An analysis of the impact of technical communication on aviation risk mitigation in the context of aircraft maintenance operations in Sri Lanka

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Abstract: *Aviation safety plays a vital role in the airline industry including aircraft maintenance operations. The equilibrium between safety and productivity is inversely proportionate as additional efforts on safety have an inverse impact on operational efficiency. Therefore, a major attribute that decides the operational effectiveness of an aircraft maintenance establishment is decided on how effectively it can handle the equilibrium between safety and productivity. Accordingly, this paper empirically evaluates the impact of technical communication on aviation safety through the theoretical framework of aviation safety management in the context of commercial aircraft maintenance operations in Sri Lanka. A conceptual framework is formulated with independent variables addressing written and verbal communication, information*

Keywords: *technical communication, risk mitigation aviation safety management, written and verbal communication, employee engagement*.

1. Introduction

1. *Background of the Study*

Effective safety management plays a vital role in the Airline industry including aircraft maintenance operations as it handles the delicate equilibrium between safety and operational productivity. Generally, aviation safety management is based on four main pillars, namely safety policy, safety risk management (SRM), safety assurance, and safety promotion (Chatzi et al., 2019). Even though there is a significant amount of research on the impact of safety policy, management, and risk assurance there is a severe dearth of literature evaluating the safety promotion's impact on overall aviation safety. The scope of safety promotion directly communication (EL Hajjar and Alkhanaizi, 2018). Technical communication generally includes verbal and written communication methods used in assessing and interpreting technical data keeping and maintenance of documentation, transferring and continuation connects with technical communication and training aspects (Andrei, 2011). Especially in the context of the Sri Lankan commercial aircraft maintenance industry, a huge scarcity is observed in technical research to prove the sustainable impact of technical communication on aviation safety. Hence, this paper is focused on addressing this long prevalent research gap through an empirical analysis.

Aircraft maintenance is a highly human-intensive process where the productivity and effectiveness of work transferring through shift work, faultfinding, rectifications, inspections, work supervision, and quality assurance is fundamentally based on effective technical

of work logs in between shifts, and maintaining the other relevant documentation in the form of the necessary information, and maintenance records (Taylor and Thomas, 2003). Especially in the context of Sri Lankan aviation, the Civil Aviation Authority of Sri Lanka (CAASL) has

specifically highlighted the essentiality of standardization of technical communication through proper SMS practices to enhance the safety of the working environment through proper record keeping, supervision, and auditing on the communication process(CAASL, 2015).

2. Problem Statement

Technical communication directly affects aviation safety through written and verbal communication lapses, misunderstandings, language problems, pronunciation, misinterpretations, etc. The situation is more complicated when considering the dynamic environments of Flightline maintenance and base maintenance activities where the fluctuating maintenance demand is to be fulfilled with limited resources without compensating the quality and standards. Also, the employee engagement of technical staff in ensuring effective communication significantly differs from person to person depending on their attributes. Against this backdrop, technical communication problems could endanger the safety of the aircraft while significantly reducing the aircraft maintenance operational productivity.

3. Research Questions

1. Does written & verbal communication with significant impact on aviation safety?

2. Does the level and quality of technical information understanding by the aircraft maintenance staff affects aviation safety?

3. Does the level of employee engagement related to aviation safety enhancements in aircraft maintenance operations?

4. Objectives

1. To evaluate the impact of written and verbal communications on overall technical communication in aircraft maintenance operations.

2. To evaluate the relationship between technical information understanding and aviation safety risk mitigation.

3. To evaluate the impact of technical employee engagement on effective technical communication.

4. To ascertain the overall impact of technical communication towards risk mitigation in aircraft maintenance operations.

2. Literature Review

1. *Theoretical Background*

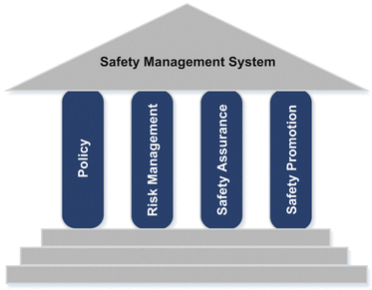

Figure 1: Four pillars of aviation safety management

According to the International Civil Aviation Organization (ICAO) definition, Aviation safety management systems (SMS) has four pillars; safety policy, safety assurance, safety risk management, and safety promotion. According to the ICAO, safety promotion focuses on safety communication and training (Andrei, 2011). Safety promotion ensures that aviation personnel training and competent to perform their duties and engage in a two-way communication of safety issues between the organization's maintenance management and operational personnel. To implement safety promotion in the aviation industry, mitigating risks in aircraft maintenance operations can be considered a crucial factor in terms of line maintenance and base maintenance. So, it is important to improve communication factors for risk mitigation (Study, 2017).

2. *Written/verbal Communication,*

The main mode of technical communication can be considered written and verbal communication. In Safety communication, make proper written and verbal communication systems for all organization members, and assist in the implementation of the safety management system. The language used in aviation-related subjects such as vocabulary, and aviation-related abbreviations understanding helps to maintain communication standards. Using communication equipment is important when attending verbal communication during aircraft maintenance activities (Parohinog and Meesri, 2015).

3. *Information Understanding*

A proper understanding of information especially in terms of technical documentation is highly important in maintenance operations. The technical staff should strictly refer to maintenance manuals, technical documentation, and other related regulatory documentation when discharging their daily duties. Here, misinterpretations, language problems, technical knowledge problems, vocabulary issues, and fundamental language problems can contribute significantly to safe operation (Yudoko and Purboyo, 2017). On the other hand, the language competencies of different technicians might impact their level of understanding of the instructions. Also, when information is overloaded, it might be leading to confusion.

In addition, information understanding on clear communication, understanding the situational hazards and getting action regarding the safety issues affect to optimize the safety performance. Supervised and advised the employees regarding proper safety procedures related to informational understanding. Making an own system of self-learning lessons at the working time and language proficiency assists in the improvement of informational understanding and help to maintain a low accident& incident rate (Alsamadani *et al.*, 2013).

4. Employee Engagement

In every industry employee engagement is significantly related to organizational performance and safety. The employee's qualifications, attitudes, behaviors, and accident & incident reporting skills improved work environment safety. Employee engagement and feedback systems positively increase the safety aspects of the organization (Alsamadani et al., 2013).

1. Methodology

This research is designed as an empirical hypothetic deductive study conducted through a statistical analysis of the responses provided by the respondents who were carefully selected to represent the aircraft maintenance technical population in Sri Lanka(Mendonca and Carney, 2017). The sampling frame used in this study was distributed to the line and base maintenance employees in Sri Lankan aviation organizations. The independent and the dependent variables were carefully selected through literature and with the qualitative responses received through a set of structured interviews as indicated in Figure 2.

1. Conceptual Framework

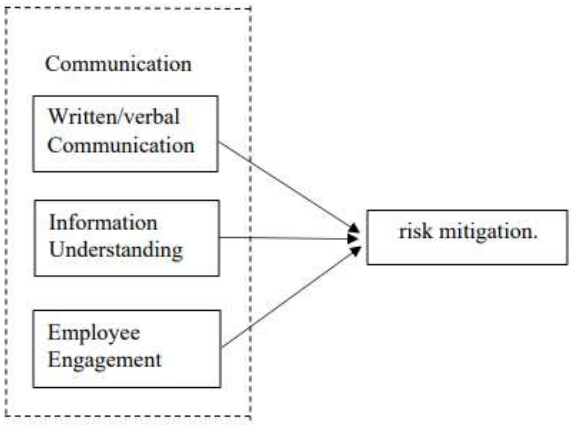

Figure 2: Conceptual Framework

Based on the above conceptual framework, the following hypothesis was developed to be tested statistically through the collected data from a carefully modulated questionnaire. The following three alternate hypotheses were formulated along with the related null

hypothesis. Collected data online through a google sheet with permissions of government and private organizations.

H1: Written & verbal communication has a positive impact on risk mitigation.

H1n: Written & verbal communication has no impact on risk mitigation.

H2: Information understanding has a positive impact on safety risk mitigation.

H2n: Information understanding has no impact on risk safety mitigation.

H3: Employ engagement has a positive impact on safety risk mitigation.

H3n: Employ engagement has no impact on safety risk mitigation.

The empirical responses were accurately captured through a Likert scale of one to five where one represents highly unsatisfactory and five represents a highly satisfactory level. The sample of the study was distributed among 160 employees. A random stratified sampling method was used to collect the data because of the difficulties of collecting data on an island-wide scale. The collected data were analyzed statistically using IBM SPSS Software.

2. Operationalization of the variables

In terms of operationalization of the independent and dependent variables following indicators were examined through the questionnaire.

Table 1: Operationalization of variables

Variable /Indicator	
Written/Verbal communication	
i.	Language proficiency
ii.	Referring technical manuals
iii.	Updating technical documents
iv.	Use of communication equipment
Information understanding	
i.	Understanding briefings & debriefing information
ii.	Understanding of maintenance documents content
iii.	Conducting maintenance meetings
iv.	Knowledge sharing among employees
Employee engagement	
i.	Use of written and verbal feedback systems
ii.	Occupational health & safety
iii.	Employee's abilities & skills in communication
iv.	Corrective & preventive actions via communication
Risk mitigation	
i.	Record incidents & accidents
ii.	Analyze reported accidents & incidents
iii.	Safety audits & informal inspection

4. Analysis and 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 2: Normality Test

	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
Risk mitigation	-.074	.199	.129	.396
Written/verbal communication	-.018	.199	-.019	.396
Information understanding	.132	.199	-.197	.396
Employee engagement & feedback	-.564	.199	.509	.396

2. Validity

Kaiser-Meyer-Olkin (KMO) method was used

to determine the validity of data and typically KMO should be between 0-1. If the value of the Kaiser-Meyer-Olkin (KMO) which is a Measure of Sampling Adequacy is obtained as 0.913 and as it is closer to 1 indicates that the data collected is acceptable (Kingdom *et al.*, 2015).

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
Written/verbal communication	.541	1.849
Information understanding	.445	2.249
Employee engagement & feedback	.674	1.485

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	Decision
H1	.523	Hypothesis accepted
H2	.607	Hypothesis accepted
H3	.522	Hypothesis accepted

5. Regression

Regression is a mathematical method used to analyze variables' relationships. If there is a situation where there is more than one independent variable multiple regression is carried out (Plotts, 2011). Here the linear relationship between independent variables and risk mitigation (dependent variable) was analyzed. According to the analysis, the R-value indicates a positive relationship with the dependent variable of risk mitigation due to the R-value being 0.728.

Table 5: 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 it could be concluded that this study is statistically significant. And the following regression equation is formulated where written and verbal communication is denoted by (WVC), information understanding is denoted by (IU), and employee engagement is denoted by (EEF).

Risk mitigation = 0.205 + 0.486 (WVC) + 0.188 (IU) + 0.214 (EEF)

Table 6: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.205	.356		.576	.565
WVC	.486	.110	.061	.787	.433
IU	.188	.093	.170	2.007	.047
EEF	.414	.079	.187	2.714	.007

5. Discussion

It is observed that all three hypotheses were accepted through the statistical results derived. This is a clear indication that the conceptual framework derived through the careful observation of previous literature and qualitative inputs derived from industry experts are highly acceptable and applicable in the Sri Lankan aviation context. Moreover, both the correlation analysis and coefficients are focused in a similar direction which again is a clear indication of the accuracy level of the research conducted.

According to the statistic findings, the following points are significant. The initial hypothesis H1 which considered the relationship between written and verbal communication for safety risk mitigation indicates that strong positive relationship (Krivonos, 2007) where the coefficient for correlation of Pearson is 0.523. Hence it can be clearly stated that there is a positive relationship between written and verbal communication toward risk mitigation.

When considering the second hypothesis H2 on information understanding it also indicates a positive impact on risk mitigation(Endsley and M. Robertson, 2000) and it is evident that situation awareness and information understanding assist to improve employee working performance and reduce accidents and incidents. According to this study coefficient for correlation of Pearson is 0.607 for information understanding. Therefore, it can also be stated that there is a positive relationship between information understanding towards risk mitigation. In terms of the third hypothesis H3, which refers to employee engagement & feedback has a positive impact on risk mitigation toward safety promotion. Baxter, Lauren (Baxter, 2013) establishes that supportive leadership and employee engagement assist to risk mitigation in the working environment. According to this study coefficient for correlation of Pearson is 0.522 for employee engagement.

6. Conclusion and Recommendation

The findings of this research present very important facts to concern ensuring of safety through efficient technical communication methods. The first hypothesis indicating a high positive correlation highlights that language proficiency, clear focus, and training on how to refer to the technical manuals have a significant impact on safety. Hence, it is very important to take measures to develop the technical communication competency of the aircraft maintenance staff especially focusing on language competency and technical literacy. In addition, the results highlight the importance of giving proper training for the handling of communication equipment, especially in flight line operations. Also, the result supports the argument that there should be a proper auditing process to check the reliability of updating technical documentation as it is based on the individual communication competency of the technical staff.

In terms of correlation, the next positively supported hypothesis is employee engagement. This supports the establishment of strong feedback systems on employee operational engagement to be conducted by the management. In addition, this relationship also highlights the importance of emphasizing more on occupational health and safety in aircraft maintenance operations. The empirical results clearly show that employees are concerned about their safety and an effective communication method should be established to get positive feedback on their occupational health and safety concerns. In addition, the results strongly support the timely communication of corrective and preventive maintenance information to the technical staff accurately. Here more emphasis should be paid to documents like service bulletins(SBs), manufacturing instructions and airworthiness directives(ADs) to be correctly communicated to the ground-level staff.

Out of the three variables, information understanding is the one that shows a lesser impact on aviation safety. However, as it is positively related to proper conducting of technical briefings and debriefings, timely conduct of maintenance meetings and technical knowledge sharing needs to be emphasized. Here the reason for the lesser significance obtained on this specific variable in the empirical response might be due to the reason that these practices are already well established in an aircraft maintenance environment. So that there is less need to re-emphasize those facts compared to the other two variables.

Hence, in conclusion, it is understood that technical communication has a very significant impact on risk mitigation and aviation safety, especially in the context of aircraft maintenance. Therefore, it is to be emphasized that written and verbal communication place a very vital role in enhancing the standards of technical communication. The other most important area to be concerned about is employee engagement in effective feedback systems. Lastly, it is revealed that relatively lesser emphasis could be paid to information understanding purely because such systems are effective in operation in the present context.

When evaluating the main limitations of this study, the difficulty in collecting information from stakeholders representing the entire industry in Sri Lanka was a challenge. In addition, with the vital role of safety, it is the path to understand that other aviation stakeholders like pilots, logisticians, air traffic controllers, and ground handlers also need a significant role to play in this research domain where their responses were not collected. Therefore, it is strongly suggested that in future research more emphasis could be paid to these areas and special focus can be paid to effective methods of improving written and verbal communication through the usage of new technology.

The KDU IRC 2022 makes the international stage for graduates and undergraduate students in Sri Lanka. This will be a huge opportunity to succeed in their future goals through innovations to the world. Specially KDU IRC 2022 is the best path for aeronautical engineering researchers with a highlighted category.

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