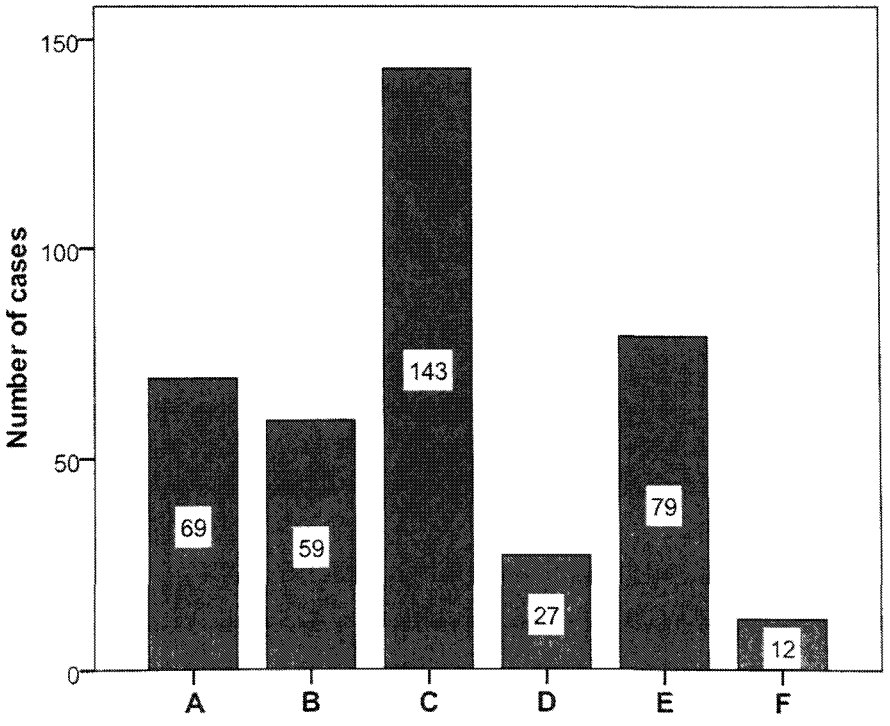

Figure 13. Reasons for not Participating in TACARE (Question 5-B)

There were 12 participants who selected the open-ended option and 11 of them wrote down their opinions. Table 7 illustrated the statements from those participants.

Table 7

Other Reasons for not Participating in TACARE.

	Frequency
Not applicable	1
I did not see any change from TACARE.	1
There are high standards for Quality Control (QC) and inspection in the company.	1
ASC did not provide just investigation; thus, I do not have confidence on ASC.	1
I did not notice any safety issue.	1
I was not aware of TACARE's existence.	2
There is not enough protection on the information.	1
I did not perform maintenance on aircraft directly.	1
Nothing needs to be reported so far.	1
The system should mandate all aviation personnel to report.	1
When the company's reporting system fail or is unable to remove the hazard, TACARE will be used.	1
Total	12

Question 6 inquired into participants' perspectives about which agencies should be held accountable for the administration of TACARE. Different parties listed in Table 8 were presented to the participants, and multiple answers were allowed for participants.

The results show that 45.8% of participants believed that CAA should collect the data and process them. The ASC was selected by 41.7% of participants. An independent organization and each company itself were selected by 31.4% and 26.8% of participants.

Table 8

TACARE Accountable Parties

	CAA	Organization	ASC	Company
Cases	277	190	252	162
Percent	45.8	31.4	41.7	26.8

Likert-Type-Scale Questionnaires

The second part of the survey was comprised of 4-point Likert-type-scale questions. The main purpose of those agreement questions was to evaluate participants' acceptance of the principles related to voluntary safety programs. In accordance with normal coding practice, they were coded as: (a) Strongly Agree = 1, (b) Agree = 2, (c) Disagree = 3, (d) Strongly Disagree = 4.

In Table 9, the results of Question 7 show that 47.2% of the respondents strongly agreed that a well-organized voluntary and confidential incident reporting system would enhance aviation safety. Another 49.3% were in moderate agreement with this statement.

Table 9

Voluntary Reporting System Related to Aviation Safety.

	Frequency	Percent	Cumulative Percent
Strongly Agree	283	47.2	47.2
Agree	296	49.3	96.5
Disagree	17	2.8	99.3
Strongly Disagree	4	.7	100.0
Total Respondents	600	100.0	

The results of Question 8 are shown in Table 10. Over 50% of respondents strongly agreed that the information in incident reports should be de-identified and remain anonymous for the public. There was a total of 93.5% of respondents who agreed this statement.

Table 10

Agreement on Personal Information Protection.

	Frequency	Percent	Cumulative Percent
Strongly Agree	305	50.8	50.8
Agree	256	42.7	93.5
Disagree	28	4.7	98.2
Strongly Disagree	11	1.8	100.0
Total Respondents	600	100.0	

Question 9 discussed the acceptance of team review in the voluntary reporting program. The results (Table 11) show that 97.3% of participants consented to the concept that incident reports should be reviewed by a team of safety experts and investigators.

Table 11

Agreement Regarding Team Review.

	Frequency	Percent	Cumulative Percent
Strongly Agree	263	43.8	43.8
Agree	321	53.5	97.3
Disagree	12	2.0	99.3
Strongly Disagree	4	.7	100.0
Total Respondents	600	100.0	

In Table 12, the results of Question 10 revealed a slightly less agreement than the average agreement on those questions. The data indicated that the concept of including an employee representative in the report review team was supported by 83.8% of participants.

Table 12

Participation of Employee Representative.

	Frequency	Percent	Cumulative Percent
Strongly Agree	196	32.7	32.7
Agree	306	51.1	83.8
Disagree	71	11.9	95.7
Strongly Disagree	26	4.3	100.0
Total Respondents	599	100.0	

Question 11 asked the degree of agreement that Just Culture should be introduced to safety experts and representatives in team review of the voluntary reporting program. The results in Table 13 showed that it was agreed to by 93.1% of participants.

Table 13

Acceptance of Just Culture.

	Frequency	Percent	Cumulative Percent
Strongly Agree	168	28.3	28.3
Agree	385	64.8	93.1
Disagree	26	4.4	97.5
Strongly Disagree	15	2.5	100.0
Total Respondents	594	100.0	

Question 12 asked about whether acceptable behaviors (human errors and at-risk behaviors) should be protected from disciplinary actions in a Just Culture. Table 14 shows 88.4% of participants concurred in this concept of Just Culture.

Table 14

Protection for Acceptable Behaviors.

	Frequency	Percent	Cumulative Percent
Strongly Agree	214	36.1	36.1
Agree	310	52.3	88.4
Disagree	57	9.6	98.0
Strongly Disagree	12	2.0	100.0
Total Respondents	593	100.0	

Question 13 asked about whether unacceptable behaviors (reckless behaviors) should not be protected in the voluntary reporting program. Table 15 shows 86.9% of participants agreed in this concept of Just Culture.

Table 15

No Immunity for Unacceptable Behaviors.

	Frequency	Percent	Cumulative Percent
Strongly Agree	184	31.2	31.2
Agree	329	55.8	86.9
Disagree	50	8.5	95.4
Strongly Disagree	27	4.6	100.0
Total Respondents	590	100.0	

The results of Question 14 shown in Table 16 discovered a slightly lesser agreement when compared to average agreement among those questions. There were 83.6% of participants who agreed and strongly agreed that in their opinion unanimous consensus must be reached by all members of the incident review team on events reported.

Table 16

Agreement on Reaching Unanimous Consensus.

	Frequency	Percent	Cumulative Percent
Strongly Agree	150	25.3	25.3
Agree	345	58.3	83.6
Disagree	83	14.0	97.6
Strongly Disagree	14	2.4	100.0
Total Respondents	592	100.0	

The results of Question 15 show that a great deal of participants (97.3%) agreed that the voluntary reporting program should create effective feedbacks to the reporting community. The data results are shown in Table 17.

Table 17

Effective Feedbacks from Incident Reports.

	Frequency	Percent	Cumulative Percent
Strongly Agree	258	43.3	43.3
Agree	322	54.0	97.3
Disagree	10	1.7	99.0
Strongly Disagree	6	1.0	100.0
Total Respondents	596	100.0	

The overall agreement of each participant regarding the concepts of the voluntary reporting program was summarized with each individual's agreement level from Question 7 to 15. With 9 Likert-type-scale questions, the maximum agreement total sum for each participant was (a) Strongly Agree = 1 x 9 = 9, (b) Agree = 2 x 9 = 18, (c) Disagree = 3 x 9 = 27, and (d) Strongly Disagree = 4 x 9 =36. The lowest possible agreement total sum with strongly agree was 9; the highest possible agreement total sum was 36. There were 582 valid cases for calculation. The mean *(M)* was 15.56, which showed the positive trend of agreement on those concepts. The confidence interval was set as 95%. The total sums of agreement level are graphed in Figure 19.

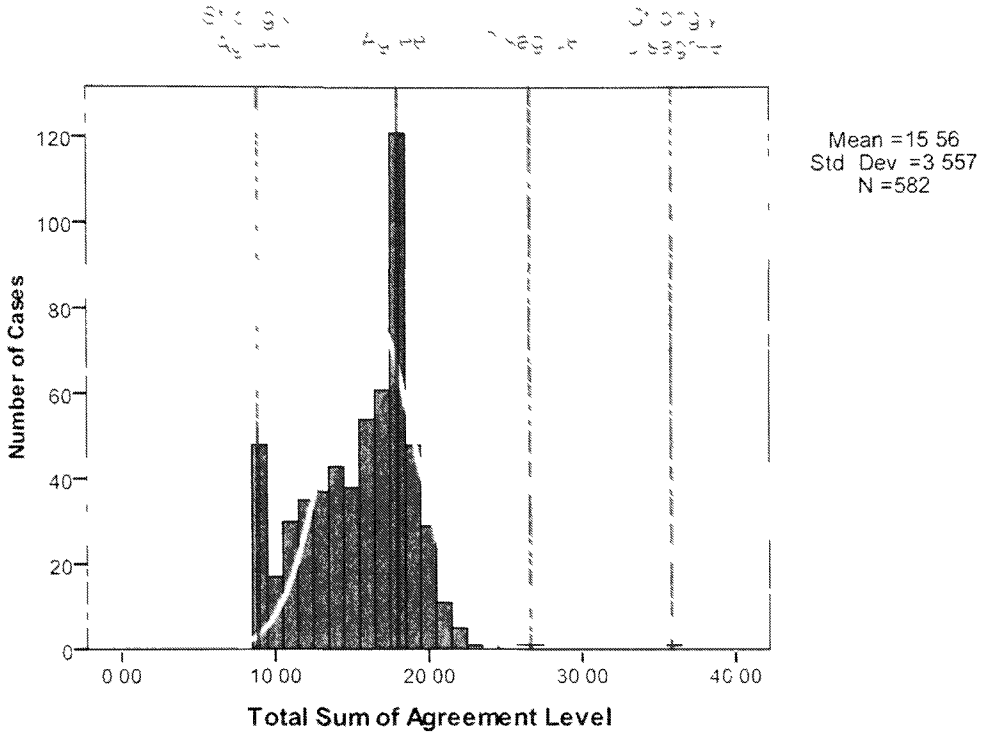

Figure 14. Total Sums of Agreement Level with Likert-type-scale Questions

Demographics

Questions 16 through 24 in the survey were demographic questions. The data from Question 16 (Table 18) found that the majority (94.7%) of maintenance personnel in Taiwan were male. There were only 32 female participants (5.3%).

Table 18

Gender of Participants.

	Frequency	Percent	Valid Percent
Male	567	93.7	94.7
Female	32	5.3	5.3
Total Respondents	599	99.0	100.0
Missing	6	1.0	
Total Participants	605	100.0	

The results from Question 17 (Table 19) show that the majority of participants (96.7%) were Taiwanese. There were only 3 participants (0.5%) who also had foreign citizenship. However, 20 participants (3.3%) did not answer this question.

Table 19

Nationality of Participants.

	Taiwanese	Foreigner	Missing
Cases	585	3	20
Percent	96.7	0.5	3.3

Question 18 asked the age group of each participant (Figure 15). Among the 600 respondents, most of them (46%) were in the age group from 31 to 40. The second highest number of participants (25.83%) was the group from age 41 to 50. The youngest age group from 18 to 30 had 16.83% of participants. There were 9.83% of participants in the age group from 51 to 60, and there were only 1.5% of participants had an age over 61.

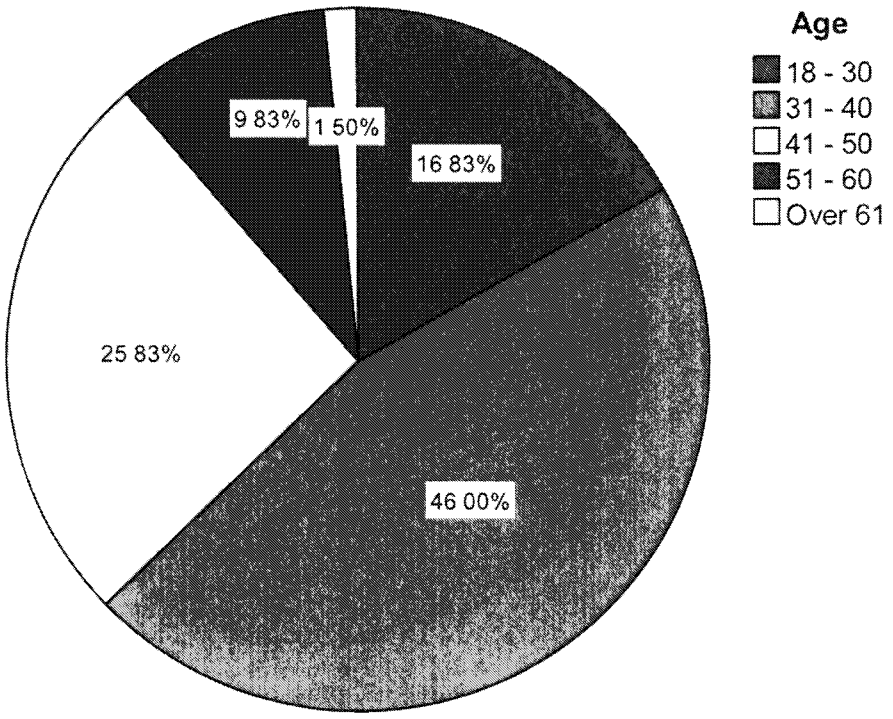

Figure 15 Participants' Age Groups

There were 29 participants that chose not to respond to Question 19. Figure 16 shows the level of experience for each respondent. The majority of respondents (45.7%) had been working in aviation industry from 11 to 20 years. There were 38.4% of respondents had less than 10 years of experience in aviation and another 16% had experience over 20 years.

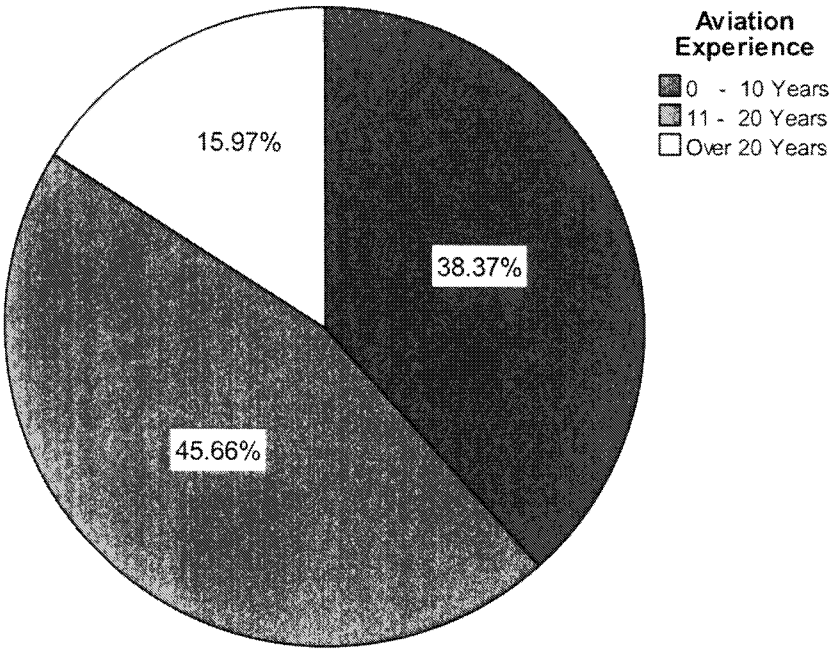

Figure 16. Groups of Aviation Experience

Question 20 represented the training sources of participants (Figure 17). Most of the participants (n=481) received training from their companies. The second highest source for training was the Taiwanese air force (n=173). Also, 142 participants received aviation related college degrees. However, there were only 69 participants who had training from an aircraft maintenance training school. Other sources of training included training from (a) manufacturer, (b) other airlines, (c) computer simulation, and (d) the government, where there were 12 participants.

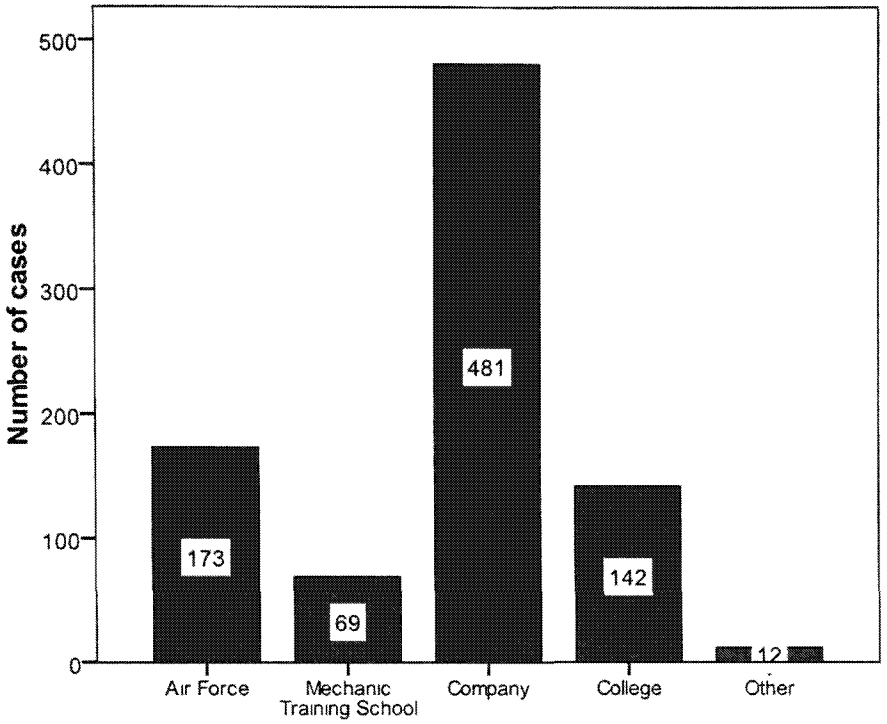

Figure 17. Sources of Aircraft Maintenance Training

In Figure 18, the results of Question 21 show that half of the participants (n=305) hold the CAA aircraft maintenance certificate. Among the participants, only 79 of them hold the FAA Airframe and Powerplant (A&P) certificate. There was one participant who held an Aircraft Parts Repair Certificate, and one with a Pratt and Whitney Powerplant certificate. On the other hand, there were 273 participants who did not hold any maintenance certificate.

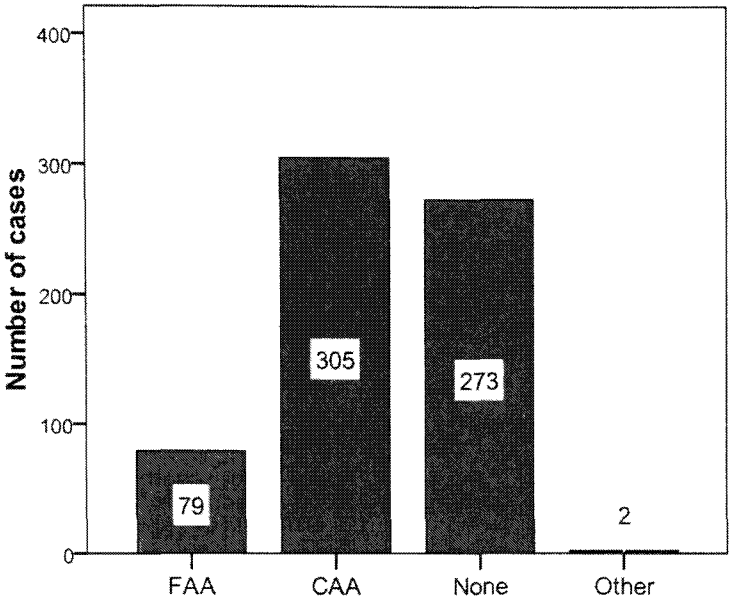

Figure 18. Maintenance Certificate Holding

Question 22 discussed the different professional fields of participants. The fields are listed in Table 20. The majority of participants (87.4%) were mechanics in the fields of (a) line maintenance, (b) hangar maintenance, (c) shop maintenance, and (d) ground services and ramp operations. There were 22.6% of participants in other functions of a maintenance organization.

Table 20

Participants' Professional Fields.

	Frequency	Percent	Cumulative Percent
Line Maintenance	104	17.2	17.2
Line and Hangar	13	2.1	19.3
Line, Hangar, and Shop	8	1.3	20.7
Line, Hangar, Shop, and Ramp	12	2.0	22.6
Line, Hangar, and Ramp	5	.8	23.5
Line and Shop	4	.7	24.1
Line and Ramp	7	1.2	25.3
Hangar Maintenance	179	29.6	54.9
Hangar and Shop	9	1.5	56.4
Hangar and Ramp	1	.2	56.5
Shop Maintenance	125	20.7	77.2
Shop and Ramp	1	.2	77.4
Ramp Operations	61	10.1	87.4
Other			
Administration	4	.7	88.1
Dispatch	1	.2	88.3
Documentation	1	.2	88.4
Engineering	9	1.5	89.9
Human Resource	2	.3	90.2
Information Technology	1	.2	90.4
Management	3	.5	90.9
Material Support	12	2.0	92.9
Production Planning and Control	5	.8	93.7
Purchasing	2	.3	94.0
Quality Assurance	11	1.8	95.9
Safety	3	.5	96.4
Security	1	.2	96.5
Training	1	.2	96.7
Not Classified	20	3.3	100.0
Total	605	100.0	

Question 23 shows the titles of participants, and the results are listed in Table 21. Mechanics and operators had the most participation (59.3%). There were 12.6% of participants who were managers and 13.4% of them who were supervisors. Other participants included (a) engineers (4.8%), (b) staff (2.5%), (c) inspectors (1.5%), and (d) others.

Table 21

Titles of Participants.

	Frequency	Percent	Cumulative Percent
Manager	76	12.6	12.6
Supervisor	81	13.4	26.0
Mechanic or Operator	359	59.3	85.3
Auditor	5	.8	86.1
President	1	.2	86.3
Confidential	1	.2	86.4
Contractor	1	.2	86.6
Controller	2	.3	86.9
Engineer	29	4.8	91.7
Inspector	9	1.5	93.2
Maintenance Planner	1	.2	93.4
Researcher	2	.3	93.7
Staff	15	2.5	96.2
Vice President	1	.2	96.4
Not Classified	22	3.6	100.0
Total	605	100.0	

Question 24 examined participants' willingness to receive the outcomes of this research. Only 90 participants (14.9%) presented their interests to be further informed about the results. The data are shown in Table 22.

Table 22

Willingness to Receive the Results.

	Frequency	Percent
Yes	90	14.9
No	501	82.8
Not Classified	14	2.3
Total	605	100.0

Comparison

The samples in this survey study were categorized into different groups by participants' demographics, such as age, experience training source, and certificate holding. To determine whether the results have significant differences between groups, the researcher utilized SPSS and conducted a series of comparisons.

Overall, there was only one significant difference regarding Question 2. The results of the comparison between the knowledge of Just Culture and aviation experience are shown in Figure 20. The three pie charts represent the differences of three experience levels. With the higher experience level, there was a tendency to have more participants who know about Just Culture. The number went from 12.33% in the group of 0 - 10 years experience to 33.70% in the group of over 21 years experience. There was no other significant difference between demographic groups on other questions.

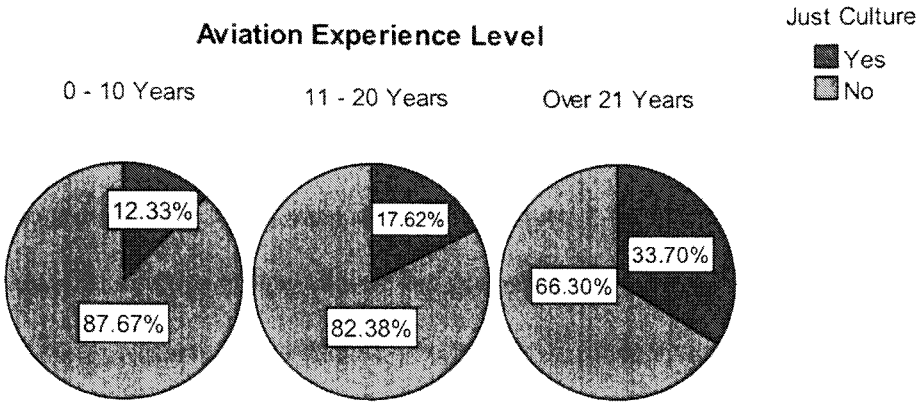

Figure 20. Differences between Experience Levels and the Knowledge of Just Culture

Interview

The strategy for the mixed research method in this research was the sequential explanatory strategy. This method collected and analyzed quantitative data (survey) in the first phase of research followed by the collection and analysis of qualitative data in the second phase. The qualitative data in this study played a supporting role to the primary quantitative data.

During the process of the interview, the qualitative data were recorded and categorized. Due to the fact that all of the participants preferred to be interviewed in Chinese, the data needed to be translated into English before analysis. There were three interviewees who requested to answer the interview questions via telephone calls. Due to the difficulties of interview timing, the other six interviewees chose to answer the interview questions via e-mail. The following sections contained descriptions about the results of those interviews.

Open-ended Questions

The open-ended questions were designed to examine (a) the factors influencing TACARE's effectiveness, (b) the issues of voluntary reporting in a maintenance organization, and (c) possible solutions to improve the utilization of TACARE. There were nine open-ended questions. The answers to Questions 1 to 9 are presented in the following sections. The numbers of respondents for each question are included. The frequencies of those common answers of each question are also listed.

Question 1 illustrated the understandings of TACARE principles. All nine interviewees answered this question, and the results are listed in Table 23. There were three interviewees who do not know the principles of TACARE. Other interviewees had knowledge about TACARE, but only partially.

Table 23

Understandings of TACARE principles.

Answers	Frequency
1. Voluntary	3
2. Submit safety recommendations	1
3. Provide confidentiality and immunity for participants	2
4. Identify safety hazards to prevent accident	3
5. Is developed by ASC to share safety information	2
6. There are TACARE newsletters on the company's bullitin board.	1
7. Only heard the term – TACARE	1
8. None	2
Total Respondents	9

Question 2 examined the issues that impact the effectiveness of TACARE. The results (Table 24) show that there was (a) no action from TACARE, (b) only little information about it, and (c) difficulty to utilize the reporting procedure. Therefore, TACARE was not commonly used.

Table 24

Effectiveness of TACARE.

Answers	Frequency
1. Insufficient Information and feedback to the stakeholders	2
2. Not enough promotion to air carriers	1
3. No actual corrective or preventive actions from TACARE	2
4. VDRP is commonly utilized	1
5. Could be easier to submit report with multiple choice questionnaire and web-based system	1
6. Only knows by researchers and people who go through ASC training courses	1
Total Respondents	7

Question 3 discussed the benefits of the existing reporting system in the organization. Even though it is not a voluntary program, the interviewees believed there were safety improvements from their in-house reporting system. The benefits were listed in Table 25. Only one interviewee suggested that there was no change from those reports.

Table 25

Benefits from In-house Reporting System.

Answers	Frequency
1. Improve controls on equipment and personnel	1
2. Additions and replacement on safety equipment	1
3. More emphasize on the inspection of working environment safety	1
4. Positive attitude toward safety	2
5. Reward and punishment	1
6. High standards from the management	2
7. Strictly follow CAA's regulation and company's Standard Operation Procedures (SOPs) as part of the company culture	2
8. Corrective or preventive actions are taken rapidly after reporting	1
9. Case study in annual recurrent MRM training	1
10. Safety notices in job task cards	1
11. Quick emergency responses	1
12. Each department has its own safety reporting beside the company one	1
13. Modified procedures	1
14. Safety record keeping	1
15. The establishment of independent safety and health department	1
16. There is no signifiacnt change since the safety of aircraft maintenance is managed by the company	1
Total Respondents	9

Question 4 demonstrated the benefits of implementing SMS. The results (Table 26) suggested that the company has had a positive safety culture. With the implementation of SMS, safety was being enhanced even more. There were positive attitudes among employees and systematic approaches to improve safety.

Table 26

Benefits from SMS.

Answers	Frequency
1. Significantly reduce the incident rate	2
2. Safety Policy	2
3. Employees are not hiding any incident	3
4. Positive attitude toward reporting in a timely manner	1
5. Surveillance and Inspection Reporting	2
6. Statistics Analysis and records	2
7. The utilization of SRM in every aspect of the company	1
8. The raise of safety awareness among employees	1
9. SMS Training	1
10. Regularly safety meetings	1
11. No matter there is SMS or not, safety cultre is there in the company	1
Total Respondents	9

The results of Question 5 (Table 27) showed the different aspects of promoting TACARE. They consisted of three parts: (a) challenges, (b) advantages, and (c) concerns. The issue of trust between authority and reporter remained a major challenge. However, there were strengths in positive company culture and audits from foreign customers. Finally, the willingness of sharing information was a great concern.

Table 27

Different Aspects of Promoting TACARE.

Answers	Frequency
Challenges	
1. The trustworthy of confidentiality	1
2. Social Culture, PD	2
3. The conflicts between TACARE, company's QA system, and CAA's oversight	1
4. The consequence against the company after reporting a problem	1
5. Continuous improvement	1
6. The company already has in-house reporting system. There is no point to submit report to TACARE	1
Advantages	
1. The passion among maintenance personnel	1
2. Foreign Customers with audits	2
3. The benefit of identifying hazards	1
4. Progressive company culture toward safety issues	1
Concerns	
1. A rapid and effective way to relay safety information	1
2. Passive and conservative attitudes	2
3. TACARE is unknown by the industry	2
4. The willingness to share personal experience	1
5. The company posseses the authority of safety, and TACARE can not get involved.	1
Total Respondents	8

Question 6 shows interviewees' knowledge about Just Culture. The answers from interviewees (Table 28) consistently showed that they had no knowledge about Just Culture.

Table 28

Knowledge about Just Culture.

Answers	Frequency
1. None	8
Total Respondents	8

Question 7 examined interviewee's understandings on the company's safety policy. Most of the interviewees were aware of the safety policy in place, but there were two interviewees who had no knowledge or were unclear of a company safety policy. The responses (Table 29) revealed that the company's safety policy did not provide confidentiality and immunity to the reporter (n=1). The reports went through open investigation and shared with the public (n=3). The company's reporting program had a group of subject matter experts to review incident reports (n=3). Then, the company took disciplinary actions to unacceptable behaviors and rewarded the good ones (n=2).

Table 29

Understandings of Company's Safety Policy.

Answers	Frequency
1. Yes, 80 percent confidence	1
2. No	1
3. Unclear about the policy	1
4. Policy is in the SMS manual, and employees are all acknowledged	1
5. Committee Review	3
6. Just and open to public investigation	3
7. Public information sharing	2
8. Standards for acceptable and unacceptable with reward and punishment	2
9. The company has full authority on the issues of safety policy, such as confidentiality and imunity	1
Total Respondents	8

Question 8 was designed to understand possible means to improve the safety culture in the organization. Table 30 shows interviewees' belief on the ways to promote safety through different forms of training and communication.

Table 30

Methods of Improving Safety Culture.

Answers	Frequency
1. Education on Just Culture	1
2. SMS training courses	1
3. Recurrent training with case studies	3
4. Field experience sharing	1
5. Active and direct communication and information sharing between CAA, ASC, and MRO	2
6. Web based Training	2
7. Continuous feedbacks from safety reports	1
Total Respondents	8

The results of Question 9 presented all the other comments. Table 31 addressed the feedback from interviewees. The main idea among those was the free flow of information between (a) regulatory oversight, (b) management, and (c) employees.

Table 31

Other Comments.

Answers	Frequency
CAA	
1. Mandate the industry to relay safety information to employees	1
2. Information sharing and trust besides regulatory oversight	3
3. Effective oversight that helps solving safety issues	1
4. Provide assistance for aviation safety	1
ASC	
1. Hold safety conference regularly with the industry	1
2. Information sharing and trust besides accident investigation	1
Safety Director	
1. Case studies as part of safety audits	1
Quality Assurance	
1. QA Notice	2
2. Confidential safety reports in the training material	1
Management	
1. Direct channel to CEO through intranet (f=2)	2
2. Provide disclosure channel with immunity for reporting safety issues	1
3. Build up safety culture as top priority	1
Safety Reward Program	
1. Reward people may be a positive way to encourage reporting	1
Total Respondents	8

Demographics

There were a total of nine interviewees, and there was one who did not wish to respond to the demographic question. Results of demographic data from the remaining eight interviewees were quantified. All of the respondents were male. The average age was 44.25. The range of age was from 40 to 48. The average number of years in aviation

experience was 18.5 with 25 years being the highest and 14 years being the lowest. All eight respondents had an aviation related bachelor's degree. Also, all of them held CAA aircraft maintenance certificates, and five of them held FAA A&P certificates. Three interviewees were senior quality engineers, and five interviewees were managers. Their responsibilities included (a) inspection, (b) investigation, (c) auditing, (d) training, and (e) production planning.

Chapter V

DISCUSSION

The mixed method design used in this research was developed to acquire a general understanding of Taiwan's aircraft maintenance industry through a quantitative data collection that was analyzed to identify the reasons for the participants' understanding of the safety programs. The purpose of the survey was to measure and examine the attitudes of Taiwanese maintenance personnel associated with voluntary safety reporting programs. The results were not intended to represent the opinions of all Taiwanese maintenance personnel; nevertheless, the sampling results represented the perspective in Taiwan's aircraft maintenance and service organizations. The interview was designed to obtain information in depth beyond what was possible to acquire from the survey. The interview was a case study of one single maintenance organization and characterized the reasons of the survey results.

Knowledge about Voluntary Safety Programs

The first question of the survey was designed to measure participants' knowledge level of various voluntary safety programs that were widely utilized in the U.S. and worldwide. The results showed that SMS was known by 55% of participants. Even though the CAA in Taiwan has published an Advisory Circular (AC) with the guidelines and mandated that each air carrier must have an SMS program, it is still only known by half of the respondents in those maintenance organizations. This result shows the lack of knowledge about SMS among employees in the organization. Nevertheless, the responses

from the interviews suggested that people acknowledged the benefits of SMS to significantly reduce the safety incident rate.

ASRS and IOSA were known by 46.4% of respondents. ASRS has been well-known by the aviation community around the world and recognized as the most successful voluntary safety reporting program. Since its policy applies to the users in the NAS alone, the program can only be utilized in the U.S. The accessibility of the safety information in ASRS was limited for the aviation community in Taiwan. Most of the air carriers in Taiwan are members of the International Aviation Transportation Association (IATA). IOSA had been awarded to some of the Taiwanese air carriers and was recognized by many maintenance organizations in Taiwan. However, not every employee shared the same knowledge in an organization. In recent years, FOQA has become a widely accepted voluntary safety program worldwide and was implemented into most of the Taiwanese air carrier operations. It is not only for flight safety, but also for aircraft performance monitoring. FOQA involved technical fields in aircraft maintenance; thus, it was recognized by a number of respondents (27.1%) in the survey.

Overall, the maintenance personnel did have partial knowledge about voluntary safety programs. Within the Taiwanese air carrier industry, it is believed that only people with positions directly or partially related to safety have an obligation to familiarize themselves with these programs. The results of interview did suggest that ICAO, IATA, and foreign business partners did facilitate some of those programs in Taiwan, such as SMS and IOSA. The air carrier and MRO facility were required to have them in order to operate internationally and have contract maintenance from foreign airlines. Understanding and implementing those voluntary programs was absolutely essential for

their international business. However, most of the employees were still lacking in knowledge about those voluntary safety programs.

Understandings of TACARE

The survey showed that over 60% of respondents knew about TACARE, but only 3.6% of them had used it before. Over 90% of respondents believed the importance of submitting safety reports and showed their willingness to participate the TACARE system. In the interview, most of the interviewees showed their understandings about TACARE, but most of their knowledge came from their own readings from TACARE's website and newsletter. They did not fully understand the policy and functions of TACARE, which caused them not to submit reports to the TACARE system. Many participants in this research were not even aware the existence of the TACARE system.

There were a variety of reasons for maintenance personnel not to participate in TACARE. From the survey data, the unfamiliarity about TACARE's reporting procedures (n=143) got the highest count of respondents among those reasons. The interview supported the survey data. Interviewees showed there was very little information about TACARE for maintenance personnel. There was not enough promotion from ASC, and TACARE was only known by a small group of people who had attended ASC's training. Also, there was insufficient safety related information from TACARE. It did not provide feedback to the participants, and there were no corrective or preventive action taken after reporting.

Even though the TACARE system was not successful, all the maintenance organizations in Taiwan had implemented their own in-house reporting programs. The

in-house reporting program in Taiwan did not resemble the ASAP program in the U.S. air carrier system. It was mandatory for employees to submit a report after a noticeable incident involved property damage or personnel injury. The program did not provide any confidentiality and immunity for the reporter. The company punished unacceptable behaviors with disciplinary actions and rewarded the achievement of good safety records. However, the interviewees believed that the company did have a fair and just investigation for each incident. There were specific committees to address different safety issues, and then corrective or preventive measures were taken rapidly. The interview showed that those in-house incident reports have helped improve safety in many ways. The strength of having a safety reporting program was well-acknowledged by interviewees.

Safety Culture in Taiwanese Maintenance Organization

Safety culture is comprised of (a) Just Culture, (b) reporting culture, and (c) learning culture. A well-developed voluntary safety program requires a healthy safety culture to support it as the foundation of trust between the authority and participants. As the results of the survey and interview showed, culture issues remain a great threat for establishing a voluntary safety reporting program in Taiwan.

In the results of the survey, over 80% of respondents have not heard of the term "Just Culture." Among the respondents, only 13.2% of them believed that they understood the concepts of Just Culture. The qualitative data from the interview also demonstrated the same result. All of the interviewees had not heard of Just Culture and were not able to describe any of its concepts. The interview results did show that the

company has its own safety policy for incident and accident investigation. There were safety committees to review the material from in-house reporting programs and to take actions toward resolving the problems. Some interviewees thought the company demonstrated fair judgments with punishment and reward. The problem was that the company has full authority to define the terms and conditions in the Just Culture; hence, the employees did not fully recognize the line between acceptable and unacceptable behaviors. In summary, both the survey and interview indicated that the maintenance personnel in Taiwan do not receive and understand the concepts of just culture completely.

Most of the respondents (73.9%) in the survey showed that it is everyone's responsibility to report safety problems and help ensure the safety of maintenance operations. However, people did not show their full confidence in a voluntary reporting program. Many believed that only the CAA or the company have the authority for confidentiality and immunity. There were existing conflicts between the functions of TACARE, the company's Quality Assurance (QA) system, and the CAA's oversight. Although the CAA has drafting a legislation to provide confidentiality and immunity to the participants in the TACARE system, the fear of the consequences toward the company and the individual still remained. Unless there is solid protection in place, people would remain passive and conservative about sharing mistakes and experiences.

Most of the respondents in the survey also believed that the CAA and ASC should be held accountable for the TACARE system. However, the results of the interview showed that both the CAA and ASC did not provide any feedback to the participants or action toward the safety issue. There were no physical improvements from the TACARE

system, which resulted in the lack of interest for people to utilize the system. Although each organization already has its own reporting system, there were still problems in relaying safety information. The information from the in-house reporting system was only shared within the company. There was no effective channel and platform (e.g., the ASIAS in the U.S.) to share safety information between the aviation industry, CAA, and ASC. Also, the lack of data in the TACARE system made it impossible to conduct long term research about safety issues; thus, the TACARE system was not able to make continuous safety improvement.

The Influences of Chinese Culture

Chinese culture had been the overall factor that influences the establishment of safety culture in the TACARE system. The culture dominates everything at both the social and organizational levels, which becomes the major challenge in Just Culture, reporting culture, and learning culture. As Gerard Hendrik Hofstede (1978) defined, the characteristics of Chinese culture were (a) high Power Distance (PD), (b) collectivism, (c) Uncertainty Avoidance (UA), and (d) masculinity. The results from both the survey and interview showed those characteristics dominate the culture in those maintenance organizations and have major influences on the success of voluntary reporting.

The high Power Distance (PD) in Taiwanese society still exists. Subordinates treat their superiors with high respect and are not in a position to question their superiors' decisions in the organization. Thus, the mechanics or operators are reluctant to report any safety problems they found since they believe it is not their responsibility. The same principle also applied to the relationship between the authority and company. This

supported the finding from the interviews whereby maintenance organizations encourage their employees to report any safety problem to their in-house safety reporting system first. People would choose to report to TACARE only if the company could not be trusted.

In Taiwanese society, collectivism made people reluctant to "snitch" on someone and break the harmony of the group. It also created a tremendous social pressure about any public event, especially for any aircraft accident or incident. The CAA and ASC were often under the pressure of the politics and the media. Consequently, this also put a company or an individual contributing to the safety problem under huge pressure, which interfered with the investigation of the problem. This social pressure also evolved into a shame culture making an individual or an organization sensitive to losing its reputation. People were afraid that their mistakes would be made known to the public. Therefore, an individual would be generally reluctant to voluntarily submit an incident report to the company or the TACARE system. The maintenance organization would also refuse to release safety information related to an incident caused by its own employees to the CAA, ASC, or other company.

The characteristics previously mentioned also form a punishment culture in Taiwanese society. Many survey respondents and interviewees expressed their fear of disciplinary action by their companies as a result of submitting TACARE reports. Unlike Western cultures where disciplinary actions were the last resource of corrective actions, in Taiwan, punishment has often been the only solution to most problems regardless of the root causes. In fact, the punishment culture had not concentrated on identifying the root cause of a problem, but utilized forms of punishment to prevent further similar

occurrences. As a result, this action contributed to the difficulty of implementing a voluntary reporting program, such as TACARE.

In the aviation industry, the composition in gender resulted in masculinity. The characteristics in competitiveness, assertiveness, and ambition resulted in the aggressive actions in the career, which may jeopardize safety by poor decision making. However, Chinese culture still has a code of honor. People desire to achieve great things and stand out as the leader in the group.

The Acceptance on the Terms of Voluntary Reporting

In the survey, there were a series of Likert-type-scale questions about the possibility of adopting ASAP principles into the TACARE system. By accepting those principles, the TACARE system might be able to improve its overall effectiveness. The majority of respondents (96.5%) believed that a well-organized voluntary reporting program would enhance safety. This indicated most of the maintenance personnel in Taiwan understood the value and importance of a voluntary reporting program. Most of the respondents (93.5%) also agreed that the program should provide protections for reporter's personal information. Although both the TACARE system and in-house reporting programs did not establish the legal protections about reporter's information, confidentiality was highly recognized as one of the means to improve the participation of the TACARE system.

For the concept of event reviewing, over 97% of the respondents agreed that safety reports should be reviewed by a group of aviation safety experts and investigators. This result was consistent with the information gained from the interview. Interviewees

suggested that the company has various committees (e.g., human factors, environment, and health) to review the incident reports from its in-house reporting program, and the preventive or corrective actions were taken rapidly afterward. However, there was no evidence showing that the TACARE system has a well-functioned Event Review Committee (ERC) similar to the ASAP program, which is consisted of subject matter experts. Thus, the TACARE system was not able to collaborate with the CAA and the industry, determine the root cause of an incident, and develop solutions to prevent reoccurrence. The survey also investigated the participants' attitude regarding the inclusion of an employee representative on the ERC. The acceptance of this concept was slightly lower than other agreements. In Taiwanese aviation industry, there was no official form of unions among those aviation firms. The concept of having representatives to negotiate terms with the company was very weak, especially for maintenance personnel. As a result, the respondents of the survey showed that an employee representative may not necessarily be included in the ERC to stand for the reporters in the program.

The concept of defining acceptable and unacceptable behaviors was accepted by most of the respondents. In a Just Culture, acceptable behaviors were being tolerated, and unacceptable behaviors were treated with disciplinary actions. Most of the respondents in the survey agreed that there should be a fine line between unintentional accidents or slips and intentional acts. However, the acceptance of immunity for acceptable behavior and punishment for unacceptable behaviors was relatively low. Since the concepts of Just Culture were not fully understood and accepted by the maintenance personnel in Taiwan, the punishment culture still dominated the process of accident or incident investigation.

The final part asked if unanimous consensus must be reached by all members of the ERC on a safety report. In order to ensure a fair judgment during investigation, this was a critical principle for an ASAP program. The ERC should consist of the representatives from the FAA, the management, and the employee. Unanimous consensus signified all participating parties were in agreement with necessary actions toward a safety report. Since the maintenance personnel in Taiwan did not fully understand this principle, the acceptance was slightly lower (83.6%) than other common principles (e.g., confidentiality) for a voluntary reporting program. Overall, the maintenance personnel in Taiwan accepted and agreed with the ASAP principles. The survey results confirmed the possibility of adapting ASAP principles into the TACARE system.

Demographics

In the Taiwan aviation industry, the male had dominated over the female as the vast majority of aircraft maintenance personnel are male. This showed that the entire population of maintenance personnel in Taiwan was under influence of Chinese culture. In the comparison between survey questionnaire and demographics, one significant difference was found. There was a positive trend in the relationship of aviation experience level and the knowledge of Just Culture. The result of this comparison showed that the percentage of respondents who knew Just Culture is 12.33% in the level of 0-10 years and 33.70% in the level of over 21 years. This trend was caused by the diverse time that respondents work in the aviation industry. With longer time in the industry, the maintenance personnel in Taiwan tend to receive more and various training and education, which lead them to have more opportunities to hear about Just Culture.

The survey results indicated that most of the respondents (n=481) received their maintenance training from the company itself. The primary contributing reason was Taiwan's educational system. There were only three universities that offer the same aviation-related program – Aerospace Engineering, and few colleges have programs related to aircraft maintenance or avionics. Moreover, there were only a few elective courses regarding safety in those academic institutions that were aviation-related. Students were usually not urged by professors to take these courses. The main reason is that these safety-related courses have been recognized as less important and not relevant to aerospace engineering. National Cheng Keng University is the only university in Taiwan that provides safety-related courses at the graduate level. However, the program lacks in materials and resources about aviation safety compared to programs in the U.S., and there were also limited number of students. As a result, the maintenance personnel in Taiwan often did not receive formal initial training regarding safety. Most of them were recruited from non-aviation professions and entered the company with less than adequate knowledge in aviation.

Since the CAA in Taiwan does not mandate that all maintenance workers be required to have a maintenance certificate to perform maintenance on aircraft, the numbers of respondents who hold maintenance certificates was low. Half of respondents (n=305) hold CAA's mechanic certificates; among them, only 79 respondents also hold FAA's A&P certificates. This discrepancy resulted from different training sources. In Taiwan's maintenance organization, the mechanics usually gained their certificates as they have more experience, and the formal training for certificate qualification was sponsored by the company. Holding a certificate often meant more responsibility as an

inspector or supervisor who signs off the work. However, the differences in the company's training for each employee resulted in the inconsistencies among employees regarding the knowledge of safety.

Chapter VI

CONCLUSIONS

A voluntary safety reporting program, such as the TACARE system, has proven to be an effective way to improve safety. It is not just identifying human's unsafe acts, but also providing a better view of the latent risks that lead to those unsafe acts. The TACARE system signifies Taiwan's efforts to improve aviation safety proactively, instead of reactively investigating aircraft accident. Even though the industry recognized the importance and benefits of having a voluntary safety reporting program, there was only minimum participation in the TACARE system, especially for aircraft maintenance personnel. The following conclusions demonstrate the reasons of little utilization by maintenance personnel in Taiwan and also their acceptance on the concepts of a voluntary safety reporting program.

One of the principal findings from both the quantitative and qualitative research was that the maintenance personnel in Taiwan lacked knowledge about voluntary safety programs. Even if the programs (e.g., TACARE, SMS, and IOSA) have been established for years in the Taiwanese aviation industry, there are still a lot of people who do not know anything about them. The research also suggested that many maintenance personnel in Taiwan were unfamiliar about TACARE's reporting procedures, which caused them not to submit a safety report to this system. People did not receive information about the TACARE system or other voluntary safety programs. Also, the majority of people did not know about the concepts of Just Culture, which are considered as the foundation of all voluntary safety programs. In other words, the ASC did not promote the TACARE system and educate on the concepts of the Just Culture

successfully, and the companies did not offer sufficient training about voluntary safety programs to all of their employees.

Secondly, the participants in this research revealed that there was no feedback to the reporter after reports were submitted to the TACARE system and no improvement from the results of the TACARE reports. Therefore, even if some of maintenance personnel were aware of the TACARE system, they are still reluctant to participate in the system. The fear of punishment still exists among the maintenance personnel in Taiwan as well. Since no legislation about the protections and immunity to the participants of the TACARE system were implemented, there is no immunity or guarantee for non-punitive actions toward the reporters. The safety policies in those maintenance organizations in Taiwan were also unclear to their employees. Thus, both the authorities (e.g., the CAA and ASC) and those maintenance organizations are still under the influences of Chinese culture.

Finally, the results of this research indicated that the maintenance personnel in Taiwan are willing to adopt the principles of the ASAP program into the TACARE system. However, they had not receive information about the ASAP program before and were not able to understand those principles, such as confidentiality and the ERC. The results of demographics showed that most of the maintenance personnel in Taiwan only received the training from their companies. There is no formal aircraft maintenance training school in Taiwan, which offers the initial training and allows the candidates to be certified by the CAA. The education in safety within the Taiwanese educational system is also limited for aviation professions. Therefore, most of the maintenance personnel in Taiwan did not receive enough knowledge of the safety in aircraft maintenance.

Chapter VII

RECOMMENDATIONS

Through the TACARE system, SMS, and the companies' in-house reporting programs, the CAA, ASC, and the aircraft maintenance industry have been taking steps to create a proactive safety reporting system. From the results of this research, the researcher found that several actions could be taken to enhance the safety in aircraft maintenance and achieve the full potential of the TACARE system.

Maintenance personnel in Taiwan lack knowledge about the TACARE system and other voluntary safety programs. It is recommended that educating maintenance personnel to a certain knowledge level regarding voluntary safety programs is considered essential. The CAA should also standardize the criteria for certification of aircraft maintenance personnel. There should be formal aircraft maintenance training schools providing initial training with basic safety knowledge. Every mechanic should go through the aircraft maintenance training first and then be certified by the CAA as an aircraft mechanic. The maintenance organizations should also offer more formal and recurrent training on safety, such as SMS, Just Culture, and case studies from voluntary safety programs.

Proper safety courses should be provided by the aviation related education institutions in Taiwan. Since the aircraft maintenance industry lacks information on the concepts of voluntary safety programs, the education system in Taiwan should provide more programs about aviation safety and cooperate with the industry closely to supply sufficient safety specialists into the workforce. With more and more education on voluntary safety programs, the maintenance organizations in Taiwan would be able to

incorporate some of the principles more easily; then, the maintenance personnel in Taiwan would be more willing to accept and participate in those voluntary safety programs.

Instead of overseeing the maintenance organizations in Taiwan through inspections and accident or incident investigations, the CAA and ASC should emphasize their efforts on promoting the concepts of voluntary reporting to let more people understand the functions of the TACARE system. The CAA and ASC should hold safety conferences regularly and provide the latest safety information for all maintenance personnel. There also should be a direct medium of exchange between the authorities and the industry to share safety information. Perhaps a platform like ASIAS in the U.S would serve as a bridge between the TACARE system and those companies' in-house reporting programs and would be beneficial to increase the overall effectiveness of safety enhancement.

In addition, the CAA and ASC should put the legislation of voluntary reporting in place as soon as possible to provide protections to its participants and establish a non-punitive environment in aircraft maintenance industry. Due to the characteristics of masculinity in Chinese culture, one can also consider a way to reward a group or individual for participating in the system. By giving a reward to an individual or a group with distinguished performance, one could be considered as a respectful person who reaches great achievements in one's career. Instead of punishing with disciplinary actions, a mechanism of rewarding participants in the TACARE system would be feasible and might increase the willingness of participation.

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APPENDIXES

APPENDIX A

THE ENGLISH VERSION OF THE SURVEY INSTRUMENT

EMBRY-RIDDLE
AERONAUTICAL UNIVERSITY

The TAiwan Civil Aviation safety REporting (TACARE) System in Aircraft Maintenance

Dear Participants,

I am a graduate student of Embry-Riddle Aeronautical University in Daytona Beach, Florida, USA. I am studying voluntary incident reporting programs for maintenance personnel, and I would greatly appreciate your input to my survey. I realize that you are very busy; and completion of the survey should require not more than 10-15 minutes of your time. Please return the completed survey to the survey collection box.

This survey is designed to examine the effectiveness of voluntary incident reporting programs for maintenance personnel. All the information will be treated confidentially and reported in the aggregate. The resultant data will be analyzed as part of my master degree's thesis. I will strictly respect the confidentiality of all participants' input. If you are a participant, and if you desire, I will provide you with a copy of the outcomes of my study. Please return the survey with your business card or contact information to indicate your interest in receiving a copy of the results.

Thank you very much for your cooperation.

Sincerely yours,

Yi-Fan (Tom) Chen
Embry-Riddle Aeronautical University, Daytona Beach, FL, U.S.A.
Master of Science in Aeronautics Graduate Student
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TACARE Survey

Question 1 and 2 is inquiry about the knowledge of voluntary safety programs.

1. Which U.S. voluntary safety program(s) are you familiar with? Please select all the following safety reporting program(s) that you have heard about or utilized. (Choose all that apply.)
   a. Aviation Safety Reporting System (ASRS)
   b. Aviation Safety Action Program (ASAP)
   c. Flight Operational Quality Assurance (FOQA)
   d. Advanced Qualification Program (AQP)
   e. Line Operations Safety Audit (LOSA)
   f. Voluntary Disclosure Reporting Program (VDRP)
   g. Internal Evaluation Program (IEP)
   h. Safety Management System (SMS)
   i. IATA Operations Safety Audit (IOSA)

2.Have you heard of the term "Just Culture"?
   a. Yes. (Please proceed to question 2-A and the followings)
   b. No. (Please proceed to question 3)

2-A. Do you feel you are well-educated on the concepts of Just Culture?
   a. Yes. b. No.

Question 3-6 consist of inquiries regard the usage of TAiwan Confidential Aviation safety REporting (TACARE) system.

3. Are you familiar with the **TA**iwan **C**onfidential **A**viation safety **RE**porting system (TACARE)?
   a. Yes, and I have used it
   b. Yes, but I have not used it
   c. No, I am not aware of TACARE
   d. No, it is no importance to me

4. Do you think it is important to submit a report to TACARE in the event of a maintenance error?
   a. Yes (Please proceed to question 5-A and 6 through 15)
   b. No (Please proceed to question 5-B and 6 through 15)

5-A. Who do you believe should have the responsibility to submit reports to TACARE in the event of a
maintenance error?
   a. Supervisor
   b. Mechanic or operator
   c. Inspector
   d. Anyone who saw the problem

5-B. I am reluctant to participate in TACARE because (Select any/all that apply from the list below):
   a. The probability of disciplinary action(s) from my airline
   b. The lack of confidence on the immunity of TACARE system
   c. My unfamiliarity with the TACARE reporting procedures
   d. I do not believe a submission of a TACARE report would not improve flight safety
   e. The company has its own reporting procedure, so TACARE is irrelevant.
   f. Other reason(s) for choosing not to participate:

   _____
   _____ (Please be specific)

6. Who do you believe should be in charge of the confidential data collected by TACARE?
   a. Civil Aeronautics Administration (CAA)
   b. Independent non-government agency
   c. Aviation Safety Council (ASC)
   d. The air carrier

Questions 7-15 consist of general statements regarding the concept of voluntary incident reporting program, please respond to each statement below by circling the choice best described your feeling.

1=Strongly Agree, 2=Agree, 3= Disagree, 4= Strongly Disagree.

7. A well-organized voluntary incident reporting program enhances flight safety.	**1**	**2**	**3**	**4**
8. The information in incident reports should be de-identified and remain anonymous for the public.	**1**	**2**	**3**	**4**
9. Confidential incident reports should be reviewed by a team of safety experts and investigators.	**1**	**2**	**3**	**4**
10. An employee representative should be included as part of the incident report review team.	**1**	**2**	**3**	**4**
11. The organization should draw a line and define what are acceptable (human errors and at-risk behaviors) and unacceptable (reckless) behaviors.	**1**	**2**	**3**	**4**
12. Participants who committed human errors or at-risk behaviors should be protected from legal and airline disciplinary actions.	**1**	**2**	**3**	**4**
13. The program should not accept and provide immunity for reckless behaviors.	**1**	**2**	**3**	**4**
14. Unanimous consensus must be reached by all members of the incident report review team on event reported.	**1**	**2**	**3**	**4**
15. The program should create rapid, useful, accessible, and intelligible feedbacks to the reporting community.	**1**	**2**	**3**	**4**

Demographics

16. Gender
    a. Male b. Female

17. Nationality
    a. Taiwanese/Chinese b. Foreign National

18. What is your age?
    a. 18-30 b. 31-40 c. 41-50 d. 51-60 e. 61+

19. How many years of aircraft maintenance experience do you have?
    a. 0-10 b. 11-20 c. over 20

20. Source of primary training?
    a. Military
    b. Airline training program
    c. Airframe and Powerplant (A&P) training school
    d. College
    e. Other: _____ (Please specify)

21. What maintenance license or certificate do you currently hold? (Choose all that apply.)
    a. Federal Aviation Administration (FAA) Airframe and Powerplant (A&P) Certificate
    b. Civil Aeronautics Administration (CAA) Mechanic License
    c. None.
    d. Other(s): _____ (Please specify)

22. What area of ground operations are you serving in?
    a. Line maintenance
    b. Hangar maintenance
    c. Shop maintenance
    d. Ground services and Ramp operations
    e. Other: _____ (Please specify)

23. Which title best describes your job position?
    a. Manager
    b. Supervisor
    c. Mechanic/Operator
    d. Other: _____ (Please specify)

24. Will you interest in the results of this research project?
    a. Yes. (Please write down your e-mail: _____)
    b. No.

NOTE: If you have any comments, please feel free to utilize the back(s) of the page(s). If your comments are specific to a question, please include a reference to the question number. Once again: Thank you for your participation!

APPENDIX B

THE CHINESE VERSION OF THE SURVEY INSTRUMENT

EMBRY-RIDDLE
AERONAUTICAL UNIVERSITY

學術研究論文

台灣飛安自願報告系統(TACARE)於航機維修安全的應用
評估我國航機維修人員對航空安全自願報告系統的認知與接受度

各位航空業界先進，諸事如意！

本人係就讀於美國安瑞德航空大學 (Embry-Riddle Aeronautical University) 航空科學研究所 (Master of Science in Aeronautics)的學生。緣於對航機修護與機務之興趣，特以「台灣飛安自願報告系統(TACARE)於航機維修安全的應用」引為「評估我國航機維修人員對航空安全自願報告系統的認知與接受度」為題，作為本人畢業研究論文之專題。並設計乙份問卷，廣徵各位在實務經驗的真知卓見。

此份問卷不需記名，期盼能藉由您的專業對於如何提升航空安全自願報告系統使用效率提供珍貴的見解。如蒙 俞允，懇請在完成問卷後，將紙本問卷投入問卷回收箱中，或將電子檔傳送至下列電子郵件信箱帳號。您的高見將僅用於本項學術研究且不對外公開，敬請放念。

誠摯地感謝您撥出寶貴的時間填寫，並對您的鼎力協助致以無限的敬意。

祝福您諸事迪吉！健康！愉快！

後學 陳怡帆 敬上

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航空安全自願報告系統研究專題問卷表

問卷開始

問題 1 和 2 是關於您對航空安全自願報告系統的認知，請勾選回答以下的問題。

1. 請標註以下您所知道的美國聯邦航空總署(FAA)或國際間的自願安全系統: (可複選)

- ☐ 美國飛安報告系統 Aviation Safety Reporting System (ASRS)
- ☐ 飛安行動計畫 Aviation Safety Action Program (ASAP)
- ☐ 飛航品保系統 Flight Operational Quality Assurance (FOQA)
- ☐ 進階資格訓練課程 Advanced Qualification Program (AQP)
- ☐ 線上安全稽核 Line Operations Safety Audit (LOSA)
- ☐ 主動提報作業計畫Voluntary Disclosure Reporting Program (VDRP)
- ☐ 內部評鑑計畫 Internal Evaluation Program (IEP)
- ☐ 安全管理系統 Safety Management System (SMS)
- ☐ 國際航空運輸委員會安全稽核 IATA Operations Safety Audit (IOSA)

2. 您是否有聽過 "Just Culture" (互信機制及公正文化) 一詞？

- ☐ 是　(請跳至問題2-A 和接下來的問題)
- ☐ 否　(請跳至問題3 和接下來的問題)

2-A. 您覺得您對 "Just Culture" (互信機制及公正文化) 的概念有良好的認知嗎？

- ☐ 是
- ☐ 否

問題 3 到 6 是在詢問您對台灣飛安自願報告系統 (**TA**iwan Confidential **A**viation safety **RE**porting system; TACARE) 的使用經驗，請勾選回答以下的問題。

3. 您是否知道飛安會(Aviation Safety Council; ASC)所設置的飛安自願報告系統 (TACARE)？

- ☐ 是，並且曾經使用過此系統
- ☐ 是，但未曾使用過此系統
- ☐ 否，且未曾注意過此系統
- ☐ 否，這對我來說不重要

4. 您覺得向飛安自願報告系統 (TACARE) 報告維修失誤等任何影響飛航安全的異常事件重要嗎？

- ☐ 重要　(請跳至問題5-A 及6 題至15 題作答)
- ☐ 不重要 (請跳至問題5-B 及6 題至15 題作答)

5-A. 在發現修護或機務安全問題後，您認為下列何者應有機會向飛安自願報告系統 (TACARE) 提出異常報告?

- ☐ 領班 (Supervisor)
- ☐ 當值維修員/操作員 (Mechanic / Operator)
- ☐ 督導 (Inspector)
- ☐ 任何發現問題的人

5-B. 您選擇不使用飛安自願報告系統 (TACARE) 提出任何異常報告原因為: (可複選)

- ☐ 有機會可能遭到公司處分
- ☐ 此系統並無豁免權
- ☐ 對此系統的提報程序並不熟悉
- ☐ 提出報告並不會提升飛航安全
- ☐ 公司擁有自己的回報程序，飛安自願報告系統(TACARE)並不需要
- ☐ 其他理由: _____

_____

_____ (請詳細說明)

6. 您認為飛安自願報告系統(TACARE)的資料應由以下哪一個機關來負責管理？(可複選)

- ☐ 交通部民用航空局 (CAA)
- ☐ 獨立之非政府機關
- ☐ 行政院飛航安全委員會 (ASC)
- ☐ 航空公司

問題 7 至15 係對於航空安全自願報告系統之敘述，請勾選最適當之答案。

	非常贊成	**贊成**	**不贊成**	**非常不贊成**
	1	**2**	**3**	**4**
7. 良好的航空安全自願報告系統可以提升飛航安全	☐	☐	☐	☐
8. 航空安全自願報告中的個人資訊應該被除去並且不對外公開	☐	☐	☐	☐
9. 航空安全自願報告應由飛安專業小組成員及飛安調查人員來做評估及檢討	☐	☐	☐	☐
10. 航空安全自願報告系統之飛安專業小組應包含工會成員或員工代表	☐	☐	☐	☐

	非常贊成	贊成	不贊成	非常不贊成
	1	2	3	4
11. 主管單位應將航空安全自願報告區分為可接受(人為失誤或潛在風險)的行為與不可接受(刻意忽視安全)的行為	☐	☐	☐	☐
12. 報告在飛安專業小組評估核可為可接受(人為失誤或潛在風險)的行為後，當事人應不受到任何法律及行政處分(豁免權)	☐	☐	☐	☐
13. 航空安全自願報告系統不應該接受並保護刻意忽視安全的行為	☐	☐	☐	☐
14. 飛安專業小組的任何決議應要在所有小組成員全無異議下才算表決通過	☐	☐	☐	☐
15. 航空安全自願報告系統應提供快速、有效、方便和明確的回應和改正計畫給參與的航空從業人員	☐	☐	☐	☐

問題16至24 請填寫您的基本資料。

16. 性別 ☐ 男性 ☐ 女性

17. 國籍 (可複選) ☐ 中華民國籍 ☐ 外國籍

18. 年齡 ☐ 18-30歲 ☐ 31-40歲 ☐ 41-50歲 ☐ 51-60歲 ☐ 61歲以上

19. 航空業資歷 ☐ 0-10年 ☐ 11-20年 ☐ 20年以上

20. 航空器修護訓練來源為 (可複選)

- ☐ 台灣或他國空軍
- ☐ 國外航空器修護訓練學校
- ☐ 公司訓練
- ☐ 大學相關科系或技職學校
- ☐ 其他：_____

_____ (請詳細說明)

21. 持有的航空器修護證照 (請選取所有您所擁有的)

- ☐ 美國聯邦航空署(FAA)航空器修護證照 (Airframe & Powerplant Certificate)
- ☐ 交通部民用航空局(CAA)航空器修護證照
- ☐ 無
- ☐ 其他：_____
  _____ (請詳細說明)

22. 工作領域

- ☐ 停機線修護 (Line Maintenance)
- ☐ 棚廠修護 (Hangar Maintenance)
- ☐ 場站修護 (Shop Maintenance)
- ☐ 機務 (Ground Services / Ramp Operations)
- ☐ 其他：_____
  _____ (請詳細說明)

23. 您的職務稱位

- ☐ 經理/課長 (Manager)
- ☐ 領班 (Supervisor)
- ☐ 維修員/操作員 (Mechanic / Operator)
- ☐ 其他：_____ (請詳細說明)

24. 您是否有意願收到本次研究的結果？

- ☐ 是 (請留下您的電子郵件信箱 _____)
- ☐ 否

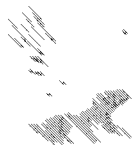
問卷結束!

感謝您撥冗提供意見，如有任何問題或其他建議，懇請在問卷後面填寫您寶貴的意見！
如果您有興趣進一步了解本研究，結果將以電子檔的形式寄到您的電子郵件信箱。

APPENDIX C

THE ENGLISH VERSION OF

THE OPEN-ENDED INTERVIEW QUESTIONS



EMBRY-RIDDLE
AERONAUTICAL UNIVERSITY

The TAiwan Civil Aviation safety REporting (TACARE) System in Aircraft Maintenance

Dear Participants,

I am a graduate student of Embry-Riddle Aeronautical University in Daytona Beach, Florida, USA. I am studying voluntary incident reporting programs for maintenance personnel, and I would greatly appreciate your input to my research. I am currently conducting interviews with experts in the area of voluntary safety reporting programs. You have been identified as a possible participant in the study.

This interview is designed to examine the effectiveness of voluntary incident reporting programs for maintenance personnel in Taiwan. All the information will be treated confidentially and reported in the aggregate. The resultant data will be analyzed as part of my master degree's thesis. I will strictly respect the confidentiality of all participants' input. If you are a participant, and if you desire, I will provide you with a copy of the outcomes of my study.

The interview is designed to be approximately 15 minutes long, and the interview questions are attached for your review. If you are available, I would like to set up a time to be in contact with you that would best suit your schedule. If you are willing to participate, please inform me of your best time and the phone number for contacting you. I look forward to speaking with you and sincerely appreciate your time and effort.

Thank you very much for your cooperation.

Sincerely yours,

Yi-Fan (Tom) Chen
Embry-Riddle Aeronautical University, Daytona Beach, FL, U.S.A.
Master of Science in Aeronautics Graduate Student
chencang30@hotmail.com
chenyi@my.erau.edu

Interview Topics

1. Are you familiar with the TACARE system? If yes, please describe your understanding.

2. If you know about the TACARE system, what is your opinion of the effectiveness of the TACARE system? (If not applicable, please skip to Question 3)

3. What improvements have you observed in your company's safety culture and operations since the implementation of the in-house safety reporting system?

4. Can you provide examples to show the positive changes in safety culture within your company after implementing the Safety Management System (SMS)?

5. What are your thoughts concerning the incorporation of a voluntary safety reporting program, such as the TACARE system, into maintenance and ramp safety?

   A. Challenges

   B. Advantages

   C. Concerns

6. Are you familiar with the concept of "Just Culture?" If yes, please describe your understanding.

7. Does your company have a safety policy for voluntary incident reporting? If it does, please describe the level of trust on the just and confidentiality between the management and employees.

8. What education or training program(s) do you think would be needed to improve safety culture when implementing a voluntary safety program?

9. Please provide suggestions on any of the items below that involve aviation safety programs.

    A. Civil Aviation Administration (CAA):

    B. Aviation Safety Council (ASC):

    C. Company's Safety Committee:

    D. Safety Director:

    E. Quality Assurance:

    F. The Management:

    G. Safety Rewarding Program:

    H. Other:

Demographics of interviewee:

Gender

Age

Source of and level of Education

Professional Certificate(s)

Years of Aviation Experience

Job Title

Main Responsibility

APPENDIX D

THE CHINESE VERSION OF

THE OPEN-ENDED INTERVIEW QUESTIONS

EMBRY-RIDDLE
AERONAUTICAL UNIVERSITY

學術研究論文

台灣飛安自願報告系統(TACARE)於航機維修安全的應用
評估我國航機維修人員對航空安全自願報告系統的認知與接受度

各位航空業界先進,新年如意！

本人係就讀於美國安德瑞航空大學(Embry-Riddle Aeronautical University) 航空科學研究所 (Master of Science in Aeronautics)的學生。緣於對航機修護與機務之興趣，目前正致力於畢業論文的專題研究。論文的研究是以「台灣飛安自願報告系統(TACARE)於航空器維修安全的應用」引為「評估我國航機維修人員對航空安全自願報告系統的認知與接受度」為主軸。因此，特設計訪談問卷一份，渴望藉由廣徵各位對於航空安全自願報告系統領域的真知卓見，期能與另一以「航空安全自願報告系統研究專題問卷表」之旨意相應並合併做更深入的探討，衷盼有您一同熱情參與。

電話訪問約需耽誤您15 分鐘，題目已先臚列於本頁後，懇祈支持與成全。如蒙俞允，煩請告知最適合您受訪的時間與方式，本人自應配合，並請以本頁左下方所列之電子郵件帳號或聯絡人之聯絡電話聯繫告知，有所不情之請，敬請包涵。

誠摯地感謝您願意撥出寶貴的時間受訪，並對您的賜覆先致以無上的敬意。

祝福您與您的家人諸事迪吉！健康快樂！

後學 陳怡帆 謹上

研究員 | 陳怡帆
電子郵件信箱 | chencang30@hotmail.com
cheny@my.erau.edu

連絡人 | 陳嘉寧
電子郵件信箱 | chencang@ms7.hinet.net
聯絡電話 | 0932-234-411

論文研究訪談題目

1. 您對台灣的飛安自願報告系統(TAiwan Confidential Aviation safety REporting system; TACARE)是否熟悉並了解其功能？如果是，請簡述您對該系統的了解。

2. 請教您對於台灣飛安自願報告系統 (TACARE) 成效之看法? (如果不了解該系統，請跳過本問題。)

3. 在公司內部之安全報告系統施行後，請舉例簡述您所觀察到公司在人員訓練管理和安全文化(Safety Culture)上的正面實質效益有哪些?

4. 請舉例簡述在實行安全管理系統 (Safety Management System; SMS) 後，對於您公司之安全文化(Safety Culture)是否有任何改善?

5. 請教您對台灣民用航空業在飛機修護和機務實行自願安全報告系統的看法為何:
    a. 面臨之挑戰:

    b. 優勢:

    c. 面臨之問題:

6. 請問您對 "Just Culture" (互信機制及公正文化) 一詞是否熟悉？如果是，請簡述您對該系統的了解。

7. 請教您公司是否有對自願安全報告系統的相關規範與政策？如果有，請舉例描述公司的員工對於其保密及公正性的信任度。

8. 您認為何種教育訓練方式有助於建立公司的安全文化(Safety Culture)並增進自願安全報告系統之成效?

9. 煩請提供以下任何部份您覺得有所助益的意見與建議：
    a. 民航局：
    b. 飛安會：
    c. 公司的安全部門：
    d. 安全部門主管：
    e. 品保單位：
    f. 公司管理階層：
    g. 安全績效獎勵計畫：
    h. 其他：

基本資料

性別 |

年齡 |

學歷 |

專業證照 |

航空業資歷 |

工作職稱 |

主要職責 |

電子郵件信箱 | (如願意收到本次研究結果)