

The Role of Apron Movement Control (AMC) In Handling Foreign Object Debris (FOD) To Maintain Flight Safety at Adisutjipto Airport Yogyakarta

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Abstract: Foreign Object Debris (FOD) is one of the factors that can interfere with the smooth operation of aircraft activities in the apron area and pose a safety risk. Apron Movement Control (AMC) is a party that plays a direct role in monitoring the condition of the apron, ensuring that vehicle movements run according to the rules, and detecting the presence of foreign objects that have the potential to endanger flight operations. This study aims to describe how AMC supervises and handles FOD at Adisutjipto Airport, Yogyakarta, as well as identify problems that arise in its implementation. The research method uses a qualitative descriptive approach through observation, interviews, and collection of documents related to apron operations. The results of the study are expected to show that the role of AMC is very important in keeping the apron area safe, but its implementation is still influenced by the availability of personnel, field equipment, and coordination between units. These findings are expected to be used as a basis for improving procedures and improving operational support to strengthen flight safety in the airport environment. [1]

Keywords: Apron Movement Control, Foreign Object Debris, Aviation Safety, Airport Operations

1. Introduction

Flight safety is a very crucial aspect in airport operations. Every activity at the airport that is outside the terminal building and is the main operational area of the aircraft, including runways, taxiways, and aprons must be carried out with high safety standards to prevent accidents and incidents that can threaten the safety of aircraft, passengers, and personnel in the field. One of the threats that is often faced in the aircraft operating area is the existence of *Foreign Object Debris* (FOD), which is a foreign object that should not be in the aircraft movement area such as *runway, taxiway, or apron*. FOD can come from metal chips, small stones, plastic, work equipment left behind, to garbage carried by the wind. The presence of FOD has the potential to cause damage to aircraft components, such as engines or tires, which can lead to serious accidents. [2]

FOD can come from a variety of sources, ranging from material fragments, small equipment that is accidentally left behind, light debris carried by the wind, to the rest of aircraft maintenance activities. Even seemingly small objects can have a major impact if they enter the engine or hit vital components of the aircraft. Various international reports show that FOD is one of the factors that has the potential to cause aircraft damage, operational delays, and accidents. In the context of airport operations, Apron Movement Control (AMC) is a unit that plays a direct role in maintaining the orderliness of the movement of aircraft, vehicles, and personnel in the apron area.

In addition to regulating movements, AMC is also tasked with monitoring the field situation and ensuring that the apron is safe, including free from the presence of FOD. In other words, AMC is the first party responsible for detecting, reporting, and coordinating the handling of FOD before it poses a risk to aviation safety. [3]

Adisutjipto Airport Yogyakarta is an airport with mixed activities between civil and military aviation, so the operational dynamics are quite complex. The high intensity of movement makes the need for FOD supervision even more important. Imoptimal control can have a direct effect on the level of safety and smooth flight operations. Therefore, this study was conducted to find out what the role of AMC in handling FOD at Adisutjipto Airport Yogyakarta, what are the procedures implemented, obstacles faced, and the extent to which these efforts contribute to flight safety. This understanding is expected to be able to provide a more complete picture of the effectiveness of apron supervision and the need to improve the quality of FOD management in the airport environment. [4]

2. Literature Review

2.1 Foreign Object Debris (FOD)

Foreign Object Debris (FOD) is defined as an object (dead/organic) that is in an inappropriate location in the airport

area and has the potential to cause aircraft damage or injury to personnel. This definition is widely used in international guidance and FOD management technical documents. [3]

Foreign Object Debris(FOD) is a general term used in the aviation world to describe Foreign Objects which are in improper locations in airport areas, especially in operating areas such as runway, Taxiway, and apron. This can be a material dead or organic, such as *pieces of metal, bolts, plastic, small stones, pieces of tire rubber, cloth, to birds or human waste and spills of aircraft fuel or oil from aircraft or vehicles on the airside*. All of these things have potential disrupting flight operations, causing damage to the aircraft, even endangering the safety of personnel and passengers. [5]

2.2 Impact of FOD

FOD can cause engine failure, system failure, unexpected accidents, and high repair costs. FOD also has an impact on Safety and productivity of field personnel. Foreign objects in the apron area can cause Work Injuries, equipment breakdown Ground Support Equipment (GSE), as well as disruption to activities Ground handling. [6]

2.3 Role of Apron Movement Control (AMC)

AMC plays the role of Vanguard (*First line of defense*) in preventing incidents on the apron due to foreign objects. The supervision activities carried out include Routine Patrols to detect the presence of FOD, both before and after flight activities. AMC is also in charge of carrying out *Coordination with Ground Handling, Security, and Maintenance Unit* to ensure that any FOD findings are promptly addressed in accordance with the *Standard Operating Procedure*(SOP) Apron security that occurs at airports. [7]

2.4 Detection Methods and Technologies

Traditional approaches include manual/patrol inspections, use of mechanical cleaning tools (FOD sweepers), *checklist, and personnel training*. Recent research has introduced detection technologies (e.g., cameras, aerial imagery with sUAS/drone plus AI/ML algorithms) that can improve the scope of FOD inspection and early detection but the application of the technology requires evaluation of resource availability, system accuracy, and regulatory compliance. [6]

2.5 Operational Constraints

There is a problem limited number and competence of personnel, obstacles arise from limited operational facilities and infrastructure, There is a question Coordination and communication between stakeholders *diapron areas, such as between AMC, ground handling, apron operators, airlines, and airport authorities, Standard Operating Procedures* (SOP) which is used sometimes Not updated Following changes in operational conditions, technological developments, and the

latest aviation safety regulations. [7]

3. Research Methods

3.1 Research Design

This study uses a qualitative descriptive method

3.2 Research Locations

Location: Adisutjipto Airport Yogyakarta

Subject/Informant: *Apron Movement Control (AMC) officers, Apron Safety, Ground Handling, and Safety & Security personnel* who are directly involved in the supervision and handling of FOD.

3.3 Data Sources

Primary Data: Obtained directly through in-depth interviews, observation of activities on the apron, and documentation of FOD reports.

Secondary Data: Derived from literature, AMC SOPs, airport safety manuals, and relevant previous research.

3.4 Data collection techniques

Direct observation in the apron area to see the implementation of patrols, FOD inspections, communication flows when FOD findings are found, vehicle/personnel compliance with SOPs, and the condition of supporting facilities such as garbage cans, marking lines, and apron cleanliness. [8]

Semi-structured interviews with AMC officers, Ground Handling, Safety staff, and apron supervisors to dig up information about operational procedures, field constraints, coordination levels, frequency of FOD findings, and the effectiveness of the handling measures that have been implemented. [8]

Documentation in the form of FOD findings reports, routine inspection logbooks, photos or videos of FOD findings, SOPs for handling FOD, incident minutes, and other safety documents that support the analysis. [8]

Field notes which contains details of the incident, time, situation, officer behavior, visible obstacles, and the officer's response when FOD is found. [8]

Data triangulation, which is comparing the results of observations, interviews, and documents to improve validity and ensure data is consistent and trustworthy. [9]

3.5 Validity of Reliability Data

To ensure the validity of the data, Triangulation of sources and methods, which is to compare the results of observations with interviews and supporting documents so that the data is more accurate and reliable. (To ensure the validity of the data, used Triangulation of sources and methods. Source triangulation This was done by comparing information from

various sources, such as AMC officers, ground handling, and SOP documents, and then seeing if the information was consistent. Triangulation method done by comparing the results Observation, Interview, and Documentation. The three pieces of data are matched with each other to ensure that the information obtained is accurate, mutually supportive, and trustworthy. [9]

In addition, the researcher also carried out Data Validity Check (Member Check) by confirming the results of the interview to the informant to ensure that the researcher's interpretation is in accordance with the respondent's real experience and views.

To keep *Reliability*, the researcher implemented systematic and well-documented research procedures, including the use of consistent interview guidelines, detailed field recordings, and transparent data storage so that it can be traced back by other parties. (To maintain reliability, the researcher uses the same interview guidelines for all informants, makes detailed and regular field notes, and stores all data (recordings, transcripts, documents) with a clear storage system so that it is easy to trace back. The data is also double-checked between notes, recordings, and documents to ensure consistent results. [9]

3.6 Data Analysis Techniques

Data reduction - selecting and compiling data from interviews and observations according to the focus of the research. Irrelevant data is eliminated, while important data is coded for easy analysis.

Data presentation - compiling results in the form of narrative descriptions, tables, or charts so that the relationships between findings can be clearly seen and make it easier for researchers to understand emerging patterns.

Conclusion drawn/verification - analyze the meaning of the data, find patterns or relationships, and then draw interim conclusions that are continuously verified with additional data until it becomes a final conclusion about the role, constraints, and effectiveness of AMC in addressing FOD. [10]

3.7 Calculation Table

Table AMC INTERVIEW ANSWER TABLE OF ADISUTJIPTO AIRPORT YOGYAKARTA

NO.	INTERVIEW ANSWERS	AMC RELEVANT	AMC IS IRRELEVANT
1	The role of AMC in safety supervision before the activity, during the activity, and after the activity is completed	√	—

NO.	INTERVIEW ANSWERS	AMC RELEVANT	AMC IS IRRELEVANT
2	The level of awareness of the FOD hazards is relatively high and the explanation that FOD has the potential to damage aircraft engines and components during take-off and landing	√	—
3	Safety briefings are carried out routinely every day, involving AMC, airlines, and ground handling	√	—
4	Intense coordination and communication with other units as safety is a shared responsibility	√	—
5	Daily check, apron check, random check, pre-flight and after-flight inspection and Detailed explanation of the apron inspection route (east-west end, GSE storage, makeup area)	√	—
6	There are several examples of FOD types such as stone, gravel, bolt, dust	√	—
7	Explanation of GH and airline procedures when finding minor and major FOD, AMC's immediate response to the location when receiving the FOD report	√	—
8	Affirmation that FOD handling is preventive before the incident occurs	√	—
9	Explanation that significant obstacles in FOD management have not existed so far	√	—

NO.	INTERVIEW ANSWERS	AMC RELEVANT	AMC IS IRRELEVANT
10	Statement that a clean airside environment improves operational efficiency	√	—
11	Handling FOD as a preventive measure before an incident	√	—
12	Statement that a clean airside environment improves operational efficiency	√	—
13	Efforts to improve through safety reminders, regulatory updates, and increased awareness	√	—
14	Suggestions and recommendations are continued to be implemented, ramp check/apron check with cross-unit and SOP review	√	—
15	The statement that the constraints of FOD handling so far are not very significant	√	—
16	AMC response that goes directly to the location when there is a report of minor and major FOD findings	√	—

Table of Analysis of the Relationship Between AMC and FOD

NO	CATEGORIES	FPS MINOR	FPS MAJOR	QUANTITY
1	AMC RELEVANT	4	3	7
2	AMC IS IRRELEVANT	0	0	0
	QUANTITY	4	3	7

B. Calculate Expected Frequency (Fe)

$Fe = (\text{Number of Rows} \times \text{Number of Columns}) / \text{Total}$

AMC Relevance

$Fe \text{ Minor} = (7 \times 4) / 7 = 4$

$Major \text{ Faith} = (7 \times 3) / 7 = 3$

AMC Irrelevant

$Fe \text{ Minor} = (0 \times 4) / 7 = 0$

$Major \text{ Faith} = (0 \times 3) / 7 = 0$

C. Calculate Chi-Square Value

Formula: $\chi^2 = \sum (Fo - Fe)^2 / Fe$

Table.

Categories	Minor	Major	Quantity			
	Heart	Faith	Heart	Faith	Heart	Faith
AMC Relevance	4	4	3	3	7	7
AMC Irrelevant	0	0	0	0	Uncountable	Uncountable
Hmmmlah	4	4	3	3	7	7

d. Conceptually Value χ^2

Because:

$Fo = Fe$ on all valid cells

No cells with data variations

So theoretically:

$\chi^2 = 0$

E. Degree of Freedom (df)

Significance level (α) = 0.05

$Df = (\text{Line} - 1)(\text{column} - 1)$

$= (2 - 1)(2 - 1) = 1$

$\chi^2 \text{ Table values } (\alpha = 0.05; df = 1) = 3.84$

F. Test Satisfaction

$X_{hitung} = 0$

$X_{tabel} = 3.84$

Because:

$0 < 3.84$

So:

H_0 accepted

Based on the calculation results, the value of Chi-Square (χ^2) is obtained as 0 with a degree of freedom (df) of 1. This value is smaller than the χ^2 value of the table at a significance level of 5%, which is 3.84. Thus, there is no significant relationship between the FOD (minor and major) categories and the relevance of the role of AMC. However, these results do not indicate that AMC does not play a role, but because all FOD findings, both minor and major, are in the relevant AMC category (100%). There is no variation in the data in the AMC category is irrelevant, so statistically no distribution differences are formed. Substantively, these results actually show that the role of AMC in handling FOD in the apron area is comprehensive and consistent with all FOD categories.

4. Expected Findings

It is hoped that this study shows that Apron Movement Control (AMC) has a consistent role in supervising, detecting, and handling Foreign Object Debris (FOD) in the apron area of Adisutjipto Airport Yogyakarta.

It was found that routine patrol activities such as daily checks, random checks, pre-flight inspections, and after-flight inspections have been carried out in accordance with the applicable standard operating procedures (SOP).

There is good coordination between AMC, ground handling, airlines, and safety & security units in handling FOD findings in both minor and major categories.

Field officers have a high level of awareness of FOD hazards, which is reflected in the implementation of routine safety briefings and quick response to findings reports.

The condition of the apron is relatively clean and controlled so that the risk of operational disruption due to FOD can be minimized.

The Role of AMC Preventive and Consistent
Supervision System Runs According to SOP
Effective Interunit Coordination
High safety awareness
Relatively Safe and Controlled Airside Environment
Need for Continuous Improvement

Although no significant obstacles were found, continuous improvement is still needed through SOP updates, training, and regular evaluations to maintain safety standards.

5. Conclusion

Based on the results of research on the role of Apron Movement Control (AMC) in handling Foreign Object Debris (FOD) at Adisutjipto Airport Yogyakarta, it can be concluded that AMC has a very strategic role in maintaining operational safety in the apron area. The implementation of supervision is carried out through routine patrols, daily checks, pre- and post-flight inspections, and random checks aimed at detecting the presence of FOD early. [11]

The results of interviews, observations, and data analysis showed that all FOD findings, both minor and major categories, were in the relevant category of AMC's role. Statistically, the results of the Chi-Square test showed a χ^2 value of 0 with a degree of freedom (df) = 1, which was smaller than the χ^2 value of table 3.84 at a significance level of 5%. This shows that there is no difference in distribution between the minor and major FOD categories to the relevance of the role of AMC. However, substantively, this condition actually indicates that the role of AMC is consistent, comprehensive, and preventive for all FOD categories.

Good coordination between AMC, ground handling, airlines, and safety and security units also strengthens the effectiveness

of FOD handling. In addition, the level of awareness of personnel to the dangers of FOD is relatively high, which is reflected in the implementation of routine safety briefings and quick response to findings reports. Thus, it can be affirmed that AMC functions as the front line in FOD control in the apron area and contributes directly to the creation of a safe, orderly, and efficient airside environment. To maintain and improve safety standards, it is necessary to periodically evaluate SOPs, increase awareness, and strengthen coordination across units to support a sustainable aviation safety management system. [12]

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