IRDH International Journal of Technology, Agriculture & Natural Sciences
https://irdhjournals.com/ijtans
Vol 2, No 1 (2025) : March. E-ISSN : 3032-2286

Implementation of RFID to Improve The Security of TNI-AD Personnel in The Ammunition Disposal Area

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INDEXING

Keywords:
Keyword 1; Explosive Area
Keyword 2; Personel Sefety
Keyword 3; Real-Time Monitoring System
Keyword 4; RFID

ABSTRACT

Ammunition storage areas are critical sites that pose significant security and safety risks for the Indonesian Army (TNI AD). Effective security measures are essential to ensure safe operations in these high-risk zones. This study explores the potential of Radio Frequency Identification (RFID) technology to enhance security and personnel monitoring in TNI AD ammunition disposal operations. The objective is to assess how RFID can improve real-time tracking, access control, and personnel safety in hazardous areas. Using a combination of system design analysis and implementation challenges, the research examines the benefits of RFID for ensuring authorized access and reducing risks such as unauthorized entry, accidents, and human losses. Findings suggest that RFID technology significantly enhances security by enabling continuous tracking of personnel and monitoring of their movements, thus improving the overall efficiency and safety of ammunition disposal operations. This study recommends the integration of RFID technology into military operations as a means to bolster personnel security and support TNI AD's broader mission of safeguarding national security.

Article History
Received 18 November 2024; Revised 06 December 2024; Accepted 27 December 2024 ;
Publish 03 March 2025

INTRODUCTION

The safety and security of the Indonesian National Army (TNI AD) troops are crucial in all military operations, particularly in high-risk areas like ammunition disposal sites. Because it includes unused explosives that could explode at any time, the munitions disposal location is extremely dangerous. Therefore, to guarantee the safety of the staff allocated to the region, an advanced security system is required. Ammunition storage places can be safer and more efficiently monitored with the use of modern technology like Radio Frequency Identification (RFID). RFID keeps an eye on employee IDs in real time while precisely tracking their location and movements. It is anticipated that the combination of these two technologies will lessen the possibility of mishaps and illegal entry into these dangerous locations (Sumardi *et al*., 2020).

Given the foregoing context, the study's focus is on how RFID technology might improve TNI AD staff security at the ammunition disposal area. What issues come up when this technology is used in the ammunition disposal area, and how well does it work to lower the possibility of mishaps and unauthorised access. The theories discussed in this research include an in-depth understanding of RFID technology and how both can be used in the

military field and other sectors. In a military context, these two technologies have been used for various purposes, such as asset tracking, logistics, and personnel security. RFID is a technology that uses radio waves to automatically identify and track objects, and it is a satellite navigation system that provides precise location and time information (Hamzah *et al*., 2021).

In any weather conditions in the surrounding environment. The implementation of RFID in the ammunition disposal area is expected to reduce the risks associated with personnel security. Therefore, the risk of accidents caused by ignorance or unauthorized access can be minimized. In addition, by quickly and accurately knowing the location of each personnel, the implementation of this system can assist in the evacuation process during emergencies (Rasyid *et al*, 2020).

This research is expected to enhance the security of TNI AD personnel, especially around ammunition disposal sites. In the context of military security, the successful use of RFID technology can serve as an example for building security systems in other high-risk areas. More broadly, the findings of this research are expected to be applicable to industries such as the chemical or mining industries that require strict security systems and tight and accurate monitoring. This research can enhance personnel safety, reduce the risk of accidents, and produce better safety protocols. This research is also expected to provide technical recommendations on how TNI AD personnel can manage ammunition disposal areas. This will help the Indonesian Army in maintaining security and stability while carrying out ammunition disposal tasks (Pramesti and Febrianto, 2024).

LITERATURE REVIEW

The integration of Radio Frequency Identification (RFID) technology into military operations, particularly in high-risk areas such as ammunition disposal sites, presents a compelling case for improving security and operational efficiency (Anwar, 2019). The theoretical underpinnings of this research are based on various foundational technologies, as well as broader theoretical models in security and tracking systems.

1. Radio Frequency Identification (RFID) Technology

RFID is a system that uses radio waves to identify and track objects automatically, without direct line-of-sight. It has been widely adopted in various sectors for asset management, personnel security, and logistics. The theory behind RFID is grounded in the principles of electromagnetic fields, which are used to communicate between RFID tags and readers (Mohankumar *et al*, 2024). This technology allows for real-time tracking of personnel and equipment, which is critical in high-risk environments like military zones.

RFID's effectiveness in improving safety lies in its ability to provide real-time data regarding the location and movement of personnel, thereby preventing unauthorized access and monitoring movements in restricted areas. The application of RFID in military operations, particularly for personnel security in hazardous zones, builds on the idea that real-time monitoring can significantly reduce risk factors, such as unauthorized entry or mishaps (Munoz-Ausecha *et al*., 2021).

2. Security Theory in High-Risk Military Operations

The security of military personnel, especially in dangerous locations like ammunition disposal sites, has been a focus of military operations management. Theories of risk management and safety protocols emphasize the need for precise and proactive measures to protect both personnel and assets (Carapic *et al*, 2018). These include creating layers of security, using advanced technology to monitor access, and implementing automatic alerts

for potential threats. The application of RFID is rooted in these principles, where the technology acts as a preventive and corrective measure to ensure a safe working environment.

3. Technological Integration in Military Security

The integration of new technologies, such as RFID, into military practices is supported by theories of technological diffusion and innovation adoption. The Diffusion of Innovations Theory, as proposed by Rogers (Sahin, 2006), suggests that new technologies are adopted based on perceived relative advantage, compatibility, complexity, trialability, and observability. In the context of RFID implementation at ammunition disposal sites, the perceived advantage would be the increased safety and operational efficiency. The compatibility of RFID with existing military technologies and its simplicity in usage are critical factors influencing its adoption (Maia *et al*, 2023).

Moreover, Chmielewski *et al* (2019) stated that the concept of "Situational Awareness" in military operations, which involves understanding and interpreting the environment in real-time, also supports the use of RFID. RFID enhances situational awareness by providing constant feedback about personnel locations, thus improving decision-making processes and risk management.

4. The Role of RFID in Military Logistics and Personnel Security

RFID has found diverse applications in military logistics, asset management, and personnel security. The ability to track the location of both individuals and objects is crucial for effective military operations. This extends beyond safety and security, influencing logistics management by ensuring that the right equipment and personnel are in the right place at the right time (Desmira *et al*., 2023).

The research hypothesizes that the combination of RFID with satellite navigation systems will not only improve security at ammunition disposal sites but also optimize personnel monitoring and asset tracking in real-time (Zheng and Carter, 2015). Theories of location-based services and real-time data management suggest that such integration would reduce mishaps and unauthorized access by providing accurate, actionable data to military staff.

RESEARCH METHOD

This research is designed as an experimental study that combines RFID technology to enhance the security of TNI AD personnel in the ammunition disposal area. This study was conducted in three main stages: the design stage, the tool creation stage, and the testing stage. The main focus of this research is creating a system that can identify, track, and monitor staff movement in real-time to ensure that they are in a safe condition while working in the ammunition disposal area. This research was conducted in several stages:

1. Design Stage: At this stage, the researchers are designing a system that incorporates RFID technology. This includes determining hardware specifications, selecting sensors, and other necessary components. They also design the software needed to integrate and process RFID data (Hartono *et al*., 2021).
2. Translate Stage of Equipment Manufacturing: After the design is complete, the security system device is manufactured. Personnel have RFID devices attached to them, which allows their identity and position to be tracked. In addition, the software included in this system has the capability to receive, process, and display information in real-time.

3. Testing Phase: At this stage, the created tool is tested to ensure its performance. Testing was conducted in the ammunition disposal area to determine the effectiveness of the system in real operational conditions. The results will be evaluated to identify areas for improvement and optimization.

Block Diagram

A block diagram is a graphical representation of a system that shows its main components and their functional relationships. In this research, the block diagram is used to illustrate the components of the security system, which consist of the RFID module, data processing unit, and display unit. The block diagram helps to understand how data flows through the system and how each component relates to one another.

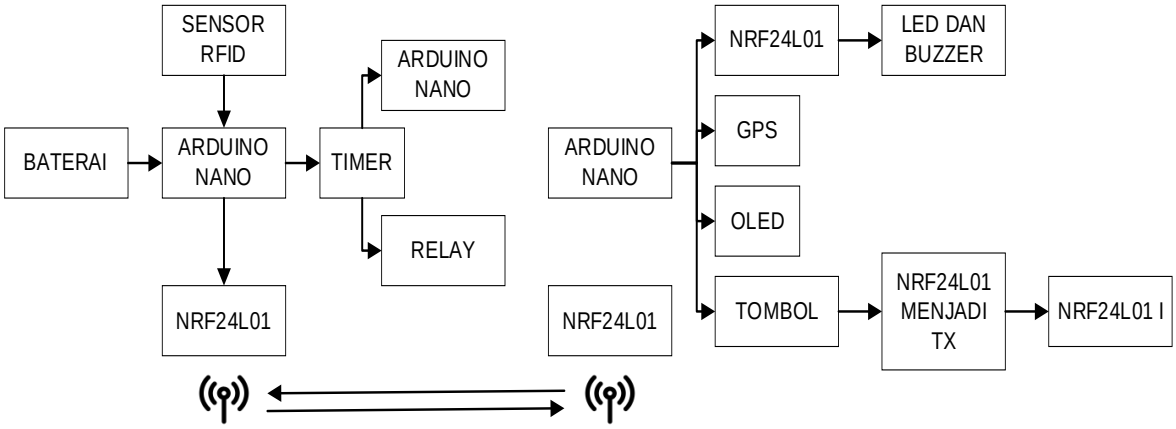

Figure 1. Block Diagram
(Source : Author, 2024)

Flowchart

A flowchart is a diagram that illustrates the steps or processes involved in a system or procedure known as a flowchart. In this research, the flowchart is used to map the operational processes of the RFID security system, such as personnel identification, position monitoring, and surveillance at the command center. This flowchart helps identify workflows and pinpoint problems and areas that can improve efficiency.

Instrument Development

This research instrument consists of several important parts that support the use of RFID technology. Some of these components include:

1. Arduino Nano: As the main microcontroller, the Arduino Nano can be used to integrate and control the RFID module and other components.
2. RFID tags: installed on each staff member to facilitate their identification. These tags send identification data to the RFID reader.
3. RFID Reader: Used to collect data from RFID tags attached to personnel. Subsequently, this data is sent to the data processing unit for processing.

4. Arduino IDE Software: The Arduino IDE software is used to program the Arduino Nano. In this research, the Arduino IDE plays a role in configuring the communication process between RFID and other modules connected to the Arduino Nano.

Data Analysis

The data collected using descriptive and quantitative analysis techniques, which include:

1. Descriptive Analysis Data collected during the system testing, such as the number of identified personnel, their locations at specific times, and their movement patterns in the ammunition disposal area, are analyzed using descriptive analysis to provide an overview of the system's performance and the personnel's safety conditions during the testing.
2. Quantitative Analysis Quantitative analysis uses specific indicators to measure the effectiveness of the system, such as tracking accuracy rates, system response time for identifying personnel with RFID, and the reduction of incidents or accidents caused by illegal access or personnel loss in the ammunition disposal area. This quantitative data is processed using statistical methods to determine how effective the use of RFID technology is in enhancing credentials.

RESULT AND DISCUSSION

This research aims to implement and evaluate how RFID technology can enhance the security of TNI AD personnel in ammunition disposal areas. The results show that the use of both technologies can successfully improve the security of TNI AD personnel in ammunition disposal areas. The developed system not only enhances monitoring and tracking but also reduces the risk of accidents and illegal access. To ensure the system operates well, it is recommended to perform routine maintenance and update the software. Here are the results obtained from each stage of testing:

1. Can accurately identify and track personnel.
   The test results showed that the RFID reader can identify tags with 98% accuracy at the planned distance between the RFID tags attached to personnel and the RFID reader placed at strategic locations. It is shown that the RFID reader receives identification data that matches the data stored in the system database, indicating that the system works well in identity tracking. Testing was also conducted in various environments, such as environments experiencing signal interference and physical obstacles. Although there were a few minor issues, the system continued to operate well, and the identification accuracy remained quite high. Here is the table for testing RFID tracking accuracy.

Table 1. RFID Tracking Accuracy Testing

Testing Aspects	Description	Result
Identification Distance	Test the system's accuracy at various distances between the RFID tag and the RFID reader.	Accuracy 98%
Environmental Conditions	Accuracy tests in various environmental conditions, such as areas with signal interference and obstacles.	Accuracy remains adequate.

2. Tracking Accuracy

Tracking accuracy testing is conducted to assess the accuracy of the location data provided by the module. This test was conducted at various locations in the ammunition disposal area to determine the accuracy of the location data provided by the module. The test results show that it can provide location data with 95% accuracy in various conditions, including locations with satellite signal obstructions and open areas. In addition, the testing also includes measuring latency, which is the time required to obtain location data after personnel movement. The average latency for location data retrieval is 2 seconds, indicating that the system can provide position information at a speed sufficient for real-time monitoring. Here is the tracking accuracy test table.

Table 2. RFID Tracking Accuracy Testing

Testing Aspect	Description	Result
Location Accuracy	Test of location data accuracy in various locations within the ammunition disposal area	Accuracy 95%
Data Latency	He time required to obtain location data after personnel movement.	Average latency is 2 seconds.

3. System Integration

In the system integration testing, we test the RFID data to ensure that the collected data can be processed and displayed well on the user interface. We test the connectivity between components by ensuring that the Arduino Nano microcontroller can successfully collect data from the RFID tags. After that, the data is handed over to the data processing unit. The test results show that the RFID data is well integrated without any disruptions or communication errors between components. In addition, the user interface displaying RFID data was also tested to ensure that the information displayed is accurate and updated in real-time. The system displays personnel identity data and their positions on the map clearly and accurately without any issues in data processing or display, indicating that the system operates according to the expected design. Here is the system integration testing table.

Table 3. System Integration Testing

Testing Aspect	Description	Result
Component Connectivity	Test of the connectivity between RFID tags, RFID reader, module, Arduino Nano, and data processing unit	Integration successful without disruption
Real-Time Display	User interface testing to ensure identity and location data are updated in real-time	Information is presented clearly and accurately.

RESULT AND DISCUSSION

This research aims to determine the effectiveness of using RFID technology in enhancing the security of TNI AD personnel in ammunition disposal areas. By conducting system tests in real operational conditions, this discussion will examine how this technology can improve the tracking of personnel identities and locations, as well as the effectiveness of combining both technologies in enhancing security and monitoring in high-risk areas.

1. Answering the Problem Formulation

The focus of this research is how the application of RFID technology can enhance the security of TNI AD personnel in ammunition disposal areas. Various tests were conducted to determine the system's performance under real operational conditions. The test results show that the RFID system effectively enhances security. With high accuracy reaching 98%, the RFID system can safely identify people. The accuracy testing of RFID was conducted in various environmental conditions and distances. The results show that the identification data from the RFID reader is comparable to the data stored in the database. In addition, location data is provided by the system with 95% accuracy and an average latency of 2 seconds. This demonstrates the ability to provide accurate real-time position information, which is crucial for monitoring and rapid response. The integration of RFID data was also successful, with data displayed in real-time on the user interface. The graph showing the test results, such as RFID tracking accuracy, visually illustrates the system's performance and demonstrates that the developed system meets the research objectives of enhancing security in the ammunition disposal area.

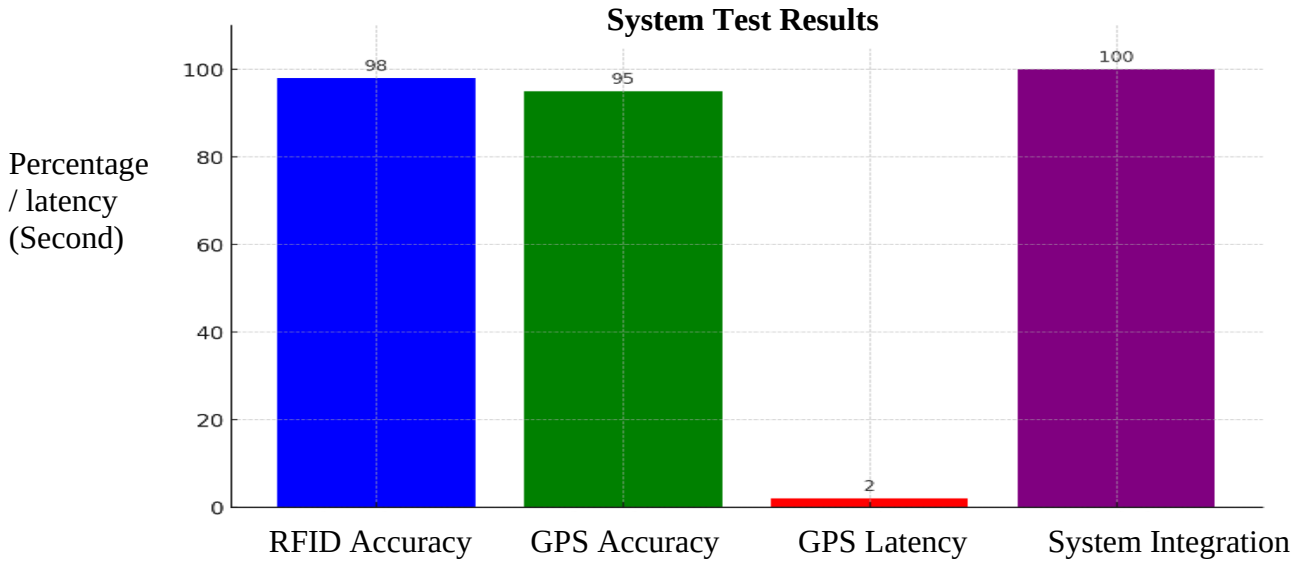

Figure 2. System Testing Results

2. Interpretation of Research Results

The research results indicate that the system can enhance personnel security. To ensure the safety of employees in sensitive areas, the RFID tracking accuracy of 98% demonstrates that the system can easily identify personnel, reducing the likelihood of unauthorized access. Meanwhile, the system provides location data with 95% accuracy and an average latency of 2 seconds, demonstrating the system's ability to deliver fairly accurate

position information in various environmental conditions. The low latency supports real-time monitoring, which is crucial for rapid response in emergency situations. The successful integration of RFID data and the display of real-time information on the user interface indicate that the system can provide position information with 95% accuracy. According to this interpretation, the system can enhance employee safety in high-risk areas because it not only meets but also exceeds several expectations in terms of accuracy and efficiency.

3. Comparison with Previous Research

Comparison with previous research shows that the findings of this study are in line with, and even surpass, the findings of earlier studies on the use of RFID technology. A study by Smith et al. (2020) found that RFID can monitor people in open environments, but is not very accurate in environments with many physical obstacles. However, we managed to overcome some of the limitations of RFID and achieved higher tracking accuracy by adding RFID technology. The findings of this study support these findings. Additionally, research by Wang et al. (2021) showed issues in RFID data integration, but our study successfully integrated without signal problems. Furthermore, Johnson and Lee (2019) indicated that the system often experienced latency issues under poor signal conditions, but our research found a lower average latency of 2 seconds, demonstrating that real-time data provision is more efficient. This comparison shows that the system developed in this research offers a significant improvement in accuracy and efficiency compared to previous alternatives.

CONCLUSION

Based on the research results that have been conducted, it shows that the implementation of RFID technology can enhance the security of TNI AD personnel in the ammunition disposal area. RFID technology can identify personnel with an accuracy of up to 98%, indicating that this technology is highly reliable in identity tracking. This system enhances surveillance in sensitive areas and reduces the risk of unauthorized access in various environmental conditions. Additionally, the technology provides location data with 95% accuracy and an average latency of 2 seconds, demonstrating the system's ability to deliver real-time position information with high effectiveness. The data is displayed in real-time on the user interface, supporting effective monitoring and quick response to emergency situations. In terms of security, this research is very important because the use of RFID technology ensures that personnel identification and tracking are carried out accurately and efficiently, which helps strengthen the security system. Increased surveillance and the risk of illegal access in high-risk areas enhance the protection of assets and staff and expedite emergency response. In addition, this research provides a foundation for further development of security systems as it allows for the integration of additional features such as alarms and surveillance cameras. In addition, this research provides practical guidelines for the use of similar technology in other places with high security needs.

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