Safety Risk Management System on Maintenance Operation of Aviation Partnership Philippines (A+)

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Abstract- The aviation industry places a premium on safety. Safety risk management is used in the workplace to assess the risk associated with identified hazards and to improve or develop effective and appropriate mitigations to prevent accidents and incidents. The study's objective was to evaluate the level of implementation of a safety risk management system in Aviation Partnership Philippines Aplus as well as its compliance with the regulatory body. This study was a combination of qualitative and quantitative research, with a questionnaire and a Key Informant Interview (KII) used to gather information that answered the statement of the problem. This study aimed to develop and improve the safety risk management system in aviation partnerships, with the goal of lowering risk severity within the company. The proposed improvement plan in this study may be useful in any maintenance company that is having issues with their safety risk management system. The aviation mechanics in Aviation Partnership Philippines participated in this study, with a total of 40 participants divided equally between 20 mechanics in component shop and 20 mechanics in line maintenance, and a four-point Likert scale was used. This four-point scale was used in this study to measure the level of implementation of Safety Risk Management System in terms of; Hazard Identification, Risk Assessment and Mitigation Process and Risk Probability. The study's findings revealed that a safety risk management system is being implemented. Using the Key Informant Interview, it served to confirm if hazard identification and risk assessment is performed in the workplace. On the other hand, this KII lend to support a recommendation for the enhancement of the existing SRM system to be fully implemented to improve plans into a continuous cycle to focus on the hazard identification to mandatory reporting and additional safety officer to ensure the implementation of remedial action necessary to maintain agreed safety performance in assessing and mitigating the risk.

Indexed Terms- Safety Risk Management, Hazard Identification, Risk Assessment, Risk Mitigation, Risk Severity, Risk Probability

I. INTRODUCTION

Humankind's curiosity has brought humanity to beautiful discoveries such as the accidental discovery of penicillin, popsicles, and flying. Experts have been puzzled about how birds fly and travel a great distance for migration, until years of rigorous research through trial and error to replicate the structure of a bird, the first flight of humanity was embarked and spearheaded by Orville and Wilbur Wright or the "Wright Brothers". The first flight of man was a success, but one thing concerned the two aviators the most was safety. Safety is the state in which risk is related with aviation activities, or direct assistance with aircraft operation in minimizing the risk in acceptable level and kept under supervision (Hamdi, 2018).

Safety Management System has been mandated by the International Civil aviation organization and obliged its contracting state, Civil Aviation Authority of the Philippines to implement SMS due to obligations and voluntary implementation with the aim of decreasing incidents and accidents. Also, it lowering inefficiencies and expenses resulting from safety failures.

The Safety Management System (SMS) is used to apply such laws, policies, and regulations; to mitigate, assess, and document any hazard, accident, or event in the workplace; and it must be followed or always monitored. SMS creates a systematic management approach to address workplace safety issues. It promotes an environment of total safety by encouraging everyone in an organization to perceive, act, and behave safely. Furthermore, the Safety Management System ensures that the operation is carried out in a safe and efficient manner. Safety consequences are defined as accidents, serious incidents, occurrences and other safety related events. SMS process metrics include indicators on safety staff, advancement, training, communication, hazard identification, risk management and emergency response. (Steffen Kaspers *et al*., 2017).

In order to allow management to make defensible and correct safety-based decisions, they need to be presented with appropriate information to determine the risk landscape to which their organization is exposed. This can only be achieved by the establishment of a robust reporting culture in which employees are fully engaged in the management of safety.

Safety Risk Management (SRM) is a key component of safety management and includes hazard identification, safety risk assessment, safety risk mitigation and risk acceptance. Assessment of the risks connected to recognized hazards is the goal of safety risk management, together with the creation and use of appropriate and effective mitigations. The aviation system is always evolving, new hazards can be added, and certain hazards and the related safety concerns might alter over time. For the maintenance community it offers some theoretical discussion regarding the "Why?" for risk management then concentrating on the "How?" to put in place an effective error reduction program. (Patankar S. Manoj, 2017).

The benefits of safety risk management are to identify possible hazards in an organization and create methods to reduce or eliminate such risks. SRM is recognizing possible threats to employee's safety and putting policies in place to reduce those risk. In light of this, SRM is of the utmost significance since it not only safeguards your employees from physical and psychological injury but also assures the financial success of your company by minimizing downtime and expensive outlays. Overall, a Safety Risk Management System offers significantly far outweigh the hazards and a successful safety risk program would be beneficiary including the maintenance, the staff, stakeholders, and regulators.

II. PROCEDURE

- Research Design

The study aimed to develop a safety risk management plan to improve the current safety management system implemented on Maintenance Operation of Aviation Partnership Philippines (A+).

A mixed method research design was used in this study. Close-ended survey questionnaire was used to determine the level of implementation of safety risk management system and for qualitative data, Key Informant Interview (KII) was conducted to obtain certain information to assess or determine the suggestions/recommendations of the participants in improving the implemented SRM.

- Population and Sampling

The Aviation Partnership Philippines Maintenance Technicians are the study's participants. They are assigned to Component Shop and Line Maintenance in the Operation Department. The study has no restrictions on the participants' positions as long as they are assigned to the Component Shop and Line Maintenance. Based on the cluster sampling method, there is an equal representation of 40 participants, twenty (20) of whom are Component Shop Technicians and twenty (20) of whom are Line Maintenance. KIIs were also performed with the three (3) selected mechanic of Aviation Partnership Philippines.

- Data Gathering Procedure

The close-ended questionnaire was used and a Key Informant Interview (KII) to determine the recommendation. The content of the questionnaire basically incorporated questions that are most relevant to the study, particularly pertaining to safety risk management. The researcher integrated questionnaires that are relevant to ICAO's Safety Management System. To ensure that the survey questionnaire is substantiating with strong and valid questions, it was first passed through content validation by different individuals who are expertise in the field of this study.

The researcher asked permission from Human Resources Management to conduct the survey. After securing permission, the researcher disseminated the questionnaires randomly to the Aviation Maintenance Technician assigned in both Component Shop and Line Maintenance via onsite survey and google form due to the availability of the participants. Then, Interview was conducted to the selected participants. The gathered data were treated, analyzed and interpreted.

- Statistical Treatment of Data

The following statistical tools for the interpretation of results according to sub-problems were frequency and percentage distribution, weighted arithmetic mean, Kruskal Wallis Test to test the significant difference in the level of implementation of safety management system when grouped according to profile.

III. RESULTS

Table 1
Summary of Frequency and Percentage of the Demographic Profile of the Participants

DEPARTMENT	FREQUENCY (f)	PERCENTAGE (%)
Line Maintenance Department	20	50.00
Component Shop Department	20	50.00
TOTAL	40	100%
RANK AND FILE/POSITION	FREQUENCY (f)	PERCENTAGE (%)
Junior Mechanic	8	20.00
Mechanic A	6	15.00
Mechanic B	10	25.00
Mechanic C	9	22.50
Mechanic A/B	6	15.00
Unit Chief	1	2.50
Operation Manager		
TOTAL	40	100%
LENGTH OF SERVICE IN THE COMPANY	FREQUENCY (f)	PERCENTAGE (%)
Less than a year	8	20.00
1-5 years	11	27.50
6-10 years	14	35.00
11 years and above	7	17.50
TOTAL	40	100%

Table 1 shows the frequency and percentage distribution of the participants. Based on the table both Line Maintenance Department and Component Shop Department had the same number of participants with an equal frequency of 20 or 50%. Additionally, out of 40 participants (100%) surveyed, Mechanic B accounted for the majority of participants with 10 or 25 percent, followed by Mechanic C with nine (9) participants or 22.50 percent while the lowest number came from the Unit Chief participant with only one (1) or 2.50 percent. There was no Operation Manager surveyed as reflected in the table. Then majority of the participants (14) had 6- 10 years' service in the company which comprised 35.00 percent; followed by one (1) – five (5) years in service with a frequency of 11 or 27.00 percent; and lowest frequency of seven (7) or 17.50 percent belonged to 11 years and above experience.

Table 2
Summary mean distribution on the level implementation of safety Risk management on maintenance operation using Hazard identification and risk assessment (HIRA) in terms of hazard identification

Maintenance technicians are required to report hazards or dangers encountered in maintenance operation.	3.55	3.30	3.42	FI	1
Incidents and accidents are investigated to determine the hazards that contributed to the occurrence. (i.e., utilization of logbook, report forms, and other documentary sheets).	3.30	3.50	3.40	FI	2.5
Adherence to mandatory reports, voluntary reporting system, accident/incident reports, safety audits and surveys are implemented when identifying hazards.	3.15	3.30	3.23	I	4
Reactive methods are implemented to address accidents and incidents that occurred in the past.	3.15	3.00	3.08	I	9
Equipment such as precision tools, cutting tools, and power tools are regularly inspected for discrepancy, calibration, and repair.	2.90	2.90	2.90	I	14
Proper shift and handover procedures are always implemented.	3.10	2.80	2.95	I	13
Adequate training and resources are given regularly to ensure the competencies and skills of personnel.	3.15	3.25	3.20	I	5
The proper use of equipment, packing and installation procedures, as well as the use of materials and parts, are all observed.	3.15	2.90	3.02	I	11.5
Documentations are done for every activity done on the aircraft.	3.45	3.35	3.40	FI	2.5
Checklists are regularly updated.	2.75	3.55	3.15	I	6
Identifying potential hazards whenever there is an abnormal audit or indication of any safety indicator trends.	3.00	2.70	2.85	I	15
Identification of specific components of hazards that were previously identified.	3.10	3.15	3.13	I	7.5
Projecting specific risk/s associated with every hazard identified	3.15	2.90	3.02	I	11.5
Conducting hazard identification and risk assessment prior to creating a new project and major equipment or facility is established.	2.55	3.10	2.83	I	16.5
Hazard Identification and Risk Assessment (HIRA) is performed when there is unexplained increase in safety-related events	3.00	3.10	3.05	I	10
Hazard Identification and Risk Assessment (HIRA) is performed when there are abnormal audit or safety indicator trends.	3.15	3.10	3.13	I	7.5

Hazard Identification and Risk Assessment (HIRA) is performed when major operational changes are planned.	2.80	2.85	2.83	I	16.5
Hazard Identification and Risk Assessment (HIRA) is performed before acquiring a project workflow; major revamp in the equipment and facilities.	2.70	2.85	2.77	I	19
Hazard Identification and Risk Assessment (HIRA) is performed during a period of significant organizational change.	2.75	2.85	2.80	I	18
WEIGHTED MEAN	2.90	3.08	2.99	Implemented	

As gleaned from Table 2, the Hazard Identification of Safety Risk Management on Maintenance Operation was given a rating of Implemented as computed in the mean distribution of level of implementation at 2.99.

In the distribution of mean among the Hazard Identification, the statements in *"Maintenance technicians are required to report hazards or dangers encountered in maintenance operation"* has a percentile rank of 1 with a mean of 3.42 with verbal interpretation of Fully Implemented.

Getting the lowest percentile rank of 19 was the statement on "*Hazard Identification and Risk Assessment (HIRA) is performed before acquiring a project workflow; major revamp in the equipment and facilities"* which received a mean of 2.77 with verbal interpretation of Implemented.

Table 3
Summary mean distribution on the level implementation of safety Risk management on maintenance operation using Hazard identification and risk assessment (HIRA) in terms of Risk Assessment and Mitigation Process

CRITERIA	Line Maintenance Department	Component Shop Department	MEAN	VI	RANK
Mitigation processes are implemented to suppress the occurrence of risk / hazard.	3.15	3.10	3.13	I	1
The basic defenses are established to reduce the probability or severity of risks associated with hazards. (i.e., Training, technology, regulations, and procedures).	3.00	3.10	3.05	I	2.5
The staff involved should be aware of the risks and defenses in place. (i.e., Training, technology, regulations, and procedures)	2.95	3.15	3.05	I	2.5
Operations or activities are stopped when the number of risks exceeds the benefits of continuing the operation or activity.	2.70	2.85	2.77	I	5
Actions are taken to isolate the risks to ensure there is a backup or fail-safe, in making sure that the devices	3.00	3.10	3.05	I	2.5

or tools will not endanger lives or property when it fails					
WEIGHTED MEAN	2.96	3.06	3.01	Implemented	WEIGHTED MEAN

Table 3 described the mean distribution on the level of implementation of safety risk management on maintenance operation in terms of risk assessment and mitigation process which is Implemented at a calculated mean of 3.01. The results further showed that the statement about "*Mitigation processes are implemented to suppress the occurrence of risk / hazard"* at rank 1 which was interpreted as Implemented at a mean level of 3.13 that was rated by Component Shop Department with the highest gathered mean of 3.13.

Table 4
Summary Mean Distribution on The Level Implementation of Safety Risk Management on Maintenance Operation Using Hazard Identification and Risk Assessment (Hira) in Terms of Risk Probability

CRITERIA	Line Maintenance Department	Component Shop Department	MEAN	VI	RANK
History occurrences are taken into consideration when predicting a probable risk.	3.00	3.30	3.15	I	2
Other equipment or similar types of components with similar defects are taken into consideration to prevent any potential risk on the field.	3.10	3.25	3.17	I	1
Reviewing of already existing organizational, management or regulatory implications for any generated threats to public safety.	2.75	3.25	3.00	I	3
The equipment should not be used if it is under assessment.	3.05	2.90	2.98	I	4
All maintenance personnel follow the procedure	2.60	3.05	2.83	I	5
WEIGHTED MEAN	2.90	3.15	3.02	Implemented	

As presented in Table 4, the mean distribution on the level of implementation of safety risk management on maintenance operation in terms of risk probability which is Implemented at a calculated mean of 3.02 which is provided by the majority of the Component Shop Department.

The statement under Indicator No. 2 about "*other equipment or similar types of components with similar defects are taken into consideration to prevent any potential risk on the field"* gathered the highest mean of 3.17.

Table 5
Mann-Whitney U Test Result on The Level Implementation of Safety Risk Management on Maintenance Operation Using Hira When Grouped According to Operation Department

VARIABLES	DEPARTMENT OPERATION	N	Mann-Whitney	P-Value	DECISION	CONCLUSION
Hazard Identification	Line Maintenance Department	20	155	0.228	Accept	Not Significant
	Component Shop Department	20				
Risk Assessment and Mitigation Process	Line Maintenance Department	20	179	0.576	Accept	Not Significant
	Component Shop Department	20				
Risk Probability	Line Maintenance Department	20	140	0.106	Accept	Not Significant
	Component Shop Department	20				

Table 5 describes the significant difference in the level of implementation of safety risk management according to their operation department.
As described in the data, Hazard Identification (P-Value= 0.228); Risk Assessment and Mitigation Process ((P-Value= 0.576); Risk Probability (P-Value= 0.106). Therefore, the decision is to accept the null hypothesis and assessed as not significant.

Table 6
Kruskal Wallis H Test Result on the Level Implementation of Safety Risk Management on Maintenance Operation Using Hira When Grouped According to Rank In File/Position

VARIABLES	POSITION	N	MEDIAN	MEAN RANK	H	SIG	DECISION
Hazard Identification	Junior Mechanic	8	3.368	22.8	1.78	0.879	Accept
	Mechanic A	10	3.053	23.3			
	Mechanic B	9	2.737	17.9			
	Mechanic C	6	2.737	19.5			
	Master A/B	6	3.053	17.4			
	Unit Chief	1	3.053	22.0			
	Operation Manager	-	-	-			

Risk Assessment and Mitigation Process	Junior Mechanic	8	2.900	21.7	2.86	0.722	Accept
	Mechanic A	10	3.100	25.0			
	Mechanic B	9	3.000	19.3			
	Mechanic C	6	2.800	16.9			
	Master A/B	6	2.900	16.8			
	Unit Chief	1	3.00	20.5			
	Operation Manager	-	-	-			
Risk Probability	Junior Mechanic	8	3.300	23.9	1.95	0.856	Accept
	Mechanic A	10	2.900	22.6			
	Mechanic B	9	3.200	19.2			
	Mechanic C	6	3.000	18.3			
	Master A/B	6	2.90	16.8			
	Unit Chief	1	3.000	19.58			
	Operation Manager	-	-	-			

Table 6 portrays the significant difference in the evaluation of the participants on the level of implementation of safety risk management on maintenance operation according to rank-in-file/position. The computed value shows that there is no significant difference on the level implementation of Safety Risk Management on Maintenance Operation using Hazard Identification and Risk Assessment (HIRA) in terms of Hazard Identification (H=1.78, p-value=0.879); Risk Assessment and Mitigation Process (H=2.86, p-value=0.722) and Risk Probability (H=1.95, p-value=0.856). Therefore, the decision is to accept the null hypothesis based on the Decision Matrix of the study.

Table 7
Kruskal Wallis H Test Result on the Level Implementation of Safety Risk Management on Maintenance Operation Using Hira When Grouped According to Length of Service

VARIABLES	YEAR IN SERVICE	N	MEDIAN	MEAN RANK	H	SIG	DECISION
Hazard Identification	Less than a year	8	3.474	28.4	5.48	0.140	Accept
	1 – 5 years	11	2.632	18.0			
	6-10 years	14	2.868	20.4			
	11 years above	7	3.000	15.5			
Risk Assessment and Mitigation Process	Less than a year	8	3.500	27.1	4.63	0.201	Accept
	1 – 5 years	11	2.800	16.4			
	6-10 years	14	3.000	21.5			
	11 years above	7	3.000	17.4			
Risk Probability	Less than a year	8	3.600	28.3	5.62	0.131	Accept
	1 – 5 years	11	3.000	17.1			
	6-10 years	14	3.100	21.0			
	11 years above	7	2.800	15.9			

The Kruskal Wallis H results are presented in Table 7 to determine whether or not there is a statistically significant difference in the evaluation of the participants on the level of implementation of safety risk management on maintenance operation according to length of service.

As shown in the table there is no significant difference on the level implementation of Safety Risk Management on Maintenance Operation using Hazard Identification and Risk Assessment (HIRA) in terms of Hazard Identification (H=5.48, p-value=0.140); Risk Assessment and Mitigation Process (H=4.63, p-value=0.201) and Risk Probability (H=5.62, p-value=0.131). Therefore, the decision is to accept the null hypothesis based on the Decision Matrix of the study.

Table 8
Summary on the Suggestions/Recommendations of the Participants in Improving the Implementation of SRM

SUGGESTIONS/ RECOMMENDATIONS			
Conduct training which includes an emphasis on the specific safety.	25	26.60	2
The operation managers should evaluate its technicians on a regular basis to verify that written procedures accurately reflect current operating practices.	28	29.80	1
Management should provide a hazard identification card for its employee and conduct weekly reporting for the hazard identified.	20	21.3	4
Checklists were provided for regular/frequent tasks, such as a maintenance checklist or a daily pre-start checklist for equipment to ensure it is in safe operating order.	21	22.3	3

Table 8 pertains the suitable suggestion/recommendation for the proposed enhancement plan. As pertain in the table, The statement on *"The operation managers should evaluate its technicians on a regular basis to verify that written procedures accurately reflect current operating practices.*' has the highest rank percentile; *"Conduct training which includes an emphasis on the specific safety."* get the second rank percentile *"checklists were provided for regular/frequent tasks, such as a maintenance checklist or a daily pre-start checklist for equipment to ensure it is in safe operating order"* obtained the third percentile rank while the statement on *"management should provide a hazard identification card for its employee and conduct weekly reporting for the hazard identified"* received the lowest percentile rank.

Table 9
Key Informant Interview Result

ITEM	INTERVIEWEE 1	INTERVIEWEE 2	INTERVIEWEE 3
HAZARD IDENTIFICATION	They fill up safety and quality form provided by the company called hazard identification, risk assessment and risk control (HIRARC) form and if urgent	All hazard and incident occur in the workplace are reported via HIRARC	Fill up the hazard identification, risk assessment and risk control (HIRARC) form where we list down all the identified hazards and the

	contact the head of department.		corrective action for that hazard.
RISK MITIGATION AND ASSESSMENT PROCESS	They provide read and sign form. Also, they are conducting a monthly safety and quality meeting because whatever hazard, accident or incident happened within those months it has to be discussed for awareness of each individual.	Management provides a session for employee and distribute read and sign forms.	They provide trainings and seminars for safety management system.
RECOMMENDATION ON THE IMPROVEMENT OF SAFETY RISK MANAGEMENT	Additional of second safety and quality personnel every time that we will have maintenance operation.	Improve the Hazard Identification and Company must require all personnel to take suggestion and mandatory reporting of all hazards for the sake of employee's safety.	Although, HIRAC is already provided but it must be mandatory.

Presented in Table 9 are conducted from selected participants from the mechanic to validate the gaps identified from the survey conducted on safety risk management system of Aviation Partnership Philippines (A+). Survey questionnaire revealed that the SRM are "Implemented" but still not fully implemented. The interview served to use for the recommendation in improving the existing SRM being implemented to be fully implemented.

CONCLUSION

1. For the demographic profile of the participants, the equal distribution of participants for both the Line Maintenance and component Shop Departments. Majority of the participants were mechanic B with the length of service of six to ten years.
2. The participants were rated the safety risk management system implementation on their company as "implemented" in terms of Hazard Identification, Risk Assessment and Mitigation Process and Risk Probability.
3. It is concluded that there was no significant difference on the participant's Operation Department, Rank and File/Position and Length of Service in the level of Implementation of Safety Risk Management System in terms of Hazard Identification, Risk Assessment and Mitigation Process and Risk Probability.
4. As shown in the recommendation, the company needs to make sure that all employees are routinely evaluated for performance, that regular training is provided on safety culture and practices, that checklists are used consistently throughout all work activities to ensure that safety procedures are followed perfectly, and that a culture and system of hazard reporting are put in place.
5. On the KII result, it concluded that despite the implementation of HIRA in the workplace, there are still gaps identified by the participants in the implementation of the SRM.
6. The proposed enhancement program for the Aviation Partnership Philippines in the implementation of SRM can contribute to the success of the organization succeed by guaranteeing the effectiveness and efficiency of

the provision of services on maintenance operation and upgrading the overall operational system.

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