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Utilization of Artificial Intelligence (AI) to Support the Implementation of Demolition in the Indonesian Air Force

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A B S T R A C T

This research employs a qualitative approach, utilizing in-depth interviews, observations, and documentation studies involving TNI AU personnel, along with data analysis from various documentary sources. The qualitative method is used to gain in-depth insights from TNI AU personnel and military technology experts on AI implementation in demolition operations through observation and documentation studies. Primary data is collected through interviews, observations, and document reviews, while secondary data is gathered from official documents, technical reports, and related publications. The findings indicate that AI usage in demolition activities within TNI AU has improved accuracy in detecting and identifying explosive threats. This research offers several recommendations to address challenges and optimize AI use in demolition activities within TNI AU.

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INTRODUCTION

In the increasingly advanced digital era, artificial intelligence (AI) has emerged as a key technology capable of revolutionizing various sectors, including the military sector. Artificial Intelligence is able to facilitate various complex things (Luckin & Holmes, 2016), Able to Encourage Critical Thinking (Chiu et al., 2023) The use of AI in the military field is not only limited to combat operations, but also includes other aspects that support the success of missions, such as in demolition activities. The use of artificial intelligence (AI) in military operations has come into major focus in recent years, especially in the context of demolition activities (Meerveld et al., 2023) Demolition activities, especially those carried out in military environments, involve high complexity and significant risks. The Indonesian Air Force (TNI AU) as one of the main components of the country's defense, faces a major challenge in ensuring that demolition operations are carried out safely, effectively, and efficiently. Military demolition is not only the process of destroying buildings or structures, but also often involves handling explosives, dismantling strategic infrastructure, and managing threats that can endanger personnel and the surrounding community (Madrid et al., 1992). In this context, accuracy in threat identification, careful planning, and timely execution are key factors for the success of demolition operations. AI, with its ability to process large amounts of data and perform analysis quickly and precisely (Westera et al., 2020), provides innovative solutions that can increase effectiveness and efficiency (Arifdarma, 2023). Especially in demolition operations in the Indonesian Air Force. Artificial Intelligence is able to detect threats with higher precision through the use of advanced sensors and algorithms designed to identify threat patterns, therefore the integration of advanced technologies such as Artificial Intelligence is needed and important (Aldosari, 2020).

In addition, AI can also be used to simulate various demolition scenarios, allowing personnel to better plan operations, anticipate various possibilities, and minimize errors. However, although the potential of AI in supporting demolition operations is huge, its implementation within the Indonesian Air Force still faces several obstacles. Insufficient technological infrastructure, limitations in the mastery of technology by personnel, and technical problems related to AI sensors and algorithms are the main challenges that need to be overcome. For this reason, a holistic approach is needed in developing technology infrastructure, strengthening training programs for personnel, and building partnerships with industry and research institutions to develop AI technology that is more sophisticated and in accordance with the needs of the Indonesian Air Force. This research aims to utilize AI to support the implementation of demolition in the Indonesian Air Force, by analyzing the increase in effectiveness, efficiency, and operational safety. Through a qualitative method with a phenomenological approach, this research is expected to provide comprehensive insights into the benefits, challenges, and recommendations for optimizing the use of AI in demolition activities in the Indonesian military environment.

LITERATURE REVIEW

A deep understanding of the potential and challenges of AI in demolition activities in the Air Force is important to review the existing literature. This literature review will explore various theories, empirical studies, and expert views on the application of AI in the military, particularly in the context of demolition. Through this review, the research is expected to find a strong theoretical framework to support the analysis as well as provide a solid foundation.

The Concept of Artificial Intelligence Intilegence

Artificial Intelligence (AI) is a branch of computer science that focuses on developing systems capable of performing tasks that typically require human intelligence, offering a number of benefits and improvements in various collaborations (Cotton et al., 2023). One of them is increasing the involvement of active participation of personnel in discussions (Li & Xing, 2021). This allows personnel to be able to work together more quickly (Lewis, 2022). *Artificial Intelligence* itself can cause chaos when used carelessly (Dehouche, 2021). AI aims to create machines that can think, learn, and adapt like humans. As technology has evolved, AI has become one of the most significant innovations that have an impact on various fields, from industry, health, education, to the military. Some prominent AI experts, define AI as "the science of making machines do things that would require intelligence if done by humans."

The basic theories underlying AI can be traced back to the fields of mathematics, logic, and psychology. The purpose of artificial intelligence systems can be divided into 4 categories (Budi Hartato et al, 2014). that is, a system that can think like a human, a system that can think rationally, a system that can act like a human, a system that can act rationally. *Artificial Intelligence* (AI) is classified of several types based on its capabilities:

a) Weak AI:
   This type of AI is designed to perform specific tasks.
b) An example is virtual assistants like Siri and Alexa, which can process natural language to answer questions, but lack broader contextual awareness or understanding.
c) General AI :
   This AI is hypothesized to have intelligence that approaches or even exceeds that of humans. Powerful AI is capable of performing a variety of different intellectual tasks with a level of intelligence equivalent to humans, by understanding contextual instructions in conversation (Zhang et al., 2023).
d) Super AI (Superintelligent AI):
   This is a level of AI intelligence that exceeds the capabilities of the human brain in all aspects. Super AI is considered a future where machines not only outperform humans in cognitive tasks, but also in terms of creativity, complex problem-solving, and strategic decision-making.

The development *of Artificial Intelligence* is carried out with a variety of approaches, each with a different methodology and application:

a) Supervised Learning:
   In this approach, machines are trained using labeled data, where the correct inputs are known. This theory is largely supported by the work of statistics and decision theory, which allows machines to predict output based on new inputs.
b) Unsupervised Learning:
   Unlike supervised learning, unsupervised learning does not use labeled data. The machine tries to find patterns or structures hidden in the data. One of the supporting theories is clustering, where data is organized based on the similarities between one data and another.
c) Reinforcement Learning:
   This approach involves machine learning through trial and error, where the machine receives rewards or punishments based on actions taken. This concept is based on the theory of behavioral psychology introduced by B.F. Skinner, which suggests that behavior can be formed through reinforcement.

Demolition in the Military

Demolition in the military context, especially in the Indonesian Air Force, is a challenging activity. This process not only involves the physical destruction of a building or structure, but must also consider security aspects, military tactics, and impact on the environment. In certain operations, demolitions can be used to damage or destroy enemy infrastructure, clear areas of potential threats such as explosives, or even secure military facilities by preventing reuse by opponents. Thus, demolition is an integral part of the defense and operational strategy of the Indonesian Air Force. However, the high complexity and risks inherent in demolition activities demand increased effectiveness and efficiency. Because basically logistics management in demolition activities must be carried out efficiently and effectively (Zhao & Bin Osman, 2023). This is where the use of Artificial Intelligence (AI) can play a key role. The combination of demolition and AI opens up opportunities to improve personnel safety, optimize the planning and execution of operations, and reduce potentially dangerous errors. One of the most relevant applications of AI in military demolition is in the detection and identification of explosives. AI can be used to process data from a variety of field-mounted sensors, such as infrared sensors, ground-penetrating radars, and chemical sensors. With machine learning algorithms, AI is able to recognize patterns that indicate the presence of explosives or other threats with greater accuracy compared to conventional methods. This needs to be done because Artificial Intelligence is considered to be able to develop a system that can perform various instructions (Huang et al., 2023). allowing the Indonesian Air Force to conduct early detection and take appropriate action before the threat becomes a bigger problem. Additionally, AI can support demolition planning through simulation of various scenarios. Using AI-based simulation technology, Indonesian Air Force personnel can test various demolition approaches in a safe

virtual environment, identify potential risks, and plan operations more carefully. Furthermore, AI can also be integrated into automated demolition control systems. In these scenarios, AI can regulate and monitor the use of explosives in real-time, ensuring that all demolition steps go as planned and minimizing unwanted impacts. Thus, AI theory provides a conceptual and methodological foundation for the development of computer systems that can perform tasks that require human intelligence, including in terms of data analysis, decision-making, and demolition process planning (Marimin., 2009), so that the use of AI in demolition in the Indonesian Air Force not only increases operational efficiency and effectiveness, but also provides an additional layer of security for the personnel involved. The proper implementation of this technology can change the way the Indonesian Air Force conducts demolition operations, making it smarter, safer, and more reliable.

Artificial Intelligence in the Military

In the military context, Artificial Intelligence offers an incredible opportunity to improve the effectiveness, efficiency, and security of operations, hence Artificial Intelligence is one of the military technologies that is developing and used today and in the future (Work & Brimley, 2014). in the field of military Artificial Intelligence has an influence on all domains and dimensions, both land, sea and air, in addition to space and information as well as all lines both politically strategic and tactical-operational (Svenmarck et al, 2018). Military demolition, which involves the structured destruction of buildings, bridges, or other strategic infrastructure, requires very careful planning and execution due to the high risks and complexity involved. AI can play a crucial role in refining various aspects of this demolition process.

a) Artificial Intelligence in the Military: A Transformation The application of AI in the military has been widely discussed by military technology and strategy experts. According to Herbert A. Simon's Intelligent Systems theory, AI is one of the pillars that is able to support decision-making in complex situations by processing large amounts of data and providing optimal solutions. In the military, AI is used in a variety of applications, such as surveillance and reconnaissance, target recognition, battlefield simulation, and even in the development of autonomous weapons. AI helps improve speed and accuracy in decision-making, which is critical in military operations that are often in dynamic and uncertain conditions.
b) Military Demolition: Complexities and Challenges Military demolition is not just the destruction of a building or physical structure, but it is also part of a broader military strategy. Demolition activities can be used to destroy enemy infrastructure, restrict enemy movement, or protect critical assets by preventing access by unauthorized parties. The demolition process involving explosives requires specialized expertise, careful planning, and precise execution. The slightest mistake in the demolition can result in great loss, both in terms of material and life. Experts , such as Paul Scharre in his book Army of None, state that the main challenge in military demolition is inherent risk, especially related to uncertainty and

threats that are difficult to detect. Therefore, the ability to detect threats quickly and accurately is essential. AI offers solutions that can address some of these challenges in ways that neither humans nor conventional technology can achieve.

c) Threat Detection and Identification with AI One of the main applications of AI is detection and identification (Machri, 2016). Various advanced features of AI have the potential to facilitate a wide range of commands (Vincent & Van Der, 2020). U.S. Military Logistics has implemented the detection and identification of aircraft damage and repair using AI (Weisberg, 2017). In addition, Artificial Intelligence is able to optimize the work in video analysis in obtaining more accurate information (Corrigan, 2017). This is considered very effective and efficient, the same as in the military the identification of explosives or other hidden threats must be carried out effectively and efficiently, which can be completed using Artificial Intelligence. In the theory of Automated Decision-Making put forward by Mica Endsley, AI functions to support and improve human ability in decision-making by providing more complete and accurate information. With machine learning algorithms, AI is able to recognize certain patterns that indicate the presence of explosives or other threats with higher accuracy than traditional methods. For example, AI can identify certain chemical compositions that indicate the presence of explosives or detect changes in soil structure that may indicate the presence of mines or improvised explosive devices (IEDs). According to a study conducted by the Defense Advanced Research Projects Agency (DARPA), the use of AI in IED detection has been shown to increase high success rates and reduce risks for military personnel.

d) Demolition Operations Planning and Simulation In addition to threat detection, AI can also be used in the planning and simulation of operations (Roth, 2019). This happens because AI has intelligent behavioral traits in implementing various tasks (Organization for Economic Co-operation and Development, 2016). Effective demolition planning entails simulating a variety of scenarios to predict the outcome of a particular action, identify potential risks, and optimize resource utilization. AI, with its ability to process and analyze large amounts of data, can create highly realistic and detailed simulations. In AI-based simulations, factors such as the type of explosive, building structure, environmental conditions, and detonation time can be incorporated into the model to predict possible impacts. The Predictive Modeling Theory put forward by Donald Michie explains that AI can use historical data to predict future outcomes. In the context of military demolition, this means that AI can use data from previous demolition operations to improve the accuracy and effectiveness of future demolition planning.

e) Demolition Operation Execution and Supervision, At the execution stage, AI can play a role in supervising and controlling demolition operations in real-time. By using automated control algorithms, AI can ensure that all demolition steps go as planned and minimize unwanted impacts. For example, AI can control the sequence of explosive detonation to ensure that structures collapse in the desired way, reducing the risk of unnecessary damage or injury to personnel.

According to the theory *of Dynamic Control Systems* developed by John C. Doyle, a system that can adapt quickly to changing environmental conditions is essential in high-risk operations. AI allows the Indonesian Air Force to have this capability, by monitoring sensor data in real-time and adjusting actions based on the latest information.

METHODOLOGY

This study uses a qualitative method with a phenomenological approach. Adopt data analysis techniques from (Miles & Huberman, 1992). A qualitative method with a phenomenological approach was used to explore in-depth insights from Indonesian Air Force personnel and military technology experts regarding the application of artificial intelligence (AI) in demolition activities. The interview was conducted with Commander Sathar 64 Depohar who was directly involved in the demolition activities and a military technology expert. In this interview, we explained the application of AI in demolition, the user experience, and the challenges and benefits felt. Questions in the interview are focused on the process of detecting and identifying threats using AI, planning and execution of demolition operations with AI support, occupational safety experience when using AI in demolition operations, technical and operational challenges in the application of AI. Observations were disseminated to TNI AU personnel regarding the use of AI in demolition. Observations included questions about the level of accuracy of threat detection using AI, operational time savings with the application of AI, the level of safety of personnel when using AI, and the technical challenges faced in the use of AI. This research utilizes official documents, technical reports, and publications related to the use of AI in demolition activities in the Indonesian Air Force. This document is used to confirm the findings of the interviews and observations and provide additional context. Primary data is obtained from interviews and observations, while secondary data is collected from official documents, technical reports, and related publications. The combination of primary and secondary data allows for a comprehensive and in-depth analysis of the application of AI in demolition activities. Data triangulation was carried out by comparing findings from interviews, observations, and document studies. Internal validation through re-checking with informants (member checking) is carried out to ensure the accuracy and validity of the findings.

RESEARCH RESULT AND DISCUSSION

Evaluation of the Implementation of Artificial Intelligence in Military Demolition

Demolition is the process of deliberately destroying or destroying a structure, building, or object for a specific purpose, such as reconstruction, waste management, or removal of hazardous materials (O'Connor, 2021), based on research results showing that AI has made a significant contribution to increasing the effectiveness, efficiency, and safety of demolition activities in the Indonesian Air Force. AI technology enables more accurate threat detection, better operations planning, and safer execution. Personnel interviewed revealed that AI helps them in various aspects of operations, from planning to demolition execution. AI also enables real-time monitoring that provides critical information for Decision making, Improving Detection Accuracy. The results of the study show that the use of AI in demolition activities in the Indonesian Air Force has increased the accuracy in detecting and identifying explosive threats by up to 85%. Pattern recognition algorithms and real-time data analysis allow for faster and more precise detection (Hafeez et al., 2012). Interviewed personnel reported that the AI is capable of detecting hidden explosives in a variety of difficult locations and conditions, which were previously difficult to identify with conventional methods.

Operational time savings. The implementation of AI in the planning and execution of demolition operations has reduced the time required compared to conventional means, allowing operations to be carried out faster and more efficiently. AI is used to process environmental and building structure data quickly and accurately, so that demolition strategy planning can be done in a shorter time. Observations show that the majority of personnel are helped by AI, which speeds up operational processes and reduces waiting times.

Improved Personnel Safety. The use of AI, including robots and autonomous drones, has reduced the risk of injury to personnel. This technology allows for the handling of dangerous explosives with minimal risk to humans. Personnel involved in the interviews reported that AI assisted in deactivating explosives remotely, reducing exposure to immediate danger. In addition, AI also aids in the supervision of operations, providing real-time information that is critical for safety decisions. The study also identified several opportunities for the development and improvement of the use of AI in demolition activities:

a) Technological Innovation: Continuing to develop more advanced and easy-to-use AI technologies will go a long way in improving operational performance. Innovations in AI algorithms, more accurate sensors, and better autonomous navigation systems are areas worth exploring. Cooperation with the technology industry and research institutes can accelerate the development of new technologies relevant to military applications.

b) Training Program: Improving training programs for Indonesian Air Force personnel to be more familiar with AI technology and able to use it optimally. AI simulation-based training can help improve the skills and readiness of personnel in real-world situations. The development of a comprehensive and ongoing training curriculum will ensure that personnel are always up-to-date with the latest technologies and best practices in the use of AI.
c) Collaboration with Industry: Cooperation with the technology industry can accelerate the adoption and development of AI in the military. The exchange of knowledge and experience with other countries that have successfully used AI in demolition activities can also provide valuable insights.

Challenges of Implementing Artificial Intelligence in Demolition in the Military

Some of the key challenges in AI implementation identified in this study include technical issues, infrastructure limitations, and resistance to change. The integration of AI into existing systems often faces technical constraints, such as hardware and software compatibility and system stability (Stracqualursi et al., 2023). In addition, inadequate technological infrastructure is an obstacle to the optimal application of AI. Observations show that informants experience technical problems in the use of AI, especially related to frivolous sensors and algorithms. Meanwhile, informants indicated the need to improve technological infrastructure. While the benefits of AI are obvious, the study also identifies some of the key challenges faced in its implementation:

a) Technical Issues, hardware and software compatibility.
b) Infrastructure Limitations
c) Resistance to Change

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the research that has been conducted, several main conclusions can be drawn. The use of Artificial Intelligence (AI) in military operations, especially in the context of demolition in the Air Force (TNI AU), shows great potential to increase the effectiveness, efficiency, and safety of operations. AI offers a wide range of capabilities, from more accurate threat detection and identification, more meticulous operation planning through simulation, to real-time surveillance and execution of demolition operations. This technology not only allows the Indonesian Air Force to reduce the risks faced by personnel, but also increases mission success through more precise and data-driven decision-making. In the context of threat detection and identification, AI has been shown to improve accuracy in detecting explosives or other hidden threats.

Processing data from various sensors using machine learning algorithms, AI can recognize patterns that conventional methods might have missed, allowing for early detection and more effective preventive measures. This capability is critical in reducing the risk of accidents and improving the safety of personnel involved in demolition operations. By using AI-based simulation technology, the Indonesian Air Force can better plan operations, test various scenarios, and predict the impact of certain actions before the actual operation is carried out. These simulations not only help in more thorough planning, but also serve as a training tool that allows personnel to prepare for a variety of situations that may occur in the field.

AI offers many benefits, its implementation in the Indonesian Air Force is not without challenges. Technological infrastructure that is not fully adequate and limitations in the mastery of technology by military personnel are obstacles that must be overcome. Therefore, investment in the development of technological infrastructure, as well as comprehensive and sustainable training and education programs, is essential to ensure that the Indonesian Air Force can make optimal use of AI. In addition, clear policies and regulations are needed to govern the use of AI in military operations, including in terms of data security and operational standards. Cooperation with the technology industry and research institutions is also important to encourage innovation and development of more advanced AI technologies

Overall, AI has the potential to revolutionize the way the Indonesian Air Force conducts demolition operations, making it safer, more efficient, and more effective. However, to achieve this potential, collaborative efforts are needed in technology development, personnel capacity building, and supportive policy and regulatory adjustments. With the right approach, the Indonesian Air Force can become a leader in the use of AI technology in the military field, ensuring that critical operations such as demolitions can be carried out successfully and with minimal risk

Based on the results of research on the use of Artificial Intelligence (AI) in supporting the implementation of demolition in the Indonesian Air Force (TNI AU), here are some policy recommendations that can be implemented to optimize the use of AI technology and overcome various challenges faced such as Aslog Kasau making policies related to the development and integration of AI-based systems specifically designed to monitor, analyze, and manage explosives and weaponry. Aslog Kasau recommends the implementation of structured evaluation procedures to assess the effectiveness of AI technology on a regular basis. Aspers Kasau recommended holding intensive training for Indonesian Air Force personnel related to the use of AI technology and monitoring systems. The Kohatmatau commander recommended the implementation of a structured evaluation procedure to assess the effectiveness of AI technology on a regular basis. The Head of Research and Development made a policy to establish partnerships with research institutions and technology developers.

Below is a complete explanation of the policy recommendations, including:

a) Development of Adequate Technology Infrastructure
b) AI Implementation Training and Education Program Development requires skilled personnel and understands this technology. Therefore, the Indonesian Air Force needs to develop a comprehensive training program that covers the basics of AI, AI system operation, equipment maintenance, and data analysis. This training must be ongoing and updated regularly to keep up with technological developments. Collaboration with Educational Institutions and Technology Industries: Establish partnerships with universities, research institutes, and the technology industry to provide specialized educational programs for military personnel. This cooperation can include advanced technical training, joint research, and the development of more advanced AI technologies.
c) Improved Operational Security and Safety: Development of Data Security Protocols: The use of AI in military operations involves the processing of sensitive data. The Indonesian Air Force must develop and implement strict data security protocols to prevent information leakage and protect the integrity of the data used in AI systems. Development of Safe Operational Standards.
d) Encouraging Innovation and Advanced Research. AI Technology Research and Development: The Indonesian Air Force should support research and development (R&D) in the field of AI with a focus on military applications, including demolition operations. R&D can include the development of new algorithms, improvements in sensor technology, and the exploration of new methods for the integration of AI in military operations. Establishing a Military Innovation Laboratory: Establishing an innovation laboratory focused on the development and testing of AI technologies for military applications. These laboratories can serve as a center for experimentation and testing of prototypes before the technology is implemented in the field.
e) Establishment of Policies and Regulations Related to the Use of AI; Preparation of a Policy on the Use of AI Regulations for Supervision and Evaluation: Implement regulations that allow periodic supervision and evaluation of the performance of AI systems in demolition operations. The regulation should also include procedures for fixing or disabling AI systems if any problems or inconsistencies are found.
f) Building Strategic Partnerships with International Industries and Institutions Collaboration with Technology Industry, Participation in International Forums.
g) Continuous Evaluation and Adjustment

ADVANCED RESEARCH

Further research on the use of Artificial Intelligence (AI) in supporting the implementation of demolition in the Air Force needs to be directed at the development of intelligent systems that are able to improve operational efficiency, precision, and safety. Future studies can focus on the integration of AI for spatial data-based demolition planning, automatic target recognition, and explosion impact prediction. The use of AI also enables real-time decision-making and remote demolition device control, while minimizing risks to personnel. With this approach, the Indonesian Air Force can build a more adaptive, fast, and high-technology-based demolition capability according to the demands of modern operations.

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