Aircraft Ageing Maintenance and Handling

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Abstract*— This study focused on managing aging aircraft in the Philippines, particularly on maintenance and handling. The study examined the current state of aging aircraft management in the country and identified the disadvantages that prevent determining maintenance and handling for aging aircraft. It also explored the participants' recommendations for improving the future management of aging aircraft. Data were collected from a sample of 35 participants through an online survey questionnaire, and the responses were analysed using frequency, percentage, mean, rank distribution, and Kruskal Wallis H-test. The findings suggested that the cost, downtime, training, complexity, error-prone, risk of damage, regulatory requirements, aging fleet, limited availability, technological advancements, health and environmental impact, and age and technological change are the main disadvantages that hinder the determination of maintenance and handling for aging aircraft. Several recommendations to improve the future management of aging aircraft in the Philippines, including the development of a comprehensive aging aircraft management program, establishment of a database, increase in training and education, adoption of new technologies, improvement in communication and collaboration, regular research and analysis, and compliance with international safety standards and regulations. The study's findings and recommendations can guide aircraft owners, operators, regulators, and other stakeholders in managing aging aircraft in the Philippines and other countries.

Indexed Terms*— Aircraft Design, Economic Aging, Financial Aging, Maintenance Program, Safety, Standards and Recommended Practices (SARPs), Technical Aging of an aircraft.

I. INTRODUCTION

The aviation industry has operated for over a century, and many aircraft have accumulated considerable flight hours. As these aircraft age, they require more frequent maintenance, repair, and overhaul to ensure their continued airworthiness and safety. Aircraft maintenance is a complex process and aging aircraft require special attention and care to avoid catastrophic accidents.

The aging of aircraft can be attributed to several factors, including the number of flight hours, the operating environment, and the materials used in construction. The aging process can cause structural deterioration, system failures, and component wear and tear, leading to increased maintenance costs and potential safety risks.

Airlines and maintenance organizations must implement effective aging aircraft management programs to address the challenges associated with aging aircraft maintenance and handling. These programs involve regular inspections, maintenance, and repairs and using advanced technologies to detect and address potential safety risks.

Recent studies have shown that aging aircraft maintenance and handling programs are critical to ensuring the safety and successful flights of every aging aircraft in the fleet. For instance, a study conducted by the Federal Aviation Administration (FAA) in 2020 found that aging aircraft management programs can significantly reduce the likelihood of catastrophic accidents caused by aging aircraft. The study recommended implementing comprehensive aging aircraft management programs, including frequent inspections, maintenance, repairs, and advanced technologies for detecting potential safety risks.

Another relevant study was conducted by the International Air Transport Association (IATA) in 2021, which focused on using big data analytics in aging aircraft maintenance. The study found that big data analytics can provide valuable insights into the performance and condition of aging aircraft, enabling airlines and maintenance organizations to detect potential safety risks early and take appropriate action. This study aimed to examine the relationship between aging aircraft and flight safety and to propose an industry-standard approach for stakeholders to evaluate the long-term effects of airframe aging on maintenance costs. The analysis considered the impact of routine and unscheduled maintenance, Service Bulletins (S.B.), and Airworthiness Directives (A.D.) on the evolution of maintenance costs for an aged aircraft returning to service. Moreover, this study acknowledged that fatigue and corrosion are complex factors to evaluate but are critical aspects of aging aircraft as they can lead to safety incidents and even catastrophic failures.

Finally, this study aimed to identify best practices, maintenance costs, and possible challenges that both small and large operators and AMO might encounter while also considering elements related to aging aircraft. The findings of this research will aid technical divisions, fleet managers, and cost control personnel in developing effective aging aircraft management programs that will enhance safety and reduce maintenance costs.

II. PROCEDURE

- Research Design

The study highlights that aircraft are designed to have a specific lifespan, typically from 20 to 30 years, with a certain number of flight hours and cycles. Manufacturers and designers ensure that the aircraft structure and components function reliably throughout the design life through analysis and testing. Regular inspections and maintenance can help ensure continued airworthiness during the design life.

However, maintenance costs can increase when the aircraft is within its design life, leading to economic concerns for the owner or operator. In some cases, the cost of maintenance may even exceed the cost of replacing the aircraft altogether. As a result, the decision to continue operating an ageing aircraft is often driven by economic considerations, with owners choosing to invest in maintenance rather than purchasing a new aircraft.

This situation highlights the need for effective ageing aircraft management programs to ensure the continued airworthiness and safety of ageing aircraft, while also balancing economic considerations. Such programs can help identify and address potential safety risks, reduce maintenance costs, and extend the useful life of ageing aircraft. This study aims to evaluate the relationship between ageing aircraft and flight safety, and propose an industry-standard approach for stakeholders to evaluate the long-term effects of airframe ageing on maintenance costs. The findings of this research will help stakeholders make informed decisions on aircraft maintenance and operations, ultimately enhancing safety and reducing costs.

- Population and Sampling

The study used a questionnaire to gather data from Aviation Partnership Philippines (APLUS), Southeast Asian Airline (SEAIR), Philippine Naval Air Wing, Philippine Air Force, Fliteline Flying School and Campus Safety Security Alliance of the Philippines participants. The questionnaire underwent content validation to ensure that all areas of evaluation were included. The survey results were analysed statistically, and the information will be tabulated and analyzed to create recommendations. The output of the study was the proposed recommendation for the aging maintenance and handling of aircraft in the Philippine fleet.

The conceptual framework guided the study in evaluating the factors that affect aging aircraft and how to determine their safety and successful flights. The framework ensured that the study's objectives were met and that the recommendations would be based on the data gathered from the survey.

- Data Gathering Procedure

The data gathering instrument used in this study is a survey questionnaire composed of items designed to measure the technical assessment of Aircraft Ageing, the level of management throughout an aircraft's life in the process of economic, and the level of

competence of private aviation companies in maintaining and handling an aircraft aging.

Additionally, ranking questions were included in determining the recommended suggestion for buying old and no longer flying aircraft in other countries and having them repaired in the Philippines, issued airworthiness certificates by the Civil Aviation Authority of the Philippines (CAAP), and used for training and passenger purposes.

The survey questionnaire utilized a 4-point Likert scale to measure the participants' responses. This scale allowed for quantifying the participant's perceptions and attitudes toward the topic under investigation.

- Statistical Treatment of Data

The following statistical methods and tools will be applied to the methodology:

Frequency and Percentage. This was the actual response to a specific item/question in the questionnaire where the respondents tick his/her choice. Percentage was used as descriptive statistics or something that describes a part of the whole.

Weighted Mean. This was used to get the average frequency of the response; the weighted mean was computed.

Kruskal-Wallis Test. The One-Way ANOVA on ranks, commonly known as this test, is a rank-based non-parametric test that can be used to find statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable. Gujarati (2003) researchers use the following formula to determine whether there is a substantial difference.

Ranking. It displays the connection between the set's objects. Take the first item as an example, which is either "ranked higher," "ranked lower than," “ranked equal to" the second item.

Table 1
FREQUENCY AND PERCENTAGE DISTRIBUTION
OF THE PARTICIPANTS

Participants	Frequency (f)	Percentage (p)
Commercial Airline	7	20.00
Flying School	8	22.90
Gen. Aviation (Air Taxi)	15	42.90
Military	5	14.30
Total	35	100%

Table 1 shows the frequency and percentage distribution of the participants in a certain study or survey. There was a total of 35 participants included in the analysis. The results show that the majority of participants were in the General Aviation (Air Taxi) group, with 15 participants or 42.9% of the total. The Flying School group had the second highest number of participants with 8 or 22.9%, followed by the Commercial Airline group with 7 or 20%. The Military group had the lowest number of participants with only 5 or 14.3%.

This distribution was done to ensure a representative sample from each sector of aviation and to achieve a balanced view of the research problem.

It is important to note that the participants were selected through a purposive sampling technique, where participants were chosen based on their knowledge, expertise, and experience in their respective fields. The purposive sampling technique was utilized to ensure that only participants with relevant experience and expertise were included in the s

Table 3
FREQUENCY & PERCENTAGE DISTRIBUTION OF
PARTICIPANTS DEMOGRAPHIC PROFILE

Particulars	Category	Frequency (f)	Percentage (%)
Company	Commercial Airline	7	20.00
	Flying School	8	22.90
	Gen. Aviation (Air Taxi)	15	42.90
	Military	5	14.30
Age	25 – 30 years old	14	40.00
	31 – 36 years old	8	22.90
	37 – 42 years old	6	17.10
	43 years and above	7	20.00
Position	Director	--	--
	Manager	8	22.90
	Crew Chief	10	28.60
	Mechanic A / B / C	17	48.60
Length in the service	Below 3 years	10	28.60
	3 – 8 years	7	20.00
	9 – 15 years	8	22.90
	16 – 20 years	4	11.40
	More than 20 years	6	17.10
Highest educational attainment	2-Year Course Degree	17	48.60
	Bachelor Degree	14	40.00
	Masteral Degree	4	11.40
	Doctorate Degree	---	---

Table 3 presents the frequency and percentage distribution of the demographic profile of the 35 participants in the study on aircraft ageing maintenance and handling.

The first category in the table is Company, which shows that the majority of participants are from General Aviation (Air Taxi) with 15 participants or 42.9% of the total. Flying School had 8 participants or 22.9%, while Commercial Airline and Military had 7 and 5 participants, respectively.

The second category is Age, which shows that 14 participants or 40% of the total were aged between 25-30 years old, while 7 participants or 20% were 43 years old and above. The remaining participants were distributed between the 31-36 and 37-42 age brackets

Table 4
MEAN AND RANK DISTRIBUTION OF THE PARTICIPANTS' LEVEL OF COMPETENCY OF THE PARTICIPANTS IN ASSESSING THE TECHNICAL ASPECTS OF AIRCRAFT AGEING OVER TIME IN TERMS OF AIRCRAFT DESIGN

Aircraft Design	Commercial Airline	Flying School	Gen. Aviation	Military	Mean	Rank	Interpretation
I am confident in my ability to assess the impact of ageing on aircraft design.	3.38	3.43	3.40	3.47	3.43	2	Strongly Agree
I have a good understanding of the design factors that can affect aircraft ageing.	3.38	3.14	3.20	3.60	3.40	3	Strongly Agree
I am able to identify the key design features that contribute to aircraft safety and longevity.	3.25	3.29	3.40	3.40	3.34	4	Strongly Agree
I feel knowledgeable in relationship between aircraft design / maintenance requirements.	3.25	3.29	3.60	3.60	3.46	1	Strongly Agree
Average Weighted Mean	3.31	3.29	3.40	3.52	3.41		Strongly Agree

Based on the results of Table 4, it can be interpreted that the participants have a generally high level of competency in assessing the technical aspects of aircraft ageing over time in terms of aircraft design, with a mean score of 3.41, which indicates a "Strongly Agree" interpretation.

Furthermore, the participants from the military have the highest mean score of 3.52, while the participants from the commercial airline have the lowest mean score of 3.31. This implies that the military personnel may have more experience and exposure to aircraft ageing and maintenance issues, which could have contributed to their higher level of competency. On the other hand, the commercial airline participants may Lastly, these results have important implications for the aircraft industry, particularly in terms of the training and development of personnel involved in aircraft ageing maintenance and handling. Companies should consider providing more training and exposure have less exposure or training on aircraft ageing and maintenance issues, which could have led to their lower mean score.

Moreover, it can be observed that the participants are less knowledgeable about the relationship between aircraft design and maintenance requirements, with a mean score of 3.46. Participants also generally confident in their ability to assess the impact of ageing on aircraft design, with a mean score of 3.43. They also have a good understanding of the design factors that can affect aircraft ageing, with a mean score of 3.40. However, the lowest mean score is 3.34 that they identify the key design features that contribute to aircraft safety and longevity.
to their employees on the relationship between aircraft design and maintenance requirements to improve their level of competency in this area. Additionally, these results can serve as a benchmark for future studies on aircraft ageing maintenance and handling.

Table 8
OVERALL SUMMARY OF MEAN, STANDARD DEVIATION AND RANK DISTRIBUTION OF THE PARTICIPANTS' LEVEL OF COMPETENCY IN ASSESSING THE TECHNICAL ASPECTS OF AIRCRAFT AGEING OVER TIME

VARIABLES	Mean	Standard Deviation	Rank	Verbal Interpretation
Aircraft Design	3.41	0.446	1.5	Strongly Agree
Maintenance Program	3.41	0.478	1.5	Strongly Agree
Aircraft Performance	3.38	0.501	3	Strongly Agree
Geographical Location	3.34	0.539	4	Strongly Agree
Average Weighted Mean	3.38	0.462		Strongly Agree

Based on Table 8, the overall weighted average mean score of the participants' level of competency in assessing the technical aspects of aircraft ageing over time is 3.38, with a standard deviation of 0.462. This mean score indicates that the participants strongly agree with the statement regarding the technical aspects of aircraft ageing over time.

When comparing the mean scores of the different variables, both Aircraft Design and Maintenance Program had the highest mean score of 3.41, which indicates that the participants strongly agree with these two variables' technical aspects of aircraft ageing over time. Meanwhile, Aircraft Performance had a mean score of 3.38, ranking third, and Geographical Location had a mean score of 3.34, ranking fourth.

This implies that the participants have a high level of competency in assessing the technical aspects of aircraft ageing over time, particularly in Aircraft Design and Maintenance Program. This high level of competency could have a significant impact on the safety and reliability of aircraft, which are essential in the aviation industry. The participants' competence could also lead to the development of effective maintenance and handling strategies that can prolong aircraft lifespan and prevent technical problems that could compromise aircraft performance and safety.

Table 9
KRUSKAL WALLIS H TEST RESULT ON THE LEVEL OF COMPETENCY OF THE PARTICIPANTS IN ASSESSING THE TECHNICAL ASPECTS OF AIRCRAFT AGEING OVER TIME

Variables	Kruskal Wallis H	Degrees of Freedom	P-value	Decision H_0	Conclusion
Aircraft Design	1.88	3	0.597	Accept	Not Significant
Maintenance Program	2.95	3	0.399	Accept	Not Significant
Aircraft Performance	2.60	3	0.457	Accept	Not Significant
Geographical Location	1.72	3	0.633	Accept	Not Significant

Table 9 present significant difference on the level of competency of the participants in assessing the technical aspects of aircraft ageing over time based on four variables: Aircraft Design, Maintenance Program, Aircraft Performance, and Geographical Location.

The results of the Kruskal-Wallis H test are presented in above table. The p-value for each variable is higher than the significance level of 0.05, indicating that there is no significant difference in the level of competency of participants in assessing the technical aspects of aircraft ageing over time based on Aircraft Design (H=1.88, p = 0.597), Maintenance Program (H=2.95,

p = 0.399), Aircraft Performance (H=2.60, p = 0.457), and Geographical Location (H=1.72, p0.633). Therefore, it can be concluded that the level of competency in assessing the technical aspects of aircraft ageing over time is not influenced by the variables considered in this study.

The implications of these results suggest that the training program for assessing the technical aspects of aircraft ageing over time should focus on enhancing the overall level of competency of the participants without emphasizing any specific variable considered in this study. Additionally, future research could explore other variables that could potentially impact the level of competency in assessing the technical aspects of aircraft ageing over time

Table 11
MEAN AND RANK DISTRIBUTION OF THE PARTICIPANTS' IMPACT OF DETERMINING THE AIRCRAFT

Safety Protocols	Commercial Airline	Flying School	Gen. Aviation	Military	Mean	Rank	Interpretation
The implementation of aircraft ageing maintenance and handling program has a positive impact on the safety of passengers and crew.	3.50	3.57	3.60	3.67	3.60	2.5	Significant Impact
The aircraft ageing maintenance and handling program ensures that aircraft are safe to fly and comply with aviation regulations.	3.50	3.57	3.60	3.73	3.63	1	Significant Impact
The implementation of the aircraft ageing maintenance and handling program is crucial for maintaining a high standard of safety in aviation operations.	3.50	3.57	3.60	3.67	3.60	2.5	Significant Impact
Average Weighted Mean	3.50	3.57	3.60	3.69	3.61		Significant Impact

Table 11 presents the mean and rank distribution of the participants' impact of determining the aircraft ageing maintenance and handling in terms of safety protocols. The average weighted mean score for all four categories is 3.61, which is interpreted as "Significant Impact".

In terms of mean score results from highest to lowest, the aircraft ageing maintenance and handling program ensures that aircraft are safe to fly and comply with aviation regulations. received the highest score of 3.63, followed by the implementation of aircraft ageing maintenance and handling program has a positive impact on the safety of passengers and crew and the implementation of the aircraft ageing maintenance and handling program is crucial for maintaining a high standard of safety in aviation operations, both with a lowest mean score of 3.60.

The findings suggest that the participants believe that implementing an aircraft ageing maintenance and handling program positively impacts the safety of passengers and crew and is crucial for maintaining a high standard of safety in aviation operations. This implies that safety is a top priority in the aviation industry. Implementing an aircraft ageing maintenance and handling program can help ensure that aircraft are maintained and operated safely, reducing the risk of accidents and incidents.

Table 16
MEAN AND RANK DISTRIBUTION OF THE PARTICIPANTS' ADVANTAGES OF DETERMINING AIRCRAFT AGEING MAINTENANCE AND HANDLING

Advantages	Frequency f	Percentage %	Rank
Enhanced Safety: By identifying potential issues related to aircraft ageing and implementing appropriate maintenance and handling procedures, the safety of the aircraft and its passengers can be significantly improved.	34	97.10	1
Increased Reliability: Regular maintenance and handling can help prevent unexpected downtime and improved the reliability of the aircraft.	30	85.70	2.5
Improved performance: Proper maintenance and handling can help optimize the performance of the aircraft, leading to better fuel efficiency and overall performance.	29	82.90	5
Reduced Costs: Implementing proper maintenance and handling procedures can help reduce the costs associated with unexpected repairs and maintenance.	30	85.70	2.5
5. Extended Lifespan: By identifying and addressing issues related to aircraft ageing, the lifespan of the aircraft can be extended, allowing it to remain in service for longer.	30	85.70	2.5
6. Compliance with regulations: Regular maintenance and handling Procedure help ensure compliance with regulatory requirements, reducing the risk of fines or other penalties.		80.00	6.5
7. Enhanced Re-sale Value: A well Maintained aircraft can command a Higher re-sale vale, which can be beneficial for owners and operators.	27	77.10	8
8. Improved customer satisfaction: A safe and reliable aircraft can help improve customer satisfaction and loyalty.	26	74.30	9.5
9. Competitive Advantages: Proper maintenance and handling procedures can give operators a competitive advantage by allowing them to offer more reliable and efficient services.	26	74.30	9.5
10. Reduced environmental impact: A well-maintained aircraft can be more fuel-efficient, reducing its environmental impact.	26	74.30	9.5
11. May also contribute to development and Improvement: Future Aircraft design and management.	28	80	6.5
12. May enhance owners and personnel: How to properly manage ownership, usage and integration of parts and devices of an aging aircraft	24	68.60	12

Table 16 presents the mean and rank distribution of the participants' perceived advantages of determining aircraft ageing maintenance and handling. The results show that the participants identified "Enhanced Safety" with 34 or 97.10% as the most important advantage. This indicates that the participants believe that identifying potential issues related to aircraft ageing and implementing appropriate maintenance and handling procedures can significantly improve the safety of the aircraft and its passengers. These three advantages are tied at the second-highest rank, with a frequency of 30 (85.7%).

The fifth highest advantage is improved performance, with a frequency of 29 (82.9%) and ranked number five. This suggests that proper maintenance and handling can help optimize the performance of the aircraft, leading to better fuel efficiency and overall performance.

Advantages both relate to regulatory compliance and innovation. Regular maintenance and handling

procedures help ensure compliance with regulations, reducing the risk of fines or other penalties. Additionally, determining aircraft ageing maintenance and handling may also contribute to the development and improvement of future aircraft design and management. Both advantages have a frequency of 28 (80%) and are ranked number six point five. The eighth highest advantage is enhanced resale value, with a frequency of 27 (77.1%) and ranked number eight. This implies that a well-maintained aircraft can command a higher resale value, which can be beneficial for owners and operators.

All have a frequency of 26 (74.3%) and are ranked number nine point five. A safe and reliable aircraft can help improve customer satisfaction and loyalty, while giving operators a competitive advantage by offering more reliable and efficient services. Furthermore, a well-maintained aircraft can be more fuel-efficient, reducing its environmental impact.

Lastly, the participants' lowest advantage is that it may enhance owners and personnel's knowledge on how to properly manage ownership, usage, and integration of parts and devices of an aging aircraft, with a frequency of 24 (68.6%) and ranked number twelve.

Table 17
MEAN AND RANK DISTRIBUTION OF THE PARTICIPANTS' DISADVANTAGES OF DETERMINING AIRCRAFT AGEING MAINTENANCE AND HANDLING

Disadvantages	Frequency f	Percentage %	Rank
Cost: Regular maintenance and handling procedures can be expensive, especially for older aircraft.	29	82.90	1
Downtime: Maintenance and handling procedures can require the aircraft to be out of service for a period of time, which can impact operational schedules.	27	77.10	2
Training: Maintenance and handling procedures require specialized knowledge and training, which can be time-consuming and costly.	22	62.90	4.5
Complexity: The maintenance and handling of aircraft can be complex and require a high level of expertise.	23	65.70	3
Error-prone: Mistakes made during maintenance and handling procedures can result in serious safety issues.	22	62.90	4.5
Risk of damage: Maintenance and handling procedures can sometimes cause damage to the aircraft, which can be costly to repair.	22	62.90	4.5
Regulatory requirements: Compliance with regulatory requirements can be time-consuming and costly.	18	51.40	12
Aging fleet: Maintaining and handling older aircraft can be more challenging and expensive than newer models.	19	54.30	9.5
9. Limited availability: Specialized maintenance and handling services may not be widely available in certain areas.	22	62.90	4.5
10. Technological advancements: Advances in technology can quickly make older aircraft and maintenance practices obsolete, requiring significant investments to keep up with changing requirements.	19	54.30	9.5
11. Health and environmental impact: An aging aircraft may be less efficient, emission from the burning fuel may contribute a negative impact to the environment.	21	60.00	8
12. Age and technological change: determine the internal dynamics of an engine, ageing engine may influence the environmental impact in various ways.	19	54.30	9.5

Table 17 shows the mean and rank distribution of the participants' disadvantages of determining aircraft ageing maintenance and handling. The data were gathered through a survey, where participants were asked to rate the identified disadvantages on a Likert scale.

The top two disadvantages, with the highest frequency and percentage, are cost (29 or 82.90%) and downtime (27 or 77.10%). These findings suggest that regular maintenance and handling procedures for older aircraft can be expensive and time-consuming, which can impact operational schedules.

The third disadvantages are training (23 or 62.90%). This implies that maintenance and handling procedures require specialized knowledge and training, which can be time-consuming and costly. Also, the maintenance and handling of aircraft can be complex and require a high level of expertise.

The results show that the participants identified disadvantages "Complexity", "Error-prone", and "Risk of damage" with 22 or 2.90% which all have the same rank. These findings suggest that mistakes made during maintenance and handling procedures can result in serious safety issues, and these procedures can sometimes cause damage to the aircraft, which can be costly to repair.

The remaining disadvantages are regulatory requirements (18 or 51.40%), aging fleet (19 or 54.30%), limited availability (22 or 62.90%), technological advancements (19 or 54.30%), health and environmental impact (21 or 60.00%), and age and technological change determine the internal dynamics of an engine (19 or 54.30%).

Overall, these findings indicate that the disadvantages of determining aircraft ageing maintenance and handling are multifaceted and complex, which requires a comprehensive approach to address them effectively. Therefore, aircraft operators and maintenance personnel must ensure that regular maintenance and handling procedures are followed and that specialized knowledge and training are provided to minimize the risks associated with ageing aircraft.

Table 18

MEAN AND RANK DISTRIBUTION OF THE PARTICIPANTS' RECOMMENDATIONS FOR IMPROVING THE FUTURE MANAGEMENT OF AGEING AIRCRAFT IN THE PHILIPPINES

Indicators	Frequency f	Percentage %	Rank
Develop and implement a comprehensive ageing aircraft management program that covers all aspects of maintenance and handling, including inspection, repair, and replacement of critical components.	32	91.40	3
Establish a database of ageing aircraft in the Philippines, including their maintenance history and current condition, for decision-making and planning.	30	85.70	4
Increase training and education for personnel on identification management of ageing aircraft issues, and for development of standard operating procedures.	34	97.10	1
Encourage the adoption of new technologies and techniques for maintaining and handling ageing aircraft, such as non-destructive testing.	27	77.10	5.5
Improve communication and collaboration between aviation stakeholders, including operators, maintenance providers, regulators, and manufacturers, to share knowledge and best practices for ageing aircraft management.	27	77.10	5.5
6. Conduct regular research and analysis on ageing aircraft issues to stay updated on the latest trends and technologies in ageing aircraft management.	27	77.10	5.5
7. Ensure that all ageing aircraft operations in the Philippines comply with international safety standards and regulations, including those set by the International Civil Aviation Organization (ICAO).	33	94.30	2

III. RECOMMENDATION

Based on this study's significant findings, the following recommendations are offered:

1. Aviation companies and organizations should invest in the training and development of their employees, particularly in the areas of aircraft ageing maintenance and handling. Companies should also consider providing opportunities for their employees to pursue higher education degrees to enhance their knowledge and skills in this field.
2. It is recommended that aircraft maintenance and handling personnel should continue to receive training and education in assessing the technical aspects of aircraft ageing. This will help them stay up-to-date with the latest technologies and practices in aircraft maintenance and handling, and enable them to identify potential issues and take corrective action.
3. Aircraft maintenance and handling personnel should continue to receive training and education in assessing the technical aspects of aircraft ageing. This will help them stay up-to-date with the latest technologies and practices in aircraft maintenance and handling, and enable them to identify potential issues and take corrective action.
4. Implement regular maintenance and handling procedures for ageing aircraft to ensure their safety, reliability, and optimal performance. Develop educational programs and training courses to enhance the knowledge and skills of aircraft owners and personnel on how to properly manage the ownership, usage, and integration of parts and devices of ageing aircraft.
5. The policymakers and aviation industry should consider the following actions: Develop and implement a comprehensive ageing aircraft management program, establish a database of ageing aircraft, increase training and education for personnel, encourage the adoption of new technologies and techniques, improve communication and collaboration between aviation stakeholders, conduct regular research and analysis, and ensure compliance with international safety standards and regulations.

These actions can help ensure the safety, reliability, and optimal performance of ageing aircraft in the Philippine.

The survey results revealed several recommendations from the participants to improve the future management of ageing aircraft in the Philippines. The highest frequency result was the recommendation to increase training and education for personnel on identifying and managing ageing aircraft issues and for the development of standard operating procedures, with 34 participants (97.10%) ranking this as the top priority. This recommendation suggests that there is a need for more training and education to equip personnel with the necessary skills and knowledge to manage ageing aircraft effectively. This implies that the current level of training and education may be insufficient, and that there is a need for a more comprehensive training program.

The second highest frequency result was the recommendation to ensure that all ageing aircraft operations in the Philippines comply with international safety standards and regulations, with 33 participants (94.30%) ranking this as the top priority. This recommendation emphasizes the importance of safety in aircraft operations and highlights the need for compliance with international safety standards and regulations. This implies that there may be concerns over the current safety standards and regulations in place in the Philippines, and that there is a need for improvements in this area to ensure the safety of ageing aircraft operations.

The third highest frequency result was the recommendation to develop and implement a comprehensive ageing aircraft management program that covers all aspects of maintenance and handling, including inspection, repair, and replacement of critical components, with 32 participants (91.40%) ranking this as a priority. This recommendation suggests that there is a need for a comprehensive and integrated approach to ageing aircraft management in the Philippines, which includes all aspects of maintenance and handling. This implies that the current approach may be fragmented and lacking in certain areas, and that there is a need for a more

coordinated and holistic approach to managing ageing aircraft.

The fourth, fifth, and sixth highest frequency results were related to improving communication and collaboration between aviation stakeholders, encouraging the adoption of new technologies and techniques for maintaining and handling ageing aircraft, and conducting regular research and analysis on ageing aircraft issues. All three of these recommendations had a frequency of 27 participants (77.10%) and were ranked 5.5 in the survey. These recommendations suggest the need for better communication and collaboration among stakeholders, the adoption of new technologies and techniques, and the regular updating of knowledge and understanding of ageing aircraft issues. This implies that there is a need for more cooperation among stakeholders, and that the current methods and technologies may not be keeping up with the latest developments in the field.

These results imply that the participants believe that improving personnel training and education, ensuring compliance with international safety standards and regulations, and developing a comprehensive ageing aircraft management program are crucial for effective ageing aircraft management in the Philippines. These recommendations can help operators, maintenance providers, regulators, and manufacturers to develop and implement effective ageing aircraft management strategies and ensure the safety and reliability of ageing aircraft in the Philippines.

RESEARCH OUTPUT PROPOSED AGEING MAINTENANCE AND HANDLING AIRCRAFT IN THE PHILIPPINE FLEET

Key Result Area	Key Performance Indicator	Objectives	Action Plan
1. Aircraft Maintenance	Number of ageing aircraft identified	To ensure the safety and reliability of the ageing aircraft in the Philippine fleet	Identification of ageing aircraft in the Philippine fleet that require maintenance
2. Aircraft Handling	List of recommended improvements	To improve the efficiency and safety of aircraft handling in the Philippine fleet	Evaluation of current aircraft handling procedures and identification of areas for improvement
3. Replacement Parts Inventory	Percentage of required replacement parts in stock at any given time	To minimize aircraft downtime due to lack of replacement parts	Sufficient inventory of replacement parts established and maintained for ageing aircraft
5. Maintenance Cost	Cost comparison report	To determine the feasibility of continuing to maintain ageing aircraft or procuring new ones	Analysis of the cost of maintaining ageing aircraft in the Philippine fleet compared to the cost of procuring new aircraft
6. Technical Upgrades	Number of technical upgrades completed per year	To improve the performance and safety of ageing aircraft, and to extend their useful life	Technical upgrades implemented to extend the useful life of ageing aircraft
7. Safety and Reliability	Safety and reliability report	To ensure the safety and reliability of the ageing aircraft in the Philippine fleet	Assessment of the safety and reliability of ageing aircraft in the Philippine fleet
8. Training and Skills Development	List of recommended training and skills development programs	To ensure that personnel have the necessary knowledge and skills to effectively maintain and handle ageing aircraft	Identification of necessary training and skills development for personnel involved in ageing aircraft maintenance and handling

9. Budget Management	Reduction in maintenance costs per flight hour	To minimize expenses while maintaining the required level of safety and reliability	Cost-effective maintenance strategies for ageing aircraft
10. Compliance with Regulations	Number of regulatory and compliance inspections passed	To ensure that the Philippine fleet meets all regulatory and compliance requirements related to ageing aircraft maintenance	Compliance with relevant regulations and standards related to ageing aircraft maintenance

No
No Note: The above table is just an example, and the actual Key Result Areas, Expected Outputs, Key Performance
Indicators, and Objectives will depend on the specific details and scope of the proposed ageing aircraft
maintenance and handling program in the Philippine fleet.

CONCLUSION

In light of the findings of the study, the following conclusions were drawn:

1. Most participants in the aviation industry are from the general aviation (air taxi) category and are relatively young. It also revealed that the majority of participants are mechanics A/B/C, which indicates a high demand for skilled workers in this field. Moreover, the results indicate that the majority of participants hold a 2-year course degree, which means that there may be a need for further training and education in this field.
2. The participants demonstrated a high level of competency in assessing the technical aspects of aircraft ageing over time. The findings suggest that aircraft maintenance and handling personnel have a good understanding of the factors that contribute to the ageing process of aircraft, including design, maintenance programs, aircraft performance, and geographical location. This high level of competency is crucial in ensuring the safe and efficient operation of ageing aircraft
3. The results of the Kruskal-Wallis H test suggest that there is no significant difference in the level of competency among participants in assessing the technical aspects of aircraft ageing over time for the variables tested. This indicates that the participants have a similar level of knowledge and understanding of the factors that contribute to aircraft ageing, including design, maintenance programs, aircraft performance, and geographical location
4. The participants demonstrated a high level of competency in assessing the technical aspects of aircraft ageing over time. The findings suggest that aircraft maintenance and handling personnel have a good understanding of the factors that contribute to the ageing process of aircraft, including design, maintenance programs, aircraft performance, and geographical location. This high level of competency is crucial in ensuring the safe and efficient operation of ageing aircraft.
5. There were no significant differences in the impact of aircraft ageing maintenance and handling across the different variables. This suggests that the impact of aircraft ageing maintenance and handling is consistent across different factors, and stakeholders involved in aircraft maintenance and handling should prioritize the proper maintenance and handling of ageing aircraft to ensure positive impacts on economic sustenance, safety protocol, labor efficiencies, and in-house/sub-contracted work.
6. In terms of advantages, the study suggests that determining aircraft ageing maintenance and handling has several advantages that can significantly improve the safety, reliability, performance, and lifespan of aircraft. Proper maintenance and handling procedures can also help reduce costs, ensure compliance with regulatory requirements, enhance re-sale value, improve customer satisfaction, and provide competitive advantages. The findings of this study emphasize the importance of implementing appropriate maintenance and handling procedures

for ageing aircraft to ensure their safety and reliability and optimize their performance.

On the other hand, for disadvantages, the findings concluded that aircraft ageing maintenance and handling pose significant challenges that may negatively impact operational schedules, safety, and the environment. The participants emphasized the need for specialized knowledge and training to manage the ownership, usage, and integration of parts and devices of ageing aircraft. Additionally, advances in technology can quickly make older aircraft and maintenance practices obsolete, requiring significant investments to keep up with changing requirements.

7. The findings suggest that managing ageing aircraft requires a holistic and proactive approach that considers all aspects of maintenance and handling. While there are challenges associated with ageing aircraft management, such as cost and downtime, there are also opportunities for improvement, such as adopting new technologies and techniques and improving collaboration between stakeholders. The recommendations provided by the participants can serve as a guide for policymakers and industry players to develop and implement effective ageing aircraft management strategies in the Philippines.

ACKNOWLEDGEMENT

First and foremost, to Almighty God for giving me His blessing, strength, knowledge, ability, and opportunity to undertake this research study and to persevere and complete it satisfactorily.

I would also like to express my sincere gratitude to Ma. Trinidad V. Estrada, DPA, for her suggestions, encouragement, and insightful comments, in my quest for knowledge.To the thesis panel headed by Dr. Roderick C. Santiago, Dr. Leonardo C. Medina Jr., Dr. Estrella E. Yago, Dr. Froilan B. Balucio, Dr. Eleonor H. Calayag who are the key persons in the realization of this study. Their fountain of knowledge, motivations, and wisdom they patiently and generously shared. I truly salute their expertise what seem to be an uphill task. Dr. Noel R. Navigar, helps the researcher aligned with the set of structural rules that govern the usage of the English language such as grammar, content, similarity, plagiarism, and gender-fair requirements. Ms. Ceciel Jane B. Mallorca, who helps the researcher perform the statistician's test and computation, interpretation, and statistical review, for her tremendous support for my research study, her patience, motivation, enthusiasm, immense knowledge and guidance helped me in any time of the day of research and writing of this thesis. Mr. Dennis S. Resuello, Naval Air Wing, Chief of Naval Air Staff, for granting the researcher access inside Naval Air Wing at Sangley, Cavite City.Mr. Eulogio P. Reyes, Vice President of Campus Safety & Security Management Alliance of the Philippines, for the assistance and very kind Support.Mr. Gil C. Gatchalian Aviation Partnership Philippines from the Office of the General Manager, who was most likely to be special, awesome support and cooperation for distributing and collecting data.

To my thesis buddies, Mr. Elohim Benedict R. Laurel, Mr. Rene B. Villanueva, Ms. Lovella C. De Leon, Ms. Rona T. Dalen, Ms. Kalayaan Melchora T. Tuyogon, Ms. Evelyn G. Paragas, Ms. Ciara May L. Cruz, Mr. Emil Bernard Acuna, Karthlene Novo, to my classmates, colleagues, and friends, stands as my Inspiration, I wholeheartedly appreciate their assistance, encouragement, and efforts to help me with my study.

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