Assessment on the Causes of Delays for Scheduled Maintenance for AMO Workshops: Basis for Improving Maintenance Services

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Abstract: -The main objective of this study was to investigate the factors contributing to delays in the scheduled maintenance of Approved Maintenance Organization (AMO) workshops. The study aimed to understand the challenges associated with these delays and identify opportunities for enhancing maintenance services for AMO. Based on the findings, recommendations were provided to improve maintenance practices, ensuring that aircraft are maintained in optimal condition for safe and efficient flights while minimizing associated costs. This study had specific objectives, which were to gather information about the profile of the respondents, including their sex, age, years in service, position, department and AMO Company; identify the causes of delays in scheduled maintenance for Approved Maintenance Organization (AMO) workshops, encompassing factors such as planning, logistic issues (specifically customs clearances), hangarage and facilities, equipment and materials availability and status, human factors, and other potential factors; understand how these causes of delays impact maintenance services in terms of downtime and cost, focusing on the effects on the length of downtime and associated costs; and determine if there is a significant relationship between the assessed causes of delays for AMO workshops, aiming to analyze the data and identify any correlations or associations among the causes of delays. It employed a quantitative-descriptive survey method, collecting data through a survey questionnaire. The study took place at various MROs/AMOs in the Philippines, including Lufthansa Technik Philippines (LTP) in Manila and Macro Asia, SIA Engineering Philippines, Asian Aerospace Corporation, and Dornier Technology, Incorporated.

Key Words—*Aircraft, Approved Maintenance Organization, Aircraft Fleet, Aircraft maintenance, Assessment, Aviation personnel, Downtime.*

I. INTRODUCTION

Maintenance in aviation involves the process of examining, fixing, and maintaining aircraft and their components to guarantee their safe and efficient operation. It is a crucial aspect of aviation safety since it is necessary to ensure that aircraft are always in proper working condition and meet all regulatory requirements. An approved maintenance organization (AMO) is described as "an organization approved by a Contracting State, in accordance with the requirements of Annex 8, Part II, Chapter 6 — Maintenance Organization Approval, to perform maintenance of aircraft, engines, propellers, or parts thereof and operating under supervision approved by that State" by the International Civil Aviation Organization (ICAO). There are different types of maintenance that can be conducted on an aircraft, including routine inspections, scheduled maintenance, and unscheduled maintenance. Routine inspections are carried out periodically to inspect for any signs of wear and tear or damage, while scheduled maintenance involves more extensive inspections and replacement of certain components based on a predetermined schedule. Unscheduled maintenance is performed when unforeseen issues occurs that need immediate attention, such as equipment failures On the other hand, damage caused by weather or other external factors. Maintenance works are performed by licensed and certified mechanics that are trained to adhere to strict guidelines and procedures to ensure that all work is carried out safely and accurately.

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To make sure reliability, which comes to aircraft availability, the aviation maintenance department performs maintenance and preventive maintenance or scheduled maintenance. This part does not prevent a part or system from randomly failing or degrading, but continuous maintenance will prevent this from happening and keep the aircraft in good flying condition.

Scheduled maintenance is a critical aspect of aviation that ensures the safety and reliability of aircraft. According to Double M Aviation (2018), preventive maintenance is performed at regular intervals to ensure that the aircraft is airworthy and ready to fly. This type of maintenance involves preflight checks, 100-hour inspections, annual inspections, and progressive inspections. By conducting these scheduled maintenance checks, potential issues can be identified and addressed promptly, ensuring that the aircraft is in excellent condition for operation. Double M Aviation (2018) emphasizes the importance of following these maintenance schedules to avoid any unexpected failures that can compromise the safety of the aircraft and its passengers.

This study aimed to examine the factors contributing to the delay of Approved Maintenance Organization (AMO) workshops' scheduled maintenance and explored ways to prevent delay by enhancing maintenance services. The study sought to categorize the reasons for delayed aircraft maintenance schedules and utilized this information as a basis for improving maintenance services for the AMO.

II. Literature Review

On an Approved Maintenance Organizations (AMOs), the Civil Aviation (Approved Maintenance Organization) Regulations, 2017, must be followed by anyone planning to operate as an approved maintenance organization. The locations of approved maintenance organizations might be either domestically or abroad. An approved maintenance organization (AMO) is described as "an organization approved by a Contracting State, in accordance with the requirements of Annex 8, Part II, Chapter 6 — Maintenance Organization Approval, to perform maintenance of aircraft, engines, propellers, or parts thereof and operating under supervision approved by that State" by the International Civil Aviation Organization (ICAO Doc 9760, Airworthiness Manual ,2020).An AMO could carry out routine maintenance, preventative maintenance, or improvements made to an equipment, engine, propeller, airframe, just the component or part for which it is rated, as long as it falls within restrictions imposed by its Specific Operational Provisions (Kenya Subsidiary Legislation, 2018).One of the most important phases of an aircraft's life cycle in aviation are maintenance. The aircraft kept ascending. As a result, comprehensive planning for maintenance was required. It can be a time-consuming, expensive, and difficult subject to maintain an aircraft which contains significant risk severe outcome as a result of aircraft system failures, maintenance area is heavily regulated by both national and international laws. Consequently, this establishes restrictive rules on the maintenance providers and their techniques (Yin ling LIU 13 December,2020). According to (Jorne Van den Bergh et al., November 2013, Aircraft Maintenance Operations: State of the art) there different types of maintenance for aircraft: scheduled and unscheduled maintenance, line and hangar maintenance, routine and non-routine checks, etc. For example, there are four major types of maintenance checks (A, B, C and D) which every aircraft must go through after a specific number of flying hours, according to FAA regulations. These four classes might alternatively be viewed as a component of scheduled or preventive maintenance techniques. Based on Acorn Welding (2020), regular inspections and maintenance procedures will help to guarantee that aircrafts remain operable for the duration of their flight. As a result, aircraft engines operate at their full potential. Operational checks should be done before each flight to ensure that failure won't occur. Despite the importance of aircraft maintenance, the scheduling of maintenance operations has not received extensive attention in the literature, creating a gap in research. To effectively schedule aircraft maintenance operations, maintenance times should be determined based on real-life situations. Although the learning effect has been extensively studied in the context of machine scheduling literature, it has not been thoroughly investigated in terms of aircraft maintenance times (Atici and Şenol, 2022). Anaroua (2023) classified the reasons for flight delays or cancellations into various categories, including those within the airline's control (e.g., crew issues, aircraft cleaning, loading of baggage, fueling), severe weather conditions, delays and cancellations attributed to the National Aerospace System (NAS) (e.g., non-extreme weather, airport operations, high volume of travel, and air traffic control), aircraft arriving late, and delays or cancellations caused by terminal or concourse evacuation or re-boarding an aircraft. Double M Aviation, (2018), for every aircraft to remain airworthy and safe to fly, regular inspections and maintenance are required. The pilot and the aircraft technician are both aware of some of the scheduled maintenance. Some sorts of maintenance are unexpected and unscheduled, and they can be brought on by issues that the pilot or the A&P discovers during an inspection. It's critical for pilots

and aircraft owners to comprehend the distinctions between scheduled and unscheduled aircraft maintenance. Scheduled tasks typically involve predetermined inspections that are conducted at regular intervals, and the nature of the work is mostly predictable and follows a set pattern. (Duarte Dinisa, et,al 2019). Atici and Şenol's (2022) study delves into the concept of the learning effect in aircraft maintenance operations, which pertains to the enhancement in productivity or efficiency attained by doing a task repeatedly. The study aims to examine the influence of the learning effect on aircraft maintenance times. Tavakkoli-Moghaddam &Fathi, (2016), the authors applied the proposed model to a case study involving the maintenance scheduling of a fleet of aircraft. The results demonstrated that the proposed approach effectively balanced the conflicting objectives of minimizing maintenance costs and minimizing the risk of maintenance-related incidents. The study concluded that the proposed model could be a useful tool for airlines and maintenance providers in scheduling aircraft maintenance operations.

III. MATHEMATICAL MODEL

3.1 Methods of Research

This chapter outlined the research plan for the study, including the methodology, selection of participants, data collection tools, data analysis techniques, statistical treatment, and validation of instruments. This chapter provided a comprehensive discussion of these aspects to ensure the accuracy and reliability of the research findings.

3.2 Respondents of the Study

The main respondents of the study were the technician, maintenance, planner, engineer and logistics that are working in MROs/AMOs at Lufthansa, SIAEP, Asian Aerospace Corporation and Dornier. 20 participants took part in the study as respondents.

3.3 Data Gathering Instruments

To gather data for this study, a questionnaire was utilized, including a Likert scale question. The survey was distributed via electronic means, specifically through Google forms, and respondents had access through their email addresses. The questionnaire was structured into three sections, with the first section gathering information about the respondents' demographics and personal details. The second section pertained to the respondents' proficiency of the reasons behind the delays in scheduled maintenance for AMO workshops. The third section dealt with the effects of certain causes on maintenance services, specifically in terms of downtime and cost. The survey questionnaire made use of a four-point Likert scale consisting of four tables, with answer options including Strongly Agree, Agree, Disagree, and Strongly Disagree. The researchers consulted with a registered statistician who approved the use of this four-point Likert scale.

3.4 Statistical Treatment of Data

Once the questionnaire data was collected, the researchers processed it by tallying, tabulating, analyzing, and interpreting the results. To ensure the validity and reliability of the data analysis, the researchers utilized a licensed version of SPSS 25. Various descriptive statistics were employed by the researcher to analyze data.

- Frequency Distribution. The data gathered will be tallied and tabulated to indicate the number of respondents to a specific question in the questionnaire.
- The percentage will be determined from the frequency of the respondents or perceived/perceptual assessment of the respondents. The formula is:

P= x 100

Where:

P - Percentage (%) n- The total population f - Frequency (number of respondents)

- Mean. The mean was used to calculate the average score of the questionnaire responses related to the causes of delays for scheduled maintenance in AMO workshops, challenges encountered by aviation personnel in managing such delays, and the measures to improve maintenance services.
- To determine whether there was a correlation between the independent and dependent variables, the researchers used the Pearson Product-Moment Correlation Coefficient.The researchers administered to the respondents the questionnaires via online platforms and explained the purpose of the instrument. The data will be tallied, tabulated, and analyze. The following scale will be regarded.

Scale	Description
3.26 – 4.00	Strongly Agree
2.51 – 3.25	Agree
1.76 – 2.50	Disagree
1.00 - 1.75	Strongly Disagree

IV. Results And Discussion

A total of 20 employees participated in the study. There are 18 or 90% male and 2 female respondents. In terms of age, most of them are 26-30 years old with a frequency distribution of 12 while there are 6 who are 21-25 years old and 2 respondents under the age of 31-35 years old. Also, in terms of the years in service of the respondents, data presents that 60% or 12 of them are already 4-6 years employed, while there are 4 with 1-3 years in service, 3 respondents who are employed only in less than a year and there is only 1 respondent who is employed for 7-9 years. Moreover, in terms of position, the respondents act mostly as engineers (8) and technicians (7) while there 5 who are assigned in logistics. They assigned in maintenance (8), planning (7) and logistics (5) department. It can also be noted that they are equally distributed in 4 aviation companies like SIAEP, Lufthansa, Asian Aerospace, and Dornier with 5 respondents each. In general, majority of the respondents are male under the age of 26-30 years old and are employed for 4-6 years. Also, most of them are engineers and technicians who are assigned in maintenance and planning department.

Table 1. Profile of the respondents

Profile	Students	
	f	%
Sex		
Male	18	90.0
Female	2	10.0
Total	**20**	**100**
Age		
16- 20 y/o		
21-25 y/o	6	30.0
26-30 y/o	12	60.0
31-35 y/o	2	10.0
36 y/o and above	0	0
Total	**20**	**100**
Years in Service		
Less the 1 year	3	15.0
1-3 years	4	20.0
4-6 years	12	60.0
7-9 years	1	5.0
Total	**20**	**100**
Position		
Engineer	8	40.0
Technician	7	35.0
Logistics	5	25.0
Total	**20**	**100**
Department		
Maintenance	8	40.0
Planning	7	35.0
Logistics	5	25.0
Total		
Company		
SIAEP	5	25.0
LUFTHANSA	5	25.0
ASIAN AEROSPACE	5	25.0
DORNIER	5	25.0
Total	**20**	**100**

Table 2.1 presents the data on the causes of delays in scheduled maintenance for AMO workshops. It is notable that in terms of planning, Statement no. 6, "Not anticipating last minute changes/ or doesn't have back up plan cause delay in maintenance" has the highest mean of 3.7 and an interpretation of "Strongly Agree". While Statement no. 4 "The planning process is efficient and effective in preventing delays" has the lowest mean of 3.2 which means "Agree". The computed weighted mean is 3.34 which means "Strongly Agree". This means that failure in planning, ineffective communication and lack of back up plans for scheduled maintenance can cause delays for AMO workshops.

In terms of logistics, statement 8, "Issues at Customs can cause Delay in Maintenance work" has the highest mean of 3.35 with an adjectival rating of "Strongly Agree". Also, the respondents "strongly agreed" in items 1, 4, and 6 that insufficient supply of logistics leads to delays in maintenance work and the delay in procurement of necessary materials and equipment causes delays in scheduled maintenance. However, the computed weighted mean is 3.21 which means "Agree". This means that problems in logistics may cause delays especially if there are issues in customs, insufficient supply, and late procurement.

In terms of housing and facilities, data reflects that substandard facilities and equipment for maintenance activities cause delays in scheduled maintenance (Item 3) "strongly agreed" by the respondents with highest mean of 3.3. The computed weighted mean is 3.09 which means agree. This means that problems about housing and facilities like substandard equipment for maintenance, lack of proper facilities and equipment for maintenance and storage for them may cause delays of scheduled maintenance.

Table 2.1. Causes of delays in scheduled maintenance for AMO workshops

Statements	Mean	Interpretation
A. Planning		
1. Lack of proper planning leads to delays in maintenance work.	3.3	Strongly Agree
2. There is a clear plan for maintenance work to be carried out.	3.25	Agree
3. Ineffective communication between departments affects the planning of scheduled maintenance.	3.45	Strongly Agree
4. The planning process is efficient and effective in preventing delays.	3.2	Agree
5. The mismanagement between departments causes delays in scheduled maintenance.	3.3	Strongly Agree
6. Not anticipating last minute changes/ or doesn't have back up plan cause delay in maintenance.	3.7	Strongly Agree
7. Time limitations contribute to inaccurate planning, which leads to delays in maintenance work.	3.15	Agree
Weighted Mean	**3.34**	**Strongly**

		Agree
B. Logistics		
1. Insufficient supply of logistics leads to delays in maintenance work.	3.3	Strongly Agree
2. The inventory logistics are well planned and executed, minimizing delays.	3.05	Agree
3. The logistics production process is efficient and effective in preventing delays.	3.05	Agree
4. The unavailability of spare parts causes delays in scheduled maintenance.	3.4	Strongly Agree
5. The lack of a proper inventory system affects the logistics of scheduled maintenance.	3.25	Agree
6. The delay in procurement of necessary materials and equipment causes delays in scheduled maintenance.	3.3	Strongly Agree
7. Damaged cargo during transportation cause Delay in Maintenance work	3.0	Agree
8. Issues at Customs can cause Delay in Maintenance work	3.35	Strongly Agree
Weighted Mean	**3.21**	**Agree**
C. Housing and Facilities		
1. Lack of proper facilities and equipment for maintenance activities cause delays in scheduled maintenance.	3.15	Agree
2. The lack of proper storage facilities for materials and equipment causes delays in scheduled maintenance.	3.05	Agree
3. Substandard facilities and equipment for maintenance activities cause delays in scheduled maintenance.	3.3	Strongly Agree
4. Disturbance from your neighbour of your housing cause delay in maintenance work	2.85	Agree
Weighted Mean	**3.09**	**Agree**

Continuation of the causes of delays of scheduled maintenance are the data reflected in Table 2.2. It shown that under equipment and materials, the respondents "Strongly Agree" in all statements except items 2 and 3. The computed weighted mean 3.31 with an adjectival rating of "Strongly Agree". This reveals that poor quality of materials and equipment, improper maintenance and equipment failures may cause delays of scheduled maintenance.

Table 2.2. Causes of delays in scheduled maintenance for AMO workshops

D. Equipment and Materials:		
1. Lack of equipment and materials lead to delays in maintenance work.	3.35	Strongly Agree
2. The equipment and materials are well preserved and meet the requirements for maintenance work.	3.25	Agree
3. The equipment and materials are well-supplied and contribute to efficient maintenance work.	3.15	Agree
4. Poor quality of equipment and materials causes delays in scheduled maintenance.	3.3	Strongly Agree
5. The lack of proper maintenance of equipment and materials leads to delays.	3.45	Strongly Agree
6. The unavailability of specialized equipment and tools causes delays in scheduled maintenance.	3.4	Strongly Agree
7. Equipment failures cause Delay in Maintenance work	3.3	Strongly Agree
Weighted Mean	3.31	Strongly Agree
E. Human Factors:		
1. Insufficient skills lead to delays in maintenance work.	3.05	Agree
2. Sufficient training contributes to efficient maintenance work and reduces delays.	3.2	Agree
3. Human factors are well-managed and contribute to efficient maintenance work.	3.2	Agree
4. The shortage of staff affects the timely execution of maintenance activities.	3.25	Agree
5. The lack of motivation among maintenance staff affects the quality and timeliness of maintenance activities.	3.3	Strongly Agree
6. Human personal behaviour cause Delay in Maintenance work E.G. Work ethics.	3.1	Agree
7. Improper handling of Equipment cause delay in Maintenance work	3.35	Strongly Agree
8. Fatigue of workers that leads delay in maintenance work	3.5	Strongly Agree
9. Inadequate supervision can result of delay, as personnel may not be properly direct or held accountable for completing maintenance task.	3.4	Strongly Agree
Weighted Mean	**3.25**	**Agree**

In addition, Table 2.2 also shows how human factors cause delays in scheduled maintenance. It is shown that "inadequate supervision can result of delay, as personnel may not be properly direct or held accountable for completing maintenance task"(item 9) is one of the causes of delay of scheduled maintenance with mean value of 3.4. The computed weighted mean is 3.25 which means "Agree". This reveals that problems involving employees (human factor) may cause delays in scheduled maintenance like inadequate supervision, shortage of staff and lack of training among the employees.

Table 3. Effects of the causes of delays in scheduled maintenance for AMO workshops

Statements	Mean	Interpretation
A. Downtime:		
1. Delays in scheduled maintenance result in longer downtime of equipment.	3.1	Agree
2. The unavailability of materials and equipment causes longer downtime of equipment.	3.25	Agree
3. The shortage of maintenance staff affects the timeliness of maintenance activities, resulting in longer downtime of equipment.	3.35	Strongly Agree
4. Delays in maintenance services makes no productivity of employees	3.2	Agree
Weighted Mean	3.23	Agree
B. Cost:		
1. Delays in scheduled maintenance result in increased maintenance costs.	3.4	Strongly Agree
2. The unavailability of materials and equipment increases maintenance costs.	3.15	Agree
3. The shortage of maintenance staff affects the timeliness of maintenance activities, resulting in increased maintenance costs.	3.15	Agree
4. Delays in maintenance services Cost profit loss to the company	3.2	Agree
5. Delayed maintenance can cause damage to equipment leading to additional repair or replacement cost	3.15	Agree
6. Delayed in maintenance task can increase safety risk for personnel and equipment which can lead to additional related to insurance, legal fees or workers compensation claims	3.1	Agree
Weighted Mean	**3.19**	Agree

Table 3 shows the effects of delays in scheduled maintenance for AMO workshops. In terms of downtime, the respondents "strongly agreed "in item 3, "The shortage of maintenance staff affects the timeliness of maintenance activities, resulting in longer downtime of equipment" with a highest mean of 3.35. In the rest of the statements, the respondents answer is "Agree". The computed weighted mean is 3.23 which means "Agree". This implies that delays in scheduled maintenance result to The shortage of maintenance staff affects the timeliness of maintenance activities, resulting in longer downtime of equipment.

Also shown in Table 3, the respondents answered those delays in maintenance result to increased maintenance costs (Item 1) with highest mean value of 3.4 and an adjectival rating of "Strongly Agree". The computed weighted mean is 3.19 which means "Agree". This reveals that delays in scheduled maintenance due to poor planning, inadequate and substandard equipment and human error may result to increased maintenance costs, damage to equipment leading to additional repair or replacement cost and increased safety risk of personnel.

As shown in Table 4, equipment and materials factor has the lowest standard deviation of .35 followed by planning (.54), human factor (.62) and the least standard deviation is that of logistics (.63) and housing facilities (.66). This shows that to top three factors that will most likely to cause delays in scheduled maintenance are insufficient and substandard materials and equipment, poor planning and lack of back-up plans and human factors like lack of trainings in handling equipment and shortage of staff.

Table 4. Significant difference based on standard deviation of causes of delays in scheduled maintenance for AMO workshops

Items	Mean	SD
Planning	3.29	.54
Logistics	3.21	.63
Housing and Facilities	3.08	.66
Equipment and Materials	3.31	.35
Human Factors	3.24	.62

V. CONCLUSION

5.1 Profile of the respondents

A total of 20 individuals participated in the study, comprising 18 males (90% of the participants) and 2 females. Regarding age, the majority falls within the 26-30 age range, with 12 individuals falling into this category. Additionally, there are 6 participants aged 21-25, and 2 respondents aged 31-35. Turning to the tenure of the respondents, 12 of them (60%) have been employed for 4-6 years, while 4 individuals have 1-3 years of service. Furthermore, 3 respondents have been employed for less than a year, and only 1 respondent has worked for 7-9 years.

Regarding their positions, the majority of participants work as engineers (8 individuals) or technicians (7 individuals). Additionally, there are 5 participants assigned to logistics. These roles are distributed across the maintenance (8 individuals), planning (7 individuals), and logistics (5 individuals) departments. It is worth noting that the respondents are equally divided among four aviation companies: SIAEP, Lufthansa, Asian Aerospace, and Dornier, each having 5 participants.

In summary, the study predominantly involved male participants under the age of 26-30, who have been employed for 4-6 years. The majority of these individuals hold positions as engineers or technicians, working in the maintenance and planning departments.

5.2 Causes of delays in scheduled maintenance for AMO workshops

The data pertains to the reasons behind delays in scheduled maintenance for AMO workshops. Notably, when it comes to planning, Statement no. 6, which states that "Not anticipating last minute changes or lacking a backup plan causes delays in maintenance," has the highest average score of 3.7, indicating a "Strongly Agree" interpretation. On the other hand, Statement no. 4, which claims that "The planning process is efficient and effective in preventing delays," has the lowest average score of 3.2, indicating an "Agree" interpretation. The computed weighted mean is 3.34, which indicates a "Strongly Agree" consensus. This suggests that inadequate planning, ineffective communication, and the absence of backup plans can result in delays for AMO workshops.

In terms of logistics, Statement 8, which states that "Issues at Customs can cause delays in maintenance work," has the highest average score of 3.35, indicating a "Strongly Agree" rating. Additionally, respondents "strongly agreed" with items 1, 4, and 6, which state that insufficient logistics supply leads to delays in maintenance work and that delayed procurement of necessary materials and equipment causes delays in scheduled maintenance. However, the computed weighted mean is 3.21, indicating an "Agree" consensus. This implies that logistics-related issues, particularly problems with customs, inadequate supply, and delayed procurement, can lead to delays.

Regarding housing and facilities, the data reveals that substandard facilities and equipment for maintenance activities (Item 3) were "strongly agreed" upon by the respondents, with the highest average score of 3.3. The computed weighted mean is 3.09, indicating an "Agree" consensus. This indicates that

issues concerning housing and facilities, such as substandard maintenance equipment, lack of suitable facilities and equipment for maintenance and storage, can cause delays in scheduled maintenance.

5.3 Causes of delays in scheduled maintenance for AMO workshops

The results and discussion section provides further insights into the causes of delays in scheduled maintenance. It is evident that, concerning equipment and materials, the respondents "Strongly Agree" with all statements except items 2 and 3. The computed weighted mean is 3.31, indicating a "Strongly Agree" rating. This indicates that delays in scheduled maintenance can be caused by factors such as poor-quality materials and equipment, improper maintenance practices, and equipment failures. Furthermore, the data highlights the role of human factors in causing delays. It is revealed that the statement "inadequate supervision can result in delays, as personnel may not be properly directed or held accountable for completing maintenance tasks" (item 9) is one of the causes of delay in scheduled maintenance, with a mean value of 3.4. The computed weighted mean is 3.25, indicating an "Agree" consensus. This suggests that issues related to employees, such as inadequate supervision, staff shortages, and lack of training, may contribute to delays in scheduled maintenance.

In terms of the effects of delays in scheduled maintenance for AMO workshops, downtime is a significant factor. The respondents "strongly agreed" with item 3, which states that "The shortage of maintenance staff affects the timeliness of maintenance activities, resulting in longer downtime of equipment," with the highest mean score of 3.35. For the remaining statements, the respondents' answers were "Agree." The computed weighted mean is 3.23, indicating an "Agree" consensus. This implies that delays in scheduled maintenance lead to longer downtime for equipment due to the shortage of maintenance staff affecting the timeliness of maintenance activities.

5.4 Effects of the causes of delays in scheduled maintenance for AMO workshops

*T*he respondents answered those delays in maintenance result to increased maintenance costs (Item 1) with highest mean value of 3.4 and an adjectival rating of “Strongly Agree”. The computed weighted mean is 3.19 which mean “Agree”. This reveals that delays in scheduled maintenance due to poor planning, inadequate and substandard equipment and human error may result to increased maintenance costs, damage to equipment leading to additional repair or replacement cost and increased safety risk of personnel.

5.5 Significant difference based on standard deviation of causes of delays in scheduled maintenance for AMO workshops

*E*quipment and materials factor has the lowest standard deviation of .35 followed by planning (.54), human factor (.62) and the least standard deviation is that of logistics (.63) and housing facilities (.66). This shows that to top three factors that will most likely to cause delays in scheduled maintenance are insufficient and substandard materials and equipment, poor planning and lack of back-up plans and human factors like lack of trainings in handling equipment and shortage of staff.

5.6 Conclusion

- A total of 20 employees participated in the study, majority are male, most of them are 26-30 years old, in terms of the years in service of the respondents; most of them are already 4-6 years employed, moreover in terms of position; the respondents act mostly as engineers and technicians. It was noted that they are equally distributed in 4 aviation companies like SIAEP, Lufthansa, Asian Aerospace, and Dornier who are assigned in maintenance and planning department.
- Failure in planning, ineffective communication and lack of back up plans for scheduled maintenance can cause delays for AMO workshops.
- Problems in logistics may cause delays especially if there are issues in customs, insufficient supply, and late procurement.
- Problems about housing and facilities like substandard equipment for maintenance, lack of proper facilities and equipment for maintenance and storage for them may cause delays of scheduled maintenance.
- Poor quality of materials and equipment, improper maintenance, equipment failures may cause delays of scheduled maintenance
- Problems involving employees (human factor) may cause delays in scheduled maintenance like inadequate supervision, shortage of staff and lack of training among the employees.
- Delays in scheduled maintenance result to the shortage of maintenance staff affects the timeliness of maintenance activities, resulting in longer downtime of equipment.

- Delays in scheduled maintenance due to poor planning, inadequate and substandard equipment and human error may result to increased maintenance costs, damage to equipment leading to additional repair or replacement cost and increased safety risk of personnel.
- The top three factors that will most likely to cause delays in scheduled maintenance are insufficient and substandard materials and equipment, poor planning and lack of back-up plans and human factors like lack of trainings in handling equipment and shortage of staff.

5.7 Recommendations

- The recommendations aim to benefit AMO, engineers, and future aviators by improving planning, enhancing communication, creating backup plans, conducting evaluations, providing training, and fostering a culture of continuous improvement. These measures ensure efficient maintenance scheduling, collaborative problem-solving, preparedness for unexpected challenges, skill enhancement, and staying up-to-date with industry advancements, ultimately leading to safer and more reliable aircraft maintenance operations.
- AMOs should establish a robust logistics management system, engineers should collaborate with suppliers and develop contingency plans, technicians should communicate supply-related issues promptly, collaborate with maintenance teams. By implementing these measures, they can ensure efficient logistics, timely availability of resources, and smooth maintenance operations, leading to reduced delays and improved overall performance.
- To address delays caused by housing and facility issues in scheduled maintenance, it is recommended that AMOs, engineers, and technicians, infrastructure, equipment, and storage solutions. AMOs should invest in upgrading facilities, engineers should assess and modify existing infrastructure, and technicians should provide feedback on equipment and storage requirements. By implementing these measures, delays can be minimized, providing a conducive environment for maintenance tasks and ensuring timely completion of scheduled maintenance.
- To mitigate delays in scheduled maintenance, focus on quality control, regular maintenance practices, and proactive equipment monitoring. Ensure high-quality materials, implement comprehensive maintenance procedures, and address equipment issues promptly. This enhances efficiency and completion of maintenance tasks.
- By ensuring sufficient staffing levels and establishing clear maintenance priorities based on criticality and equipment downtime impact, AMOs can enhance operational efficiency, minimize delays, and improve service delivery. This approach also benefits maintenance personnel by alleviating workloads and enabling effective task management. Future aviation personnel can benefit from understanding these factors to excel in maintenance roles.
- To improve maintenance efficiency and minimize delays, Approved Maintenance Organizations (AMOs) should enhance planning with thorough assessments and detailed schedules. They are encouraged to invest in high-quality equipment, promptly address any issues, and provide comprehensive training programs. These measures streamline workflow for maintenance personnel, enhance task performance, and promote safety. Aspiring aviation personnel can benefit from understanding the significance of these factors for successful career development.

REFERENCES

[1]. Acorn Welding. (2020, March 27). Why Regular Aircraft Maintenance is So Important.
[2]. Anaroua, F. I. (2023). Analysis of Flight Disruption Data to Determine Problem Areas Utilizing Database Applications. J Math Techniques Comput Math, 2(2), 110- 116.
[3]. Atici, U., & Şenol, M. B. (2022). Determining aircraft maintenance times in civil aviation under the learning effect. Aircraft Engineering and Aerospace Technology, 94(8), 1366-1378.
[4]. Civil Aviation Authority of the Philippines. (n.d.-c). Civil Aviation Regulations (CAR) Part 6: Approval of Maintenance Organizations.
[5]. Double M Aviation. (2018). Understanding scheduled and unscheduled aircraft maintenance.
[6]. International Civil Aviation Organization. (n.d.). Approved maintenance organization (AMO).
[7]. Liu, Y., Wang, T., Zhang, H., & Cheutet, V. (2021). Simulation-based fuzzy-rough nearest neighbor fault

classification and prediction for aircraft maintenance. Journal of Simulation.

[8]. Tavakkoli-Moghaddam, R., & Fathi, M. R. (2016). A multi-objective approach for aircraft maintenance scheduling under fuzzy parameters. Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability, 230(4), 291-306.

[9]. Van den Bergh, J., De Bruecker, P., Belien, J., & Peeters, J. (2013). Aircraft maintenance operations: State of the art.