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The Development of Fighter Aircraft Maintenance Management Through Artificial Intelligence Technology to Support the Duties of the Indonesian Air Force

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A B S T R A C T

Fighter aircraft maintenance management is a crucial aspect in ensuring the operational readiness of the Indonesian Air Force. In this context, the use of Artificial Intelligence (AI) technology has been highlighted as a potential solution to improve efficiency and effectiveness in maintenance. The method used in writing this journal is a qualitative method. There are two theories used in this research, namely; First, fighter aircraft maintenance management is discussed by referring to the theory of Terry Wireman who emphasizes the importance of availability, reliability, and maintainability. The emphasis on structured planning and proactive maintenance implementation is crucial to ensure that fighter aircraft are always in operational readiness. The application of AI technology can improve failure prediction, more effective maintenance planning, and more accurate spare parts inventory management. The conclusion of this paper is that the application of AI technology with a systematic approach and structured planning can overcome various challenges and obstacles in maintenance management. Thus, AI technology has enormous potential to improve the success of fighter aircraft maintenance management. This will significantly support the readiness and effectiveness of the Indonesian Air Force in carrying out its strategic tasks.

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INTRODUCTION

Fighter aircraft maintenance is a critical element in supporting the operational readiness of the Indonesian Air Force. Fighter aircraft are a type of defense equipment that requires maintenance intensive And sustainable For ensure performance optimal in every mission carried out. Effective and efficient maintenance management is needed to prevent unwanted damage and to extend the service life. shelf life aircraft However, the challenge Which faced Fighter aircraft maintenance management is quite complex. Manual, paper-based maintenance processes are often ineffective, time-consuming, and prone to human error. This can negatively impact operational readiness. And security flight. By Because That, required something a new, more modern and reliable approach to addressing this problem.

Artificial Intelligence (AI) technology offers a potential solution for improving fighter aircraft maintenance management. AI has the ability to analyze data big in a way fast And accurate, identify pattern and anomalies, and provide predictions that can be used for more proactive and targeted maintenance planning. Implementing AI in maintenance management can improve operational efficiency, reduce downtime, and extend aircraft service life.

However, the application of AI technology in fighter aircraft maintenance management is not without challenges and obstacles. Adaptation to technology new This need change culture organization, investment Which significant, as well as personnel training and skills development. Furthermore, AI integration with existing systems and data security issues are also key concerns.

In an effort to understand and explore the potential and challenges of applying *Artificial Intelligence* (AI) technology to fighter aircraft maintenance management, this research review will examine various relevant literature and previous studies. These previous studies provide a theoretical and empirical basis for important For identify practice best, innovation latest, as well as constraint challenges that may be encountered in integrating AI into fighter aircraft maintenance systems. Through this review, the authors will gain a more comprehensive picture of the benefits and implications of AI technology for fighter aircraft maintenance management, which in turn will support the development of an effective implementation strategy for the Indonesian Air Force.

Based on the description above, the author has a basic assumption that Artificial Intelligence (AI) technology has great potential to improve the efficiency and effectiveness of fighter aircraft maintenance management within the Indonesian Air Force. With the rapid development of technology, AI is expected to help improve various aspects of maintenance, such as component failure prediction, resource management, and maintenance schedule optimization. In this context, effective maintenance is crucial to ensuring aircraft operational readiness. combat Which support various task strategic Indonesian National Armed Forces Force Air. Furthermore, the primary objective of this paper is to examine how the application of AI technology can improve the fighter aircraft maintenance management system in the Indonesian Air Force,

particularly in increasing aircraft reliability, availability, and readiness. This research also aims to identify challenges and obstacles. Which Possible faced in implementation technology AI, as well as This paper provides practical recommendations for the effective and efficient implementation of this technology, thus supporting the strategic tasks of national air defense. The problem formulation in this paper is as follows: How is fighter aircraft maintenance managed? What are the challenges and obstacles to this management? maintenance aircraft combat through implementation technology artificial intelligence? Considering the various aspects discussed, the use of Artificial Intelligence technology in fighter aircraft maintenance management is a strategic step that the Indonesian Air Force (TNI AU) needs to consider. This technology has great potential to improve efficiency, accuracy, and And reliability in aircraft maintenance combat, Which on Finally will support operational readiness and aviation safety. However, to achieve this, a deep understanding of current maintenance management and identification of challenges and barriers to implementing AI technology are required. Therefore, this paper will explore two formulations. problem main: How management maintenance aircraft combat moment it's running And How challenge as well as obstacle in apply technology artificial intelligence in management.

LITERATURE REVIEW

Management Theory

Etymologically, management comes from the English word " *management,* " which comes from the verb " *to manage,*" meaning control. In Indonesian, management can be interpreted as: controlling, handling, or administering. Management studies how create *effectiveness* business (*doing right things*) in a way *efficient (doing things right)* and productive, through certain functions and cycles, in order to achieve organizational goals Which has set (Ndraha, 2011). Function management is Basic elements that will always be present and inherent in the management process that will be used as a reference by managers in carrying out activities to achieve goals. According to Terry (2013), the management functions are as follows: **First** , the Planning Function . Planning *is* the process of determining the work that must be carried out by a work group to achieve the specified goals. This *planning* includes decision-making activities, because it includes selecting alternatives for a decision. Second, the *Organizing* Function . The Organizing stage includes; First, dividing the components of the activities needed to achieve the goals. has been determined within the group. Second, assigning tasks to a leader or manager to categorize activities and work. Third, determining tasks and authorities among groups or organizational units. **Third,** *the* Actuating Function . *Actuating* includes activities carried out by a manager to initiate and continue activities determined by the planning and organizing elements so that goals can be achieved.

Management Theory Maintenance.

Wireman (2004) defines maintenance management as a series of activity Which done For guard asset physique in condition optimal operation, maximizing service life, and ensuring consistent performance. Wireman emphasized the importance of a proactive and structured approach to maintenance. to prevent damage And reduce costs. More According to Wireman, a number of indicator main in management maintenance includes; **First,** Availability . The percentage of time the equipment is available for use. *Second* **,** Reliability .

Anthony Kelly (2006) defines maintenance as any activity carried out to maintain, restore, or improve the condition of a physical asset so that it remains in optimal operational condition. The average time required For repair equipment Which experience failure, Which measuring the ease and speed of repair. Third, *Availability* . The percentage of time that equipment is available and ready for use, calculated based on MTBF and MTTR. Fourth, *Preventive Maintenance Compliance* . Level compliance to Preventive maintenance schedule, which reflects the extent to which maintenance is performed proactively to prevent failure. Fifth, *Cost of Maintenance* . Costs incurred for maintenance include labor, spare parts, and downtime.

METHODOLOGY

This study employs a qualitative approach combined with a literature review to explore the application of artificial intelligence (AI) in fighter aircraft maintenance management within the Indonesian Air Force (TNI AU). The qualitative approach is used to gain in-depth insights into processes, experiences, and perceptions that cannot be measured quantitatively (Creswell, 2014). Data were collected from primary and secondary sources. Primary data were obtained through in-depth interviews with aircraft maintenance management personnel and AI experts, while secondary data were gathered from academic literature, research reports, and official documents relevant to maintenance management and AI technology.

Data collection techniques included individual interviews and document analysis. The collected data were analyzed using qualitative data analysis procedures consisting of data reduction, data presentation, and conclusion drawing. To ensure the validity and reliability of the findings, data triangulation and expert validation were conducted. This methodology aims to provide comprehensive insights into how AI technology is implemented in maintenance management and its impact on improving efficiency and effectiveness, thereby supporting the operational readiness of the Indonesian Air Force.

RESEARCH RESULT

Development of fighter aircraft maintenance management through Artificial Intelligence technology (AI) For support task Indonesian National Armed Forces Force Air is field This is a promising area with great potential to improve operational efficiency and effectiveness. To understand and develop

this topic, it is important to review previous research and identify research gaps and the novelty of proposed new research.

S. A., & Padhy, S. C. (2023) discuss implementation AI in maintenance predictive machine Combat vehicles, which enable repairs before failure occurs, demonstrate the relevance of AI to increase the lifespan of military components. Research by Azhar, ZA, et al. (2022) developed a military asset management system in Indonesia, which can be adapted to support the application of AI in the maintenance of defense equipment. Setiarsono, Y., & Rakita, Z. (2024) Studies This research strategy industry defense national in support modernization defense equipment, including use AI in maintenance to improve reliability and readiness. Agustian, ES (2020) research discusses the aircraft weapon system reliability control program, showing how AI can strengthen this program through data analysis and failure prediction. Purja, A., et al. (2023) highlights the prospect of using AI in the Indonesian National Armed Forces (TNI) ship information system to improve reliability and efficiency, which can also be applied in fighter aircraft maintenance. Yusmahendra, RA, & Wahyuni's research, H. C. (2022) propose strategy mitigation risk in maintenance Information technology-based aircraft, relevant for the application of AI in failure prediction. Biringkanae, P., & Bunahri, R. R. (2023) give review about development AI in aviation, highlighting the challenges and potential of applying AI in aircraft maintenance.

These studies collectively support the idea that AI can improve military maintenance management, particularly in the context of failure prediction and increased operational readiness. The proposed research, "Developing Fighter Aircraft Maintenance Management Through Artificial Intelligence Technology to Support the Duties of the Indonesian Air Force," has several innovative aspects. Which give contribution significant to field This. First, This research will be the first to deeply explore how AI can be applied to fighter aircraft maintenance management within the Indonesian Air Force. Data Which generated by fighter aircraft sensors covers various aspects, such as engine performance, avionics systems, And condition physique aircraft. Use AI For manage And Analyzing this data effectively will allow for faster and more accurate problem identification, allowing for more efficient and effective maintenance.

Third, this research will also include strategies for developing skills and training for personnel. maintenance in use And utilization technology AI. Aspect This very important Because implementation AI need skill special in programming, data analysis, and maintenance of AI systems. By providing a tailored training program, the Indonesian Air Force can ensure that maintenance personnel have the competencies necessary to effectively use this new technology. Fourth, this research combines a multidisciplinary approach that

encompasses information technology, mechanical engineering, and management. thus, study This offer framework Work Which comprehensive for the application of AI in fighter aircraft maintenance management. This approach is not only increase effectiveness maintenance but Also reduce cost operationally overall, so that give mark plus Which significant for operation Indonesian Air Force.

In a way overall, study This No only fill in gap Which There is in This research not only builds on previous literature but also offers a new and innovative approach to applying AI technology to support the operational tasks of the Indonesian Air Force more effectively and efficiently. Therefore, this research has great potential to make significant contributions to the field of fighter aircraft maintenance management and enhance national defense capabilities.

Management Maintenance Aircraft Combat

Fighter aircraft maintenance data at Iswahjudi Air Force Base between 2020 and 2023 shows several significant trends and patterns, especially in terms of the amount of maintenance carried out for two main aircraft types, namely the F-16 and T-50i, at three maintenance levels: light, medium, and heavy, as well as unscheduled maintenance .

Table 1. Aircraft Maintenance at Air Force Base Iswahjudi 2020-2023 Academic Year

PSWT (SAT)	TYPE HAR	2020		2021		2022		2023	
		RENC	LAKS	RENC	LAKS	RENC	LAKS	RENC	LAKS
F- 16	LIGHT	1018	1063	1031	1117	963	960	598	638
(SKD 3)	CURRENTLY	20	18	17	23	249	158	191	135
	HEAVY	37	16	56	34	41	30	19	25
	NO SCHEDULED		849		891		679		405
T- 50i	LIGHT	512	382	475	367	513	412	435	422
(SKD 15)	CURRENTLY	160	155	131	115	167	125	176	140
	HEAVY	6	7	5	5	13	6	9	4
	NO SCHEDULED		572		686		732		558

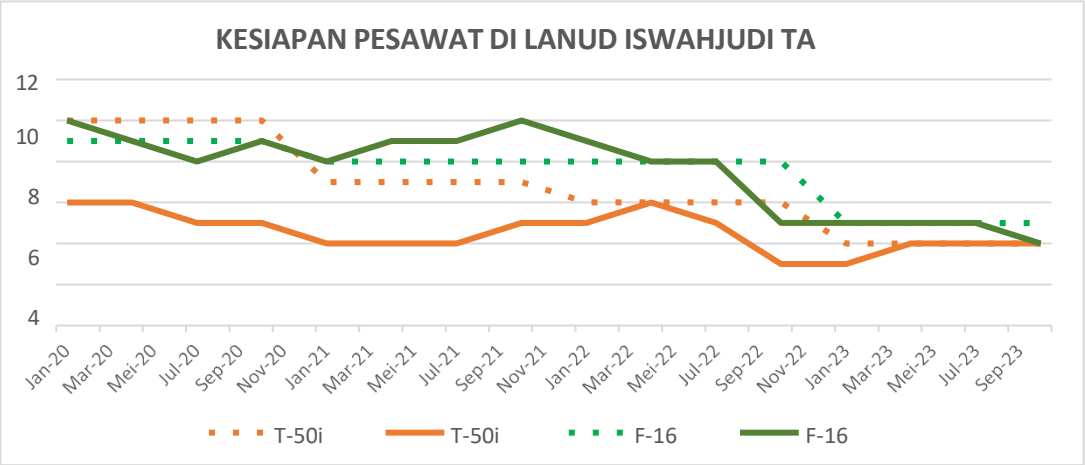
Source: Report Evaluation Program Work Field Logistics of Air Squadron 3 and Air Squadron 15 for the 2020-2023 fiscal year.

First, Light Level Scheduled Maintenance. light dominate activity maintenance in Air Force Base Iswahjudi, with consistently high numbers for both aircraft types. However, there are fluctuations in the realization of this maintenance, namely; For the F-16, the number of light maintenance performed (LAKS) was generally slightly higher than planned (RENC), especially in 2020 and 2021, indicating an increase in maintenance needs that may be due to the intensity of use or an increased focus on operational readiness. However, in 2023, although the number of planned maintenance decreased significantly, the realization was still higher than planned, indicating the presence of unforeseen factors affecting maintenance needs. On aircraft T-50i, realization maintenance light tend A little lower than planned, especially in 2020 and 2021, which could indicate constraint in source Power or efficiency of implementation maintenance. Second, Medium Scheduled Maintenance.

Medium maintenance shows greater variation, especially on the F-16, namely; In 2022, there was a significant increase in the planning and execution of medium maintenance for the F-16, likely in response to increased operational needs or increasing aircraft age requiring more intensive maintenance. For the T-50i, the amount of medium maintenance is more stable, although there are slight fluctuations indicating adjustments to annual operational needs. Third, Heavy Scheduled Maintenance. Heavy maintenance also experiences variation, namely; On the F-16, the amount of heavy maintenance executed tends to be lower than planned each year, indicating possible constraints in resources or time that prevent all planned heavy maintenance from being realized. The T-50i shows amount maintenance heavy Which more low in a way overall, with fluctuations small Which reflect need maintenance Which more stable or better managed. Fourth, Unscheduled Maintenance.

Unscheduled maintenance indicates pattern what is interesting is: Amount maintenance unscheduled on F-16 was higher at the beginning of the period (2020-2021) and decreased drastically in 2022-2023, which can indicates improvement effectiveness maintenance scheduled or decrease in operational intensity. In contrast, on the T-50i, unscheduled maintenance increased from 2020 to 2022, before down return on 2023, show existence problem that arose and were then successfully resolved.

Chart 1. Readiness Aircraft Combat in Air Force Base Iswahjudi TA. 2020-2023



Air Force Base Iswahjudi can anticipate need maintenance, organize resources effectively and reduce the risk of aircraft downtime. **Second,** the Organizing Function. **Third,** after planning, the organizing stage serves to divide the components of planned activities. In the context of fighter aircraft maintenance, this means categorizing maintenance tasks into specific work units and dividing tasks and authorities. to personnel Which appropriate. In Air Force Base Iswahjudi, organizing Which It enables every maintenance unit, from squadron to depot, to work in sync to achieve maintenance objectives, namely maintaining the reliability and availability of fighter aircraft. **Fourth,** the Actuating Function. Actuating includes actions taken by managers to initiate and continue maintenance operations. activity maintenance in accordance with plan Which has set. In fighter aircraft maintenance, this function ensures that every planned step is actually implemented in the field. Actuating the process at Iswahjudi Air Force Base involves close coordination between various maintenance units and the use of technologies such as AI to support effective maintenance execution.

This includes real-time monitoring of aircraft conditions during maintenance to ensure that process walk in accordance with standard Which has determined. **Fifth,** Function Supervision (Controlling). Supervision is function management Which plays a role in ensuring that all planned and implemented maintenance activities meet established standards. At Iswahjudi Air Force Base, this function is crucial for evaluating whether maintenance activities are proceeding according to plan and for detecting and correcting any deviations. Controlling also involves evaluating maintenance performance, allowing managers to implement continuous improvements to enhance maintenance efficiency and effectiveness.

When faced with management theory which includes the functions of planning, organizing, movement, And supervision, then **the analysis** to The Fighter Aircraft Maintenance Planning implemented at Iswahjudi Air Force Base can be described as follows:

First, Planning . Maintenance planning at Iswahjudi Air Force Base is in accordance with the planning function in management theory, where this process includes determining the work that needs to be done and making decisions regarding it . maintenance scheduled as well as No scheduled. However, effectiveness This planning relies heavily on the ability to predict maintenance needs based on data historical And analysis condition aircraft. Challenge Which faced is how maximize use data For anticipate constraint Which potential emergencies, as well as ensuring resource readiness. The application of AI technology to this planning can be very helpful in providing more accurate predictions, allowing maintenance to be carried out more proactively and efficiently.

Second, Organizing . At Iswahjudi Air Force Base, organizing fighter aircraft maintenance involves dividing tasks and authority among *the* various maintenance units, from squadrons to depots. This ensure that every unit own not quite enough answer Which clear and support success maintenance. Theory management emphasize The importance of good organization to achieve goals. Here, synchronizing annual work plans with monthly and daily work plans is key to effective maintenance. AI can help better coordinate these various activities, ensuring that each unit operates according to the established plan.

Third, Actuating Function mobilization at Lanud Iswahjudi, involving implementation activity maintenance in accordance with plan, Already is quite well structured. However, to further enhance its effectiveness, AI can be used to monitor aircraft conditions in real time during maintenance, allowing for rapid adjustments if any changes or issues arise. This is in line with with theory management Which state that function movement must ensure plan Which Already arranged truly implemented And objective achieved.

Fourth, Supervision (*Controlling*). Supervision at Iswahjudi Air Force Base is an aspect critical For ensure that maintenance implemented in accordance with established standards. The controlling function in management theory emphasizes the importance of continuous evaluation of activity implementation and correction of deviations. In here, AI can play a role big in strengthen function supervision by providing the ability to detect deviations early and enable rapid corrective action. The use of AI in supervision also helps in analysis performance maintenance, Which can used For continuous improvement.

Overall, the fighter aircraft maintenance planning implemented in Air Force Base Iswahjudi Already reflect principles management Which effective This is in line with management theory. However, there is a significant opportunity for optimization through the application of AI technology. AI can strengthen every management function—from planning to monitoring—by providing more accurate predictions, better coordination, more efficient execution, and tighter oversight. Thus, the application of AI will not only increase effectiveness and efficiency, but also improve the effectiveness and efficiency of management. planning maintenance in Air Force Base Iswahjudi, but Also will support operational readiness of fighter aircraft in supporting the strategic tasks of the Indonesian Air Force.

Fighter aircraft maintenance management is a crucial aspect in ensuring operational readiness and mission effectiveness of the Indonesian Air Force. Referring to the maintenance management theory proposed by Wireman (2004), the author can understand the important elements that must be considered in fighter aircraft maintenance management. Wireman (2004) defines maintenance management as a series of activities carried out to maintain physical assets in optimal operational condition. This includes planning, implementing, and controlling maintenance to ensure that equipment remains in good condition, maximizes service life, and minimizes *downtime* .

First, Availability . Fighter aircraft availability is a key indicator in maintenance management. Wireman (2004) emphasized the importance of maintaining a high level of availability to ensure operational readiness. In the context of fighter aircraft, this means the aircraft must always *be* ready for use in emergencies or sudden missions. The implementation of preventive and predictive maintenance based on real-time data is crucial to achieving optimal availability.

Second, Reliability . The *reliability* of a fighter aircraft is the aircraft's ability to operate without interruption for a certain period of time. Wireman emphasized that effective maintenance must be able to improve reliability through detection early And handling potential problem. By using technologies such as AI For analysis data And prediction failure, reliability aircraft combat can be improved significantly.

Third, *Maintainability* . Maintainability referring to on convenience And speed in carrying out maintenance or repair of equipment. Wireman (2004) shows that equipment must designed And maintained such appearance so that repair can be done with fast And efficient. In context aircraft combat, This means have systems and procedures that enable technicians to perform maintenance quickly, as well as ensure that ethnic group spare parts And equipment maintenance always available.

Fourth, *Total Productive Maintenance* (TPM). Wireman (2004) introduced draft TPM, Which involving all over organization in effort maintenance to increase efficiency And productivity. In management maintenance fighter aircraft, this means that all personnel, from technicians to pilots, must participate in maintenance And report problem in a way proactive. Approach This ensures that maintenance is not only the responsibility of the technician, but Also part integral from operation daily. Implementation theory management maintenance from Wireman (2004) in context aircraft combat give framework Work Which systematic and structured to improve maintenance efficiency and effectiveness.

Use Technology AI.

The use of Artificial Intelligence (AI) technology in fighter aircraft maintenance management offers several significant advantages. AI can improve availability and reliability indicators through more accurate failure prediction. This technology utilizes data analysis generated by the aircraft. by aircraft during operational For predict When Certain components will require maintenance or replacement. This allows for proactive maintenance before damage occurs, reducing the risk of unexpected downtime. Furthermore, AI can assist in maintenance planning and spare parts management. With in-depth data analysis, AI can more efficiently determine spare parts requirements, ensuring that necessary components are always available and ready for use. This improves the maintainability and operational efficiency of fighter aircraft, which in turn supports the readiness of the Indonesian Air Force in carrying out its duties.

a. Process Maintenance Structured.

Following the principles of Total Productive Maintenance (TPM), a structured maintenance process involves the entire organization in maintenance activities. In this context, AI can serve as a tool to integrate And coordinate effort maintenance in all over organizational level. Active participation of all personnel, from technicians to managers, ensure that problem can identified And handled more beginning. Process This reduce downtime And increase readiness operational fighter aircraft. Structured maintenance also means that every maintenance action is documented and analyzed. Data from previous maintenance activities is used to inform future actions, creating a continuous cycle of improvement that increases overall equipment reliability. Thus, TPM principles and technology AI together form base from management maintenance effective and efficient.

a. Improvement Reliability And Availability.

A proactive approach to maintenance, as advocated by maintenance expert Wireman, focuses on preventing problems before they occur. By using AI to perform predictive analysis, the Indonesian Air Force can identify potential issues with fighter aircraft before they disrupt operations. ensuring that the aircraft is always in optimal condition and ready for use on missions. This approach improves reliability And availability aircraft combat. Reliability Which Higher availability means that aircraft can be relied upon to operate without interruption for longer periods. Meanwhile, higher availability ensures that more aircraft are available for use whenever needed, supporting the operational readiness of the Indonesian Air Force.

a. Efficiency Cost.

The implementation of planned, data-driven maintenance allows for better control over maintenance costs. With AI, maintenance can be performed more efficiently, reducing time spent on unnecessary repairs and minimizing the use of inappropriate spare parts. Data analysis helps determine when and how maintenance should be performed, optimizing resource use and reducing operational costs. This cost efficiency is crucial given the high operational and maintenance costs of fighter aircraft. By reducing expenditures Which No need, Indonesian National Armed Forces Force Air can allocate Greater resources for technology upgrades and development, as well as personnel training, all of which contribute to improving overall operational capabilities. Overall, the integration of AI technology into fighter aircraft maintenance management at Iswahjudi Air Force Base has great potential. For increase efficiency, reliability, And readiness operational Indonesian Air Force fighter jets. By adopting this technology, the Indonesian Air Force can better face future challenges, ensuring they are always ready to protect and defend Indonesia's air sovereignty.

4.2 Challenges and Obstacles of Fighter Aircraft Maintenance Management Through the Application of Artificial Intelligence Technology.

Fighter aircraft maintenance management through the application of Artificial Intelligence technology (AI) own potential big For increase efficiency And effectiveness.

However, implementation This No off from various challenge And obstacle. Referring to In Anthony Kelly's maintenance theory, the author can identify and analyze these challenges in a more structured manner. Kelly (2006) defines maintenance as an activity carried out to maintain, restore, or improve the condition of physical assets so that they remain in operational condition. Which optimal. Indicator main in maintenance according to Kelly including *Mean Time Between Failures* (MTBF), *Mean Time to Repair* (MTTR), *Availability, Preventive Maintenance Compliance,* and *Cost of Maintenance* . The application of Artificial Intelligence (AI) technology in the development of fighter aircraft maintenance management can provide impact significant in support task Indonesian National Armed Forces Force Air. However, the challenges and obstacles faced in this process need to be properly understood and addressed.

First, Complexity Data And System. Challenge integration AI in Fighter aircraft maintenance management requires highly complex data processing. Fighter aircraft are equipped with numerous sensors that generate large amounts of diverse data. Effectively managing and analyzing this data is a major challenge. Meanwhile, barriers include limitations in information technology infrastructure and technical expertise to handle large and complex data. can become obstacle. Lack of integration system Also can hinders the optimal use of AI in the context of aircraft maintenance. Fighter aircraft maintenance management is very complex because fighter aircraft are equipped with various

sensor Which produce data in amount big And diverse. This data covers various aspect, start from performance machine, system avionics, until The physical condition of the aircraft. A major challenge in implementing AI is how to effectively manage and analyze this data. AI technology can integrate multiple data sources, provide predictive analysis, and identify potential damage before it occurs. However, significant barriers exist in terms of information technology infrastructure and technical expertise to handle this large and complex data set. Many information systems currently in use may not be designed for integration. with technology AI, so that need There is effort big in upgrade or replace the system which exists. Besides That, limitations in skill technical is also a big challenge, because big data management requires a deep understanding of data science and machine learning.

Second, Data Reliability and Validity. AI challenges rely heavily on data quality and validity. Incomplete or inaccurate data can reduce effectiveness model AI in prediction And analysis. Temporary obstacle that is an error man (*human error*) in input data, limitations sensors, And inconsistency

Data collection can be a significant obstacle. Ensuring data security and integrity in sensitive military environments is also a challenge. AI very depends on quality And validity data Which used to train the model. Lack of complete or inaccurate data can reduce the effectiveness model AI in prediction and analysis. In the context maintenance In fighter aircraft, human error in data input, sensor limitations, and inconsistencies in data collection can pose significant obstacles. Addressing these challenges requires more sophisticated and consistent data collection systems, as well as better training for personnel involved in data collection and processing. Data security and integrity are also crucial in sensitive military environments. The use of encryption technology and stringent security protocols must be implemented to ensure that data cannot be easily compromised or manipulated.

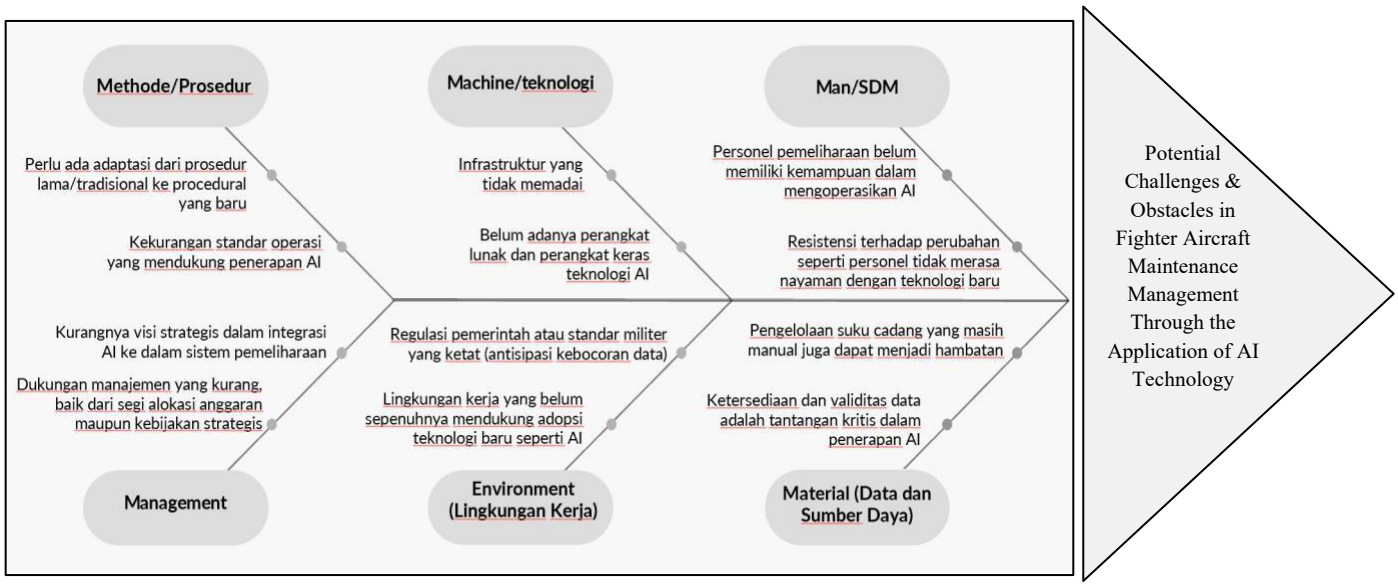
Third, the Need for Expertise and Training. The challenge is that implementing AI requires specialized expertise in programming, data analysis, and maintaining AI systems. Maintenance personnel require additional training to use AI systems. And understand technology new This. As for obstacle that is limited human resources with the necessary skills and lack of training programs Which adequate can hinder effectiveness implementation AI in Maintenance management. The application of AI in fighter aircraft maintenance management requires specialized expertise in programming, data analysis, and maintaining AI systems. Maintenance personnel require additional training to use and understand this new technology. This challenge can be addressed through specially designed training programs to enhance personnel competency in these areas. However, limited human resources with the necessary expertise and a lack of adequate training programs can hinder the effectiveness of AI implementation. To address this, the Indonesian Air Force needs to collaborate with educational institutions and training institutions to develop relevant curricula and ensure that maintenance personnel have access to the training they need.

Fourth, Adapting Organizational Culture. Challenges include the implementation of new technologies such as AI, which requires a change in organizational culture. Support from all levels of the organization, from management to technicians, is needed to accept and implement the use of AI. The obstacle lies in resistance. to change And lack of awareness will benefit AI can become a major obstacle. The established work culture may be difficult to change without effort change management Which significant. Implementation technology new like AI requires a change in organizational culture. Support from all levels of the organization, from management to technicians, is crucial for successful AI implementation. The main challenges in this regard are resistance to change and lack of awareness will benefits of AI. To overcome obstacle This requires significant management change efforts. This is This includes outreach on the benefits of AI, intensive training, and perhaps incentives for personnel who actively support the implementation of new technologies. Furthermore, an established work culture may be necessary. difficult changed without existence effort Which consistent And sustainable from management to support and encourage the use of AI.

Fifth, Investment and Cost. The challenge in this area is that AI implementation requires significant upfront investment in hardware, software, and training. Meanwhile, budget constraints and spending priorities can hinder the ability to invest in AI technology. The costs of maintaining and updating AI technology also need to be carefully considered in budget planning. AI implementation requires investment beginning Which significant in matter device hard, device software, and training. Budget constraints and spending priorities can hinder the ability For invest in technology AI. Cost maintenance And AI technology updates also need to be carefully considered in budget planning. To overcome this obstacle, the Indonesian Air Force needs to conduct thorough budget planning and seek additional funding sources if necessary. could include working with the defense industry or seeking grants from the government. For technology projects advanced. Besides That, need done comprehensive cost-benefit analysis to ensure that investments in AI technology provide significant added value to fighter aircraft operations and maintenance.

Implementing AI in fighter aircraft maintenance can provide numerous benefits, including increased efficiency, reduced downtime, and improved safety. AI can be used to perform predictive analytics, which can help identify components that are prone to failure before they occur. failure happen. Matter This allows maintenance Which more proactive and can reduce time aircraft No operate. Besides That, AI can used to optimize maintenance schedules and ensure that resources are allocated efficiently. For example, AI can help in determining when and in where maintenance must done, as well as predict need ethnic group reserves based on historical data and current operational conditions. Thus, AI does not only increase effectiveness maintenance but Also reduce cost overall operations.

Picture 1. Analysis Fishbone Challenge And Obstacle Management Fighter Aircraft Maintenance Through the Application of Artificial Intelligence Technology in Air Force Base Iswahjudi



Source: Processed by writer.

In an effort to implement technology Artificial Intelligence (AI) in fighter aircraft maintenance management at Iswahjudi Air Force Base, various challenges and obstacles can be identified using the Fishbone Analysis approach. The following is an in-depth description. about challenges the based on category Man, Machine, Method, Material, Environment, and Management.

***Resources* .** One of the biggest challenges in implementing AI at Iswahjudi Air Force Base is limited human resources, particularly in terms of technical expertise. Implementing AI requires specialized knowledge in programming, data analysis, and maintaining AI systems. However, many maintenance personnel at Iswahjudi Air Force Base may not have received adequate training to operate this advanced technology. This limitation can hinder the effective implementation of AI, as without skill Which required, potential full AI No can utilized. In addition , resistance to change is also a significant barrier. The implementation of new technologies such as AI often causes discomfort or distrust in circles personnel, especially If they feel get used to method conventional. If resistance This No overcome with strategy Without proper change management, the AI adoption process can be slow or even fail.

a. ***Machines* (Equipment and Technology).** The existing technological infrastructure at Iswahjudi Air Force Base may not be fully adequate to support the full implementation of AI. This includes limitations in hardware, device soft, And network Which required For operate system AI optimally. For example, existing hardware may not have the capacity processing Which

Enough For support analysis data scale big required by AI. In addition, the integration between AI systems and maintenance equipment Which There is Can become challenge. If system Which used moment If it is incompatible or outdated, the integration process can be complicated and require updating or replacing equipment, which of course requires additional costs and time.

b. ***Method*** **(Methods and Procedures).** Existing maintenance methods and procedures may need to be adjusted or enhanced to support the use of AI. Traditional methods that have been used for years may not be fully compatible with the data-driven approach used by AI. For example, unstructured procedures or those that rely on human intuition may be less effective when combined with AI systems that require structured and consistent data. The lack of operating standards that support AI implementation can also be a barrier. AI requires structured data and consistent procedures to function properly. If these standards are not in place, AI results may be suboptimal, which can undermine confidence in this new technology.

Materials **(Data and Other Resources).** Data is main fuel for AI. Therefore, data availability and validity are critical challenges in AI implementation. AI relies on accurate and complete data to generate prediction Which appropriate. However, If data Which available No adequate, not consistent, or spread in various system Which No integrated, results AI-generated data can be suboptimal. This also applies to historical data that may be unavailable or poorly documented. Furthermore, manual spare parts management can be a barrier. AI requires real-time, structured inventory data to support decision-making. maintenance. If data ethnic group spare parts No available or No updated automatically, this can hinder the effectiveness of AI in optimizing maintenance processes.

c. ***Environment*** **(Work Environment).** The work environment at Iswahjudi Air Force Base may be Not yet fully support adoption technology new like AI. Organizational cultures that have been formed over many years may not be ready to accept change technology in a way massive. Adoption technology new This often requires cultural changes, including how teams work and communicate. External environmental factors also play a role, such as government regulations or stringent military standards. These regulations can limit flexibility in AI implementation, especially if there are compliance requirements. This can slow the adoption and implementation of new technologies.

d. ***Management*** **(Policy and Leadership).** Management support is a key factor in the success of AI implementation. However, if management does not provide sufficient support, either in terms of budget allocation or strategic policies, implementation will be hampered. AI may not receive the priority it needs. This can happen if management doesn't fully understand AI's potential or if there's uncertainty about its long-term benefits. A lack of strategic vision for integrating AI into maintenance systems can also lead to partial and suboptimal implementation. Without clear direction from management, AI implementation

can be half-hearted and fail to produce the desired impact on efficiency and operational readiness.

By using Fishbone Analysis, challenges and obstacles in implementing AI at Iswahjudi Air Force Base can be systematically identified into key categories. This helps design more specific strategies to address each obstacle, allowing for smoother AI implementation and supporting increased efficiency and overall fighter aircraft operational readiness. Integrating AI technology into fighter aircraft maintenance management at Iswahjudi Air Force Base requires a holistic approach encompassing human resource development, infrastructure improvements, method adjustments, and strong management support.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis of the two problem formulations in this journal, the following conclusions can be drawn: **First,** fighter aircraft maintenance management requires a structured and proactive approach to ensure operational readiness and reliability. Referring to Terry Wireman's maintenance management theory, a number of indicator key like availability, reliability, And Maintainability must be considered. The application of AI technology can help improve these indicators through more accurate data analysis and more effective predictions. Thus, AI has great potential to improve the efficiency and effectiveness of fighter aircraft maintenance management. **Second,** the application of AI technology in fighter aircraft maintenance management faces various challenges and obstacles, such as data complexity, data reliability and validity, the need for expertise and training, organizational culture adaptation, and initial investment and costs. Comparing these challenges with Anthony Kelly's maintenance theory shows that while AI can improve indicators such as MTBF, MTTR, availability, and compliance, obstacles such as data errors, resistance to change, And limitations budget must overcome through strategy Which right and planned.

Coaching management maintenance aircraft combat through AI technology has great potential to improve the efficiency and effectiveness of Indonesian Air Force operations. However, existing challenges, such as data and system complexity, data reliability and validity, the need for expertise and training, organizational culture adaptation, and investment and costs, need to be addressed with the right strategy. This includes appropriate investments in technological infrastructure, personnel training, and cultural change. organization, AI can become tool Which very valuable in support The Indonesian Air Force's duties. The application of AI can help optimize fighter aircraft maintenance, improve safety, and reduce operational costs, enabling the Indonesian Air Force to carry out its duties more effectively and efficiently.

Overall, the application of AI technology in the maintenance management of Indonesian Air Force fighter aircraft offers many potential benefits, but requires effort Which significant For overcome various challenge And Obstacles. With a systematic approach and strong organizational support, this technology can be implemented effectively to support the Indonesian Air Force's operational duties and readiness.

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