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Optimization of Weapon Management in the Warehouse of the Indonesian Defense University Using Web-Based QR Code Technology

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Abstract

This study aims to develop a weapon management system in the warehouse of the Indonesian Defense University using QR code-based technology integrated into a web application. This system is designed to address various challenges of conventional management, such as slow recording processes, human error, and data discrepancies, which frequently occur in weapon inventory management. QR code technology enables automated data entry, tracking, and reporting processes, enhancing efficiency, accuracy, and data security. The Agile methodology is applied in the development of this system, covering several stages, including planning, sprint development, iterative testing, and refinement. This system provides key features such as weapon recording using QR codes, student data management, weapon borrowing and returning, and inventory report generation. Testing results show that this system successfully minimizes recording errors and accelerates operational processes. This research significantly contributes to creating a professional, transparent, and accountable weapon warehouse management model, which can serve as a reference for the development of similar systems in other defense environments.

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1. Introduction

Firearms management is one of the key aspects in supporting effectiveness and security in the defense environment (priyatmoko, 2020). The armory as a storage center requires an accurate, efficient, and structured management system to support operations. Research on optimizing weapons management using modern technology is crucial to ensure that data recording, searching, and reporting processes can be carried out quickly and precisely. The implementation of web-based technology and the integration of QR codes has become one of the strategic steps to address this challenge. QR code

technology itself has been widely adopted in various sectors to support process efficiency, including in the development of digital kanban-based web applications implemented to optimize circuit movement on production lines, as demonstrated by the study "Implementation of Performance Testing on Digital Kanban Web Application for Circuit Movement Optimization in Production Line" (Pramadansyah et al., 2024). Therefore, the optimization of technology-based weapons management at the Republic of Indonesia Defense University is highly relevant to meet these needs.

In the context of inventory management, demand is a critical variable that affects inventory control systems. Demand characteristics, such as the level of certainty and structural dependency, play an important role in determining an effective inventory management approach. Demand can be deterministic (known with certainty) or stochastic (containing uncertainty), and can also be independent or dependent on other factors (Munyaka & Yadavalli, 2022). In addition, the integration of inventory management systems in ERP platforms has been proven to improve operational efficiency and data accuracy in the management of resources and logistics (Zhao & Tu, 2021). The application of web-based information systems has also demonstrated effectiveness in improving accountability and efficiency in inventory management, as shown in research conducted in the education sector by (Feriyanto & Puspitasari, 2024) on the information system for monitoring and managing facilities and infrastructure inventory at SMK N 1 Gadingrejo. Furthermore, the integration of warehouse management systems with Industry 4.0 principles also shows great potential in supporting the achievement of sustainable development goals (SDGs), through increased efficiency, flexibility, and reduced environmental impact (Aravindaraj & Chinna, 2022).

QR code as a form of digital identification has proven effective in accelerating verification and data recording processes, even in crisis conditions such as a pandemic. A study by (Wang & Jia, 2021) showed that the implementation of QR code systems in health data management in China helped accelerate tracing and service access processes, while also improving data-based decision-making efficiency. In addition, the implementation of a private blockchain-based management system integrated with QR code has proven to enhance security and transparency in procurement and asset management, as demonstrated in the study "Private Blockchain-based Procurement and Asset Management System with QR Code" (Hugo & Ngo, 2024). Another relevant study was conducted by (Fajar et al., 2025), which examined the integration of QR codes with sequential search algorithms in inventory management at a regional revenue office. The results showed improved efficiency in the process of real-time asset identification and recording. Furthermore, research by (Rabiah et al., 2022) on the implementation of web-based applications with QR code and RFID integration in telecommunications laboratories showed significant improvements in equipment recording and tracking efficiency, a concept that can be adapted for weapons management in defense environments to support more accurate and responsive monitoring. A study by (Nugraha & Kalifia, 2024) on the e-stock mobile application also emphasized the effectiveness of QR codes in managing electronic inventory efficiently and in real-time. Research by (Putra & Primayani, 2022) also showed that the implementation of an Android-based inventory application with QR codes in a minimarket environment can improve the speed and accuracy of stock data recording. In addition, a study by (Shafira, 2022) revealed that the use of smartphones as barcode scanner media can optimize web-based inventory management, which is relevant to increasing warehouse management system efficiency. In a literature review (Setiawan et al., 2024), it was explained that web-based warehouse management systems using barcode scanner technology in the manufacturing sector can increase productivity and reduce recording errors. A study by (Aulawi et al., 2022) on the implementation of web services with QR codes in inventory management applications also showed the potential for technology integration to improve item data management performance. Research by (Nirawati & Seibinna, 2024) on the digitalization of stock-taking processes using QR codes showed improved accuracy and efficiency in recording office stationery assets. Furthermore, a study by (Balaji et al., 2024) confirmed that the use of QR codes in web-based inventory management systems significantly contributes to stock management optimization and data transparency.

Furthermore, global trends in weapons systems also highlight the importance of integrating advanced technologies such as artificial intelligence and automation in the management and operation of weapons. The study 'Development of Android-based Weapon Monitoring Application in the Armory' (Balaji et al., 2024) demonstrated that the use of mobile devices enables real-time monitoring of loan status, tracking of physical weapon locations, and automatic notifications when anomalies occur, thereby enhancing security and improving operational responsiveness of the armory. According to (Feldman et al., 2019), modern weapon systems that integrate AI show great potential in improving decision-making efficiency and operational responsiveness in complex and high-risk situations. Although the context is different, these findings highlight the important value of technology-based systems to support more adaptive and responsive weapons management.

The management of weapons in the armory of the Republic of Indonesia Defense University is currently still carried out conventionally, which takes a long time to record incoming and outgoing items. In addition, the process of searching for weapon data for return is also not automated, making it difficult to manage many users. Human error in recording often causes data to be incomplete or inaccurate, which can potentially lead to administrative and operational problems. This condition indicates that conventional management is no longer adequate and requires a technology-based solution to improve data efficiency, accuracy, and security.

Based on observations at the weapons warehouse of the Republic of Indonesia Defense University, it was found that the weapon recording process takes an average of 10-15 minutes per transaction. In addition, interviews with warehouse staff revealed that recording errors often occur due to conventional processes, such as forgetting to record weapon details or data discrepancies between physical records and final reports. Officers also experience difficulties in finding certain weapon data due to the absence of an automatic search feature, especially when users request weapon returns.

Previous research by (Hermawan, 2022) entitled "Sistem Informasi Pengelolaan Data Senjata Api pada Biro Sarpras Polda Lampung" developed a web-based system to manage firearm data. This system successfully improved the efficiency of weapons data management with features such as recording incoming and outgoing goods, searching weapon data, and integrated reporting. This study showed that the use of information technology can minimize human error in data recording.

This study aims to develop and implement a web-based application that automates the weapon data recording process, provides an automatic search feature for returns, and improves data accuracy and completeness through the application of QR code technology. The optimization of weapon management at the armory of the Republic of Indonesia Defense University using web-based technology and QR codes is an urgent solution to address issues of data efficiency, accuracy, and security. This study is expected to provide a tangible contribution to improving the operational effectiveness of the weapons warehouse and serve as a reference for the development of similar systems in other defense environments. With an automated and structured system, weapons management can be carried out more professionally, transparently, and accountably.

2. Research Methodolgy

Research Design

This study employs an experimental approach in developing and implementing a web-based system to replace the conventional method of weapon borrowing recording in the Indonesian Defense University warehouse, which previously relied on manual paper-based records. This system is designed to automatically record each weapon borrowing and returning transaction using QR code technology, ensuring accurate weapon data recording and instant borrower identification.

The system enables users to scan a weapon's QR code during borrowing and returning, allowing related information, such as the borrower's name, student ID number, study program, and return status, to be automatically recorded. Additionally, the system supports the printing of borrowing history in PDF format for administrative and reporting purposes.

Experiments were conducted by comparing the effectiveness of the conventional method and this web-based system in terms of time efficiency, recording accuracy, and ease of data retrieval. The study also involved interviews with warehouse staff to obtain feedback regarding system usability and its impact on warehouse operations.

Alternatives and Criteria

This study compares several alternative weapon data recording and management methods based on data collected from observations and interviews with warehouse staff. The alternatives considered include manual paper-based recording, a web-based system without QR code integration, and a web-based system with QR code integration. The manual method has weaknesses in time efficiency and is prone to human errors. Meanwhile, the web-based system without QR codes enhances digital recording but still requires manual input of weapon and borrower data. The final alternative, a web-based system with QR codes, enables automatic recording during weapon borrowing and returning and supports borrowing history printing in PDF format for documentation and reporting.
The evaluation of alternatives was based on key criteria, including:

1. Time efficiency – How quickly the system records and retrieves data compared to conventional methods.
2. Recording accuracy – The level of accuracy in recording weapon borrowing and returning transactions.
3. Data security – Protection against data loss or administrative errors.
4. Ease of use – How intuitive the system is for warehouse staff.
5. Report generation capability – The availability of PDF-formatted borrowing history for administrative purposes.

Based on evaluations of these criteria, the web-based system with QR code integration was selected as the optimal solution for improving efficiency and accuracy in weapon management.

Technical Data Analysis

Data analysis in this study was carried out through several stages:

1. Initial Data Collection: Observations in the Indonesian Defense University weapon warehouse, interviews with staff, and a review of documents related to previous recording systems.
2. Performance Measurement: Measuring the time required for recording, searching, and managing data before and after implementing the web-based system.
3. Error Rate Analysis: Evaluating the number of recording errors in the conventional method compared to the QR code-based system.
4. Effectiveness Evaluation: Comparing test results of the web-based system with the conventional method using descriptive statistical analysis.
5. Result Validation: Confirming research findings through discussions with warehouse staff and information system experts to ensure the effectiveness and relevance of the developed solution.

With this approach, this study aims to demonstrate that implementing a web-based system with QR codes can improve efficiency, accuracy, and security in weapon management at the Indonesian Defense University warehouse. Additionally, the ability to print borrowing history in PDF format is expected to add value to administration and reporting.

3. Results and Discussion

The study results indicate that the web-based system with QR code integration significantly enhances efficiency and accuracy in weapon management at the Indonesian Defense University warehouse. The system enables automatic recording of weapon borrowing and returning through QR code scanning, ensuring immediate data entry into the database.

Testing results show that the weapon borrowing and returning recording time was reduced from 10-15 minutes to less than 2 minutes per transaction. Additionally, recording errors commonly found in

manual methods were minimized. Warehouse staff can easily search for borrowed weapon data and print borrowing histories in PDF format for administrative and reporting purposes.

Table 1. comparison between the conventional method and the web-based system with QR code integration

Evaluation Aspect	Conventional Method	Web-Based System with QR Code
Recording Time	10-15 minutes	<2 minutes
Error Rate	High	Low
Data Search	Manual, slow	Automatic, fast
Data Security	Prone to loss	Integrated, securely stored
Report Printing	Not available	Available in PDF format

4. Conclusion

The implementation of this technology-based weapon management system has been proven to improve efficiency, accuracy, and data security in managing the weapon warehouse at the Indonesian Defense University. With QR code-based automation, borrowing and returning records become faster and less prone to errors compared to manual paper-based methods. The system also provides a data search feature that facilitates staff in accessing weapon information and supports the generation of borrowing history reports in PDF format for administrative and auditing needs. With these advantages, the implementation of this system can serve as a model for other institutions seeking a modern and structured solution for asset management.

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