



Exploratory Factors in Aviation Voluntary Safety Reporting According to International Civil Aviation Organization

Supasuta Sharnprapai*, Thanyarat Khamproh and Apirada Namsang

Civil Aviation Training Center, Jatujak, Bangkok, 10900, Thailand

*Corresponding author, E-mail: s_supasuta@hotmail.com

Abstract

The objective of this research is to identify voluntary safety reporting factors in Thailand's service providers, including Airport Operator, Air Operator, Air Navigation Service Provider, Approved maintenance organizations, Approved Training Organization, General Aviation and Aircraft/Product design and manufacturers. This research was applied a mixed methods combined, both quantitative and qualitative, which includes 3 steps of the research procedures as follows: 1) to study the variable concerning the factors of voluntary safety reporting by literature review, and collecting qualitative data from 17 key informants, which consists of representatives of the executive level, supervisor level, staff level from safety unit, and operational officers working in 7 service providers, as Airport Operator, Air Operator, Air Navigation Service Provider, Approved maintenance organizations, Approved Training Organization, General Aviation and Aircraft/Product design, and manufacturers to utilize content analysis for analyzing related variables, 2) to develop opinionnaire for collecting quantitative data from a sample of 400, from safety personal and front-line operation personal in 7 service providers, 3) to analyze factors of voluntary safety reporting. The statistic used in data analysis were frequencies, percentage, means, standard deviation, exploratory factor analysis with 2 test statistics including Kaiser-Mayer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The results of this study found that factors of voluntary safety reporting consist of 5 factors. There are 1) Public consciousness of reporters which related to 3 main aspects of consciousness, 2) Corporate safety management related to safety policy, objectives, resources and safety promotion, 3) Implementation and response of the safety unit can be described as safety's unit potential, 4) Efficient reporting system, which mentioned to characteristic of safety reporting system and 5) Reporter's attitude related to 3 aspects of attitude.

Keywords: *Exploratory factor analysis, International civil aviation organization (ICAO), Safety management system, Voluntary safety reporting*

1. Introduction

International Civil Aviation Organization (ICAO) states that Safety Management System (SMS) is a systematic approach to managing safety, including the necessary organizational structures, accountability, responsibilities, policies and procedures. Safety Management seeks to proactively mitigate safety risks before resulting in aviation accidents and incidents, by collecting safety data of lower consequence events or process performance, and analyzing the safety information or frequency of occurrence to determine if a hazard could lead to an accident or incident, therefore, reliable safety data and the safety information are necessary to identify trends, making decisions and evaluating safety performance, related to safety targets, safety objectives, and assessing risk. ICAO (2018) also claims that mechanism for proactive hazard identification is a voluntary safety reporting system (ICAO, 2013), which is essential for collecting safety data, and safety information. It did not capture, by the mandatory safety reporting system, in order to illuminate latent conditions, such as inappropriate safety procedures, or regulations, human error and active failures (ICAO, 2018). The data used to support safety analyses are reported by multiple sources. One of the best sources of data is direct reporting, by front-line personnel (pilots, air traffic controllers, aircraft maintenance engineers), since they observe hazards, as part of their daily activities, nevertheless, from passengers or the general public. (ICAO, 2013)



The effective management of safety is highly dependent on the effectiveness of safety data collection, analysis and overall management capabilities. (ICAO, 2013) The Civil Aviation Authority of Thailand (CAAT, 2019a, b) has begun implementing the CAAT Requirement No.22, related to mandatory and voluntary occurrence reporting, in order to ensure the effective implementation of the requirement across all service providers including Airport Operator, Air Operator, Air Navigation Service Provider, Approved maintenance organizations, Approved Training Organization, General Aviation and Aircraft/Product design and manufacturers. This is to set the acceptable levels of State safety performance, by safety performance indicators (SPIs) and Safety Performance Targets (SPTs), (Civil Aviation Authority of Thailand, 2019).

According to literature reviews, related to voluntary safety reporting found, various barriers and supporting factors in High Reliability Organizations (HROs), which implement safety management system (Reason, 1990), such as aviation industry, medical industry, as well as chemical industry (Guldenmund, 2010). Thus, it would be advantage to broaden the scope of the study, because of factors in each research is specific. Moreover, the research of safety report system cannot be found in Thailand. For this reason, the researchers were motivated to study voluntary safety reporting factors in Thailand's service providers, to encourage proactive safety management.

2. Objective

1) To identify voluntary safety reporting factors, in Thailand's service providers, consisting of Airport Operator, Air Operator, Air Navigation Service Provider, Approved maintenance organizations, Approved Training Organization, General Aviation and Aircraft/Product design, and manufacturers.

3. Research Methodology

This research was applied a mixed method, combined both quantitative and qualitative, which includes 3 steps of the research procedures as follows:

1. To study the variable concerning the factors of voluntary safety reporting by using content analysis. Firstly, reviewing the conceptual document, academic theories, manuals, for both domestic and international research. Furthermore, secondly, collecting qualitative data from 17 key informants, which consists of representatives of the executive level, supervisor level, staff level from safety unit and operational officers. It includes 7 service provider employees, as Airport Operator, Air Operator, Air Navigation Service Provider, Approved maintenance organizations, Approved Training Organization, General Aviation and Aircraft/Product design and manufacturers. This is considered by the criteria as follows: 1) Experienced in SMS training record, 2) Experienced in safety unit at least for 5 years, or, 3) Experienced in voluntary safety reporting.

2. To first develop opinionnaire with Likert's rating scale, and to consider the Index of Item-Objective Congruence; IOC by 3 aviation industry experts. Next, the researcher will calculate the reliability with Cronbach's Alpha Coefficient, by giving a try out of the survey to a group of 30 people, presented the reliability at 0.94, which is considered as highly reliability, for collecting quantitative data, from a sample of 400 safety personnel, and front-line operation personnel in 7 service providers, from November to December, 2020. The study is calculated the sample by Cochran (1953) sampling techniques, because this study cannot solve specific amount of group, sampling by setting a 95 percent confidence level, and a 5 percent tolerance level.

In this study, the opinionnaire was composed of two parts:

Part 1: A general questions that gathers the respondent's information such as gender, age, educational background, type of service provider, work experience, experienced in SMS training record, and experienced of voluntary safety reporting.

Part 2: A five-point opinionnaire related to voluntary safety reporting factors, using 64 items within the questionnaire, including respondents' suggestions



3. To analyze factors of voluntary safety reporting, by using Exploratory factor analysis (EFA) to extract the variables, that were important factors in Principal Component Analysis (PCA) and in orthogonal rotation. Varimax rotation is used to obtain a critical variable, as a voluntary safety reporting factor. In this study, the researcher used the element extraction method, by determining the possible number of components, from 3-6 factors, and by using the method to determine the variance of the variables (Eigenvalues), and it is found that the determination of five factors was most appropriate, in explaining this factor analysis.

Data Analysis

1. The computer program will be used, to analyze the collected data statistically, by the Exploratory Factor Analysis (EFA). Frequencies and percentage were used to explain respondent's information in part 1 of questionnaire. The statistic used in part 2 of questionnaire data analysis were means, standard deviation and exploratory factor analysis, with 2 test statistics, including KMO value (Kaiser-Mayer-Olkin Measure of Sampling Adequacy), that must be greater than 0.5, and close to 1 and Bartlett's Test of Sphericity, which is used to test the variables, whether they are related or not. Here, the Chi-square value and the statistically significant of less than 0.05 were considered.

Table 1 Kaiser-Mayer-Olkin Measure of Sampling Adequacy and Bartlett's test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.635
Bartlett's test of Sphericity	Approx. Chi-square	27653.22
	Df	2016
	.Sig.	.000

KMO was .635 higher than 0.5, indicating that the information of the analyzed data was appropriate to analyze the factor. To test the hypothesis with Bartlett's test of Sphericity found that the chi-square value was 27653.22, with the probability of rejecting the null hypothesis of 0.000, which is less than 0.05, that can be described, as the variable's correlation coefficient matrix that is not identity matrix. The variables are related to one another; therefore, the data will be suitable, and can be analyzed for further factors.

2. The researcher analyzed data by factor analysis to extract the variables, that were important factors in Principal Component Analysis (PCA), and orthogonal rotation, by using Varimax rotation, to obtain a critical variable, to be used as a voluntary safety reporting factor. In this study, we used the element extraction method by determining the possible number of components from 3-6 factors, and Eigenvalues from the consideration of the researcher. It is found the results of the analysis revealed that, the determination of five factors was most appropriate in explaining the factor analysis. Eigenvalues should be higher than 1, supporting these five rate factors term, and condition as designated by standard criteria. Factor analysis results which determine total number of 5 factors. The analysis results are presented as table 2 below.

Table 2 The result of Varimax rotation

Factor	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Eigenvalue	% of Variance	Cumulative % of Variance	Eigenvalue	% of Variance	Cumulative % of Variance
1	18.341	28.658	28.658	6.905	10.789	10.789
2	4.949	7.732	36.390	6.689	10.452	21.241
3	3.235	5.055	41.445	6.306	9.853	31.094
4	2.665	4.164	45.609	6.028	9.419	40.512
5	2.531	3.954	49.564	5.793	9.051	49.564

[263]



4. Results and Discussion

4.1 Result

The results demonstrating the Eigenvalues are between 5.793 and 6.905. This is to demonstrate a percentage of variance between 9.051 and 10.789 with all 64 questions. The variance of all factors was able to explain 49.564% from the determination of the factor loading of each factor, considering the criteria from 0.50 or more and, each factor must have 3 or more variables used to describe. If variables less than 3 the variable are not counted in voluntary safety reporting factor. It was found 43 variables met the criteria and 21 variables was elimination from opinionnaire, thus, the factors meeting the criteria will be displayed as table 3 below.

Table 3 The result of Variable's factor loading

Variable	Factor loading				
	Factor1	Factor2	Factor3	Factor4	Factor5
Variable 36: Job description and Job Specification	.724				
Variable 15: Protect yourself from negative feelings	.705				
Variable 18: Need to use knowledge	.688				
Variable 34: Corporate image	.668				
Variable 16: Engagement for organization and colleagues	.567				
Variable 35: Duty and responsibility	.566				
Variable 28: Sufficient budget for organization	.553				
Variable 9: Ability to collect and access information	.529				
Variable 38: Evaluation of employees to exchange ideas	.502				
Variable 31: Training for correct knowledge of safety		.662			
Variable 33: Recognizing the important of safety reporting from top management		.644			
Variable 32: Safety vision and responses from top management		.639			
Variable 22: Clear work objectives and safety objectives		.627			
Variable 26: Good management in the organization		.626			
Variable 6: Intention of reporters		.598			
Variable 27: Intention of reporters		.555			



Variable	Factor loading				
	Factor1	Factor2	Factor3	Factor4	Factor5
Corporate policies that promote or support safety reporting					
Variable 25:		.540			
Safety culture and reporting culture					
Variable 48:		.534			
Good publicity from safety unit					
Variable 58:		.517			
A timely reporting system that is always available to use					
Variable 43:			.760		
Acknowledgment and response of safety unit					
Variable 20:			.632		
The need to improve the quality of work					
Variable 44:			.614		
Report the progress of corrective action or a summary of the incident report in terms of changes from safety unit					
Variable 42:			.606		
Good interactions within reporter's unit which consists of a good relationship between workers					
Variable 40:			.601		
Just Culture in organization					
Variable 45:			.585		
Accuracy and fair data analysis of safety unit to check information before considering					
Variable 46:			.581		
Potential to use information in reporting to improve safety of safety unit					
Variable 29:			.571		
Problems have been resolved or changed in the organization					
Variable 50:			.519		
Non-impact reporting back to the reporter and smooth post-reporting process					
Variable 62:				.832	
Reporting form with clear explanations of information in easy-to-understand language					
Variable 53:				.782	
Reporting system that does not require reporter identification or disclosure					
Variable 52:				.670	
Application of techniques and technologies such as online reporting system					



Variable	Factor loading				
	Factor1	Factor2	Factor3	Factor4	Factor5
Variable 54: The reporting system must be attractive to use.				.618	
Variable 51: Clear guidelines and procedures for reporting				.609	
Variable 56: The reporting form must have sufficient space to attach description and pictures				.595	
Variable 57: A simple reporting system must be easy to use and uncomplicated.				.523	
Variable 60: A secure incident reporting system that is reliable and trusted by reporters				.510	
Variable 7: The comfort of the reporter					.590
Variable 13: Willingness of the reporter					.586
Variable 4: Understanding the reasons and the pros and cons of the report					.570
Variable 10: Feeling safe of the reporter					.554
Variable 59: Reporting system with data protection and report confidentiality					.529
Variable 11: Belief of the reporter					.526
Variable 47: Good interactions between the reporter and safety unit related to a good relationship, cooperation and communication between departments.					.525
43 Total Variables	9 Variables	10 Variables	9 Variables	8 Variables	7 Variables

All factor loadings were greater than 0.50, considered as practically significant. 43 variables were condensed into five factors. These are five factors with eigenvalues higher than 1, explaining 49.564% of the variance together. The most essential factor will be sort by relative weight, which could be calculated by loading factor with the values, by using the rotated factor pattern matrix in SPSS program. Thus, loading factor determines eigenvalue (Suhr, 2006).

Voluntary safety reporting factors were categorized into five groups with sub-factor 43 variables. Factors were ranked by the weight. The findings are described as follows, respectively:

The first factor called Public consciousness of the reporter consist of 9 variables, related to engagement for organization and colleagues of reporter, to protecting yourself from the negative feelings such as Self-guilt or other neighbor, including job description and qualification of front-line operational staff



that need to use knowledge, understand of safety, with ability to collect and access information of safety. This is to provide opportunities for employees to exchange ideas and corporate image as well as allocating sufficient budget to manage safety for resource support and training. Public consciousness factor has the factor loading between 0.502 - 0.724. The Public consciousness factor has the highest relative weight. It is the most important factor for voluntary safety reporting factors, that is rearranged by weight.

The second factor called corporate safety management consists of 10 variables, related to the organization policy that supports safety report, especially the clear policy that reports occurrence and sets work objective and also safety objective. To create safety culture, reporting culture as well as good manage in organization, such as uncomplicated work regulations, it should be good publicity from the reporting unit and to ensure correct safety knowledge, from the training management, to create a responsive, perspective, recognizing the importance of knowledge-driven safety report. This is for senior management's understanding of aviation safety, and the reporting system should always on time. The second factor has the factor loading, that was between 0.517. - 0.662.

The third factor called Implementation and response of the safety unit, consists of 9 variables related to acknowledgment, and responds when reports from voluntary safety unit, the summary of the incident report in terms of improvement, the need to improve quality of work for the reporter, have a good interaction within the reporter unit. It consists of a good relationship between workers and supervisors, who have to understand altogether, with good communication in the organization, and creating a Just Culture. Ability to analyze and identify impartial information from reporting, and to conduct a review of the information before consideration and the potential for the use of information, in reporting to improve the safety of the report receiver unit, for changes in the organization in a better way. Reporting should not affect the reporter and must be easy in post-reporting process for reporters. The third factor has the factor loading, that was between 0.519 - 0.760.

The fourth factor called Efficient reporting system, consist of 8 variables, related to a simple reporting system, must be easy to use and can be used for real Intuitive, to clear guidelines and procedures for reporting, as well as being user-friendly. Guidelines and procedures for clear incident reporting of the form, and the report form must have sufficient space, to attach descriptive and pictures, by the reporting system which must be attractive to use. It might be application of techniques and technologies, such as online reporting system, but it does not forget to require reporter identification or disclosure. The fourth factor has the factor loading between 0.510-0.832.

The fifth factor called Attitude of the reporter, consists of 7 variables, related to the comfort of the reporter, the willingness of the reporter, that understands the reason and the advantage and disadvantage of the report, as well as having good interactions, between the reporter and safety unit, which consists of a good relationship, cooperation and communication between departments. The fifth factor has the factor loading between 0.525-0.590. Thus, the total relative weight of this factor was rearranged to the last factor, for voluntary safety reporting factors.

4.2 Discussion

This research found 5 voluntary safety reporting factors, which can be discussed as follows:

1. Public consciousness of the reporter was able to discuss by 9 variables, related to volunteerism behavioral patterns, corresponding to (Singhaphon, 1999). The theories can be described into 3 awareness. Firstly, self- consciousness for duty, responsibility, job description and job specification. Secondly, public consciousness that is engagement for organization and colleagues. Thirdly, social awareness which is corporate image and sufficient budget for organization. Furthermore, Clary (1992) claims that protecting yourself from negative feelings and willing to use knowledge and Evaluation of employees, to exchange the



ideas voluntary function. Finally, the ability to collect and access information, complies with the concept of effective reporting system (ICAO, 2018).

2. Corporate Safety Management in organization was suitable for discussion by 10 variables. These findings are corresponding to Safety Management System (ICAO, 2018). The component 1 related to safety policy, objectives and resources that comply with good management in the organization. Top management sets clear work objectives and safety objectives to support safety reporting in corporate policies. Finally, the component 4 related to safety promotion, which complies with good publicity from safety unit, providing a training for correct safety knowledge to all personnel, in order to make an intention of reporters.

3. Implementation and response of the safety unit was able to discuss by 9 variables. These findings are corresponding to concept of reducing resistance, in safety reporting (ICAO, 2016), including attitudes and barriers to incident reporting research (Evans, 2006), which complies with acknowledgment and response of safety unit. This is to report the progress of corrective action or a summary of the incident report and solve the problem on safety unit. After that, Capability of Safety Unit is applying information of report, in order to improve safety, by verify information with interactions within reporter's unit, which consists of a well relationship among colleagues, since easy of decision is just culture in organization, that complies with the characteristics of reporting (Farrow, 2010).

4. Efficient reporting system was able to be discussed by 8 variables. These findings are corresponding to confidential incident reporting systems, that creates vital awareness of safety problems research (Chappell, 1996). It mentioned guidelines for supporting confidentiality reporting. The theory complied with clear guidelines and procedures for reporting, a secure incident reporting system, that is reliable and trusted by reporters, a reporting form with clear explanations of information, in easy-to-understand language, and has enough space to attach description and pictures. For application of techniques and technologies such as online reporting system, it is resource-saving that is consistent with the effective definition (Pipatphen, 2014). Moreover, The Taiwan Civil Aviation Safety Reporting (TA- CARE) System in Aircraft Maintenance research described unfamiliar with the procedure, and improper process reporting, that affects the performance of the reporting system (Chen, 2010).

5. According to (Fishbein & Ajzen, 1975) claims that the rational action theory has 3 components of attitudes. Initially, the conceptual aspect describes a person's response utilize of thought processes, beliefs, reasoning, knowing the pros and cons of reporting, including the self-belief of the reporter. Next, feeling and emotion' aspects describe the willingness, that comes from the individual needs of the reporter and the behavioral aspects, described a person's expression on a subject or person, consistent with the reporter and the safety unit in the good way. These 3 components of attitude corresponding to a reporter attitude factor was able to be discussed by 7 variables related to attitudes.

5. Conclusion

The objective of this research is to identify voluntary safety reporting factors in Thailand's service providers. The results found voluntary safety reporting factors, consist of 5 factors rearranged by importance and there were: 1) Public consciousness of reporters 2) Corporate safety management 3) Implementation and response of the safety unit 4) Efficient reporting system and 5) Reporter's attitude.

To achieve the goal, service providers should complete voluntary safety reporting factors in organization, from input process to output process. Firstly, providing appropriated knowledge to all staff in order to encourage a public consciousness of reporters, and reporter's attitude under corporate safety management in input step. Then, establishing an efficient reporting system for process step in order to attract user. Lastly, implementation and response of the safety, because of the summary on the incident report, in terms of improvement, will impact to reporters in initial process.



The information from this study will be beneficial to Thailand's service providers. Voluntary safety reporting factors will become a guidance or checklist for Gap analysis.

The recommendations for the next research can be describe as follows:

1. To specify responder's age range as a generation to study the level of opinions on the voluntary safety reporting factors, due to a difference behavior such as technology experience.
2. To study the level of opinions on the voluntary safety reporting factors, in the state's authorities.
3. To compare the level of opinions on the voluntary safety reporting factors, among front line operational staff and safety staff in service providers.

6. References

- Chappell, S. L. (1996). *Confidential Incident Reporting Systems Create Vital Awareness of Safety Problems*. California: National Aeronautics and Space Administration.
- Chen, Y. F. T. (2010). *The Taiwan Civil Aviation Safety Reporting (TACARE) System in Aircraft Maintenance: An Evaluation of the Acceptance of Voluntary Incident Reporting Programs*. Daytona Beach, Florida: Embry-Riddle Aeronautical University
- Clary, E. G., & Stukas, A. A. (2000). The functional approach to volunteerism. *Why we evaluate: Functions of attitudes* (pp. 365-393). In Maio, G.R. & Olson J.M. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Cochran, W. G. (1953). *Sampling Techniques*. New York: John Wiley & Sons., Inc.
- Clary, E. G., Snyder, M., Ridge, R. D., Copeland, J., Stukas, A. A., Haugen, J., & Miene, P. (1998). *Understanding and assessing the motivations of volunteers: A functional approach*. *Journal of Personality and Social Psychology*, 74(6), 1516–1530. Retrieved May 12, 2020, from http://www.communicationcache.com/uploads/1/0/8/8/10887248/understanding_and_assessing_the_motivations_of_volunteers-_a_functional_approach.pdf
- Evans, S. M., Berry, J., Smith, B., Esterman, A., Selim, P., O'Shaughnessy, J., & DeWit, M. (2006). *Attitudes and Barriers to Incident Reporting: A collaborative Hospital Study*, 15(1), 39-43.
- Farrow, D. R. (2010). *FAA Voluntary Safety Programs*. Florida: Embry-Riddle Aeronautical University.
- Fishbein, M. & Ajzen, I. (1975). *Theory of rational action*. [Online]. Retrieved from <https://www.sciencedirect.com/topics/medicine-and-dentistry/theory-of-reasoned-action>
- Guldenmund, F. W. (2010). (Mis) understanding safety culture and its relationship to safety management. *Journal of Risk Analysis*, 30(10), 1466-1480.
- ICAO. (2013). *DOC 9859 Safety Management Manual*. Third Edition. International Civil Aviation Organization. Retrieved January 6, 2020, from http://www.anac.gov.ar/anac/web/uploads/ssp-sms/doc-9859_ed3_en.pdf
- ICAO. (2018). *Doc 9859 Safety Management Manual*. Fourth Edition. International Civil Aviation Organization. Retrieved January 6, 2020, from <https://unitingaviation.com/publications/9859/#page=1>
- Pipatphen, T. et al. (2014). *Kan Pramoen Prasitthi Phap Lae Prasitthi Phon Kan Pati Bat Ratchakan Khong Thetsaban Nakhon Songkhla*. Retrieved March 15, 2020, from https://www.songkhla-city.go.th/files/com_content/2014-10/20141002_odtydwp.pdf
- Reason, J. (1990). *Human Error*. UK: Cambridge University Press.
- Singhaphon, S. (2012). *Tong son hai koet chit sammuk mai*. Retrieved February 17, 2020, from http://www.ska2.go.th/reis/data/research/25611231_121928_1298.pdf



- Suhr, D. D. (2006). Exploratory or Confirmatory Factor Analysis? Exploratory or Confirmatory Factor Analysis?, 200–231. Retrieved March 20, 2020, from https://www.researchgate.net/publication/318722840_Exploratory_or_Confirmatory_Factor_Analysis
- The Civil Aviation Authority of Thailand. (2019a). *Phaen niraphai nai kan bin phonlaruan haeng chat*. Retrieved February 23, 2020, from [https://www.caat.or.th/wp-content/uploads/2019/04/Security_Safety_Plan_in_National_Civil_Aviation_year_2019_\(แผนนิรภัยในการบินพบบเรือแห่งชาติ-พ.ศ.-2562.pdf\)](https://www.caat.or.th/wp-content/uploads/2019/04/Security_Safety_Plan_in_National_Civil_Aviation_year_2019_(แผนนิรภัยในการบินพบบเรือแห่งชาติ-พ.ศ.-2562.pdf)).
- The Civil Aviation Authority of Thailand. (2019b). *Kho kamnot samnakngan kan bin phonlaruan haeng prathed thai Chabap thi Yisipsong waduai kan raingan hetkan dan khwam plotphai nai kan bin phonlaruan*. Retrieved February 23, 2020, from <https://www.caat.or.th/th/archives/46174>.