

Development of android-based weapon monitoring application in the armory

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ABSTRACT

Information and communication technologies (ICT) are of vital importance in the context of modern military operations, with Android-based solutions becoming increasingly relevant for the improvement of military weapons management systems. This study addresses the inefficiencies of current manual weapon management practices, which are susceptible to data errors and operational delays. The objective of this research is to enhance the accuracy, efficiency, and security of weapon management through the development of an Android-based monitoring application. The Rapid Application Development (RAD) methodology was employed to streamline the development process, which entailed the planning of requirements, the design of the user interface, the construction of the application, and its implementation. The application was constructed using Kotlin for the front end and Node.js with Express.js for the back end. It integrates real-time data updates, automated notifications, and efficient data management. The system's design incorporates a comprehensive class diagram for database structure, user interface mockups, and various backend components, including models, migrations, controllers, routing, and middleware. The results demonstrate that the application markedly enhances weapon management by reducing manual errors, increasing operational efficiency, and providing enhanced security and accountability through accurate, real-time digital record-keeping.

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1. INTRODUCTION

Information and communication technologies are vital to modern military operations, affecting numerous sectors. Android-based technology is a crucial factor in improving the effectiveness of military weapons management systems (Шершнева & Мезенцева, 2024). Information and communication technologies must be applied in military weapons management to improve operational efficiency and maintain a strategic advantage in modern warfare scenarios (BALMUŞ et al., 2022).

It is imperative that we streamline the management of military weapons in the field. All members who take or borrow weapons must possess a weapon authorization certificate, psychological examination results, and a military ID card. The current system, which relies on manual record-keeping, is untenable. It is unfeasible to expect staff to manage the armory with such a cumbersome process. (Haris & Kurniati, 2021). The manual system is ineffective and negatively impacts data quality. A technology-based solution is needed to improve weapon monitoring, including

tracking the status, location, and condition of weapons. The use of a manual system is inefficient and forces staff to memorize weapons and their owners, limiting command interaction and direct supervision by commanders (Priyatmoko & Capah, 2020). A similar study was conducted by (Priyatmoko & Capah, 2020), which also identified the issue of manual data entry for transactions related to borrowing and weapon acquisition. The manual process of recording each transaction in a logbook is time-consuming and prone to data inconsistencies. It is therefore evident that a support system is required which will enhance the efficacy of weapon monitoring.

To address these challenges, this study proposes the development of an Android-based monitoring application. This application aims to streamline the process of weapons management by leveraging mobile technology, thus eliminating the need for computers or laptops. The application will be accessible via personal mobile devices, making it a convenient and user-friendly solution. Built using Kotlin, the application will enhance efficiency, accuracy, and security in weapons monitoring, providing quick and easily accessible information to authorized personnel.

The study follows a structured approach to system development, guided by the Software Development Life Cycle (SDLC) and Rapid Application Development (RAD) methodologies. The SDLC model, as described by Santi et al. (2024) and Valian Yoga Pudya Ardhana et al. (2024), ensures a systematic planning, organization, and management of the software development process, minimizing risks and maximizing quality. The RAD methodology, characterized by its incremental nature, allows for parallel processing of various phases, including business modeling, data modeling, process modeling, application formation, testing, and implementation (Umar et al., 2022).

The implementation phase integrates the frontend and backend systems using modern technologies. The mobile frontend is developed using Kotlin, while the backend employs Node.js with Express.js. Database management is handled by PostgreSQL, with Prisma ORM facilitating schema management. This integration ensures that the system is robust, efficient, and secure, capable of handling concurrent user requests and processing data accurately.

The application includes several key features designed to enhance the efficiency and effectiveness of military weapons management. The real-time data analytics feature allows users to monitor the status, location, and condition of weapons in real time, utilizing advanced data processing techniques to provide up-to-date information. This enables timely decision-making and operational efficiency by identifying patterns and trends, such as excessive borrowing of specific weapons, allowing administrators to take proactive management actions. Additionally, the application can generate quick reports in PDF format, enabling users to create comprehensive reports on various aspects of weapon management, including transaction histories, weapon status, and inventory levels. This capability enhances transparency and accountability, as the reports can be easily shared with relevant stakeholders, such as commanding officers or external auditors. Furthermore, a notification system is integrated to alert users about upcoming transaction deadlines, ensuring that borrowed weapons are returned on time and improving overall management. These notifications can be customized based on user preferences, delivering timely alerts through preferred channels such as push notifications or emails.

A warehouse is defined as a facility that is responsible for the storage and management of an item or product within the context of a supply chain (Chen et al., 2021). The role of warehouses in ensuring uninterrupted product flow and efficient supply chain operations is of paramount importance (Verma et al., 2023). A weapon is defined as a tool that is designed and utilized for the purposes of attack or defense. Weapons may take the form of structures, such as buildings, or chemical substances that can be emitted, or devices. The armory is a crucial location within a military agency, where the borrowing, taking, and returning of weapons is conducted according to established procedures (Hoffmann et al., 2021; Michalak, 2022).

Monitoring is a process of activities that aims to observe, measure, and understand various activities over time. It involves collecting data and assessing outputs, outcomes, and impacts in other contexts. Monitoring can be used in various scientific fields, one of which is service digitization. Monitoring can be done by various methods, such as self-monitoring, professional assistance, and the use of digital technology (Razumovskiy et al., 2020).

Mobile applications are software programs designed to run on mobile devices, including smartphones and tablets. Mobile applications can be utilized for a multitude of purposes, including

communication, information dissemination, entertainment, and educational opportunities (Azgar et al., 2022). These applications possess distinctive characteristics pertaining to their hardware, software, and networks. It is of paramount importance that their design incorporates a user-centric approach. Mobile applications can be pre-downloaded on mobile devices or obtained from app stores, and their usage is witnessing a surge in popularity (Cruz-Cortes, 2020).

SDLC stands for Software Development Life Cycle. It is a process or methodology followed by a software engineering team to develop software projects that have certain skills with the goals and scale of the project. The purpose of SDLC is to complete software projects on time and achieve the desired goals (Santi et al., 2024; Valian Yoga Pudya Ardhana et al., 2024). SDLC is also very necessary to minimize the level of risk and failure and also to maximize project quality (Gupta et al., 2022). The SDLC model helps plan, organize, and manage the software development process, ensuring that all team members are responsible for different parts of the software (Suwarno & Devalia, 2022). By following the SDLC, software project managers and their teams can solve complex problems efficiently, save time, and develop software that solves problems accurately and efficiently.

Unified Modeling Language is a standard language for visualization, planning, and documentation of software systems and information systems. It is used in the information system design process by including use case diagrams, class diagrams, and sequence diagrams (Dewi et al., 2023). UML has advantages such as being more flexible, easy to understand, and easier to expand and test the system.

Rapid Application Development (RAD) is one of the information system development methods that is characterized by an incremental nature and is utilized in the context of short-term work. This method permits the processing procedure to be conducted in parallel from business modeling, data modeling, and process modeling, through to application formation, testing, and turnaround (Umar et al., 2022). In the development of information systems, there are several phases or stages in the use of RAD, including the planning phase, design phase, construction phase, and implementation phase. This method can be used optimally in the development of information systems due to its highly effective manipulation (Zulkarnain & Dkk, 2021).

In a recent study, Angga, Amali, and Suwarno developed a web-based inventory system for PT. Cabinindo Putra employs the PHP programming language and the XAMPP database management system, integrating barcode scanning functionality. The methodology employed was that of the waterfall model. However, the system is deficient in several respects, including the absence of report printing, security systems, and validation mechanisms (Angga et al., 2023).

Atmaja and Susanto optimized the SIMAK-BMN application for state asset inventory, employing both web and Android models. The web component was developed using the PHP Laravel framework, while the Android version was created with the App Inventor platform. The system, developed in accordance with the Rapid Application Development (RAD) methodology, is deficient in several key features, including the ability to print reports, implement robust security protocols, and enforce data validation (Atmaja & Susanto, 2019).

Chaidhir Ismail and Imron Rosadi developed an Android-based inventory monitoring application for PT. The PLN (Persero) UP3 Pasuruan employs the FIFO (First In, First Out) algorithm. Similarly, the application, which was developed based on the waterfall model, lacks the functionality to print reports, incorporate security features, and implement validation mechanisms (Chaidhir Ismail & Imron Rosadi, 2022).

Priyatmoko and Capah developed a web-based weapon management application using the CodeIgniter framework. This application, which follows the waterfall model, facilitates reporting on weapon loans and conditions. However, it is constrained by its absence of security systems and its reliance on PHP for web development (Priyatmoko & Capah, 2020).

This study builds on existing research by addressing key limitations identified in previous systems. For instance, Angga et al. (2023) developed a web-based inventory system that lacked report printing, security systems, and validation mechanisms. Similarly, Atmaja and Susanto (2019) and Chaidhir Ismail and Imron Rosadi (2022) developed inventory systems that were deficient in these areas. The proposed Android-based application overcomes these limitations by incorporating comprehensive security features, validation mechanisms, the ability to print reports, real-time data

analytics, and a notification system for transaction deadlines, thereby enhancing overall system functionality.

This study addresses the critical issues in military weapons management by developing an Android-based monitoring application that significantly improves operational efficiency, accuracy, and security. The proposed system leverages advancements in ICT and mobile technology to provide a user-friendly and effective solution, addressing the limitations of existing systems. The integration of real-time data analytics, quick report generation in PDF, and a notification system for transaction deadlines ensures that the application not only meets current needs but also provides a robust platform for future enhancements.

Future research could focus on further optimizing the application, exploring additional features such as enhanced data security measures and integration with other military systems, to provide a comprehensive solution for weapons management.

2. RESEARCH METHOD

The system development method used by the researchers in this study is one of the Software Development Life Cycle (SDLC) models, namely the Rapid Application Development (RAD) method. RAD combines various structured approaches with prototyping and joint application development methods, aiming to shorten application development time (Saputra et al., 2021). This method was chosen because it can make the development process more efficient compared to other processes (Amrullah et al., 2021).

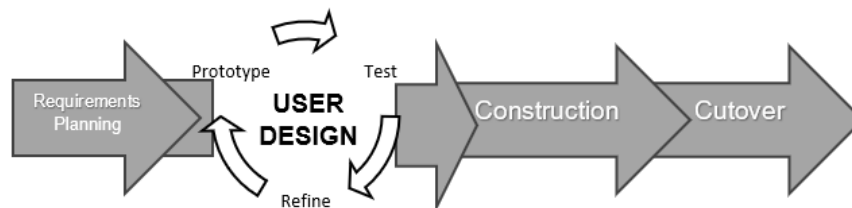


Figure 1. Rapid Application Development (RAD)

Based on Figure 1, the stages of the Rapid Application Development method consist of four development stages (Wicaksono & Suryawan, 2023):

1) Requirements Planning

This process ensures a thorough understanding of the system's objectives, the problems it faces, the necessary functions, the required components, and the necessary information requirements. This process also includes data collection through field research, such as observations and interviews, as well as literature studies based on books, similar research, and articles. This stage is the first step to guarantee that there are no communication errors between users and developers during system development.

2) User Design

This process ensures that the design is created according to the needs to achieve the development objectives. This involves creating the design and making improvements if any design deviations are identified. The development team uses the Unified Modeling Language (UML) to describe the system design. At this stage, the researchers create mockups of the application and design how the system will function and operate using UML diagrams, including use case, activity diagram, class diagram, and sequence diagram.

3) Construction

The construction process implements the system according to the design made in the previous process. This includes building the system components, coding, and integrating all these elements to create a functioning and operational system ready for implementation. At this construction stage, the researchers build the application using Android-based programming with the Kotlin programming language and SQLite.

4) Cutover

This process involves comprehensive testing of the entire built system, with each component being carefully tested using black box testing techniques. The goal of this process is to identify and reduce potential system errors by focusing on the software's functional specifications. In this black box testing, the researchers provide several test cases to determine the functionality of the developed application.

3. RESULTS AND DISCUSSIONS

1) Requirements Analysis

This study determined the minimum system requirements for the software and hardware used by the researcher to test and implement the application system. The following section explains the minimum requirements needed to run the application system to be developed.

Tabel 1. System Minimum Requirement (Android)

Component	Specification Item
Device Name	Android
OS	Android 5.0 Lollipop or higher
CPU	Dual-core 1.5 GHz or higher
RAM	Minimum: 2 GB
Screen	Minimum resolution: 720 x 1280 pixels (HD)
Internet Connection	Wi-Fi or mobile data connection to download the application and necessary updates

In addition to the system requirements, the researcher has also identified the functional requirements for the application system to be developed:

a. General (Owned by All Users)

These are general functions possessed by all registered users, such as administrators and regular users.

- Login and Logout
- Input transaction data
- View transaction data
- Edit transaction data
- View item data
- Search for item data and transaction data

b. Administrator

The administrator role has access to manage master table data and has the highest privileges in the system. Administrators are responsible for the Armory and have the highest authority.

- Display all data (user, personnel, items, transactions)
- Add all data (user, personnel, items, transactions)
- Edit all data (user, personnel, items, transactions)
- Delete all data (user, personnel, items, transactions)
- Print reports
- Export data tables (user, personnel, items, transactions)
- Print invoices

c. Regular User

A regular user is a user with limited access rights. These users are armory staff who do not have the authority to modify and manage all master tables.

- Input transaction data
- View transaction data
- Edit transaction data
- View item data
- Search for item data and transaction data

After detailing the system requirements for the two user roles, the results can be modeled using Unified Modelling Language (UML).

2) User Design

This phase is initiated subsequent to the completion of the requirements planning phase. Subsequent to the analysis phase, the design phase is initiated with the objective of establishing the framework of the application. This design is created with the intention of providing a reference point during the subsequent construction and implementation phases, in alignment with the findings of the aforementioned requirements analysis. The design is divided into two distinct components: the database design and the mockup design.

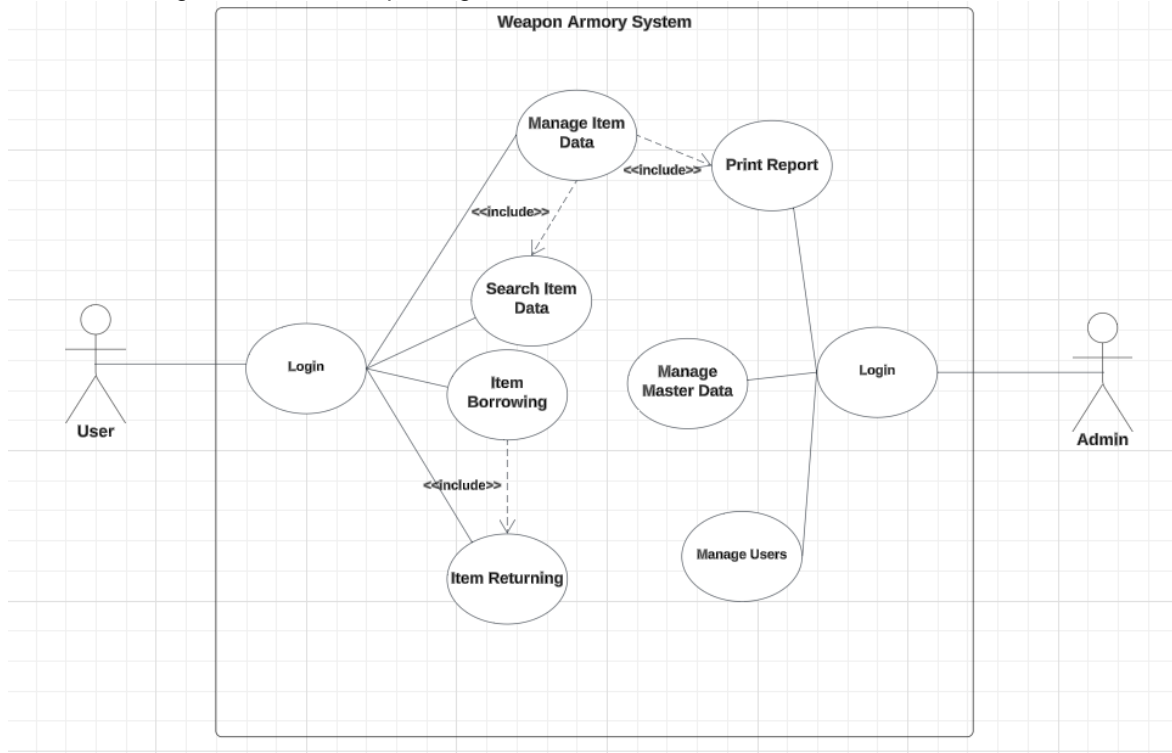


Figure 2. Usecase diagram of System

Figure 2 illustrates the activities that can be performed by armory system warehouse staff or "users." These activities include managing weapon data, searching weapon data, borrowing weapons, and returning weapons. When managing weapon data, the user can search for weapon data. Similarly, when borrowing weapons, the user can retrieve weapons and manage their condition. Additionally, the administrator can perform activities such as managing conditions, managing master data, and generating reports.

a. Database Design

In this research project, the class diagram is employed for the purpose of database mapping. As illustrated in Figure 3, the class diagram has been constructed in accordance with the findings of the requirements planning analysis.

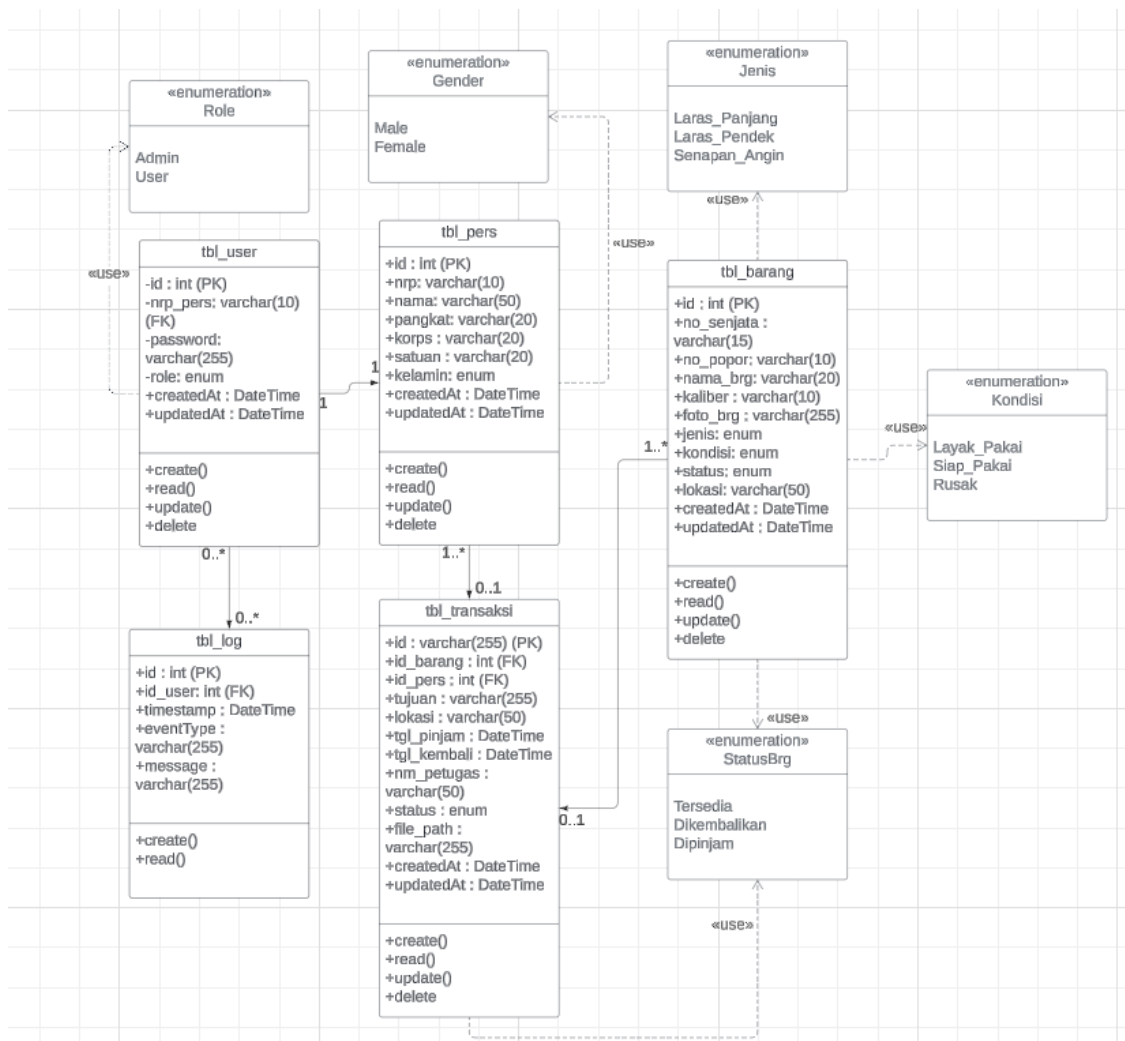


Figure 3. Class Diagram

The class diagram serves as the design for the database, outlining the structure and relationships between different entities within the system. This diagram provides a visual representation of the database schema, defining the tables, fields, and associations necessary for the application. It acts as a blueprint that guides the development of the database, ensuring that all data is organized, related, and accessible in a manner consistent with the system's requirements and functionalities (Fauzan et al., 2021).

b. Mockup Design

The mockup design represents one of the construction or development stages of the application, conducted by the author of this research. This stage is of significant importance, as it provides the author with a reference design for the construction of the user interface (UI) that will be utilized by the users. The mockup design is created using the Figma application. The objective of this activity is to guarantee that the developer can readily construct the application's interface in accordance with the established UI/UX design. As illustrated in Figure 4, the mockup design for the system has been created.

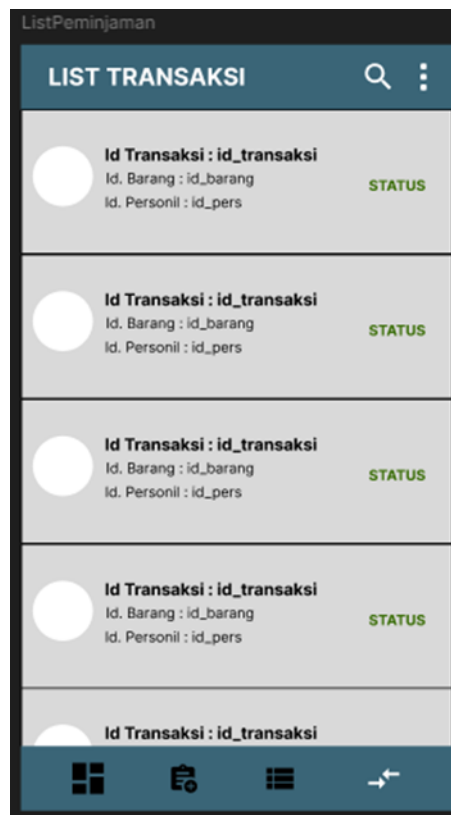


Figure 4. Mockup design

c. System Implementation

In this phase, the elements developed in the preceding stages are integrated to construct a system that operates in an optimal manner. The mobile frontend is developed using the Kotlin programming language, while the Node.js framework with Express.js is employed for the backend. In the construction of a backend application, the creation of a model is employed to define the structure of tables within the database, thereby facilitating schema management and ensuring data integrity. The creation of a migration, utilizing PostgreSQL and the object-relational mapping (ORM) Prisma, generates the fundamental schema of the database structure, thereby enhancing both productivity and security. The controller serves as the nexus between the model and view, facilitating the processing of data from users and the implementation of the application's business logic. Routing defines the manner in which the web application responds to client requests based on URI and HTTP methods, thereby ensuring security and scalability. Middleware acts as an intermediary processing layer, handling authentication, authorization, error handling, and other tasks in server request and response processing. As illustrated in Figure 5, the result of the system application implementation demonstrates the seamless integration of the backend with the frontend.



Figure 5. Frontend of System

The armory management application system significantly enhances efficiency, accountability, and real-time data accessibility through its key features. Real-time data analytics provide up-to-date information on weapon status, location, and condition, enabling timely decision-making and operational efficiency while identifying patterns and trends for proactive management. Quick report generation in PDF format facilitates transparency and accountability by allowing comprehensive reports on transaction histories, weapon statuses, and inventory levels to be easily shared with stakeholders. The notification system ensures timely returns of borrowed weapons by alerting users about upcoming deadlines, thus reducing the risk of overdue items and improving overall management. The study's detailed system and functional requirements analysis ensures the application runs efficiently on widely available devices, with clear roles and functions tailored for administrators and regular users, facilitating a scalable and adaptable system. The design phase, including database and mockup designs, provides a clear visual representation of the system's structure and functionality.

The seamless integration of the mobile frontend developed in Kotlin and the backend using Node.js, along with secure database management via PostgreSQL and Prisma, ensures data integrity and system scalability. Compared to traditional methods, the application offers significant advantages in accuracy, efficiency, and accessibility. Features like real-time data analytics, quick report generation, and customizable notifications set it apart from existing solutions. Future enhancements could include integrating advanced analytics, predictive features, and machine learning for improved anomaly detection, as well as expanding compatibility to iOS and web-based interfaces. In summary, the armory management application system advances military weapon management through real-time analytics, quick reporting, and timely notifications, providing a robust, scalable, and user-friendly solution ready for future enhancements and broader adoption.

4. CONCLUSION

The study, based on research and implementation results at the Armory, concludes that adopting an Android-based monitoring application significantly enhances the accuracy and timeliness of weapon

management, effectively overcoming inherent errors associated with manual input. The application offers real-time status updates, reduces the incidence of manual recording errors, and enhances operational efficiency through features such as automatic return notifications and rapid mobile access, thereby improving transparency and oversight. Furthermore, the integrated system improves security and accountability by enabling accurate, real-time digital record-keeping, facilitating the tracking of weapon transactions, and ensuring comprehensive documentation and auditability of all management activities. In summary, the armory management application system advances military weapon management through real-time analytics, quick reporting, and timely notifications. Its detailed analysis and structured design ensure a robust, scalable, and user-friendly system, ready for future enhancements and broader adoption.

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