

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

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Abstract

The purpose of this research was to evaluate the effectiveness of the Taiwan Civil Aviation safety REporting (TACARE) system for maintenance personnel to improve aircraft safety. The researcher identified the issues that affect participation of maintenance personnel in the TACARE system. How well maintenance personnel in Taiwan understood the safety culture in Taiwan was a specific focus of the research project. A mixed-methods approach, which involved both a survey and an interview, was used to sample the acceptance and opinions regarding the TACARE system for the maintenance personnel in Taiwan. A statistical analysis of the data obtained from 605 survey respondents and 9 interviewees concluded the maintenance personnel in Taiwan lacked the necessary knowledge of voluntary safety reporting. The results suggested a need to increase the importance of-- and promoting of-- a voluntary safety reporting program within the Taiwanese aircraft maintenance profession.

Introduction

Safety has always been a concern in the inherently high-risk aviation industry. “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). Before voluntary safety programs were implemented, information about hazards and safety problems became available only after an accident occurred. Voluntary safety programs have increasingly enabled the airline industry to detect hazards and vulnerabilities in the air transportation system. According to the

statistical data from the U.S. Federal Aviation Administration (FAA), voluntary incident reporting programs, such as the Aviation Safety Reporting System (ASRS) and the Aviation Safety Action Program (ASAP), have disclosed 90% of the problems which were previously unknown to the air carrier industry or the FAA (Farrow, 2010).

The voluntary reporting systems for aircraft maintenance, such as ASRS and ASAP, have been successful in the United States. They have accumulated two thousand reports from aircraft maintenance personnel every year (FAA, 2009). 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. Taiwan's ASC established a voluntary reporting program for its civil aviators in 1999, known as the TACARE system. Statistics of the Civil Aeronautics Administration (CAA, n.d.) in Taiwan show that there are 2,210 certified mechanics in Taiwan. However, only a small number of them participate in the TACARE system. The current study examined the safety culture among Taiwanese maintenance personnel and identified factors affecting participation in the TACARE system.

Human Factors in Aircraft Maintenance

Human factors have been implicated in 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 flight (Patankar & Taylor, 2004). Therefore, most of the safety issues remained unseen by others until an accident or incident occurs.

In Taiwan, there has been only one fatal incident that involved maintenance errors in the last 10 years (ASC, n.d.). 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 experienced 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 appropriate 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.

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" (p. 8-1). 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). Under those principles, there are ASRS and ASAP for the civil aviation industry in the U.S.

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). 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 (FAA, 1997).

For the ASAP program in the airlines, the 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 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. With the success in ASRS and ASAP, the concepts of voluntary reporting and non-punitive culture helped civil aviation worldwide developed the Safety Management Systems (SMS) under ICAO's initiation.

Safety Management Systems

The SMS are organized approaches 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 defined and established by the State(s) concerned (ICAO, 2006). ICAO initiated provisions for the SMS in November, 2006. Air carriers, airdrome operators, and maintenance organizations around the world are required to implement SMS (Galotti, Rao, & Maurino, 2006). Since then, ICAO has worked in close collaboration with Member States to develop a new Annex dedicated to safety management responsibilities and processes. The Safety Management Annex will be based on safety management provisions initially adopted in ICAO Annexes 1, 6, 8, 11, 13 and 14 (ICAO, 2011).

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. SMS has been assisting the FAA in maintaining the voluntary reporting programs that have been operated effectively and efficiently in the U.S. On the other hand, Taiwan also has mandated Taiwanese air carriers to implement the SMS as of January 1, 2009 (CAA, AC 120-32B, 2007).

The performance-based approaches to the management of safety have been demonstrated by SMS. A 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, pp. 18-19). Using a Risk Matrix, the likelihood of occurrence and the severity of the event would be measured against the cost of the particular safety intervention. 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.

Safety Culture

A safety culture can be thought of as an “engine” that continues to drive the organization toward 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). 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).

Voluntary safety programs are generally impeded by many difficulties, such as trustworthiness 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. 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).

Chinese Culture

The dimensions of social culture were first defined by 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. Low PD accepts power relations that are more consultative or democratic. On the contrary, high PD means less powerful accept power relations that are more autocratic and paternalistic (Hofstede, 1978). 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. UA reflects the extent to which members of a society attempt to cope with anxiety by minimizing uncertainty. Masculinity versus its opposite - femininity, refers to the distribution of roles between the genders.

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 for the last 100 years, certain perspectives of Chinese culture persist in Taiwan (Lee & Weitzel, 2005).

In Chinese culture, there is a high PD. Authoritarianism is a characteristic based on 5,000 years of dictatorship. 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. Therefore, there has been a common belief that a figure of authority is error-free. This belief has led authoritative figures not to allow challenges or questions (Lee & Weitzel, 2005). On the contrary, Western culture 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.

Traditional Chinese culture is characterized by its strong emphasis on collectivism, and Western culture is considered as individualism 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 at a young age to listen, not to speak or speak only when spoken to. On the other hand, children in the U.S. are taught to be raised questions if any doubts. Nevertheless, human society is formed as a group and can function well, but it relies heavily on individual performance. One of the priority concerns to maintain the function of the society is the harmony of the group. Therefore, they are not dependent upon themselves, but the society. This may become a latent risk in aviation safety (Lee & Weitzel, 2005).

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 feelings. The society is heavily ruled and structured in both written and unwritten ways. In contrast, the American culture emphasizes 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).

Just Culture

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). In a 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).

Effective incident reporting necessarily involves the air carriers, authorities, and employees working together. Getting people to report an incident is about building trust. Trusting 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) for the voluntary incident reporting program.

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 functioning Chinese style social 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 reporting program.

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.

Taiwanese Civil Aviation Authorities

In Taiwan, the civil aviation authorities are roughly equivalent to the analogous aviation 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.

In June 1999, National Cheng Kung University conducted a feasibility study of the reporting system used in Taiwan (TACARE, n.d.). 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 (TACARE, n.d.). TACARE has provided five ways 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 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.). 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 a 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.

Research Questions

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

1. "What is the understanding of voluntary safety programs for maintenance personnel in Taiwan"?
2. "How would Taiwanese maintenance personnel embrace the concept of a voluntary safety reporting program"?
3. "Will the terms of an U.S. style voluntary safety reporting program for aircraft maintenance operations be accepted by the Asian culture?"

Research Methods

Very little research has been conducted to study the safety of aircraft maintenance in Taiwan. Since the perspectives of maintenance personnel toward TACARE were unknown previously, this research used a mixed method design to obtain that data. This design provided quantifiable results and added validity to the research questions. A questionnaire and a set of structured interview topics were designed and administered 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.

The sampling 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 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 e-mail communication 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.

Results and Discussion

The purpose of the survey was to measure and examine the attitudes of Taiwanese maintenance personnel associated with voluntary safety reporting programs. The sampling results represented the perspective in Taiwan's aircraft maintenance and service organizations. The interview was designed to obtain information in depth. 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. 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 the International Aviation Transportation Association (IATA) Operational Safety Audit (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 National Airspace System 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 conducted by 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, Flight Operational Quality Assurance (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.

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.

The survey 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 improve flight safety, (e) the company has its own reporting procedure, so TACARE is irrelevant, and (f) other reasons. In Figure 1, statement “c” had the highest count of 143 respondents, which suggested the lack of knowledge on the reporting procedures. Interviewees showed there was very little information about TACARE for maintenance personnel. Also, the TACARE system did not provide feedback to the participants, and there were no corrective or preventive action taken after reporting.

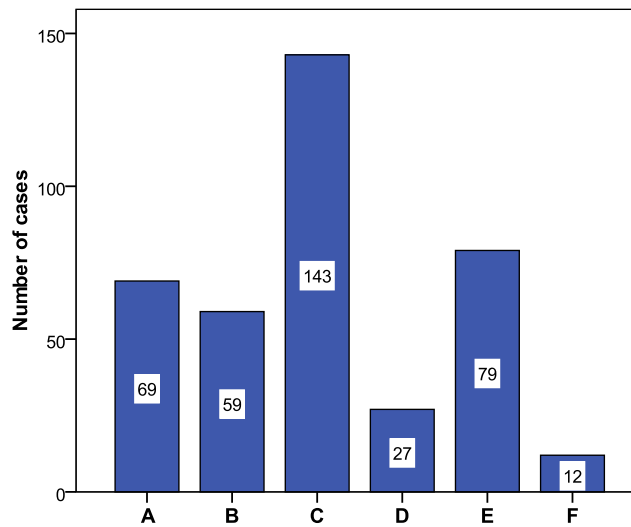


Figure 1. Reasons for not participating in TACARE.

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

In the results of the survey, over 80% of respondents have not heard of the term “Just Culture.” Among the respondents, only 80 of 605 (13.2%) participants 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. 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.

Also, in the survey, 416 of 563 (73.9%) respondents 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. 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 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 to share safety information between the aviation industry, CAA, and ASC.

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. Those principles included (a) confidentiality, (b) ERC, and (c) Just Culture. By accepting those principles, the TACARE system might be able to improve its overall effectiveness. The overall agreement of each participant regarding the concepts of the voluntary reporting program was summarized with each individual’s agreement level. With 9 Likert-type-scale questions, the maximum agreement total sum for each participant was (a) Strongly Agree = $1 \times 9 = 9$, (b) Agree = $2 \times 9 = 18$, (c) Disagree = $3 \times 9 = 27$, and (d) Strongly Disagree = $4 \times 9 = 36$. 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 2. The statistic showed that the majority of the respondents are more than agreed to those statements. This result indicated the participants are willing to adopt the principles of ASAP program.

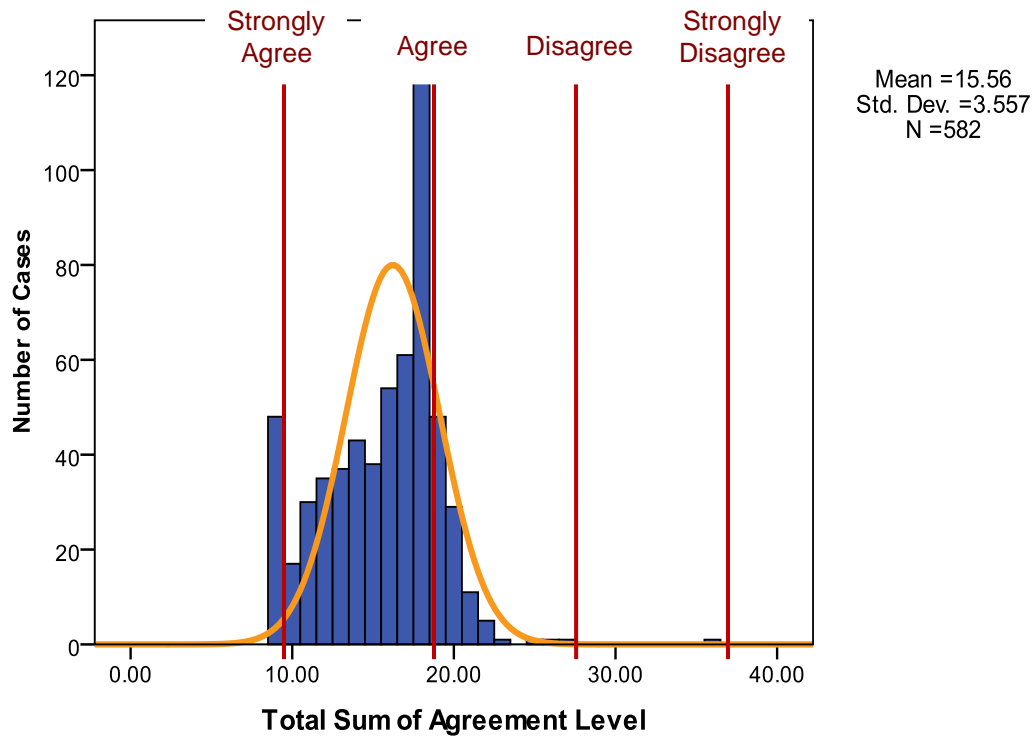


Figure 2. Total sums of agreement level with likert-type-scale questions.

Demographics

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. Few colleges have programs related to aircraft maintenance or avionics. Moreover, there were only a few elective courses regarding aviation safety in those academic institutions. The aviation education 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. Half of respondents (n=305) hold CAA's mechanic certificates; among them, only 79 respondents also hold FAA's Airframe and Powerplant 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.

Conclusions

The principal finding of this study was that maintenance personnel in Taiwan lacked basic knowledge about a voluntary safety program. The demographics showed that most of the maintenance personnel in Taiwan only received the training from their companies. The education about aviation safety is limited. Therefore, many maintenance personnel in Taiwan were unfamiliar about TACARE's principles and reporting procedures, which caused them not to submit a safety report to this system. The survey participants also revealed that there was no feedback to the reporter after submitting to the TACARE system and no perceived improvements from the results of the TACARE reports. Since there is no legislation about the protections and immunity to the participants of the TACARE system, the fear of punishment exists among the maintenance personnel in Taiwan as well. Finally, the results of this research indicated that maintenance personnel in Taiwan believe a well-developed voluntary reporting program could improve safety, and are willing to adopt the principles of the ASAP program into the TACARE system.

From the result of this research, it is recommended that the CAA and ASC should emphasize their efforts on promoting the concepts of voluntary reporting and let people understand the functions of the TACARE system. The maintenance organizations should 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. With more and more education on voluntary safety programs, people would be able to incorporate the principles and willing to participate in those safety programs. On the other hand, the CAA and ASC must 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 order to establish a Just culture for the TACARE system, the ASC could incorporate the ERC concept from the ASAP program. A joint review committee with members from the CAA, airline representatives, and third party experts should enhance the confidence of the stock holders. It will also serve as a direct medium of exchange between the authorities and the industry to share safety information. The free flow of information and knowledge would be beneficial to increase the overall effectiveness of safety improvement.

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