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Aircraft Safety in Focus: Evaluating Foreign Object Debris/Damage Detection Practices among Aircraft Mechanics at Clark International Airport

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Abstract:
The acronym FOD is now used to describe both the foreign objects themselves, and any foreign object damage attributed to them. A FOD-prevention program of training, facility inspection, maintenance, and coordination between all affected parties can minimize FOD and its effects.

Keywords: Aircraft Mechanic, Airports, FOD, Hazards, Safety.

I. INTRODUCTION

The International Civil Aviation Organization or ICAO (2022) determined that safety is a fundamental principle which ensures the services in regards to commercial aircraft transport the safest way to travel the world [1]. Safety is a condition of being protected from danger and unlikely to cause risk and injury. Aviation is where safety is at the top of the list of priorities for different organizations in the industry. One of the hazards that can affect safety is foreign object debris or foreign object damage.

Foreign Object Debris is any substance, debris, or article alien to a vehicle or system which could potentially cause damage, while Foreign Object Damage is damage to an aircraft or aircraft part which is attributed to Foreign Object Debris. FOD at airports can cause damage that costs airlines, airports, and airport tenants millions of pesos every year. FOD is any object that does not belong in or near airplanes and, as a result, can injure airport or airline personnel and damage airplanes. FOD includes a wide range of material, including loose hardware, pavement fragments, catering supplies, building materials, rocks, sand, pieces of luggage, and even wildlife. FOD is found at terminal gates, cargo aprons, taxiways, runways, and run-up pads.

The acronym FOD is now used to describe both the foreign objects themselves, and any foreign object damage attributed to them. A FOD-prevention program of training, facility inspection, maintenance, and coordination between all affected parties can minimize FOD and its effects.

FOD (Foreign Object Debris/Damage) awareness and training is one of the most significant prerequisites upon entry in the aviation industry. Several incident relating to FOD are attributed to the lack of discipline and housekeeping standards resulting in catastrophic loss of lives and costly damages of aircraft components. One of these incidents occurred on July 25, 2000 where Air France Flight 4590 caught fire after having one of its fuel tanks ruptured by a debris, a strip of metal, left from another aircraft. This resulted in the death of all passengers and crew members on board with a total count of 113. Accidents such as these may be prevented by the strict implementation of an effective FOD Detection and Control Program.

For this study, the researchers aim to evaluate the detection practices done by aircraft mechanics based in Clark International Airport.

II. Review of Related Literature

Effect of Foreign Object Debris/Damage on Safety and Training

An effective FOD detection system allows organizations to improve their safety parameters and reduce hazards which may cause incidents and accidents. This is further supported by a study regarding pre-flight inspection, which emphasizes the crucial role of pre-flight inspections in preventing hazards. The meticulous 360-checks serve as the last safeguard in ensuring a smooth and safe flight. The awareness of potential hazards during these inspections contributes significantly to airworthiness and passenger safety [2].

In a study conducted for an Aviation Training Organization (ATO), the researchers highlighted the significance of safety training for aspring aircraft maintenance personnel in promoting compliance with preventive measures. The integration of preventive measures into audits and safety improvement efforts ensures a comprehensive approach to hazard mitigation and FOD prevention [3]. Safety training draw attention to the impact of employees on hazard reduction and FOD prevention. Managers play a crucial role in influencing employee compliance with preventive measures, and documented policies, processes, and checklists further contribute to the systematic assessment and mitigation of hazards and FOD [4].

The impact of FOD not only affects the safety aspect, but also affects the economy of an organization. Foreign object damage encompasses not only the direct costs associated with equipment repair but also the broader financial consequences arising from disruptions to flight schedules, customer dissatisfaction, potential legal liabilities, and increased workload for airline personnel. Understanding and mitigating these economic repercussions are integral to maintaining the financial stability and operational efficiency of the aviation industry [5].

Foreign Object Debris/Damage Detection

Traditionally, the detection of foreign objects debris on airport has always been performed visually by every personnel present in the area, but this method has limitations such as inattention and environmental factors. On of the most commonly done FOD detection done is thru doing “FOD Walks”, which at a set time, maintenance and other personnel are required to walk around and check for FODs in their area. The shortcomings of this method extend to individual differences in physiological responses and variations in visual field accuracy which leads to inconsistencies in object recognition. Additionally, environmental

factors, such as adverse weather conditions and specific circumstances can further limit the accurate judgment of a person using only their naked eyes. As a response, the imperative for effective foreign object debris (FOD) detection systems has gained prominence, driven by the rapid advancements in computer technology, communication technology, and image processing technology [6].

The development and implementation of FOD detectors and programs for airport runways should have systems based on various principles which contributes to the increase in airport safety [5]. FOD prevention programs must be initiated from the highest organizational levels. The comprehensive nature of these programs, starting from the top and garnering continuous support, underscores the efficacy in promoting safety within the aviation industry. By targeting personal belongings, maintenance operations, and infrastructure vulnerabilities, these prevention programs contribute significantly to the overarching goal of unlimited safety [7].

FODs are typically found in 2 main areas, the runway and on the taxiway or apron. All personnel involved in the operations on an aerodrome have a responsibility to remove or report any sightings of foreign object debris [8]. A study conducted in 2013 identifies three primary causes—airport infrastructure, aircraft operations, and personal belongings—which further underscores the multifaceted nature of FOD sources. Deterioration, maintenance, and construction activities contribute significantly, with small debris easily transported to airplane maneuver areas, posing potential threats. Refueling, catering, and maintenance operations further exacerbate FOD risks, emphasizing the need for targeted prevention strategies [9].

The company, Boeing, has suggested implementing certain techniques in which FOD prevention can play a crucial role in maintaining airport safety, including:

- **Sweeping**

It is done either manually or with the aid of airfield sweepers. Routine sweeping is recommended for all areas, including aircraft maneuvering areas, aprons, gates, and their adjacent spaces.

- **Magnetic Bars:**

Employing magnetic bars suspended beneath tugs and trucks presents an innovative approach to picking up metallic material, a common type of FOD.

- **Rumble Strips**

The utilization of rumble strips serves as a proactive measure to dislodge FOD from vehicle undercarriages.

- **FOD Containers and Waist Pouches**

The placement of FOD containers at all gates facilitates the systematic collection of debris. Regular emptying of these containers is imperative to prevent overflow, which could inadvertently become a source of FOD itself. Airport personnel can also wear waist pouches for collecting debris, offering a mobile and efficient means of control [5].

III. METHODOLOGY

The researchers used a quantitative approach to evaluate the foreign object debris and damage detection practices done by aircraft mechanics working around Clark International Airport. The researcher utilized deductive reasoning in which the researcher defined the study's purpose, collected data through electronic form and questionnaires and the findings when statistical treatments were applied.

The researchers used a sample size calculator with 95% confidence level, 5% margin of error, 50% population proportion, and population size of 200 aircraft maintenance personnel. The sample size should be 132 respondents. .A stratified random sampling technique will be applied, considering factors such as job roles and years of experience to ensure representation across various demographics within the population. The information was collected between the October and December 2023.

The survey questionnaire will be developed based on a thorough review of existing literature on FOD detection practices and relevant factors influencing aircraft safety. The questionnaire will be designed to capture information on:

- Awareness and understanding of FOD detection practices.
- Utilization of available tools and technologies for FOD detection.
- Frequency and effectiveness of training programs related to FOD.
- Perceived barriers and challenges in FOD detection.

The researcher used a 4-point Likert scale that intends to evaluate the foreign object debris/damage detection practices done by different aircraft mechanics. Prior to survey distribution, ethical considerations will be addressed. Participants will be informed about the purpose of the study, the voluntary nature of their participation, and the confidentiality of their responses. Informed consent will be obtained from each participant.

Likert Scale	Interval	Description
1	1.00-1.75	Strongly Disagree
2	1.76-2.50	Disagree
3	2.51-3.25	Agree
4	3.26-4.00	Strongly Agree

Table 1.1 Interpretation of the Four-point Likert Scale

IV. RESULTS AND DISCUSSION

The data employed in the following analysis was obtained from two hundred (200) aircraft mechanics working in the various organizations around Clark International Airport.

4.1 Demographic Profile of the Respondents

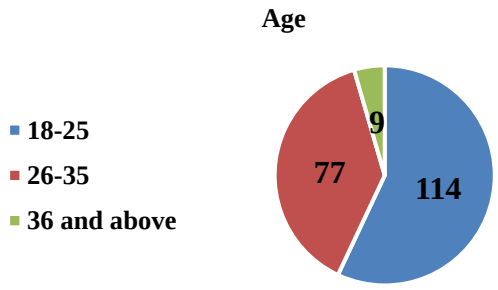

Fig 1.1 Age of the Respondents

Fig 1.1 shows the age of the respondents. On the data collected, 114 respondents, or 57% were between the ages of 18 years old to 25 years old, 77 respondents, or 38.5% of the respondents were between the

ages of 26 years old to 35 years old, and 9 respondents, or 4.5% of the respondents were at 36 years old and above.

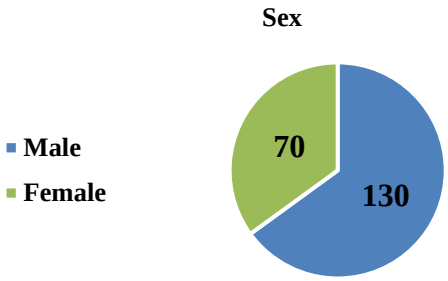

Fig 1.2 Sex of the Respondents

Fig 1.2 shows that there are 130 male respondents or 65% while the remaining 35%, or 70 female respondents.

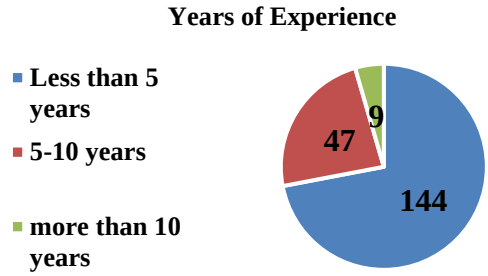

Fig 1.3 Years of Experience

Based on the data shown on Fig 1.3, 144 respondents have less than 5 years experience, 47 of the respondents have an experience of 5-10 years, while the remaining 9 have more than 10 years of experience on the field. Based on the data, majority of the respondents are new to working in the field. As seen on Fig 1.4, 125 of the mechanics are working as Base Mechanic and 75 are working as Line Mechanics.

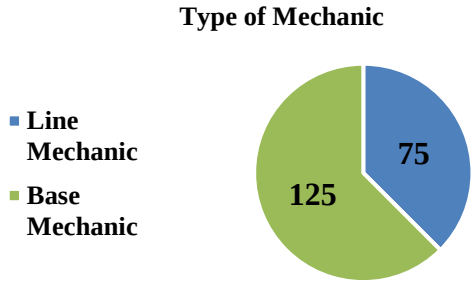

Fig 1.4 Type of Mechanic

4.2 FOD Detection Practices

	Mean	Interpretation
4.2.1 Awareness and Understanding of FOD Detection Practices	**3.524**	**Strongly Agree**
1. FOD Training Emphasis	3.495	Strongly Agree

2.	Critical Safety Aspect	3.555	Strongly Agree
3.	Cost Awareness FOD	3.435	Strongly Agree
4.	New Personnel Training	3.515	Strongly Agree
5.	Accessible Prevention Programs	3.495	Strongly Agree
6.	Daily Responsibility Feeling	3.490	Strongly Agree
7.	Open FOD Communication	3.520	Strongly Agree
8.	Positive Safety Influence	3.685	Strongly Agree

Table 2.1 Awareness and Understanding of FOD Detection Practices

Based on Table 2.1, the overall mean for Awareness and Understanding of FOD Detection Practices achieved a 3.524. This data suggests that a relatively high level of awareness and understanding among respondents regarding FOD detection practices in their organization. This can be interpreted as "Strongly Agree" result. The following shows the specific results for each item:

1. FOD Training Emphasis with a mean of 3.495 suggests that respondents perceive a strong emphasis on FOD training.
2. Critical Safety Aspect with a mean of 3.555 suggests that respondents consider FOD detection as a critical safety aspect.
3. Cost Awareness FOD has a mean of 3.435) which indicates a positive perception regarding cost awareness in the context of FOD.
4. New Personnel Training having a mean of 3.515 shows that respondents find the training provided by their organizations to new personnel in FOD detection to be positive, indicating a commitment to ensuring that new staff is well-prepared.
5. Accessible Prevention Programs with mean value of 3.495 suggests the different organizations the mechanics are associated with implement prevention programs related to FOD as accessible.
6. Daily Responsibility Feeling with a mean of 3.490 suggests that respondents feel a sense of responsibility for FOD detection as part of their daily routine.
7. Open FOD Communication the data shows that this item has a mean of 3.520, suggesting a positive perception of open communication regarding FOD-related concerns among the maintenance team, indicating a healthy communication culture.
8. Positive Safety Influence with a mean of 3.685. This mean is the highest among the items, indicating a strong belief that a focus on FOD detection positively influences the overall safety culture. It suggests a high level of confidence in the impact of such practices on safety.
9.

	Mean	Interpretation
4.2.2 Utilization of Available Tools and Technologies for FOD Detection	**3.248**	Agree
1. Familiar with FOD Tools	3.450	Strongly Agree
2. User-Friendly Detection Tools	3.295	Strongly Agree
3. Access to Detection Resources	3.245	Agree
4. Adequate FOD Equipment	3.280	Strongly Agree
5. Investing in Detection Technologies	2.970	Strongly Agree

Table 2.2 Utilization of Available Tools and Technologies for FOD Detection

The data on Table 2.2 shows the data for questions relating to the Utilization of Available Tools and Technologies for FOD Detection. Overall, the mean received a 3.248. Based on Table 1.1, this can be interpreted as a "Agree" result. This reveals that this aspect can still be improved. The following shows the specific results for each item:

1. Familiar with FOD Tools with a mean of 3.450 suggests that respondents feel familiar with the tools used for FOD detection.
2. User-Friendly Detection Tools having a mean value of 3.295 shows that respondents perceive the detection tools to be user-friendly.
3. Access to Detection Resources with a mean of 3.245 indicates that respondents feel they have adequate access to resources for FOD detection.
4. Adequate FOD Equipment showing a mean of 3.280 suggests that respondents believe there is adequate equipment for FOD detection in their respective organiztions.
5. Investing in Detection Technologies having a mean value of 2.970 is notably lower than the other items, suggesting a lower level of satisfaction or perception regarding the organization's investment in detection technologies. This may indicate a potential area for improvement.

	Mean	Interpretation
4.2.3 Frequency and Effectiveness of Training Programs Related to FOD	**3.449**	Strongly Agree
1. Regular FOD Updates	3.460	Strongly Agree
2. Sufficient Training Frequency	3.465	Strongly Agree
3. Reinforcing Skills Refresher	3.440	Strongly Agree
4. Practical Training Sessions	3.420	Strongly Agree
5. Audits for Detection Effectiveness	3.460	Strongly Agree

Table 2.3 Frequency and Effectiveness of Training Programs Related to FOD

Using the data on Table 2.3, the researcers found that the overall mean for the Frequency and Efficiency of Training Programs Related to FOD to be at a value of 3.449, which is interpreted as a "Strongly Agree" result. It indicates a positive outlook on the FOD-related training progams provided the various organization to their employees. The following shows the specific results for each item:

1. Regular FOD Updates with mean of 3.460 indicates a positive perception of regular updates related to FOD. It suggests that respondents feel adequately informed and up-to-date on relevant information.
2. Sufficient Training Frequency shows a mean of 3.465, this mean that respondents find the frequency of FOD detection training to be sufficient. This is a positive indicator, indicating a sense of adequacy in the training schedule.
3. Reinforcing Skills Refresher with a mean value of 3.440 suggests that respondents find refresher courses effective in reinforcing FOD detection skills.
4. Practical Training Sessions data shows a mean: 3.420, this resuls shows that respondents find practical training sessions to be effective.
5. Audits for Detection Effectiveness having a mean of 3.460 indicates a positive perception regarding audits for detection effectiveness. Respondents may feel that these audits contribute to the overall effectiveness of FOD detection practices.

	Mean	Interpretation
2.4 Perceived Barriers and Challenges in FOD Detections	**3.422**	Strongly Agree
1. Efficient FOD Procedures	3.455	Strongly Agree
2. Clear Reporting Protocols	3.420	Strongly Agree
3. Awareness of FOD Incidents	3.435	Strongly Agree
4. Management Seeks Feedback	3.405	Strongly Agree
5. Incentives for Performance	3.420	Strongly Agree
6. Colleague Commitment	3.385	Strongly Agree
7. Constructive Feedback Received	3.420	Strongly Agree
8. Regular Equipment Inspections	3.435	Strongly Agree

Table 2.4 Perceived Barriers and Challenges in FOD Detections

The results form the questions regarding the Perceived Barriers and Challenges in FOD Detections, shown in Table 2.4, shows the overall mean value is at 3.422 and interpreted as a "Strongly Agree" result. This result indicates that the aircraft mechanics based in Clark International Airport perceive that their organization's FOD Detection practices face minimal barriers and challenges. The following shows the specific results for each item:

1. Efficient FOD Procedures having a mean of 3.455 indicates that respondents perceive the FOD procedures to be efficient. This is a positive indicator, suggesting that the processes in place are considered effective.
2. Clear Reporting Protocols showing a mean of 3.420 uggests that respondents find reporting protocols for FOD incidents to be clear. .
3. Awareness of FOD Incidents with a mean of 3.435 suggests that respondents are aware of FOD-related incidents.
4. Management Seeks Feedback with a mean: 3.405 indicates that respondents feel that management actively seeks feedback. While slightly lower than some other items, it still suggests a positive sentiment.
5. Incentives for Performance have a mean of 3.420 suggests that respondents perceive incentives for performance in FOD detection are adequate which increases the safety parameters regarding FOD.
6. Colleague Commitment with a mean of 3.385 shows that respondents perceive a commitment among colleagues to FOD detection practices to be helpful and reduces the chance of FOD.
7. Constructive Feedback Received with a mean of 3.420 indicates that respondents receive constructive feedback on their FOD detection efforts.
8. Regular Equipment Inspections with a mean of 3.435 reveals that respondents perceive regular equipment inspections to be part of the FOD detection practices.
9.

V. CONCLUSION

Foreign Object Debris and Foreign Object Damage is one of the biggest safety risks in the aviation industry. Something as small as a nail can potentially lead to a fatal accident which can cause a huge loss of life. .

The results from the data shows information on:

1. The data shows a positive perceptions and attitudes toward various aspects of FOD detection practices and safety culture within the organization.
2. It also shows that tools and technologies used for FOD detection are adequate but also shows that it still has room for improvement or increased investment in this particular aspect of FOD detection.
3. The overall sentiment for frequency and effectiveness of training programs related to FOD practices is positive.
4. The barriers and challenges faced in FOD detection is minimal.

According to different literature and data collected and analyzed, the researhcers conclude that the FOD detection practices of aircraft mechanics based in Clark International Airport is effective and efficient. The different organizations the mechanics are associated with is perceived to place a significant amount of importance in their FOD detection practices and programs.

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