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IMPACT OF ARTIFICIAL INTELLIGENCE IMPLEMENTATION ON AIRCRAFT MAINTENANCE OPTIMIZATION THROUGH ANOMALY DATA CENTER DETECTION

Aditya Wardhana[1], Tri Mulyani Setyowati[2], Abrar Galuh Zuama[3], Arasy Fahrul Aziz[4]
[1, 2, 3, 4] Institut Transportasi dan Logistik Trisakti, Jakarta, Indonesia
Corresponding author: adityawardana2358@gmail.com

Abstract: This study aims to determine the impact of Artificial Intelligence (AI) implementation on aircraft maintenance optimization through data center anomaly detection at PT GMF Aeroasia. The data used in this research is primary data, taken from the answers of 32 respondents, namely maintenance division employees at PT GMF Aeroasia with saturated sampling technique. This research uses a quantitative approach and uses Structural Equation Modeling-Partial Least Square (SEM-PLS) analysis techniques to determine the impact of implementing AI on aircraft maintenance optimization through data center anomaly detection on GMF. The results showed that there was a positive and significant impact of artificial intelligence implementation and anomaly data center detection on aircraft maintenance optimization both partially. This research can enhance aircraft maintenance efficiency, predict potential issues, boost passenger safety and comfort. Additionally, it can contribute to the understanding of AI and anomaly detection in optimizing aircraft maintenance.
Keywords: *Artificial Intelligence (AI);Anomaly Data Center Detection;Aircaft Maintenance Optimizing;Maintenance Management*

1. Introduction

The aviation industry is one of the most important sectors in the global economy, playing a vital role in connecting people and goods between countries. The success of this industry depends on aircraft reliability and safety, which is achieved through effective and efficient aircraft maintenance. Aircraft maintenance is a crucial aspect of the aviation industry to ensure the safety of flight operations. High technology is required for the maintenance of a transportation, one of which is air transportation, the only mode of transportation with the highest level of safety. In the era of modern technology, artificial intelligence (AI) has become a potential solution in improving the efficiency and quality of aircraft maintenance.

Every person operating an aircraft shall maintain the aircraft, aircraft engines, propellers, and components to maintain reliability and airworthiness on an ongoing basis. (Agustian, 2023). In this research, the author will discuss how the application of artificial intelligence (AI) and data center anomaly detection can optimize aircraft maintenance. AI has an extraordinary ability to analyze data in depth and recognize hidden patterns. Meanwhile, data center anomaly detection enables early identification of abnormalities in aircraft performance. By combining these two technologies, the aviation industry can transform its approach to aircraft maintenance to be more proactive, cost-effective and problem prevention-oriented. These AI technologies have the potential to save costs on spare parts, maintenance labor and grounded time in aircraft maintenance.

Anomaly detection is the process of identifying anomalous events that do not match the expected behavior of the system. This enables the detection of new and hidden attacks. (Tushkanova et al., 2023) Anomaly detection in the data center also plays an important role in obtaining the information required for effective aircraft diagnosis and maintenance. Aviation data centers store vast and complex data on aircraft performance, including engine parameters, sensors, and maintenance history. By analyzing this data in real-time, data center anomaly detection can identify patterns that deviate from the norm, signaling potential impending problems. Its ability to identify potential problems early helps airlines save costs in several aspects, such as Reduced spare parts costs by anticipating breakdowns and proactively planning component replacements, Reduced maintenance labor costs by detecting problems that can be resolved before they require technician intervention, Reduced aircraft downtime by identifying and resolving problems before they result in grounded aircraft, thus improving flight punctuality and revenue.

The application of artificial intelligence technology in the aviation industry has been highly developed and this has become one of the backgrounds for the success of flight operations and the prevention of accidents on aircraft. The aviation industry that has implemented AI is Garuda Indonesia, Lion Air, PT GMF Aeroasia, namely the use of an engine health monitoring system (Engine Health Monitoring System) which can detect potential problems with aircraft engines before greater damage occurs. And the use of an aircraft structure monitoring system (Aircraft Structural Monitoring System) that can detect potential damage to the aircraft structure. Artificial Intelligence (AI) technology can improve flight performance and have a significant impact on the aviation industry. By analyzing Predictive and AI develops airlines' strategic approach to determine effective aircraft maintenance processes.

This research aims to analyze the direct and indirect impact of the application of artificial intelligence on aircraft maintenance optimization through data center anomaly detection by seeing how effective, efficient, and optimal aircraft maintenance is. This system is expected to assist airlines in achieving their goals of improving safety, efficiency, and customer satisfaction.

2. Literature Review

2.1. Maintenance Management

From the functions of management, there are branches of management science, one of which is maintenance management. Referring to the book (Pranowo, 2019) with the title Maintenance Systems and Management. Maintenance management can be defined as all management activities used to determine goals or priorities, maintenance, strategies, and responsibilities. Managing maintenance is the act of executing maintenance tasks which must be done with care and attention to the technical aspects of isolation, disassembly, cleaning, repairing, replacing, reassembling and testing equipment and components. In order to ensure continuous improvement, it is necessary to improve maintenance activities and support which can be achieved by management support, processes and effective communication.

”Aircraft Maintenance is purposive to be keeping the aircraft in a state which will or has enabled a certificate of release to service to be issued. Maintenance may incorporate such tasks as ensuring continuity with Airworthiness prescriptions or Service reports. The maintenance of aircraft is highly synchronized, in order to ensure precise and safe functioning during flight” (Al-Rabeei et al., 2022). Maintenance and repair are things that must be done on an engine or a machine, so that the machine can work properly and optimally. Therefore, aircraft maintenance and repair actions are needed to maintain the safety of its passengers and be able to make the aircraft operate properly.

In the process of management, maintenance management, and aircraft maintenance is a unity that makes maximum results for aircraft flight operations. Where if all aircraft components are maintained with a good management system, it will result in a high level of safety. Aircraft maintenance is highly synchronized, to ensure proper and safe functioning during flight. The role of the management function here is very much played with effective processes and communication.

2.2. Artificial Intelligence (AI)

Artificial intelligence (AI) is an extensive computing component responsible for the creation of intelligent machines capable of performing tasks that require human ingenuity

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(Gupta & Kumar, 2021). Artificial Intelligence' term was first used in 1956 for the first "Dartmouth Summer Research Project on Artificial Intelligence", and is generally refers to any machine that exhibits traits associated with a human mind, such as learning and problem-solving (Degas et al., 2022). Artificial intelligence is a branch of computer science that studies and imitates human thinking and is implemented in machines (Aprilia, 2008). The integration of AI into design models has the potential to enhance safety and reliability (Bautista-Hernández & Martin-Prats, 2024). Artificial intelligence (AI) is a branch of computer science that aims to create intelligent machines that are able to imitate human thinking abilities, such as learning and solving problems. This term was first used in 1956 and since then has continued to grow rapidly. The integration of AI in various design models has been proven to improve safety and reliability. The application of AI is increasingly widespread and has the potential to have a significant impact in various areas of life.

2.3. Anomaly Data Center Detection

Anomaly detection is the process of identifying anomalous events that do not match the expected behavior of the system. This allows the detection of new and hidden attacks (Tushkanova et al., 2023). Refer to research (Rahman et al., 2021) "One of the efforts in establishing an internet network security system is anomaly detection. Anomaly detection is a process of finding deviant behavior in internet usage The basic principle of anomaly detection is to define normal user behavior well so that attack behavior on the internet network can be identified correctly". In the context of aircraft maintenance, anomaly detection can be used to detect potential problems by analyzing sensor data, maintenance history, and aircraft operating parameters. Anomaly detection allows airlines to identify problems early and take preventative action before they escalate into greater damage.

2.4. Aircaft Maintenance Optimizing

The digital transformation sweeping airline maintenance operations has enabled more nuanced analysis that goes beyond the scope of legacy maintenance strategies to provide prescriptive maintenance tools and to assess the risk of air outages across airline networks. Big data analytics and predictive algorithms have been developed to determine impending failures at individual components, aircraft and fleet levels, and then provide complete repair solutions (Tsakalerou et al., 2022).

Refer to research (Stanton et al., 2023)" automated tools will enable a greater number of people to build PdM models on aircraft data. Greater research into automated tools in this field will encourage both more development and use in the industry, leading to greater savings and safety afforded to in-service aircraft". On research (Ichou & Veress, 2023) "The digitalization and the potential application of artificial intelligence in aircraft MRO processes will increase speed, improve reliability, and reduce costs by achieving predictable and consistent turnaround time (TAT). In this paper, the capabilities of neural networks for predicting the actual man hours were tested because accurate TATs lead to better aircraft release compliance and hence customer satisfaction."

The development of AI tools to build predictive maintenance models (PdM) from aircraft data has great potential. The convenience offered by this automatic tool will encourage increased development and use of this technology in the aviation industry. As a result, we can expect greater cost savings and increased safety of the aircraft fleet in operation. Optimizing aircraft maintenance is an important area in the aviation industry that aims to ensure the reliability, safety and efficiency of flight operations. By implementing strategic practices and leveraging innovative technology, airlines and aircraft operators can streamline their maintenance processes, reduce downtime and maximize aircraft availability.

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To create efficient maintenance operational costs, airlines need to have strategies in place. By prioritizing worn components by replacing them with new ones according to quality standards, aircraft service life and safety will be increased while reducing operational costs. AI technology like predictive maintenance on the basis of anomaly detection can also save time and costs in carrying out aircraft maintenance operations because AI has an algorithm to detect abnormal data. All of this is done to optimize aircraft maintenance.

Table 1. Previous Research

Variables	Research Title	Writer	Key Findings
Artificial Intelligence Implementation	Artificial Intelligence with the Formation of Values and Character in the Education Sector	(Mulianingsih et al., 2020)	AI works by quickly combining large amounts of data, and intelligent algorithms, allowing software to learn automatically from patterns or features in the data. AI is a broad field of study that encompasses many theories, methods, and technologies, as well as major subfields.
Anomaly Data Center Detection	A Survey on Explainable Anomaly Detection	(Li et al., 2023)	The Explainable Anomaly Detection technique can provide a global explanation in the sense that this technique makes subsequent anomaly detection models more transparent and interpretable by retaining features that are not too relevant or redundant, or providing feature representations that can be understood by humans.
Aircraft Maintenance Optimizing	Applications of Machine Learning in Aircraft Maintenance	(Karaoğlu et al., 2022)	By analyzing historical data from the aircraft maintenance system, a predictive model is provided to predict high-priority failures in advance, and preventive maintenance can be performed based on the model's prediction results. Over the decades, maintenance technology has advanced, and ways to reduce the likelihood of engine system failure have been discovered. Corrective and preventive maintenance are two general types of maintenance approaches

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3. Research Method

3.1. Hypothesis

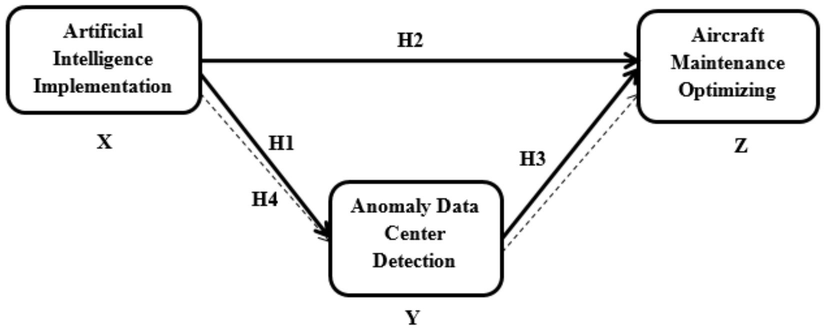

Figure 1.Conseptual Framework

- **Application of Artificial Intelligence – Anomaly Data Center Detection**

  H1: The application of artificial intelligence (AI) has a direct positive and significant impact on Anomaly Data Center Detection.

- **Application of Artificial Intelligence – Optimization of Aircraft Maintenance.**

  H2: The application of artificial intelligence (AI) has an impactdirectpositive and significant towards Optimizing Aircraft Maintenance.

- **Anomaly Data Center Detection - Aircraft Maintenance Optimization.**

  H3: Anomaly Data Center Detection has a direct positive and significant impact on optimizing aircraft maintenance.

- **Application of Artificial Intelligence - Anomaly Data Center Detection - Optimization of Aircraft Maintenance.**

  H4: The application of artificial intelligence has a positive and significant indirect impact on optimizing aircraft maintenance through Anomaly Data Center Detection

3.2. Method

This research will use quantitative research methods with primary data analyzed using models Structural Equation Modeling (SEM). The research method used was a survey of 32 respondents from the maintenance division at PT GMF Aeroasia used probability sampling with a saturated sampling technique. In data processing, analytical techniques are used Partial Least Squares (PLS)**.** This research uses the SmartPLS-4 research tool. This approach allows researchers to build comprehensive models of relationships between variables, as well as test research hypotheses by considering the complexity of primary data which may have limitations.

Table 2.Measurements Indicators

Variables	Indicators	Statements
Application of artificial intelligence (X)	**Task Automation**	Automation of aircraft maintenance tasks using AI has significantly increased work efficiency.
	Predictive Data Analysis	AI-based predictive data analysis is very helpful in identifying potential problems with aircraft before damage occurs.

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	Improved Accuracy	The use of AI has significantly improved the accuracy of problem diagnosis and aircraft maintenance planning.
	Optimization of Spare Parts Inventory	AI is helpful in managing spare parts inventory, ensuring timely availability and reducing storage costs.
	Integration with Systems	The integration of AI systems with existing aircraft maintenance systems has significantly improved workflow and data accessibility.
	Ease of Use	AI is very easy to use and helps technicians understand and utilize the information generated by the system.
	Training and Development	The training that employees receive is very helpful in increasing their understanding and ability to use AI technology for aircraft maintenance.
	Performance Evaluation	Regularly evaluating the performance of AI systems is very important in increasing the effectiveness and efficiency of implementing AI in aircraft maintenance in companies.
Anomaly Detection (Y)	**Detection Accuracy**	The anomaly detection system in the data center accurately identifies potential problems with the aircraft that could impact aircraft performance.
	Detection Speed	Anomaly detection systems can quickly identify and provide early warning of potential problems with aircraft.
	Types of Anomalies Detected	Anomaly detection systems are capable of detecting various types of anomalies, such as malfunctions, hardware failures, or aircraft equipment failures.
	Alert response	The anomaly detection system provides clear and informative alerts, enabling rapid response to prevent disruption to aircraft maintenance.
	Anomalous Data Visualization	The visual display of anomaly data generated by the system is easy to understand and provides relevant information for further analysis.
	Cause Analysis	Anomaly detection systems help in analyzing the root causes of detected problems, thereby facilitating future repairs and prevention.
	System usage	The anomaly detection system is easy to use and integrates well into existing aircraft maintenance workflows.
	Adaptation to Change	Anomaly detection systems can adapt to changes in the data center environment and remain effective in detecting new anomalies.
	Impact Evaluation	The use of anomaly detection systems has had a positive impact in optimizing aircraft maintenance by preventing disruptions caused by aircraft data system failures.
Optimizing Aircraft Maintenance (Z)	**Reduced Downtime**	The implementation of AI and anomaly detection in the data center has reduced unscheduled aircraft downtime due to technical problems.
	Increased Maintenance Intervals	The use of AI and anomaly detection has made it possible to increase the time interval between scheduled maintenance of aircraft.

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Reduction in Maintenance Costs	The implementation of AI and anomaly detection has contributed to reducing overall aircraft maintenance costs.
Improved Safety	The use of AI and anomaly detection has increased the operational safety level of aircraft.
Optimizing Aircraft Performance	The application of AI and anomaly detection has improved aircraft performance, such as fuel efficiency and component reliability.
Increased Customer Satisfaction	Optimizing aircraft maintenance with AI and anomaly detection has increased customer satisfaction with aviation services.
Increased Operational Efficiency	The use of AI and anomaly detection has increased operational efficiency in the aircraft maintenance process.
Increased competitiveness	Optimizing aircraft maintenance with AI and anomaly detection has increased the competitiveness of airlines.
Improved standards of care	The application of AI and anomaly detection has contributed to improving aircraft maintenance standards in the company.
Integration with Systems	AI and anomaly detection systems integrate well with existing aircraft maintenance systems, such as maintenance management systems.

4. Results and discussion

4.1. Outer Model Testing

In the outer model evaluation, validity is carried out using two criteria, namely convergent and discriminant validity, while reliability evaluation is carried out based on two criteria, namely Cronbach alpha and composite reliability.

Table 3. Convergent Validity

	Aircraft Maintenance Optimizing_(Z)	Anomaly Data Center Detection_(Y)	Artificial Intelligence Implementation_(X)
ADCD1		0.753	
ADCD2		0.893	
ADCD3		0.818	
ADCD4		0.830	
ADCD5		0.866	
ADCD6		0.873	
ADCD7		0.837	
ADCD8		0.778	
ADCD9		0.920	
AII1			0.885
AII2			0.879
AII3			0.785
AII4			0.755
AII5			0.882
AII6			0.817
AII7			0.809
AII8			0.712

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AMO1	0.835
AMO10	0.881
AMO2	0.826
AMO3	0.840
AMO4	0.867
AMO5	0.815
AMO6	0.838
AMO7	0.907
AMO8	0.928
AMO9	0.953

source:SMART-PLS-4,2024

Based on table 3, it is known that the loading factor value produced by each indicator is more than 0.7. Thus, these indicators are declared convergently valid

Discriminant validity
Table 4. Cross Loading

	Aircraft Maintenance Optimizing_(Z)	Anomaly Data Center Detection_(Y)	Artificial Intelligence Implementation_(X)
ADCD1	0.555	**0.753**	0.577
ADCD2	0.756	**0.893**	0.744
ADCD3	0.652	**0.818**	0.696
ADCD4	0.796	**0.830**	0.768
ADCD5	0.720	**0.866**	0.692
ADCD6	0.719	**0.873**	0.706
ADCD7	0.748	**0.837**	0.730
ADCD8	0.719	**0.778**	0.651
ADCD9	0.836	**0.920**	0.760
AII1	0.743	0.691	**0.885**
AII2	0.730	0.660	**0.879**
AII3	0.699	0.680	**0.785**
AII4	0.601	0.660	**0.755**
AII5	0.757	0.693	**0.882**
AII6	0.777	0.715	**0.817**
AII7	0.756	0.746	**0.809**
AII8	0.708	0.622	**0.712**
AMO1	**0.835**	0.633	0.747
AMO10	**0.881**	0.797	0.765
AMO2	**0.826**	0.671	0.784
AMO3	**0.840**	0.763	0.794
AMO4	**0.867**	0.833	0.776
AMO5	**0.815**	0.619	0.759
AMO6	**0.838**	0.815	0.693
AMO7	**0.907**	0.774	0.776
AMO8	**0.928**	0.775	0.799
AMO9	**0.953**	0.802	0.810

source:SMART-PLS-4,2024

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Based on table 4, the cross loadings values show that the indicators have higher loadings on their respective constructs compared to other constructs. It can be concluded that the construct or latent variable already has good discriminant validity.

Table 5. Reliability Test

	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
Aircraft Maintenance Optimizing (Z)	0.964	0.969	0.757
Anomaly Data Center Detection (Y)	0.948	0.956	0.710
Artificial Intelligence Implementation (X)	0.928	0.941	0.669

source:SMART-PLS-4,2024

Based on table 5, the reliability test shows that variable*Cronbach's Alpha*and composite reliability has a value > 0.7. Thus, it can be concluded that this construct has good reliability with the minimum required limit.The resulting AVE value for each variable is above 0.05. This shows that indicator variables that have an AVE value greater than 0.05 are latent variables that can explain more than half of the variance in the indicators that exist in the average.

Inner Model

Table 6. R-square

	R-square	R-square adjusted
Aircraft Maintenance Optimizing (Z)	0.834	0.822
Anomaly Data Center Detection (Y)	0.702	0.692

source:SMART-PLS-4,2024

Based on table 6, test results*R-square*shows that the Aircraft Maintenance Optmizing (Z) variable has an R-square value of 0.834 and likewise, the Anomaly Data Center (Y) variable has an R-square value of 0.702. So it can be concluded that in forming this model it is considered strong.

Table 7. Effect Size

	Aircraft Maintenance Optimizing_(Z)	Anomaly Data Center Detection_(Y)	Artificial Intelligence Implementation_(X)
Aircraft Maintenance Optimizing_(Z)			
Anomaly Data Center Detection_(Y)	0.295		
Artificial Intelligence Implementation_(X)	0.533	2,356	

source:SMART-PLS-4,2024

On table 7, The parameters used are 0.35 (strong); 0.15 (moderate); and 0.02 (weak). Analysis of the effect size value shows that Anomaly Data Center Detection (Y) has a big impact on Aircraft Maintenance Optimizing (Z) with an F^2 value of 0.295. Artificial Intelligence Implementation (X) has a big impact on Aircraft Maintenance Optimizing (Z) with

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an F^2 value of 0.533 and Artificial Intelligence Implementation (X) has a very big impact on Anomaly Data Center (Y) with an F^2 value of 2.356.

Table 8. Goodness of Fit Model Test

Average variance extracted (AVE)	R-square
0.757	0.834
0.710	0.702
0.669	

GOF Formula:= $\sqrt{AVE \,.\, R^2}$
$= \sqrt{0.712 \,.0.5898^2}$
$= 0{,}648$

From the calculation results based on the equation above, the value of Goodness of Fit (GoF) in this research model is 0.648. Overall, this research model shows better combined performance of the 0-1 scale, which is divided into small GoF = 0.1, medium GoF = 0.25, and large GoF = 0.38. With these calculated values, it can be concluded that the model or performance of the relationship between the outer and inner models is fit or validWhichhas a GoF value in the large category with a value above 0.38.

Hypothesis Testing Results

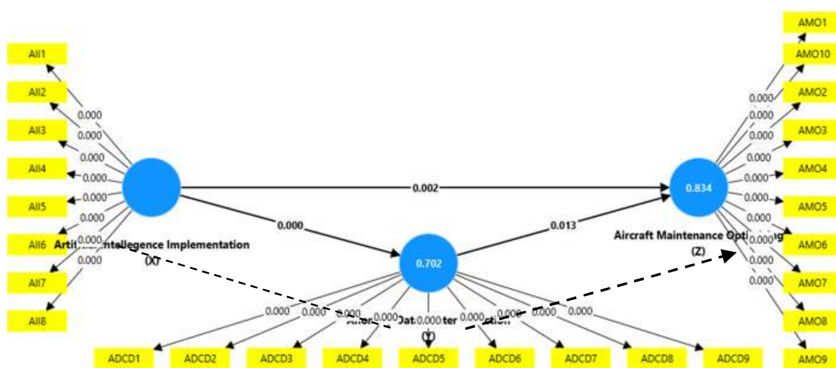

Figure 2. Path Coefficients

Table 9. Hypothesis Testing

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Anomaly Data Center Detection_(Y) -> Aircraft Maintenance Optimizing_(Z)	0.406	0.425	0.164	2,476	0.013
Artificial Intelligence Implementation_(X) -> Aircraft Maintenance Optimizing_(Z)	0.546	0.528	0.174	3,136	0.002
Artificial Intelligence Implementation_(X) -> Anomaly Data Center Detection_(Y)	0.838	0.843	0.066	12,764	0,000

source:SMART-PLS-4,2024

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Following are the results of the Original sample (O) test in table 9 based on the results of the Path Coefficients as follows:

1. The impact of Anomaly Data Center Detection on Aircraft Maintenance Optimizing.
   The impact of Anomaly Data Center Detection on Aircraft Maintenance Optimizing has a positive or unidirectional impact with the original sample value of 0.406. This shows that if Anomaly Data Center Detection increases by one unit, then Aircraft Maintenance Optimizing will experience an increase of 0.406 unit.
2. The impact of Artificial Intelligence Implementation on Aircraft Maintenance Optimizing
   The impact of Artificial Imtelligence Implementation on Aircraft Maintenance Optimizing has a positive or unidirectional impact with the original sample value of 0.546. This shows that if Artificial Intelligence Implementation increases by one unit, then Aircraft Maintenance Optimizing will experience an increase of 0.546 unit.
3. The impact of Artificial Intelligence Implementation on Anomaly Data Center Detection
   The impact of Artificial Intelligence Implementation on Anomaly Data Center Detection has a positive or unidirectional impact with the original sample value of 0.838. This shows that if Artificial Intelligence Implementation increases by one unit, then Anomaly Data Center Detection will increase by 0.838 unit.

In SEM PLS, statistical testing of each hypothesized relationship is carried out using simulation. In this case, it is carried out using the bootstrapping method for the sample. The following are the results of the PL bootstrapping analysis:

1. The results of testing the first hypothesis, namely the direct impact of Anomaly Data Center Detection on Aircraft Maintenance Optimizing, show a p-value of 0.013 < significance level 0.05 and a t-statistic value of 2.476 > t-table 1.961. According to research (Karaoğlu et al., 2022) which stated that "By analyzing historical data from the aircraft maintenance system, a predictive model is provided to predict high-priority failures in advance, and preventive maintenance can be performed based on the model's prediction results." These results show that Anomaly Data Center Detection has a significant and positive impact on Aircraft Maintenance Optimizing (H3).
2. The results of testing the second hypothesis, namely the direct impact of Artificial Intelligence Implementation on Aircraft Maintenance Optimizing, show a p-value of 0.002 < significance level 0.05 and a t-statistic value of 3.136 > t-table 1.961. Refer to research (Stanton et al., 2023)" automated tools will enable a greater number of people to build PdM models on aircraft data. Greater research into automated tools in this field will encourage both more development and use in the industry, leading to greater savings and safety afforded to in-service aircraft" These results show that Artificial Intelligence Implementation has a significant and positive impact on Aircraft Maintenance Optimizing (H2).
3. The results of testing the second hypothesis, namely the direct impact of Artificial Intelligence Implementation on Anomaly Data Center Detection, show a p-value of 0.000 < significance level 0.05 and a t-statistic value of 12,764 > t-table 1.961. This is in line with research (Mulianingsih et al., 2020) which stated that "AI works by combining large amounts of data quickly, and intelligent algorithms, allowing software to learn automatically from patterns or features in the data." These results show that Artificial Intelligence Implementation has a significant and positive impact on Anomaly Data Center Detection (H1).

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Table 10. Specific Indirect Effect

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Artificial Intelligence Implementation_(X) -> Anomaly Data Center Detection_(Y) -> Aircraft Maintenance Optimizing_(Z)	0.340	0.360	0.149	2,281	0.023

source:SMART-PLS-4,2024

Based on the Original sample (O) in table 10, it is found that the relationship between the variable Artificial Intelligence Implementation and Aircraft Maintenance Optimizing via Anomaly Data Center Detection has a positive or unidirectional relationship with the original sample value of 0.340. This shows that if Artificial Intelligence Implementation increases by one unit, then Aircraft Maintenance Optimizing via Anomaly Data Center Detection will experience an increase of 0.340.

The results of the specific indirect test, namely the indirect impact of Artificial Intelligence Implementation on Aircraft Maintenance Optimizing through Anomaly Data Center Detection, show a p-value of 0.023 < significance level 0.05 and a t-statistic value of 2,281 > t-table 1.961. On research (Ichou & Veress, 2023) ”The digitalization and the potential application of artificial intelligence in aircraft MRO processes will increase speed, improve reliability, and reduce costs by achieving predictable and consistent turnaround time (TAT). In this paper, the capabilities of neural networks for predicting the actual man hours were tested because accurate TATs lead to better aircraft release compliance and hence customer satisfaction.” Predictive maintenance on the basis of anomaly detection can also save time and costs in carrying out aircraft maintenance operations because AI has an algorithm to detect abnormal data. All of this is done to optimize aircraft maintenance. These results show that Artificial Intelligence Implementation has a significant and positive impact on Aircraft Maintenance Optimizing through Anomaly Data Center Detection (H4).

5. Conclusion

Artificial Intelligence Implementation of Anomaly Data Center Detection: from processed data,shows that there is a direct positive and significant impact. The implementation of AI can improve anomaly detection capabilities more quickly and accurately, thereby helping to identify potential problems that can affect aircraft maintenance operations. This proves that AI is an effective tool in monitoring and analyzing complex data in data centers.

Artificial Intelligence Implementation of Aircraft Maintenance Optimizing: from processed data, shows that there is a direct positive and significant impact. With the implementation of AI, the aircraft maintenance process becomes more efficient so that it can improve aircraft operational performance and effectiveness.

Anomaly Data Center Detection for Aircraft Maintenance Optimizing: from the processed data, it shows there is a direct positive and significant impact. Early detection of problems can prevent disruptions caused by aircraft system failures so that the aircraft maintenance process can be carried out more optimally.

Artificial Intelligence Implementation of Aircraft Maintenance Optimizing through Anomaly Data Center Detection; from the processed data, shows that there is a positive and significant indirect impact. Anomaly Detection acts as a link between the application of AI and the optimization of aircraft warnings. Thus, the integration between AI and anomaly detection

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works partially in improving the quality and efficiency of aircraft maintenance at GMF.

6. Implications

6.1. Theoretical Benefits

The application of artificial intelligence (AI) and anomaly detection in aircraft maintenance management has great potential to optimize cost efficiency. AI technology can analyze sensor data, maintenance data and weather data to detect anomalies that indicate potential problems with the aircraft before they develop into serious damage. In this way, airlines can carry out more timely and efficient predictive maintenance, reduce unexpected repair costs, and minimize the risk of flight cancellations or delays due to technical problems.

This research is expected to provide insight into the potential cost efficiencies in aircraft maintenance optimization that can be achieved by applying AI and anomaly detection in aircraft maintenance management. Provides guidance to airlines and aircraft operators on integrating AI and anomaly detection systems into their maintenance management processes. Increasing the effectiveness of the application of artificial intelligence (AI) in aircraft maintenance, thereby increasing flight safety and efficiency.

By analyzing parts usage and failure data, AI can predict parts demand and ensure the right parts are available at the right time. This can reduce storage costs and minimize the risk of spare parts shortages. By optimizing maintenance schedules and reducing unexpected downtime, AI can help improve airline operational efficiency. This can result in cost savings and increased profitability.

6.2. Practical Benefits

This research can be implemented to increase the efficiency of aircraft maintenance costs by accurately predicting aircraft component failures and providing early warnings about potential problems so as to prevent aircraft damage and accidents.

This research can increase the feeling of safety and comfort for passengers. as well as reducing the risk of flight delays or cancellations due to technical problems.

This research can increase knowledge regarding the benefits of AI and data center anomaly detection in optimizing aircraft maintenance to streamline flight operational costs.

7. Research limitations

The limitations of this research include several crucial aspects. First, the availability of comprehensive, high-quality aircraft maintenance data can be an obstacle, as incomplete or inaccurate data can affect the accuracy of AI models in detecting anomalies.

Second, the complexity of modern aircraft systems with many components and complex interactions can make it difficult to develop AI models capable of accurately modeling all possible anomalies.

Fourth, the developed AI model may have limitations in terms of generalization to different aircraft types or airlines as differences in aircraft design, maintenance procedures, and operational conditions may affect model performance.

Fifth, human factors such as errors in data collection, data labeling, or interpretation of AI results can affect the validity of research findings.

Sixth, implementing AI and anomaly detection technologies on a large scale can require significant investments in hardware, software, and personnel training, which can be a barrier to implementation.

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