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The Influence of Effectiveness and Reliability on Equipment Operational Feasibility through Aerodrome Lighting Equipment Maintenance Program

Semuel Pongbala[1]; Prasadja Ricardianto[2]; Erna Widodo[3]

[1,3]Magister of Management Study Program, Trisakti Institute of Transportation and Logistics, Jakarta, Indonesia
[2]Faculty of Transportation and Logistics Engineering, Trisakti Institute of Transportation and Logistics, Jakarta, Indonesia

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Abstract: This research aims to analyze the influence of Equipment Effectiveness and Equipment Reliability on the Operational Feasibility of Equipment, both directly and indirectly through the Maintenance Program of Aerodrome Lighting Equipment in the Airport Equipment Department in Electrical Section at Juanda International Airport, Surabaya, Indonesia. This research used a quantitative approach with the method of Structural Equation Modeling-Partial Least Squares through evaluating outer model, inner model, bootstrapping, and mediation test. The population which was at the same time as the research sample consisted of 66 personel of Airport Equipment specified through saturated sampling. Data was collected using the statement instrument of five-level Likert scale consisting of 28 indicators. The research result showed that Equipment Effectiveness and Equipment Reliability positively and significantly influenced the Equipment Maintenance Program and the Operational Feasibility of Equipment. The Equipment Maintenance Program positively and significantly influenced the Operational Feasibility of Equipment and partially mediated the complementary influence of Equipment Effectiveness and Equipment Reliability on the Operational Feasibility of Equipment. The model explained 59.1% of Equipment Maintenance Program variable and 83.6% of Operational Feasibility of Equipment variable. The result of this research implied the need for making maintenance program as the main mechanism of feasibility control through reliability-and-effectiveness-based maintenance, increasing the preparedness of diagnostic tools, spare parts, the competency of technicians, as well as the linkedness between inspections, maintenance action, examination, and the verification of operational feasibility status.

Keywords: *Equipment Effectiveness; Equipment Reliability; Maintenance Program; Operational Feasibility; Aerodrome Lighting.*

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I. INTRODUCTION

One of the important facilities in the airport operation is airside facility. Airside facility includes runway, taxiway, apron, markings, signs, electricity system, and lighting system used for supporting the activities of aircraft landing, take-off, taxiing, movement. In general, airport management must include airside facility arrangement, landside facility arrangement, operational services, security, safety, and flight-supporting facility management [1]. In this context, aerodrome lighting has a strategic function because it provides the pilots and operational personnel with a visual guide to identify direction, position, border, path, and area of aircraft movement. [2] explains that the visual aids of aerodrome are an important part for supporting the safety and orderliness of flight operation. Thus, aerodrome lighting cannot only be regarded as a lighting system, but as the safety facility of airport operation which must be managed in an effective, reliable, and operationally feasible manner.

To assess the performance of aerodrome lighting, the aspects to be paid attention are not limited on the lamp condition wether on or off. ICAO Doc 9157 Part 4 – Visual Aids explains that the characteristics of airport lighting system are formed by four main elements known as four Cs, namely configuration, colour, candela, and coverage.

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Configuration is related to the arrangement, position, and distance of lamps; Colour is related to the meaning of visual information provided for the pilots; Candelas are related to the luminous intensity that determine the lamp visibility; while Coverage is related to the coverage of gleam so that the visual guide can be adequately accepted. Those four elements serve to provide the pilot with a three-dimensional visual orientation in the aircraft activities of approaching, landing, take-off, taxiing, and movement on the airside [3].

The operational reality in performing the job of aerodrome lighting equipment maintenance at Juanda International Airport shows a quite substantial gap with the ideal condition. The high intensity of aircraft traffic (>250 movements/day on average, with the daily peak reaches >30 movements/day in certain periods) drastically narrow the available window time to conduct inspection and maintenance. On the other hand, the efficiency policy of operational budget and the limited logistic supply chain have made the spare part availability become critical, diagnostic test tools and the number of certified competent technicians are not always sufficient according to the work load.

The high intensity of aircraft movement narrows the time of inspection and maintenance, whereas limited spare parts, diagnostic test equipment, measuring instruments, and certified technicians can obstruct the maintenance execution. Consequently, maintenance has the potential to shift to a more reactive corrective pattern, so that it is difficult to maintain the efectiveness and reliability of equipment consistently. It is the gap between standard requirements and actual condition that becomes fundamental basis to study the influence of equipment effectiveness and equipment reliability on the operational feasibility of equipment through the maintenance program of aerodrome lighting equipment at Juanda International Airport. The high intensity of flight operation at Juanda International Airport requires the aerodrome lighting equipment to be always in the condition of being effective, reliable, and operationally feasible. The effectiveness of aerodrome lighting equipment cannot be fully maintained if the functions of lighting, colour, intensity, configuration, position, and visual support for the equipment are not always in an optimal condition. Such a condition can make the equipment less maximal in supporting the landing, take-off, taxiing, and aircraft movement on the airside, thus affecting the operational feasibility of equipment.

Equipment effectiveness indicates the ability of equipment to run the lighting function in accordance with its intended purpose, support the smoothness of airside operation, and can be utilized optimally in the flight activity. The effectiveness of aerodrome lighting equipment can decrease if there are still malfunction, lights out, decrease in intensity, instability of electricity system, circuit fault, or a fault in the supporting components such as control panel and constant current regulator. The maintenance program of aerodrome lighting equipment cannot run optimally if the execution of preventive maintenance, periodic inspection, examination result recording, follow-up on disruptions, and evaluation of equipment condition are not yet carried out in a regular, documented, and sustainable manner.

Limited maintenance resources such as measuring instruments, diagnostic test tools, main spare parts, backup lamps, electric components, work equipment, and appropriate competent technicians, can hinder the execution of equipment maintenance program. The recording of disruption data, inspection results, examination results, and aerodrome lighting equipment maintenance activities need to be optimized as the basis of maintenance decision making. The operational feasibility of aerodrome lighting equipment becomes the main problem that needs to be studied since the operational feasibility condition is not only determined by the equipment ability to light up or to be used, but also by the effectiveness of lighting function, reliable operation, the regularity of maintenance program, resources preparedness, hazard control, and the sufficient evidences of inspection and examination.

In his study, [4] explains that equipment effectiveness is related to the equipment ability to be available, to work at the expected performance, and to bring about outputs in accordance with standard operation. [5] explains that reliability, availability, and maintainability are important aspects in maintaining the system performance and in supporting the optimization of maintenance policy. Reliable equipment will be better able to support flight operations on a sustained basis because the equipment function is predictable and the risk of failure can be reduced. Aerodrome Lighting Damage Report 2024 from AirNav shows the disruption in the lighting airside facilities that needs technical handling so that it does not hinder the operation readiness. The result of operational supervision of Visual Approach Slope Indicator or Precision Approach Path Indicator in Box A R10 also shows the disruption in visual aid facility that serves to provide the pilot with a landing angle guide. Those findings indicate that the problem of aerodrome lighting is not only related to the damage of equipment, but also related to maintenance system, resource preparedness, and the organization’s ability to maintain the reliability of facilities sustainably.

Equipment maintenance program becomes important because maintenance is a technical and administrative process to keep or return the equipment to the expected operational condition [6]. In term of critical facility like aerodrome lighting, it is necessary that maintenance program is conducted in a regular, procedural, and documented manner, and it is supported by measuring instruments, testing tools, spare parts, and competent technicians. [7] explains that maintenance function has developed from reactive approach to proactive approach, so that maintenance is not only carried out after damage, but it is aimed to prevent any disruption and keep the preparedness of equipment.

Theoretically, airport management should include the airside facility arrangement, landside facility arrangement, operational services, security, safety, and flight-supporting facility management [1]. Physical asset management does not only focus on asset ownership, but also on how the assets are planned, operated, maintained, evaluated, renewed, and how their utilization along the asset life cycle is stopped [8]. In the standard aerodrome, lighting system is a part of visual aids that

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support the safety and orderliness of flight operation [2]. It is explained in [3] that there are four main elements completely forming the characteristics of land aerodrome lighting system. Those are resulted from a research and development program, as well as practical or direct experiences through the field implementation in a long time period. In the equipment effectiveness variable, [10] explains that effectiveness indicates the achievement level of result, goal, or target planned in the real condition. In addition, [6] explains that the concept of Overall Equipment Effectiveness (OEE) is used to assess equipment effectiveness through the aspects of availability, performance, and quality. Equipment can be assessed effectively if the function availability, lighting quality, and its operational performance can support the activities of landing, take-off, taxiing, and aircraft movement on the airside [9]. The quality of lighting output indicates that colour, intensity, position, configuration, and lamp visibility are in line with the need for visual operation [11]

Theoretically, equipment reliability variable is explained by [12], using distribution [13], that flexible probability distribution figures out the service life and failure pattern of a component. They explain that analyzing the time between failures and the characteristics of equipment component damage is the base of maintenance optimization and of system operation life extension. [14] defines reliability as the probability that an equipment can run the required function in a certain condition and time period. [5] explains that reliability describes the ability of system to work without failure, availability indicates the readiness of system for use, whereas maintainability is related to the system ability to recover when a disruption occurs. [15] explains that the analysis of reliability, availability, and maintainability can help organizations understand the downtime pattern, identify critical points, and determine a more appropriate maintenance strategy. In the context of aerodrome lighting, the equipment reliability has an important meaning because it will influence the support of lighting for pilot and operational personnel, especially at night, raining condition, crowded operation, or limited visibility [2].

Equipment maintenance program as the third variable being studied is a series of activities planned, conducted, recorded, and evaluated to keep the equipment in the condition suitable with the operational needs. In the physical asset management, maintenance is not only understood as the activity to repair damages, but as the managerial process to maintain the function, preparedness, and ability of assets to keep supporting the organizational goals [8]. In the context of critical facilities, maintenance becomes an important factor because equipment disruption can affect operational smoothness, safety, and service quality [16]. Corrective maintenance is conducted to recover the equipment function after disruption [17]. Predictive maintenance is conducted regarding the indication of equipment condition so that potential failures can be known earlier. [6] explains that maintenance is a combination of technical and administrative activities aimed at keeping the equipment, instalation, and other physical assets stay in the expected operational condition or returning them to the previous condition. [7] explains that modern maintenance has shifted from reactive approach to proactive approach. Meanwhile, reliability-based maintenance emphasizes on the maintenance strategy selection based on equipment function, failure pattern, and asset criticality level [5].

In the last variable, namely the operational feasibility of equipment, [18] explains that the preparedness of a system reflects the fitness condition for an intended purpose, namely the suitability of a system with the specified usage purpose. Operational preparedness is not only determined by the completed provision of a system, but also by the preparedness of operation environment to accept and utilize the system safely, efficiently, and effectively. Related to airport facilities, operational feasibility has an important meaning because the facilities used in the flight operation must be able to support the safety, orderliness, and smoothness of aircraft movement [11]. [2] explains that aerodrome must meet the standard design and operation to be able to provide the flight activity with safe supports. Meanwhile, operational feasibility is the final condition indicating that the equipment is ready, safe, accordance with standard, fit for use, and supported by adequate evidences of inspection, examination, maintenance, component replacement, or calibration [19]. Overall, it can be explained that the operational feasibility of aerodrome lighting equipment can be meant as the condition of equipment preparedness and supporting environment to run the service function of visual flight guide safely, effectively, and in accordance with the usage purpose.

Some previous researches support the importance of relationship among equipment condition, maintenance and facility performance. [6] confirms that the measurement of maintenance function performance needs to link the maintenance goal, maintenance process, and maintenance result. [5] indicates that the approaches of reliability, availability, and maintainability can be used to optimize the maintenance policy and decrease downtime. [17] finds that the low reliability in the critical component can affect the safety aspect. Meanwhile, [16] shows that disciplined, information-based, and personnel-involving maintenance practices can support the improvement of operational performance. These researches strengthen that critical facility management cannot be separated from function effectiveness, equipment reliability, maintenance program, and operational feasibility status. Based on the explanation above, it is important to conduct this research since there is a gap between the ideal condition requiring aerodrome lighting to be always effective, reliable, maintained, and operationally feasible and the empirical condition showing there are still function disruption, need for maintenance improvement, limited supporting resources, and need for strengthening the equipment control.

In general, this research wants to know and analyze the direct influence of equipment effectiveness and equipment reliability as well as equipment maintenance program on the operational feasibility of aerodrome lighting equipment and also the indirect influence of equipment maintenance program on operational feasibility through the mediation of equipment effectiveness and equipment reliability. Therefore, based on the theoretical explanation above, previous researches, then this research establishes some research hypotheses as follows (Figure 1):

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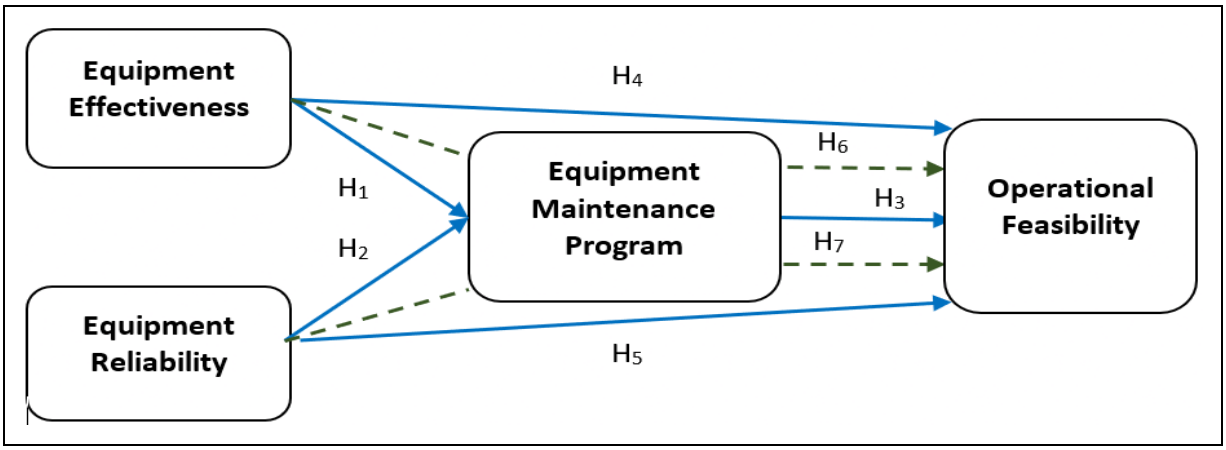


Fig 1 Conceptual Model

- H1: Equipment effectiveness directly influences equipment maintenance program.
- H2: Equipment reliability directly influences equipment maintenance program.
- H3: Equipment maintenance program directly influences equipment operational feasibility.
- H4: Equipment effectiveness directly influences equipment operational feasibility.
- H5: Equipment reliability directly influences equipment operational feasibility.
- H6: Equipment effectiveness indirectly influences equipment operational feasibility through equipment maintenance program.
- H7: Equipment reliability indirectly influences equipment operational feasibility through equipment maintenance program.

II. RESEARCH METHODS

This research was conducted in the Airport Equipment Department, Electrical Section, at Juanda International Airport Surabaya. The selection of research location was based on the consideration that this unit has a direct linkedness with the operation, maintenance, supervision, and evaluation of aerodrome lighting equipment which became the object of this research. The research object focused on the aerodrome lighting equipment used for supporting flight operation. As the analysis tool, this research used a quantitative approach with the method of Structural Equation Modeling-Partial Least Squares. The research method was through stages of outer model evaluation, inner model evaluation, bootstrapping, and mediation test. In this research, the population is the personnel of Airport Equipment numbering 66 people who had involvement in or understanding of the management, operation, maintenance, supervision, and evaluation of aerodrome lighting equipment at Juanda International Airport. The research population consisted of the personnel with the positions as Airport Equipment Coordinator, Airport Equipment Supervisor, Airport Equipment Engineer, Airport Equipment Technician, and maintenance personnel involved in the technical activities of equipment maintenance. Data was collected using the statement instrument of a five-level Likert scale comprising 28 indicators. The primary data in this research was obtained directly from the 66 respondents of Airport Equipment personnel through close statements. The statements were distributed online using Google Forms.

Descriptive analysis was used to describe the characteristics of respondents and the tendency of respondents' answer in each research variable. This analysis helped the researchers understand the respondents' perception overview of the conditions of equipment effectiveness, equipment reliability, maintenance program, and the operational feasibility of aerodrome lighting equipment. Subsequently, measurement model or outer model evaluation was carried out to ensure that the research instruments fulfilled the criteria of validity and reliability. Outer model evaluation included convergent validity, discriminant validity, composite reliability, and Cronbach's alpha. This stage was important to ensure that every indicator could measure the variable being studied appropriately and consistently.

After the measurement model had fulfilled the criteria, structural model or inner model evaluation was carried out. This evaluation was used to examine the inter-variable relation in the research model. Measurement Model or Outer Model analysis used Convergent validity, with the criteria that the value of outer loading was more than 0.70. In addition, the value of Average Variance Extracted (AVE) was expected to be higher than 0.50. In this research, discriminant validity was tested through the value of cross loading and Fornell-Larcker Criterion. Construct reliability was used to know the internal consistency of indicator in measuring the variable. The criteria used was that the value of Cronbach's Alpha and Composite Reliability was higher than 0.70. It was continued with inner model evaluation including the values of $R_{\text{-square}}$, $Q_{\text{-square}}$, path coefficient, hypothesis test, and mediaton test. This stage was intended to know the direct and indirect influences of equipment effectiveness and equipment reliability on the equipment operational feasibility through equipment maintenance program. The analysis result was then discussed in the stage of research result discussion. In this stage, the researchers interpreted the result of statistical testing, connected it to the theory, previous researches, and the empirical condition of aerodrome lighting equipment management at Juanda International Airport.

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III. RESULTS AND DISCUSSION

➢ *Model of Measurement (Outer Model)*

Outer model evaluation was used to assess the quality of measurement model through convergent validity, construct reliability, and discriminant validity. The structural model resulted from SEM analysis SEM was shown in Figure 2.

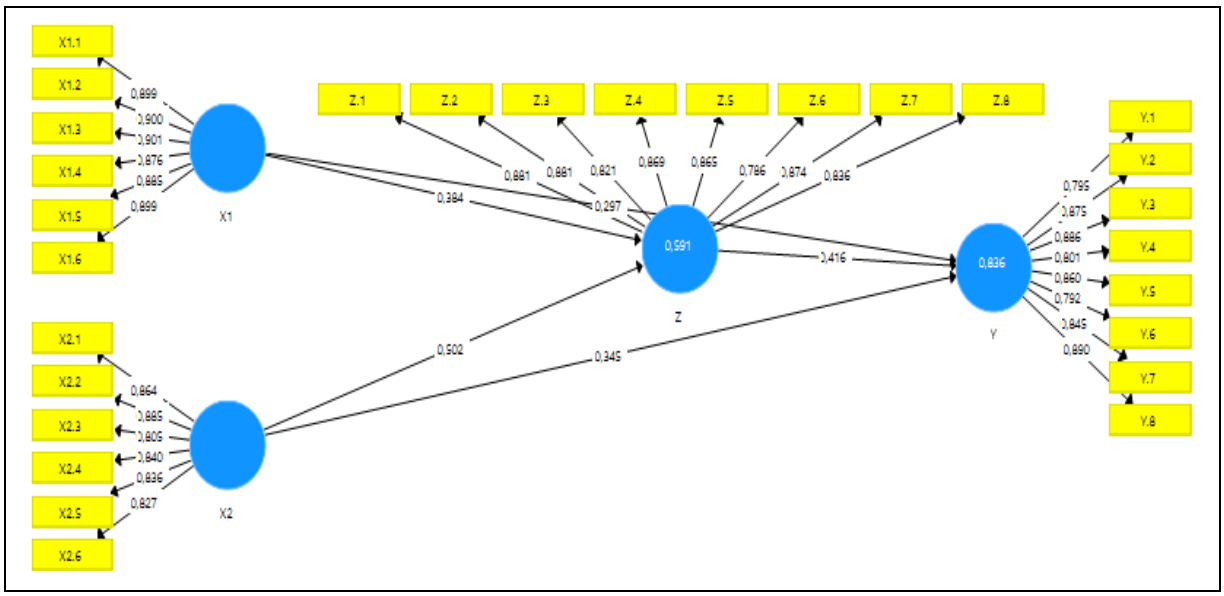


Fig 2 The Structural Model of Outer Model

The inspection was done based on AVE, outer loading, Cronbach's Alpha, Composite Reliability, cross loading, and Fornell–Larcker criterion.

Table 1 AVE Values

Conctruct	AVE	Result
Equipment effectiveness	0.798	valid
Equipment reliability	0.711	valid
Equipment maintenance program	0.726	valid
Equipment operational feasibility	0.712	Valid

Based on Table 1 all the research constructs have Average Variance Extracted (AVE) value above 0.50, ranging from 0.711 to 0.798. The construct of equipment effectiveness got the highest AVE value 0.798, followed by equipment maintenance program 0.726, equipment operational feasibility 0.712, and equipment reliability 0.711. These results show that each construct can explain more than 50% of the indicator variances that form them.

All the 28 indicators have outer loading value above (>) 0.700, ranging from 0.786 to 0.901. Because all the values have exceeded the criterion of 0.700, each indicator can reflect the construct being measured adequately and is stated as meeting the convergent validity at indicator level. Therefore, no indicator needs to be eliminated based on the result of outer loading in this research model.

➢ *Discriminant Validity*

The discriminant validity analysis in this research considered the value of cross loading. The criterion was that the indicator's cross loading value in the variable should be the biggest among other variables. The result explains that each indicator used in this research has had a good discriminant validity to compose each variable studied. Based on the analysis, the square roots of AVE in the main diagonal are 0.893, 0.843, 0.852 and 0.844 respectively for each variable studied. Each diagonal value is bigger than the correlation of related construct, so that the Fornell–Larcker criterion is formally fulfilled. The result explains that the higher value of AVE square root in its own variable correlation rather than the intervariable correlations indicate that the discriminant validity of the research variable is met.

➢ *Composite Reliability and Cronbach Alpha*

Reliability test was carried out to know the consistency of internal indicator in measuring each research construct. Construct reliability was evaluated using the values of Cronbach's alpha and composite reliability. A construct is stated as reliable if it has composite reliability value higher than (>) 0.70 and Cronbach's alpha value higher than 0.60.

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Table 2 Construct Reliability

Construct	Cronbach's Alpha	Composite Reliability	Result
Equipment effectiveness	0.950	0.960	Reliable
Equipment reliability	0.919	0.937	Reliable
Equipment maintenance program	0.946	0.955	Reliable
Equipment operational feasibility	0.942	0.952	Reliable

Based on Table 2, all the constructs have Cronbach's Alpha and Composite Reliability values higher than (>) 0.70. The results show that the indicator in each construct has a high internal consistency and can explain more than half of its indicator variance. Equipment effectiveness, equipment reliability, equipment maintenance program, and equipment operational feasibility are stated as reliable and meet the convergent validity at construct level.

➢ *Inner Model Evaluation*

Inner model evaluation in this section assessed the ability of exogenous construct to explain the endogenous construct. The measurements used were R_{Square} and R_{Square} Adjusted for Equipment maintenance program and Equipment operational feasibility. The analysis of R_{square} and Q_{square} values are shown in Table 3.

Table 3 R_{Square} Values

Endogenous Construct	R_{Square}	R_{Square} Adjusted
Equipment maintenance program	0.591	0.578
Equipment operational feasibility	0.836	0.828

Based on Table 3, the R_{Square} value of Equipment maintenance program is 0.591. This means Equipment effectiveness and Equipment reliability can simultaneously explain 59.1% of the Equipment maintenance program variabel. The R_{Square} value of Equipment operational feasibility is 0.836 showing that Equipment effectiveness, Equipment reliability, and Equipment maintenance program can explain 83.6% of the Equipment operational feasibility variabel. Based on the calculation, the value of Q square obtained is 0.933. This value is bigger than zero and approaching one, so that the research model has a very strong predictive relevance. Therefore, the combination of Equipment effectiveness, Equipment reliability, and Equipment maintenance program has a high predictive ability for Equipment operational feasibility in the model being tested.

Table 4 Path Coefficient Values

Hypothesis	Path Coefficient Value	Result
H1	0.384	Positive
H2	0.502	Positive
H3	0.297	Positive
H4	0.345	Positive
H5	0.416	Positive
H6	0.160	Positive
H7	0.209	Positive

Based on Table 4, all the path coefficients have positive marks. In the relationsip leading toward Equipment maintenance program, Equipment reliability gives the biggest coefficient of 0.502, whereas Equipment effectiveness has coefficient of 0.384. In the direct relationship with Equipment operational feasibility, Equipment maintenance program has the biggest coefficient of 0.416, followed by Equipment reliability of 0.345 and Equipment effectiveness of 0.297. These results indicate that the increase of effectiveness, reliability, and maintenance program quality goes in the same direction with the increase of equipment operational feasibility. The coefficient of indirect influence of Equipment reliability on equipment operational feasibility through Equipment maintenance program is 0.209, bigger than the indirect influence of Equipment effectiveness which is 0.160. This pattern shows that the reliability path through maintenance program has a relatively bigger contribution to operational feasibility than effectiveness path through maintenance program.

➢ *Hypothesis Testing*

Table 4 Results of Direct Influence Hypothesis Testing

Hypothesis	Original Sample	$t_{statistic}$	p_{value}	Result
H1	0.384	2.662	0.010	Accepted
H2	0.502	3.705	0.000	Accepted
H3	0.416	3.080	0.003	Accepted
H4	0.297	2.178	0.033	Accepted
H5	0.345	2.954	0.004	Accepted

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Equipment effectiveness positively and significantly influences Equipment maintenance program with the coefficient of 0.384, $t_{statistic}$ value of 2.662, and p_{value} of 0.010 so that H1 is accepted. Equipment reliability also positively and significantly influences Equipment maintenance program with the coefficient of 0.502, $t_{statistic}$ value of 3.705, and p_{value} of less than 0.001 so that H2 is accepted. Equipment maintenance program positively and significantly influences Equipment operational feasibility with the coefficient of 0.416, $t_{statistic}$ value of 3.080, and p_{value} of 0.003 so that H3 is accepted. Equipment effectiveness positively and significantly influences Equipment operational feasibility with the coefficient of 0.297, $t_{statistic}$ value of 2.178, and p_{value} of 0.033 so that H4 is accepted. Equipment reliability also positively and significantly influences Equipment operational feasibility with the coefficient of 0.345, $t_{statistic}$ value of 2.954, and p_{value} of 0.004 so that H5 is accepted.

Table 5 Results of Indirect Influence Hypothesis Testing

Hypothesis	Original Sample	$t_{statistic}$	p_{value}	Result
H6	0.160	2.148	0.035	Accepted
H7	0.209	2.018	0.048	Accepted

Equipment effectiveness positively and significantly influences Equipment operational feasibility through Equipment maintenance program. The indirect influence has a coefficient of 0.160, $t_{statistic}$ value of 2.148, and p_{value} of 0.035 so that H6 is accepted. Equipment reliability also positively and significantly influences Equipment operational feasibility through Equipment maintenance program with the coefficient of 0.209, $t_{statistic}$ value of 2.018, and p_{value} of 0.048 so that H7 is accepted.

➢ *Discussion*

- H1: The influence of Equipment effectiveness on Aerodrome lighting equipment maintenance program

The testing result shows that equipment effectiveness positively and significantly influences equipment maintenance program. Thus, the hypothesis stating there is a positive influence of equipment effectiveness on equipment maintenance program can be accepted. This finding can be explained through air transportation management which places facilities, equipment, human resources, procedures, and supervision as the elements that must be integrally managed so that flight operations run safely and smoothly [20]; [1]. In the perspective of physical asset management, effectiveness shows the ability of asset to run the functions needed by the organization, whereas maintenance is a part of life cycle management to maintain the value, function, and preparedness of asset [8]. The concept of effectiveness through availability, performance, and quality also shows that the condition of equipment function need to be sustainably monitored [4]. In term of aerodrome lighting, the monitoring is translated into maintenance program which maintain the availability of function, the harmony of colour, intensity, configuration, position, and light coverage in accordance with the operational needs.

The result of this research is conceptually in line with [6] explaining that the goals of maintenance, maintenance process, and maintenance result must be linked in an integrated performance framework. This finding also gets supports from [5] showing that the evaluations of reliability, availability, and maintainability can identify the critical point and help choose the maintenance policy. Research [16] also shows that disciplined maintenance, information tracking, and operator involvement are related to the increase of operational performance. So, based on the result of the first hypothesis and previous researches, it can be concluded that equipment effectiveness positively and significantly influences equipment maintenance program.

- H2: The influence of Equipment reliability on Aerodrome Lighting equipment maintenance program

The analysis result shows that equipment reliability positively and significantly influences equipment maintenance program. This finding explains the consistency level of function, operational stability, and the low disruption in aerodrome lighting related to the increasingly good execution of maintenance. In the physical asset management theory, reliability is the ability of asset to run the function consistently in certain condition and period of, whereas maintainability shows the ability of asset to be recovered when any disruption occurs [8]; [5]. The finding of this research is supported by [17], showing that the low reliability of critical component is related to safety risk and needs improvement in the maintenance strategy based on the analyses of reliability, availability, maintainability, and safety. The results are in line with [5], showing that the patterns of failure and repair can be used for identifying bottleneck and choose a more optimal maintenance policy. Therefore, based on the results of the second hypothesis and previous researches, it can be concluded that equipment reliability positively and significantly influences equipment maintenance program.

- H3: The influence of Equipment maintenance program on Aerodrome Lighting equipment operational feasibility

The analysis result shows that equipment maintenance program positively and significantly influences equipment operational feasibility. This finding shows that regular, documented, responsive, and resource-supported maintenance plays a role in ensuring aerodrome lighting in the conditions of ready, safe, on standard, and fit for use. In the physical asset management, maintenance is a managerial process throughout the asset life cycle to maintain or return the asset to the expected operational condition [8]. [6] puts maintenance as the combination of technical and administrative activities that link goal, process, resources, and result.

This result is consistent with [16], finding that the Total Productive Maintenance praktice influences operational

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performance and that disciplined maintenance and information tracking become important elements in the performance achievement. [8] also shows that the Total Productive Maintenance practice gives a positive influence to quality, cost, and delivery performance. The similar support is stated by [21] finding that a productive maintenance practice increases cost effectiveness, quality, punctuality, and performance flexibility. Those three researches show the importance of maintaining the asset condition and resulting in better operational performance. In the context of airport, the results are reflected in achieving the preparedness, security, and feasibility of aerodrome lighting. Therefore, based on the result of the third hypothesis and previous researches, it can be concluded that equipment maintenance program positively and significantly influences equipment operational feasibility.

- H4: The Influence of Equipment effectiveness on Aerodrome Lighting equipment operational feasibility

The test result shows that equipment effectiveness positively and significantly influences equipment operational feasibility. This finding explains that aerodrome lighting which is available when needed results in a suitable visual function, and able to support aircraft movement will be more likely to meet the requirements of operational feasibility. Air transportation management explains that the preparedness of flight facilities and infrastructure is part of integrated operation management to maintain safety, orderliness, and smoothness of aircraft movement [20]; [1]. In the concept of equipment effectiveness, availability indicates function preparedness, performance indicates the ability to support operational performance, and quality indicates the suitability of output with the standard or need [4]. The three dimensions are directly related to the concept of operational feasibility, that is the condition when the equipment is ready, safe, fulfilling technical requirements, and not causing unacceptable risks [8]; [22]

In term of aerodrome lighting, the suitability of visual function as defined in [2], is an inseparable part of evaluation whether or not the equipment is feasible to support flight operation. Support from previous research by [4] shows that the comprehensive safety indicator needed for sustainably monitoring the airside operational condition. The result strengthening the importance of facility function effectiveness as the leading indicator before safety disruption occurs.

Another opinion, [22] also finds that ground operation management and the compliance with the procedures positively influences flight safety performance. Although those researches do not specifically examine aerodrome lighting, both of them show that the quality of operational functional execution and facility control in the airside area is related to the achievement of safe operational condition. Thus, based on the result of the fourth hypothesis and previous researches, it can be concluded that equipment effectiveness positively and significantly influences equipment operational feasibility.

- H5: The influence of Equipment reliability on Aerodrome Lighting equipment operational feasibility

The test result shows that equipment reliability positively and significantly influences equipment operational feasibility. This finding means that the aerodrome lighting, which rarely experience failures, is capable to work without repeated interruption and maintain function stability, having a bigger possibility of being in the operational feasible condition. In the theory of reliability, reliability explains the ability of system to work with no failure, availability indicates the preparedness of system for use, and maintainability indicates the ability of system to recover after interruption [5]. These three aspects become important parts of physical asset management because asset stability determines the operation sustainability and the risk level faced by the organization [8].

This finding is supported by [17], showing that the low reliability of critical component can affect the safety aspect although the availability level in general has met the standard. The result confirms that it is not enough to assess feasibility and safety from momentary availability, but it needs to consider the pattern of component failure. [5] also finds that the analyses of reliability, availability, and maintainability can identify bottleneck, decrease downtime, and increase the dependability of system. Thus, based on the result of the fifth hypothesis and previous researches, it can be concluded that equipment reliability positively and significantly influences equipment operational feasibility.

- H6: The influence of Equipment effectiveness on Aerodrome Lighting equipment operational feasibility through Equipment maintenance program

The test result shows that the direct influence of effectiveness on operational feasibility is still positive and significant. Therefore, maintenance program acts as a partial mediator in that relationship. The mechanism of mediation is in accordance with physical asset management that considers asset condition, management process, and operational result as an interconnected series throughout the asset life cycle [8]. Effectiveness describes the availability, performance, and quality of equipment function, whereas maintenance becomes a process that maintain these three dimensions in order not to decrease [4]; [6].

The result of this research is consistent with the result from [8], finding that the Total Productive Maintenance practices have both direct and indirect influences on manufacturing performance. [16] also shows that Total Productive Maintenance influences operational performance and has a strong correlation with Total Quality Management which subsequently supports performance. [6] gives additional conceptual basis that maintenance process becomes the link between maintenance goal and the result obtained by the asset. Therefore, based on the result of the sixth hypothesis and previous researches, it can be concluded that equipment effectiveness positively and significantly influences operational feasibility through equipment maintenance program.

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- H7: The influence of Equipment reliability on Aerodrome Lighting equipment operational feasibility through Equipment maintenance program

The test result shows that equipment reliability positively and significantly influences operational feasibility through equipment maintenance program. The direct influence of reliability on operational feasibility is still positive and significant. Therefore, maintenance program acts as partial mediator. This result is in line with [5], showing that the integrated evaluation of reliability, availability, and maintainability with the optimization of maintenance policy can reduce downtime and increase dependability. [17] also confirms that the finding of reliability in the critical component needs to become the base for improving maintenance strategy because it is related to safety. In addition, [8], provides the evidence that maintenance practices can be a part of indirect mechanism that results in improved performance. All the research results support the explanation that reliability does not automatically guarantee the operational result; such a condition needs to be maintained and translated through a planned maintenance program to bring about operational preparedness and safety. Thus, based on the result of the seventh hypothesis and previous researches, it can be concluded that equipment reliability positively and significantly influences feasibility through equipment maintenance program.

IV. CONCLUSION

The better the function availability, lighting quality, and aerodrome lighting ability to support airside operation, the better the need for maintenance is translated into regular inspection, testing, recording, and technical follow-up. Failure pattern, repeated disruption, function atability, and equipment ability to operate between disruptions are important inputs in determining intensity, priority, and maintenance strategy. Schedule regularity, preventive and corrective actions, response to disruption, documentation, equipment support, spare part, as well as technician's competency are the main mechanism to maintain the equipment ready, safe, on standard, and fit for use.

The equipment which is available when needed and able to generate colour, intensity, configuration, position, and appropriate light coverage will be more able to meet the technical and operational requirements as airport visual facilities. Function stabililty, low rate of failure, and equipment ability to work consistently provide greater certainty that aerodrome lighting can support flight operation safely and sustainably.

Effectiveness gives direct contribution through the quality of visual function, and at the same time gives indirect contribution when the result of effectiveness inspection is used as the basis of maintenance action and feasibility verification. Indirect path is relatively stronger than the mediation path of Equipment effectiveness. This finding shows that interruption recording, failure pattern analysis, maintenance of critical components, and function recovery are important series to maintain operational feasibility.

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