An empirical analysis of the impact of aircraft maintenance technical training on risk mitigation in the Sri Lankan aviation industry

SCM Bandara[1], KMGMWB Samarkoon[1] and WTS Rodrigo[1#]

[1]*Department of Aeronautical Engineering*
General Sir John Kotelawala Defence University, Colombo, Sri Lanka

#thusith.rodrigo@kdu.ac.lk

***Abstract**: The operational efficiency of aircraft maintenance activities is pivoted on the equilibrium between safety and productivity. Against this backdrop, aviation safety management systems play a vital role in ensuring safe operations while enhancing operational efficiency. Out of the main four pillars of safety management systems, safety promotion and to be specific technical training and its impact on risk mitigation are analyzed in this paper through an empirical study. A conceptual framework with the independent variables covering initial training, continuous training, and the availability of training infrastructure is evaluated against the impact on risk mitigation. This addresses a very specific research gap, especially in the context of the Sri Lankan commercial aviation sector where the relationship between technical training and aviation safety is very rarely researched. The research is conducted in the form of a hypothetic deductive study based on the empirical responses of aircraft maintenance field stakeholders evaluated through statistical analysis. The outcome of the research reveals some important points as all three hypotheses are positively supported and highlight the importance of qualitative improvement of initial training and continuous training. Meanwhile, it also highlights the importance of expanding the training infrastructure to cater to the increasing technical manpower demand.*

***Keywords**: Aviation Safety Management System, safety promotion, technical training, Continuous training, risk mitigation*.

1. Introduction

1. Background of the Study

Importance of technical training both initial and the job is of very high importance to ensure safe operations in all aircraft maintenance endeavors. Even though the umbrella word training is used in most literature, it needs to be critically evaluated in detail. especially in the context of aviation safety management systems, the prominence of technical training is emphasized through the main aspect of safety promotion. A safety management system consists of Risk management, Safety promotion, Safety assurance, and Safety policy. Especially in the context of Sri Lankan aviation safety promotion is given a very minimum emphasis. Safety is an essential phase of a civil aviation organization's survival and development. Aircraft maintenance can take as a far-reaching accountable factor for the safe operation of the aircraft. The accepted SMS model is credible to reduce hazards and risks, but it is difficult to directly link safety performance and risk mitigation. However, identified through training and education. Organization development gains effective competency in maintaining leadership for health and safety. (Mcdonald *et al.*, 2000). Aviation training design assists to enhance communication skills, safe working techniques, and developing situational awareness among employees (Chatzi *et al.*, 2019). Aviation safety training and education is

an essential factor to enhance safety performance. Safety promotion includes training and education and safety communication. Training and education should consist of initial job-oriented training, continuous training, and recurrent training (Andrei, 2011).

Management leadership capabilities and knowledge-sharing behavior directly affect the performance of the organization and safe working conditions. Considering the training schedule, training environment & facilities, and management review. (Alkhanaizi, 2018). Proper training on written and verbal communication, the use of communication equipment, and language proficiency is important for safe maintenance activities (Thomas, 2003). When considering the Sri Lankan aviation industry, SMS implementations are used to maintain a safe working environment and risk mitigation. So, risk assessment, hazard identification, maintaining safe data quality, record keeping, advanced safety training, improving occupational health and safety, and continuous monitoring are given a high priority by the civil aviation authority Sri Lanka within the SMS implementation framework (CAASL, 2015).

2. Problem Statement

Training and education directly affect risk mitigation through safety promotion because of factors of low consideration of training and education, training capacity, lack of training knowledge, training experience problems, lack of training concurrency, etc. The safety management system is considered a systematic approach to managing safety. Training and education failures directly affect aviation safety because of the lack of updates on safety promotion. Aircraft maintenance, in-flight activities, maintenance manual referring, data records, correct procedures, and many more sectors are affected by effective technical training and education. Without proper training and education aircraft safety will entirely collapse. All modern commercial aircraft and associated equipment are highly complicated and any person who performs maintenance activities on them needs to have in-depth exposure and training without which it will endanger both the safety of the aircraft and the passengers who are flying on board.

Aviation safety management systems (SMS) have four main pillars; safety policy, safety assurance, safety risk management, and safety promotion. Safety promotion ensures that aviation personnel is trained and competent to perform their duties and engage in a two-way communication of safety issues between the organization's management and operational personnel. To implement safety promotion in the aviation industry, mitigating risks in aircraft maintenance operations can be considered an important factor in terms of line maintenance and base maintenance. According to the ICAO, safety promotion focuses on two elements as training & education and safety communication (Andrei, 2011). So, it is important to improve training & education to mitigate the risks. Aviation risk management considers the knowledge and education of employees, Training on hazard identification and using PPE, Occurrence reporting, resources management, concern about OSH, and information understanding (Study, 2017). Therefore, considering these backgrounds researchers tend to investigate, how can these factors affect improving safety promotion towards risk mitigation in the aviation industry.

3. Research Questions

1. Does continuous training impact aviation safety?

2. Does the level and quality of Initial Training by the aircraft maintenance staff affects aviation safety?

3. Does the level and quality of Training resources available by the aircraft maintenance staff affects aviation safety?

D. Objectives

1. To evaluate the impact of continuous training on overall Training & education in aircraft maintenance.

2 To evaluate the relationship between initial training and Training & education in aircraft maintenance.

3. To evaluate the impact of Training resources availability towards Training & education in aircraft maintenance.

4. To ascertain the overall impact of Training & education towards risk mitigation in the craft maintenance operations.

2. Literature Review

1. Theoretical Background

Safety is the most important phase in the aviation industry. The national transportation safety committee of Indonesia assures that 60% of accidents and incidents occur from human factors and 34% occur from technical problems and the rest happened due to environmental problems (Yudoko and Purboyo, 2017). For safety management systems and safety performance in the aviation industry, a self-regulatory model was introduced to improve the safety of organizational aspects. The SMS should identify and reduce safety hazards by maintaining a proper level of safety risk controls. To suggest an SMS model for federal aviation regulations 141 approved flight schools have the potential to allow safety enhancement through a well-structured management system to control risk in operations. The SMS model develop based on ICAO and FAA concepts and adheres to their safety protocols. This model includes processes to initiate responsibilities and accountabilities for safety, evaluate associated risks and identify safety hazards. Safety communication and safety training & education are initial factors for risk mitigation. One of the most significant causes of accidents is still deficiencies in the training of technical personnel. Hence improving the training of technical personnel is an effective way to increase the safety of the organization (Mendonca , 2017).

2. Initial Training, continuous training, and training resources availability perspective on safety promotion.

An adequate level of initial training helps to enhance the safety of the working environment; This initial training is a supportive path to getting experience and improvement of work reliability and safety in the organization (Teperi, 2010). A proper training procedure improves employees' knowledge about all areas of safety-related activities in the organization. Training conduct for the use of personal safety equipment, maintenance safety, corrective actions, emergency precautions, responsibilities of own job areas, and how to behave in a safe work environment is most important because the final expectation of these pieces of training is risk mitigation in the working environment (McCulloch et al., 2009). Workplace productivity and standard of maintenance also depend on continuous training. Providing effective continuous training to all employees ensures better performance of the organization. To improve performances, aircraft maintenance organizations have to maintain continuous training & monitoring, updates about new manuals, and updates about new technology (Robson et al., 2010). In resource availability, the different kind of rescores and tools are important to conduct basic maintenance activities. Aircraft maintenance safety depends on the availability of technical and human resources. Aviation is the most functioning industry in the world because of that day to day updating with new procedures, tools, technology, and technical resources, and maintaining resources is very important. Maintenance resources management training also helps to enhance the performance and safety of the organization. To improve the training availability of qualified persons for training, allocating sufficient time and resources for training is also important (Datta, Srivastava and Roy, 2013).

3. Methodology

This research is conducted by using the quantitative method and the study is a cross-sectional analysis. The research is based on the deductive approach which is concerned with building up hypotheses relevant to an existing

theory of aviation safety management systems. The sampling frame used in this study was distributed to the line and base maintenance employees in Sri Lankan aviation organizations. This study considered independent variables such as initial training, continuous training, and training resources availability. Risk mitigation is considered a dependent variable. According to the variables, the conceptual framework was developed to link safety promotion and risk mitigation. The necessary data for the execution of the study was gathered through a Likert scale questionnaire by creating a google form. The sample of the study was distributed among 160 employees. The random stratified sampling method was used to collect the data because of the difficulties of collecting data island-wide. The parameter became the training and education of the statistic of maintenance employees in the Sri Lankan Airlines Engineering, Fits Aviation, and Sri Lanka Airforce. The questionnaire is based on considered variables and contains eight sections. The data which was collected from questionnaires were analyzed statistically using IBM SPSS Software to examine the impact of initial training, continuous training, training resources availability, written/verbal communication, information understanding, employee engagement & feedback towards risk mitigation.

1. Conceptual Framework

By referring to the SMS model for federal aviation regulations 141 approved flight schools (Mendonca and Carney, 2017) developed the conceptual framework to link safety promotion and risk mitigation. training and education are categorized as initial training, continuous training, and training resources availability. The research will be discussed under six hypotheses.

H1: Initial training has a positive impact on risk mitigation towards safety promotion.

H1n: Initial training has no impact on risk mitigation towards safety promotion.

H2: Continuous training has a positive impact on risk mitigation towards safety promotion.

H2n: Continuous training has no impact on risk mitigation towards safety promotion.

H3: Training resource availability has a positive impact on risk mitigation towards safety promotion.

H3n: Training resource availability has no impact on risk mitigation towards safety promotion.

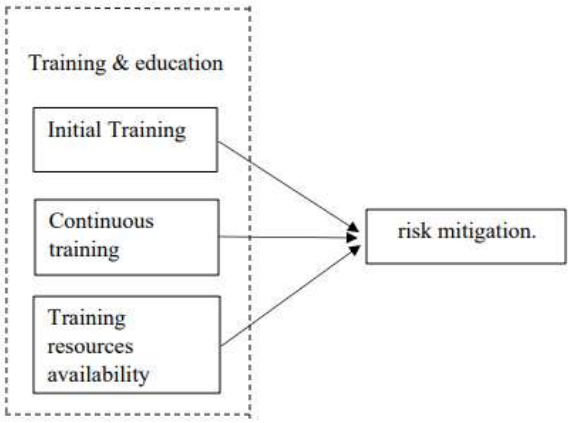

Figure 1: Conceptual Framework

4. Results

1. Normality

Checking the information is normally distributed by Skewness and Kurtosis. For Skewness, the agreed value should be within -1 to + 1 and for Kurtosis, should be within the range of -3 to + 3 (Mishra *et al.*, 2019).

Table 1: Normality Test

	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
Risk mitigation	-.074	.199	.129	.396
Initial Training	-.205	.199	-.543	.396
Continuous Training	-.102	.199	.019	.396

Training resources availability	-.499	.199	-.141	.396

2. Validity

Kaiser-Meyer-Olkin (KMO) use to determine the validity of data and typically KMO should be between 0-1. If the value of the KMO is closer to 1 indicates that the data collected is acceptable (Kingdom *et al.*, 2015).

Table 2: KMO Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.913

3. Multicollinearity Test

Multicollinearity considers an identical linear relationship between two or more of the input variables. Regression analysis and subsequent results can be influenced by this situation (Daoud, 2018). The tolerance value must usually be greater than 0.1 and VIF should be less than 5 (Shrestha, 2020).

Table 3: Multicollinearity Test

variables	Collinearity Statistics	
	Tolerance	VIF
Initial Training	.430	2.327
Continuous Training	.437	2.287
Training resources availability	.530	1.886

4. Correlation

Pearson's correlation coefficient is generally used as a measurement to determine the correlation. If there is a coefficient (r) range between -1 to +1 it is considered a proper correlated relation. To test whether there is an adequate relationship between dependent and independent variables. Significance value can also be used as a measure to take a hypothesis decision (Zhang and Wang, 2018).

Table 4: Correlation Test

Hypothesis	Pearson Correlation	Sig. (2-tailed)	Decision
H1	.655	.000	Not Rejected
H2	.606	.000	Not Rejected
H3	.524	.000	Not Rejected

5. Regression

Regression is a mathematical method used to analyze variables relationships. If there is a situation where there are more than one independent variable multiple regression is carried out (Plotts, 2011). Here the linear relationship between independent variables and risk mitigation (dependent variable) has been analyzed.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.740[a]	.548	.528	.400

According to the above model summary, the R-value indicates a positive relationship with the dependent variable of risk mitigation due to the R-value being 0.728.

Table 6: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	27.384	6	4.564	28.445	.000[b]
Residual	22.624	141	.160		
Total	50.008	147			

According to the above table, it can be concluded that the overall regression model is a good fit for the data where F (6,141) = 26.576

and p<0.0005. Therefore, by considering the overall significance level given in the ANOVA table which is .000 can be concluded that this study is statistically significant.

Table 7: Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.205	.356		.576	.565
IT	.243	.076	.277	3.209	.002
CT	.158	.083	.162	1.988	.049
TRA	.072	.084	.067	.856	.393

According to the unstandardized coefficients (B) values in the above table the regression equation can be derived which indicates, that change in one unit in independent variables affects the increase of risk mitigation as per the unstandardized coefficients B values. The equation can be derived as follows,

Risk mitigation = 0.205 + 0.243 (IT) + 0.158 (CT) + 0.072 (TRA)

5. Discussion

The hypotheses suggested by the researchers based on the conceptual framework will be contributed to the discussion of the study. So mainly focus of this research is to analyze the relationship between safety promotion and risk mitigation. It can be done through training & education and communication channels related to safety promotion. Training & education effectiveness were analyzed through three channels initial training, continuous training, and training resources availability. Results of the normality test Skewness and Kurtosis values are within the good range as in the mid, near to zero (+1,-1 & +3,-3) and it shows good results in normality.When considering the first hypothesis that initial training has a positive impact on risk mitigation towards safety promotion, research carried out by Ahmad and Muhammad (Ahmad and Adamu, 2014) has proven that training effect employee performance and risk mitigation. According to this study, findings revealed that initial training has a positive relationship with risk mitigation. The linear relationship between initial training and risk mitigation was found significant value (P) less than 0.01. According to findings the coefficient for correlation of Pearson is 0.655 also indicates the linear relationship.

The second hypothesis that considered continuous training has a positive impact on risk mitigation towards safety promotion, research carried out by Robson, Stephenson, and Carol (Robson *et al.*, 2010) found that continuous training and enhance knowledge assist to improve safe working conditions. According to this study, for an appropriate correlated relationship, the coefficient should range from -1 to + 1. According to findings the coefficient for correlation of Pearson is 0. 606. Therefore it can be concluded that there is a positive relationship between continuous training and risk mitigation.

Referring to the third hypothesis training resource availability has a positive impact on risk mitigation towards safety promotion, according to the previous findings of Siddiqui, Habibullah, and Iqbal (Siddiqui, Iqbal, and Manarvi, 2012) establish that maintenance resources management assists to maintain safe work environment. According to this study, findings revealed that training resource availability has a positive relationship with risk mitigation. The linear relationship between training resources availability and risk mitigation was found significant value (p) less than 0.01. According to findings the coefficient for correlation of Pearson is 0.524 also indicates the linear relationship. But according to the regression, there is only a marginal contribution of training resources availability towards risk mitigation.

6. Conclusion

This study specifically examined the factors that impact safety promotion toward risk mitigation. The initial training, continuous training, and training resources availability were the variables that were used as affecting factors during this research and after the study, the researchers verified that all the above factors have a significant impact on safety promotion improvement towards risk mitigation. The findings confirm that the initial training, continuous training, and training resources availability, have a positive impact on risk mitigation in the aviation industry. According to our findings initial training highly affected safety promotion towards risk mitigation. So, to mitigate risk in an organization safety promotion improvement is very important. But training resource availability has only a marginal contribution towards risk mitigation.

As recommendations, the results of this research could be served as a foundation for further research on safety promotion evaluation in the aviation industry. Training resource availability areas have to be significantly improved for risk mitigation. When considering the initial training aspects can improve hazard identification training, use of personal protective equipment training, and human factor training for technicians and engineers. Continuous training is also an important factor in enhancing safety. Engaging continuous training of safety procedures in maintenance activities, and updating employees about new manuals and technology have to be improved. Training resource availability enhancement and the development of innovative training systems are also essential. Maintaining better learning & working environment and engaging qualified persons for training activities are necessary factors. Providing training course materials and training program evaluation by management assists to improve the training performance.

When considering the limitations of the study, the data were collected from just aviation-related organizations and selected only aviation-related employees. Also, only consider the line maintenance and base maintenance trades for data collection. The study was based on quantitative data and further research may be carried out by embedding qualitative data gathered through interviews and focused group discussions for in-depth analysis. The result of this study paper could be served as a foundation for further research on enhancing safety culture through training & education.

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Author Biography

Dr. WTS Rodrigo
Senior Lecturer
Department of Aeronautical Engineering
General Sir John Kotelawala Defence University Colombo, Sri Lanka

SCM Bandara
Undergraduate in Engineering
Department of Aeronautical Engineering
General Sir John Kotelawala Defence University
Colombo, Sri Lanka

KMGMWB Samarakoon
Undergraduate in Engineering
Department of Aeronautical Engineering
General Sir John Kotelawala Defence University Colombo, Sri Lanka