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Analysis of the Impact of Spare Part Availability and Procurement Lead Time on Maintenance Operational Performance (Case Study: Batam Aero Teknik (BAT), Batam)

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Abstract: Aircraft maintenance operational performance is highly influenced by supply chain effectiveness, particularly spare parts availability and procurement lead time. This study aims to analyze the influence of spare parts availability and procurement lead time on maintenance operational performance at Batam Aero Teknik, a Maintenance, Repair, and Overhaul (MRO) facility operating in the Batam Free Trade Zone (FTZ). A quantitative approach was employed using a survey method involving 57 respondents engaged in maintenance and spare parts management activities. Data were analyzed using multiple linear regression and supported by interviews. The results indicate that spare parts availability has a positive and significant effect on maintenance operational performance, while procurement lead time has a positive but partially insignificant effect. Simultaneously, both variables significantly influence maintenance operational performance. These findings suggest that improving maintenance performance depends more on effective spare parts availability management than solely on procurement speed.

Keywords: Spare Parts Availability, Procurement Lead Time, Aircraft Maintenance, Operational Performance, MRO.

INTRODUCTION

The Maintenance, Repair, and Overhaul (MRO) industry plays a crucial role in ensuring the safety, reliability, and operational sustainability of aviation. With the growth of the aviation industry and the increasing number of aircraft fleets in Indonesia, the demand for efficient and competitive MRO services continues to rise. As one of the largest aviation markets in Southeast Asia, with more than 1,500 registered aircraft, Indonesia requires MRO facilities capable of ensuring aircraft airworthiness while simultaneously enhancing the competitiveness of the national aviation industry (Fahriza et al., 2025) .

Maintenance operational performance is a key factor determining the success of MRO activities. Maintenance that is not carried out according to schedule can lead to flight delays, operational cancellations, increased maintenance costs, and a higher risk of Aircraft on Ground (AOG). These conditions not only affect airlines but also impact service quality and overall

operational efficiency. Therefore, an organization's ability to maintain maintenance operational performance is a critical aspect of the aviation industry.

One of the main challenges faced by the MRO industry is spare parts supply chain management. Aircraft spare parts expenditure in Indonesia continues to increase alongside the growth of the aircraft maintenance market, which is estimated to grow at approximately 12.87% per year. The value of aircraft spare parts demand over the next five years is estimated to reach between USD 0.89 billion and USD 1.56 billion. Most of these spare parts are still imported, resulting in relatively high prices and long delivery times (Franciscus, 2017). Dependence on imported spare parts means that the maintenance process is heavily influenced by material availability and procurement speed.

From a supply chain management perspective, spare parts availability refers to an organization's ability to provide the required material at the right time, in the right quantity, and with the right specifications to support smooth operational processes. (Heizer et al., 2020) explain that inventory availability is an important factor affecting operational effectiveness and business continuity. In the MRO industry, spare parts availability is a critical factor because any delay or mismatch of parts can postpone maintenance processes and increase the risk of AOG. Adequate spare parts availability allows maintenance to be carried out according to schedule, whereas limited spare parts can increase Turn Around Time (TAT) and reduce fleet operational readiness. (Gu et al., 2015) explain that aircraft spare parts inventory management is an important factor in supporting smooth maintenance operations, especially in dealing with demand uncertainty and supply constraints. Therefore, companies must balance spare parts availability and inventory efficiency to minimize maintenance delays and enhance fleet operational readiness.

(Shirinfar et al., 2022) explain that spare parts availability, ordering, and distribution are essential elements in aircraft maintenance activities. Delays in providing spare parts can directly impact the completion of maintenance work and affect the operational performance of MRO facilities. These findings indicate that effective spare parts management not only influences the smoothness of maintenance processes but also the organization's ability to maintain fleet operational readiness.

In addition to spare parts availability, procurement lead time is another factor affecting operational effectiveness. According to (Krajewski et al., 2019), lead time refers to the period required from the initiation of an order until the material is received and ready for use. Long lead times may increase operational uncertainty and hinder maintenance activities. In the aviation industry, spare parts procurement lead times are often affected by import procedures, customs administration, and complex logistics distribution systems. Therefore, shorter procurement lead times are expected to support maintenance efficiency and improve operational performance.

Maintenance operational performance reflects an organization's ability to carry out maintenance activities effectively, efficiently, and on time. This performance is generally measured through achievement of Turn Around Time (TAT), Aircraft on Ground (AOG) rate, fleet reliability, and the effectiveness of maintenance program execution. The better the maintenance performance, the higher the level of aircraft operational readiness and the lower the risk of operational disruptions that could affect flight services.

Research by (Fahriza et al., 2024) shows that procurement and supply chain issues remain major challenges in the Indonesian MRO industry, mainly due to dependence on imported spare parts, limited procurement information visibility, and complex logistics processes. That study also identified that delays in spare parts procurement can increase downtime and AOG risk, directly impacting the effectiveness of maintenance activities. Furthermore, (Fahriza et al., 2025) explain that improving MRO procurement performance depends not only on the speed of material procurement but also on information integration and

inventory management that enhance spare parts demand visibility and support more effective decision-making.

Batam Aero Teknik (BAT) is one of the largest MRO facilities in Indonesia, located in the Batam Free Trade Zone (FTZ). As an MRO facility serving the maintenance needs of national airline fleets, BAT faces challenges in spare parts supply chain management, particularly regarding spare parts availability and procurement lead time. The import process for spare parts, tax obligations, and the mechanism for transferring goods from the FTZ to Other Places Within the Customs Area (TLDDP) have the potential to extend logistics time and affect the achievement of aircraft maintenance Turn Around Time targets.

Based on the above rationale, there is a gap between fiscal policies and customs facilities designed to accelerate logistics flows and the operational reality, where spare parts procurement lead times remain inconsistent and subject to fluctuation. This discrepancy affects maintenance operational performance, particularly in achieving aircraft Turn Around Time (TAT) targets at Batam Aero Teknik. Furthermore, empirical studies specifically examining the effects of spare parts availability and procurement lead time on maintenance operational performance within MRO facilities operating in special economic environments such as the Batam Free Trade Zone (FTZ) remain limited.

Although various studies have addressed procurement and supply chain issues in the MRO industry, research specifically examining the influence of spare parts availability and procurement lead time on maintenance operational performance at MRO facilities operating in a Free Trade Zone remains relatively limited. The unique characteristics of the FTZ, which has different customs and distribution mechanisms compared to regular customs areas, make this research context distinctive. Various studies show that FTZs can improve logistics efficiency, accelerate goods flow, and enhance company competitiveness through various trade and fiscal facilities provided (Sun & Zhou, 2024).However, the effectiveness of FTZ implementation in supporting the operational needs of industries that heavily rely on spare parts availability, such as the MRO industry, requires further investigation. Therefore, this research is expected to provide empirical contributions to understanding the relationships between spare parts availability, procurement lead time, and maintenance operational performance in an MRO environment with specific logistics and regulatory characteristics.

Based on the above description, this study aims to analyze the influence of spare parts availability and procurement lead time on maintenance operational performance at Batam Aero Teknik (BAT). The results are expected to provide academic contributions to the development of logistics management and MRO supply chain studies, as well as serve as a basis for formulating practical recommendations for the industry and policymakers to improve operational efficiency and the competitiveness of the national MRO sector. The research questions are: (1) Does spare parts availability affect maintenance operational performance at Batam Aero Teknik (BAT); (2) Does procurement lead time affect maintenance operational performance at Batam Aero Teknik (BAT); (3) Do spare parts availability and procurement lead time simultaneously affect maintenance operational performance at Batam Aero Teknik (BAT).

METHOD

This study employs a quantitative approach using a survey method, supported by qualitative data from interviews as a complement (triangulation). The quantitative approach is used to test the influence of spare parts availability and procurement lead time on maintenance operational performance at Batam Aero Teknik (BAT), while interviews are used to deepen understanding of the statistical analysis results.

The type of research is explanatory research, which aims to explain the relationship between independent and dependent variables through hypothesis testing. The study was conducted at Batam Aero Teknik (BAT), located in Batam, Kepulauan Riau, Indonesia.

The research population consisted of all employees involved in maintenance, logistics, and spare parts management activities at Batam Aero Teknik (BAT). The sampling technique used was saturated sampling (census), where all population members were made respondents. A total of 57 respondents participated in this study.

The research variables consist of spare parts availability as the first independent variable (X1). For this variable, the questionnaire instrument was developed based on the suitability of spare part types provided by vendors, the quantity of available spare parts, minimum spare parts inventory levels, and storage location management. Procurement lead time serves as the second independent variable (X2) in this study. The questionnaire instrument for this variable was developed based on delivery time, administrative processes, customs procedures within the Free Trade Zone (FTZ), and the duration required for releasing goods from the FTZ area to the Other Places Within the Customs Territory (Tempat Lain Dalam Daerah Pabean/TLDDP). Maintenance operational performance is the dependent variable (Y). The measurement of this variable was based on questionnaire items related to the speed of aircraft maintenance Turn Around Time (TAT), maintenance On-Time Performance (OTP), and the reduction of Aircraft on Ground (AOG) risks. The determination of variables was carried out using a questionnaire instrument developed from a literature review and adjusted to the operational characteristics of the Maintenance, Repair, and Overhaul (MRO) industry. All questionnaire items were measured using a five-point Likert scale ranging from strongly disagree to strongly agree.

Primary data were obtained by distributing questionnaires to research respondents. In addition, structured interviews were conducted with internal company personnel to obtain information regarding spare parts management, procurement processes, Free Trade Zone (FTZ) regulations, and the implementation of the Electronic Maintenance, Repair, and Overhaul (E-MRO) system used by the company.

The data analysis technique used was multiple linear regression to test the effects of spare part availability and procurement lead time on maintenance operational performance. The regression equation model used in this study is:

$$Y = a + b_1X_1 + b_2X_2 + e$$

Where:

Y	= Maintenance Operational Performance
a	= Constant
b_1 and b_2	= Regression Coefficients
X_1	= Spare Parts Availability
X_2	= Procurement Lead Time
E	= Error Term

Before conducting the regression analysis, a pilot test was carried out involving ten respondents who possessed characteristics similar to those of the study population. The purpose of this pilot test was to ensure the clarity of the questionnaire items and the consistency of the research instrument. The results indicated that all questionnaire items were well understood by the respondents.

Following the pilot test, validity and reliability tests were conducted to ensure the quality of the research instrument. Subsequently, classical assumption tests were performed, including tests of normality, multicollinearity, and heteroscedasticity, to assess the suitability of the regression model. Hypothesis testing was conducted using the t-test to determine the partial effect of each independent variable on the dependent variable, the F-test to examine the simultaneous effect of both independent variables on the dependent variable, and the coefficient of determination (R^2) to measure the extent to which the independent variables explain the variation in the dependent variable. All data processing and statistical analyses were carried out using Statistical Package for the Social Sciences (SPSS) version 26, with a significance level of 5 percent.

To strengthen the quantitative findings, this study also employed structured interviews with five key informants from the maintenance planning, procurement, logistics, warehouse, and supply chain management departments. The interview data were analyzed using a thematic analysis approach and were utilized as a triangulation method to provide deeper interpretation and validation of the statistical results.

RESULTS AND DISCUSSION

This study aims to analyze the influence of spare parts availability and procurement lead time on maintenance operational performance. Based on data processing from 57 respondents, it was found that maintenance performance issues do not stand alone but are closely related to supply chain conditions and spare parts procurement systems. To ensure that the analysis results are accurate and accountable, instrument testing, classical assumption testing, and multiple linear regression analysis were conducted, complemented by interviews with Batam Aero Teknik (BAT) employees.

1. Reliability and Convergent Validity Assessment

The Reliability and Convergent Validity Assessmentresults indicate that all statement items for the variables of spare parts availability, procurement lead time, and maintenance operational performance have an r-calculated value greater than the r-table, declaring all instruments valid.

Table 1 Reliability and Convergent Validity Assessment

Construct	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)	Interpretation
Spare Parts Availability (X1)	0,85	0,892	0,624	Reliable and Valid
Procurement Lead Time (X2)	0,74	0,821	0,541	Reliable and Valid
Maintenance Operational Performance (Y)	0,81	0,873	0,579	Reliable and Valid

As shown in Table 1, all constructs achieved Cronbach's Alpha values ranging from 0,74 to 0,85, exceeding the recommended threshold of 0,70. Furthermore, Composite Reliability (CR) values ranged from 0,821 to 0,892, indicating satisfactory internal consistency. The Average Variance Extracted (AVE) values for all constructs exceeded 0.50, suggesting that the indicators adequately explain the variance of their respective constructs. Therefore, the measurement instrument demonstrates acceptable reliability and convergent validity.

2. KMO and Bartlett's Test

Table 2 KMO and Bartlett's Test Results

Test	Value
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0,764
Bartlett's Test of Sphericity (Chi-Square)	425,317
Degrees of Freedom (df)	105

Table 2 presents the results of the sampling adequacy and factorability tests. The KMO value of 0.764 exceeds the minimum acceptable threshold of 0.50, indicating that the sample size is adequate for factor analysis. Additionally, Bartlett's Test of Sphericity is statistically

significant ($p < 0,001$), confirming that sufficient correlations exist among the indicators to justify the application of factor analysis.

3. Discriminant Validity Assessment Using the Fornell-Larcker Criterion

Table 3 Discriminant Validity Assessment Using the Fornell-Larcker Criterion

Construct	X1	X2	Y	Construct
Spare Parts Availability (X1)	0,790			Spare Parts Availability (X1)
Procurement Lead Time (X2)	0.412	0,736		Procurement Lead Time (X2)
Maintenance Operational Performance (Y)	0,523	0,367	0,761	Maintenance Operational Performance (Y)

As presented in Table 3, the square root of AVE values (diagonal elements) for each construct is greater than the corresponding inter-construct correlations. For example, the square root of AVE for Spare Parts Availability (0,790) is higher than its correlations with Procurement Lead Time (0,412) and Maintenance Operational Performance (0,523). Similar patterns are observed for the remaining constructs. These findings indicate that discriminant validity has been established, as each construct is empirically distinct from the others.

4. Classical Assumption Test Results

Classical assumption testing was conducted to ensure the feasibility of the multiple linear regression model used. The normality test results showed that the data were normally distributed, thus satisfying one of the prerequisites for regression analysis.

The multicollinearity test showed tolerance values greater than 0,10 and Variance Inflation Factor (VIF) values less than 10. These results indicate no strong relationship between the independent variables, so the regression model is free from multicollinearity symptoms.

Furthermore, the heteroscedasticity test showed no specific pattern in the distribution of residuals, indicating that the regression model does not suffer from heteroscedasticity. Since all classical assumptions were satisfied, the regression model was deemed appropriate and reliable for hypothesis testing.

5. Multiple Linear Regression Results

Table 4 Multiple Linear Regression

Variable	B (Unstandardized)	Std. Error	t-calculate	Sig.
Constant	0,825	0,234	3,523	0,001
X1 – Spare Parts Availability	0,297	0,062	4,782	0
X2 – Procurement Lead Time	0,14	0,104	1,332	0,185

The regression equation obtained in this study is:

$Y = 0,825 + 0,297X_1 + 0,140X_2$

This equation shows that spare parts availability and procurement lead time have a positive relationship with maintenance operational performance. The regression coefficient for spare parts availability of 0,297 indicates that each one-unit increase in spare parts availability will increase maintenance operational performance by 0,297 units, assuming other variables are constant. Meanwhile, the regression coefficient for procurement lead time of 0,140 indicates a

positive relationship with maintenance operational performance, although this effect is not statistically significant.

These results indicate that spare parts availability is a more dominant factor in supporting maintenance operational performance compared to procurement lead time. This finding aligns with (Heizer et al., 2020) who explain that inventory availability is an important factor in maintaining organizational operational effectiveness. In the context of the MRO industry, adequate spare parts availability enables maintenance to be carried out on schedule, reduces the risk of Aircraft on Ground (AOG), and supports the achievement of Turn Around Time (TAT) targets.

Meanwhile, procurement lead time at Batam Aero Teknik (BAT) tends to be influenced by external factors such as import administration processes, customs regulations, and goods distribution mechanisms from the Free Trade Zone to Entry of VATable goods from Other Places Within the Customs Area (TLDDP).Consequently, although procurement lead time exhibits a positive relationship with maintenance operational performance, its effect is not statistically significant when examined individually.

6. T-Test

Table 5 t-Test

Independent Variable	Regression Coefficient(B)	t-calculate	Sig.
Spare Parts Availability (X1)	0,297	4,782	0
Procurement Lead Time (X2)	0,14	1,332	0,185

Based on the t-test results in Table 5, the spare parts availability variable (X1) has a significance value of 0,0, which is less than 0,05. Therefore, spare parts availability has a positive and statistically significant effect on maintenance operational performance. This finding indicates that the higher the level of spare parts availability, the better the maintenance operational performance achieved by the company.

This finding supports the research of (Rifai et al., 2022) which states that spare parts availability is one of the main factors affecting the effectiveness of aircraft maintenance activities. This result is also consistent with (Gu et al., 2015) who explain that effective spare parts inventory management plays an important role in maintaining the smoothness of maintenance operations and reducing the risk of delays due to demand and supply uncertainties. Furthermore, (Shirinfar et al., 2022)affirm that spare parts availability, ordering, and distribution are essential elements in supporting MRO operational effectiveness and the timely completion of maintenance work.

The relatively stronger influence of spare parts availability indicates that the main issues affecting maintenance performance at Batam Aero Teknik (BAT) lie in the internal aspects of the supply chain, particularly regarding the suitability of spare part types, safety stock control, and inventory management. This finding aligns with the concept of inventory availability put forward by (Heizer et al., 2020), which explains that inventory availability is an important factor in maintaining organizational operational effectiveness.

Meanwhile, the procurement lead time variable (X2) has a significance value of 0,185, which is greater than 0,05, so it does not have a significant partial effect on maintenance operational performance. This result indicates that although procurement lead time has a positive relationship with maintenance performance, its influence is not sufficiently strong to have a statistically significant impact. This condition suggests that the company has been able to mitigate the impact of procurement delays through relatively good inventory management, material requirements planning, and the use of inventory control systems that support smooth maintenance operations.

The insignificant effect of procurement lead time suggests that maintenance operational performance at Batam Aero Teknik is not directly dependent on procurement speed alone. Several alternative explanations may account for this finding.

First, the company implements a safety stock policy, allowing maintenance activities to continue even when procurement delays occur. Second, effective material requirements planning and demand forecasting help reduce the risk of spare parts shortages. Third, long-term relationships with vendors and a relatively high level of supplier reliability contribute to maintaining supply continuity. Fourth, flexibility in maintenance scheduling enables the company to make adjustments when procurement delays arise. Fifth, the implementation of the Electronic Maintenance, Repair, and Overhaul (EMRO) system enhances real-time visibility of inventory levels and procurement status, thereby minimizing the impact of procurement delays.

These findings suggest that within an MRO environment operating under the Free Trade Zone (FTZ) framework, spare parts availability plays a more critical role than procurement speed in supporting maintenance operational performance.

Although procurement lead time does not have a statistically significant partial effect, it remains an important factor that requires attention because it is highly influenced by external conditions, such as import administration procedures, fiscal policies, and the distribution of goods from the Free Trade Zone (FTZ) to Other Areas Within the Customs Territory (TLDDP). The interview results revealed that these factors may cause fluctuations in spare parts procurement lead times, which, under certain circumstances, have the potential to disrupt the continuity of maintenance activities. The characteristics of the Free Trade Zone (FTZ) create operational conditions that differ from those of MRO facilities located in regular customs areas. While the FTZ provides various fiscal incentives and import facilitation benefits, the distribution of goods from the FTZ to Other Areas Within the Customs Territory (TLDDP) must still comply with administrative procedures and regulatory requirements that may affect logistics efficiency. Therefore, achieving high maintenance operational performance depends not only on procurement speed but also on the company's ability to manage inventory effectively, coordinate logistics activities, and anticipate potential regulatory constraints.

Overall, the t-test results show that spare parts availability is the most influential factor on maintenance operational performance at Batam Aero Teknik (BAT). This finding supports the research of (Fahriza, 2024) which identified that procurement and spare parts availability issues remain major challenges in the Indonesian MRO industry. Therefore, improving maintenance performance requires not only enhancements in procurement processes but also integrated inventory management, accurate material requirement planning, and information systems capable of improving overall spare parts visibility and control throughout the supply chain.

7. F Test Result

Table 6 F Test

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	0,1502	2	0,0751	11,060	0,000
Residual	0,3684	54	0,00682		
Total	0,5186	56			

The F-test results presented in Table 6 show an F-value of 11,060 with a significance level of 0,000, which is lower than the significance threshold of 0.05. Therefore, spare parts availability and procurement lead time simultaneously have a statistically significant effect on the maintenance operational performance of Batam Aero Teknik (BAT).

This finding indicates that maintenance performance is not influenced by a single factor but rather results from the interaction of various aspects within the spare parts supply chain.

Although procurement lead time does not exhibit a statistically significant effect when analyzed individually, it still contributes to maintenance operational performance when examined together with spare parts availability. These results highlight the importance of integrated spare parts supply chain management in supporting the effectiveness of maintenance activities.

The findings are consistent with those reported by (Fahriza et al., 2025) who explain that improving MRO procurement performance is not determined solely by the speed of material procurement but also by information integration, needs planning, and effective inventory management.

8. Coefficient of Determination & Research Discussion

Based on the questionnaire results, the spare parts availability variable (X1) showed relatively strong quantitative conditions but remained weak in terms of suitability and inventory control. Low scores on the indicator of spare parts type suitability indicate that vendors have not been able to provide parts that fully match aircraft technical specifications. This condition is caused by high dependence on imported spare parts and still limited procurement alternatives, including the use of Part Manufacturer Approval (PMA).

Conversely, the indicator for the number of items received the highest score, indicating that quantitatively, spare parts stock is relatively sufficient to support maintenance operations. However, the low score on safety stock implementation and the neutral score on maximum stock control indicate that the inventory management system is not yet optimal in anticipating demand fluctuations or procurement delays. This finding aligns with (Heizer et al., 2020) who explain that operational effectiveness is strongly influenced by an organization's ability to maintain appropriate availability and inventory control.

The procurement lead time variable (X2) showed fluctuating conditions influenced by various external factors. The indicator of supplier delivery time received a relatively high score, indicating that deliveries from foreign vendors generally run on schedule under normal conditions. However, import administration processes and fiscal policies received relatively low scores, indicating that bureaucratic factors remain the main obstacle to accelerating spare parts procurement.

The Free Trade Zone (FTZ) mechanism indicator was at a neutral level, reflecting that FTZ facilities provide fiscal benefits but have not been fully able to accelerate logistics flows. The lowest score was on the indicator of goods distribution from the FTZ toOther Places within the Customs Area (TLDDP), indicating that regulatory restrictions remain the main bottleneck in actual spare parts procurement lead time. This finding reinforces interview results showing that regulatory and administrative constraints remain challenges in MRO supply chain management.

Table 7 Model Summary

Statistic	Value
R	0,539
R^2	0,291

The coefficient of determination (R^2) value of 0,291 indicates that spare parts availability and procurement lead time explain 29,1% of the variation in maintenance operational performance. Meanwhile, 70,9% of the variation in maintenance operational performance is influenced by other factors not included in this research model.

The moderate coefficient of determination indicates that maintenance operational performance is a complex phenomenon and is not only influenced by spare parts availability and procurement lead time. Other factors such as technician competence, maintenance planning, facility capacity, fleet condition, information systems, and company managerial policies also potentially affect maintenance performance. Nevertheless, both variables studied still have

significant contributions to explaining the variation in maintenance operational performance and are relevant to focus improvements in MRO supply chain management.

Interviews with several employees revealed that Batam Aero Teknik (BAT) still has a relatively high dependence on imported spare parts, which are expensive and have long delivery times. To address this condition, the company collaborates with various spare parts vendors, establishes partnerships with logistics service providers, and proposes the use of Part Manufacturer Approval (PMA) as an alternative to increase spare parts procurement flexibility.

The main obstacle in the mechanism for transferring goods from the Free Trade Zone (FTZ) to Other Places within the Customs Area (TLDDP) is government regulations that restrict the outflow of goods from the FTZ area. On the other hand, the existence of Special Economic Zones (SEZs) provides different regulatory approaches, posing its own challenges in operational practice. Interview results also showed that procurement lead time is fluctuating and highly dependent on the availability of spare parts in the global market and the associated logistics processes. However, these impacts can be minimized through effective inventory management and more accurate material requirements planning.

Additionally, Batam Aero Teknik (BAT) has developed an Electronic Maintenance, Repair, and Overhaul (EMRO) system that enables real-time monitoring of aircraft requirements, spare parts availability, distribution, and material usage. This system has proven to assist operational decision-making and strengthen supply chain management. This finding supports the research of (Fahriza et al., 2025) which explains that improving MRO procurement performance depends not only on the speed of material procurement but also on information integration and supply chain visibility that enhance the effectiveness of spare parts management and support the achievement of maintenance operational performance.

CONCLUSION AND SUGGESTION

Conclusion

Based on the results of multiple linear regression analysis supported by interview findings, this study concludes that spare parts availability has a positive and significant effect on maintenance operational performance at Batam Aero Teknik (BAT). This finding indicates that spare parts availability is the most dominant factor in supporting the effectiveness of aircraft maintenance activities.

Meanwhile, procurement lead time has a positive but not partially significant effect on maintenance operational performance. Nevertheless, the simultaneous test results show that spare parts availability and procurement lead time together have a significant effect on maintenance operational performance.

The coefficient of determination (R^2) value of 0,291 indicates that both independent variables explain 29,1% of the variation in maintenance operational performance, while the remaining percentage is influenced by other factors outside the research model. This finding indicates that improving maintenance performance depends not only on spare parts and procurement management but also on other operational and managerial factors.

Overall, this study confirms that effective management of spare parts availability is a key factor in improving maintenance operational performance in the MRO industry, particularly at facilities operating in a Free Trade Zone.

2. Suggestions

a. Batam Aero Teknik (BAT) is advised to strengthen its management of spare part availability by improving the accuracy of material requirements planning, optimizing safety stock, diversifying vendors, and accelerating the implementation of Part Manufacturer Approval (PMA) as an alternative for spare part procurement. Additionally, the development of the Electronic Maintenance, Repair, and Overhaul (EMRO) system

needs to be continuously improved to support real-time visibility of inventory, material distribution, and operational decision-making.

b. The government is expected to harmonize policies related to the Free Trade Zone (FTZ), Special Economic Zones (SEZs), and the mechanism for distributing goods to Other Places within the Customs Area (TLDDP) so that the spare parts procurement and distribution process can proceed more effectively without reducing supervisory functions. Simplification of administrative processes and improved inter-agency coordination are also needed to support the competitiveness of the national MRO industry.

c. Future research is advised to develop research models by adding other variables that potentially affect maintenance operational performance, such as technician competence, maintenance planning, facility capacity, information systems, managerial policies, and logistics regulatory factors. In addition, future research may use a larger number of respondents, broader research objects, or more comprehensive analytical methods to gain deeper insight into the factors affecting maintenance operational performance in the MRO industry.

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