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SI-MATRE: A No-Code Integrated Application for Used Material Management in a Power Generation Company

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Abstract

Purpose: This study develops SI-MATRE, an integrated web-based application for managing used materials at PT PLN Indonesia Power Unit Bisnis Pembangkitan (UBP) Keramasan, a gas and steam power generation unit. The system addresses inefficiencies from manual, paper-based recording, including material accumulation, poor traceability, and delayed disposition decisions.

Methodology: Using the Extreme Programming (XP) agile methodology, development proceeded through planning, design, coding, and testing. Glide Apps, a no-code platform, with Glide Table as backend, enabled rapid prototyping without programming. System artifacts included Context Diagram, DFD, ERD, data dictionary, flowcharts, and UI mockups. Functional modules support material intake, outflow recording, and transaction history with monthly analytics. Seven black-box test scenarios evaluated the system.

Results: All test scenarios passed, confirming system accuracy and completeness. SI-MATRE digitized material movement tracking with OTP-secured authentication, automated code-based data retrieval, and visual analytics. Material accumulation was reduced, and items categorized for repair, auction, or disposal were better organized.

Conclusions: No-code platforms like Glide Apps can effectively deliver industrial inventory solutions, improving transparency, speed, and traceability.

Limitations: Scope is limited to the used material return warehouse, with storage constraints under the Glide free tier, no formal user acceptance testing, and untested peak load performance.

Contributions: This study provides a replicable no-code application framework for industrial material management in energy sector facilities.

Keywords: *Inventory Management, Material Return, No-Code Development, Used Material Warehouse, Warehouse Information System*

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1. Introduction

Indonesia transition towards Industry 4.0 has progressively integrated digital technologies across its critical infrastructure sectors, including energy generation and distribution. PT PLN (Persero), a state-owned electricity enterprise responsible for the national power supply, operates a network of generation units whose operational continuity depends critically on effective material and spare part management (Suhada, Yustanto, & Puariesthaufani, 2023). Among the generation assets, gas and steam power plants (PLTGU) represent strategically vital facilities requiring high-availability, high-precision maintenance regimes to prevent supply disruptions, the downstream consequences of which span industrial production, public services, and household consumption.

PT PLN Indonesia Power UBP Keramasan is a PLTGU facility located in South Sumatra, organized into three operational divisions: Finance and General Affairs, Engineering, and Operations and Maintenance (OPHAR). Within OPHAR, the Logistics unit is responsible for managing materials and spare parts stored across multiple warehouse types: general, chemical, lubricant, and used material (bekas pakai) warehouses. The used material warehouse is particularly challenging to manage: as components reach their end-of-life and are replaced to maintain generation reliability, the return warehouse accumulates diverse materials categorized as repairable, auctionable, or non-repairable. Without effective tracking, these materials pile up, creating spatial constraints, audit compliance risks, and delayed disposition decisions that ultimately affect maintenance planning and asset utilization efficiency (Winata, Ayuningtyas, & Putra, 2024).

The existing material recording process at PT PLN Indonesia Power UBP Keramasan relies on manual, paper-based entry of individual material movements, which is both time-intensive and error-prone (Huda, Hartati, Nurhidayanti, & Daspar, 2022). The absence of a digitalized, integrated recording system across warehouse subunits creates data silos, prevents real-time stock visibility, and inhibits analytical monitoring of material flow patterns (Ramdhani & Supena, 2022). These limitations are well-documented in the inventory management literature: manual inventory processes have been shown to produce error rates significantly higher than digital equivalents, with consequent effects on procurement efficiency and operational costs (Teadliyanto, & Ola, 2023; Yudiana, Darmansyah, Anggraeni, & Yuliyanto, 2023).

The digitization of inventory management through web-based or mobile applications has been widely adopted as a response to these challenges (Solehudin, Fariz, Wahyu, & Saifudin, 2023). However, conventional custom software development requires specialized programming expertise, extended development timelines, and non-trivial financial investment, barriers that frequently impede adoption in the operational units of large state-owned enterprises, where IT development resources are centralized and prioritized for core business systems. No-code and low-code development platforms address this barrier by enabling domain expert practitioners to construct functional applications without writing conventional code, substantially reducing development time and cost while enabling rapid iterative adaptation to operational requirements (Rokis & Kirikova, 2022).

Glide Apps is a no-code platform that enables the creation of web applications connected to structured data sources including Glide Table, Google Sheets, and relational databases. Its visual component-based interface allows practitioners to assemble authenticated, data-driven applications with inventory tracking functionality without requiring programming expertise (Family, 2023; Glide, 2022). Despite the growing adoption of no-code platforms in small and medium enterprises, their application in industrial warehouse management in Indonesian state-owned energy enterprises has not been thoroughly documented in the academic literature.

This study addresses this gap by documenting the design, development, and functional evaluation of SI-MATRE, a no-code integrated web application built on Glide Apps for material management at PT PLN Indonesia Power UBP Keramasan. The primary research objectives are as follows: (1) to analyze the operational requirements of the used material return warehouse and define system functional and non-functional specifications; (2) to design the system architecture, data model, and user interface using the Extreme Programming methodology; (3) to implement the application using Glide Apps with Glide Table as the backend data store; and (4) to validate the system through comprehensive black-box functional testing (Juanika, 2022). The novelty of this contribution lies in its documented application of the no-code development methodology to a specialized industrial materials management context in the Indonesian electricity sector, providing a replicable development reference for comparable facilities. The remainder of this paper is organized as follows: Section 2 reviews the relevant theoretical and empirical literature. Section 3 describes the research methodology used in this study (Makarim & Hamzah, 2024). Section 4 presents the system design, implementation, and testing results of the proposed method. Section 5 concludes with the limitations and future research directions.

The implementation of integrated digital inventory systems has been demonstrated to improve both operational accuracy and strategic decision-making in industrial settings, particularly when applied to complex supply chains with multiple points of storage and distribution. Recent studies in industrial engineering emphasize that digital transformation in warehouse systems not only minimizes errors inherent in manual processes but also supports advanced analytics such as demand forecasting, stock anomaly detection, and maintenance analytics, capabilities that are essential for high-availability infrastructure assets (Berry, & Tagarev, 2021 Ivanov, Dolgui, Sokolov, & Ivanova, 2020) . In the context of electricity generation, where material downtime can critically impact generation continuity and safety, the combination of digital tracking and real-time data access increases responsiveness to unplanned maintenance events and optimizes procurement scheduling. Moreover, emerging research indicates that applications developed on low-code and no-code platforms can be effectively integrated with IoT sensors and Enterprise Resource Planning (ERP) systems, further enriching the decision support available to operational managers without imposing heavy IT development reliance (Gartner, 2022; Mohammadi, Shokouhyar, & Seddigh, 2021). These gains align with global efforts toward Industry 4.0 maturity, underscoring that digital inventory ecosystems contribute not only to operational efficiency but also to strategic asset performance indicators that inform executive management review cycles and regulatory compliance reporting (Qin, Liu, & Grosvenor, 2022).

2. Literature Review and Hypothesis/es Development

2.1 Inventory and Logistics Management in Industrial Organisations

Inventory management encompasses the coordinated processes of receiving, storing, maintaining, and distributing materials to support operational continuity (Ramdhani & Supena, 2022). In industrial organizations, such as power generation facilities, effective inventory management is a determinant of operational reliability: component unavailability caused by inventory tracking failures directly increases the Mean Time to Repair (MTTR) and risks unplanned generation outages (Hakim, Utomo, & Kusumastutie, 2019). In this context, logistical management extends beyond physical stock control to encompass data integration across warehousing units, supplier relationship management, and disposition planning for end-of-life components.

The management of used or returned materials represents a distinct subdomain within industrial inventory management, characterized by high material heterogeneity, uncertain reuse potential, and complex disposition (Yudiana, Darmansyah, Anggraeni, & Yuliyanto, 2023). Unlike primary stock management, used material management requires classification workflows that assess each item's condition against repair, auction, or disposal thresholds, a process that, when conducted manually, introduces subjectivity and delays that impair warehouse throughput and space utilization (Winata, Ayuningtyas, & Putra, 2024).

The digitization of used material inventory management has emerged as a critical enabler of operational efficiency and audit compliance in industrial facilities. Studies have shown that integrating real-time tracking systems with automated classification and disposition workflows significantly reduces the risk of stock discrepancies and ensures timely availability of repairable components, thereby minimizing operational downtime and supporting predictive maintenance strategies (Solehudin, Fariz, Wahyu, & Saifudin, 2023). Furthermore, the use of web-based or no-code platforms allows logistics personnel to directly engage with system configuration, facilitating immediate feedback, continuous refinement, and enhanced data accuracy across warehouse subunits (Rokis & Kirikova, 2022). In practical terms, implementing such digital solutions in power generation facilities not only streamlines the intake and outflow processes but also optimizes spatial utilization in return warehouses, accelerates decision-making for component repair, auction, or disposal, and provides management with actionable analytics to support inventory forecasting, compliance reporting, and cost optimization (Teadliyanto & Ola, 2023). Collectively, these advancements underscore the strategic importance of digital inventory systems in high-stakes industrial environments where effective material return management directly impacts reliability, safety, and organizational performance.

2.2 Digitalisation of Inventory Management Systems

The digitalization of inventory management has been demonstrated to yield significant improvements in recording accuracy, process speed, stock visibility, and decision-making quality across multiple industry contexts (Suhada et al., 2023; Teadliyanto & Ola Aman, 2023). Web-based inventory applications specifically enable real-time stock monitoring, multi-location data integration, and historical transaction analytics, capabilities that are fundamentally unavailable in paper-based systems (Solehudin, Fariz, Wahyu, & Saifudin, 2023). Baihaqi et al. (2021) documented an inventory information system implementation at PT Pembangkitan Jawa Bali that demonstrated improved recording precision and inter-warehouse data consistency in an electricity generation context directly analogous to the setting of the present study.

Cross-warehouse system integration, which enables real-time data exchange between geographically distributed storage units, has been identified as a critical capability for multi-subunit organizations managing materials across several locations (Rahayu et al., 2022; Hakim et al., 2019). Without integration, data duplication, inter-unit recording inconsistencies, and delayed reporting compound the inefficiencies of manual processes. Integrated systems further reduce human error through automated data retrieval mechanisms, such as material code-triggered auto-population of transaction forms, which minimize the manual transcription burden on warehouse operators (Winata, Ayuningtyas, & Putra, 2024).

2.3 No-Code Development Platforms in Information Systems

No-code Development Platforms (NCDPs) represent an emerging paradigm in information systems development that enables application creation through visual interfaces and prebuilt components rather than traditional programming (Rokis & Kirikova, 2022). NCDPs lower the technical barrier to application development, enabling domain experts, sometimes termed 'citizen developers', to build functional systems that directly address operational requirements without dependency on centralized IT development teams (Richardson & Rymer, 2016). Glide Apps is a representative NCDP supporting web application development with structured data connectivity, user authentication, and a library of visual interface components, including tables, forms, charts, and image fields (Family, 2023; Glide, 2022).

Despite growing practitioner adoption, the academic documentation of NCDP applications in industrial inventory management contexts remains limited Rokis & Kirikova, 2022. Most published no-code platform studies address small- and medium-sized enterprise deployments in commerce, education, and community services. The application of NCDPs to warehouse management in regulated industrial facilities, where data integrity, access control, and audit traceability requirements are elevated, represents an underexplored research area with practical significance for digital transformation initiatives in Indonesia state-owned enterprises sector.

However, the potential of NCDPs in industrial contexts has begun to attract scholarly attention as researchers investigate their impact on organizational agility, innovation diffusion, and system development effectiveness. Early studies indicate that the use of visual development tools can accelerate application delivery and improve alignment between business needs and system functionality, while still raising important questions regarding scalability, security, and governance in enterprise settings (Mäntylä, Petersen, & Claes, 2021). Furthermore, research on digital transformation in manufacturing and logistics suggests that platforms enabling rapid application creation to contribute to improved operational responsiveness by reducing the time and cost associated with custom software development, making them particularly relevant for environments where rapid adaptation to changing inventory or maintenance workflows is critical (Stentoft, Mikkelsen, & Rajkumar, 2019). These findings imply that NCDPs not only support operational innovation but also may serve as catalysts for broader digitalization efforts in asset-intensive sectors such as energy, transportation, and industrial manufacturing.

2.4 Extreme Programming Methodology for Application Development

Extreme Programming (XP) is an agile software development methodology characterized by short iterative development cycles, continuous stakeholder feedback, and adaptive responses to evolving requirements (Andriani, 2023). XP four-phase cycle planning, design, coding, and testing is particularly well-suited to the development of operational support applications in organizational settings where requirements are initially incompletely specified and refined through user engagement (Atmojo, 2023). In the context of no-code development, XP iterative structure maps naturally onto the rapid prototyping capabilities of platforms such as Glide Apps, enabling functional prototypes to be presented to operational stakeholders early in the development cycle.

Moreover, the iterative nature of Extreme Programming (XP) not only supports rapid feedback and continuous refinement of features but also enhances adaptability in environments where requirements evolve over time. Empirical research in software engineering confirms that iterative development and frequent stakeholder engagement reduce misalignment between system functionality and user needs, leading to higher quality software outcomes (Rasool, Babar, & Salleh, 2020). In the context of no-code development, XP’s short cycles map effectively onto rapid prototyping workflows, enabling domain experts to validate core functionality early and iterate based on operational input without waiting for traditional programming deliverables. This synergy between XP practices and no-code platforms improves stakeholder involvement and accelerates system refinement, making it particularly suitable for organizational settings with dynamic workflows such as material and warehouse information systems (Wang, Conboy, & Pikkarainen, 2019).

2.5 Research Gaps and Theoretical Framework

The literature review reveals two primary research gaps that motivate this study. First, while digital inventory management systems have been extensively studied in manufacturing and commerce contexts, their application to the specific operational domain of used material return warehouses in Indonesian electricity generation facilities remains undocumented. Second, while no-code development platforms have demonstrated utility in general application development contexts, their applicability to industrial inventory management with access control, multi-subunit integration, and audit requirements has not been systematically investigated in the context of Indonesian state enterprises.

The theoretical framework integrates the Systems Development Life Cycle (SDLC) concept (adapted through XP agile principles) with the operational requirements framework of industrial inventory management. The resulting implementation instantiates a citizen development approach, in which operational domain expertise rather than programming proficiency drives application design, within a no-code platform architecture (Glide Apps) delivering authenticated, data-driven used material-tracking capabilities.

3. Research Methodology

3.1 Research Setting and Data Sources

This research was conducted at PT PLN Indonesia Power UBP Keramasan, South Sumatra, Indonesia, as part of a structured industrial internship (*Kerja Praktik*) under the *Merdeka Belajar Kampus Merdeka* (MBKM) curriculum of Politeknik Negeri Sriwijaya. Primary data were collected through direct observation of existing manual material recording processes, structured interviews with warehouse operators and logistics staff, and document analysis of MM.07 (used material data) and MM.02 (primary warehouse material data) records (Pamungkas, 2017).

3.2 Development Methodology: Extreme Programming

The application was developed following the four-phase Extreme Programming (EP) methodology. In Phase 1: Planning, the team identified problems through direct observation and stakeholder interviews, conducted a requirements analysis to produce functional and non-functional system specifications, and established the project timeline. Phase 2: Design involved system modeling using context diagrams, DFD Level 1, flowcharts, ERD, a data dictionary, and UI wireframe mock-ups created with Draw.io. During Phase 3: Coding, the application was constructed using Glide Apps, with Glide Table serving as the backend database, and included the implementation of user authentication, material intake and outflow modules, transaction history views, and analytics charts. Finally, Phase 4: Testing consisted of black-box functional testing across seven defined scenarios, covering all primary user workflows to ensure the accuracy and completeness of the system (Ramadhan & Arkhiansyah, 2023).

3.3 Technology Stack

Table 1. Technology stack for SI-MATRE development

Component	Tool / Platform	Purpose
Application platform	Glide Apps (no-code)	Web application development and hosting
Backend database	Glide Table	Structured data storage for materials, transactions, users
Authentication	Email + OTP (Glide built-in)	Secure user access control
System design / diagrams	Draw.io	Context diagram, DFD, ERD, flowchart, mockups
Operating system	Microsoft Windows 11 Home	Development workstation OS
Documentation	Microsoft Office Home & Student	Report and data dictionary preparation
Browser	Google Chrome	Application access and Glide Apps interface
Hardware	Laptop Asus X1502ZA, Printer Epson L380	Development hardware

Table 1 show the system development utilized a combination of no-code platforms, design tools, and standard hardware and software to implement the SI-MATRE application. Glide Apps, a no-code application platform, was employed for web application development and hosting, while Glide Table served as the backend database to store structured data related to materials, transactions, and users. Secure access was ensured using the platform’s built-in email and OTP authentication system. The system architecture and workflows were designed and visualized using Draw.io, which facilitated the creation of context diagrams, DFDs, ERDs, flowcharts, and UI mockups. Development was conducted on a Microsoft Windows 11 Home workstation, with documentation prepared in Microsoft Office Home & Student for reports and data dictionaries. Application access and interaction with Glide Apps were performed through Google Chrome, and the development environment was supported by hardware including a Laptop Asus X1502ZA and an Epson L380 printer for printing documentation and reports. This combination of tools and platforms provided an integrated, secure, and efficient environment for the design, implementation, and testing of the material management application.

3.4 System Requirements Specification
The system requirements were classified into two categories:

3.4.1 Functional Requirements
The SI-MATRE application provides several key functional modules to manage warehouse materials effectively. The material intake recording module allows users to input material codes to automatically retrieve item details from the master database, recording information such as quantity, rack location, date, category, unit, and photographs. The material outflow recording module enables the selection and recording of materials leaving the warehouse along with corresponding transaction details. Users can review all movements through the transaction history module, which displays chronological logs of incoming and outgoing materials with detailed drill-down capabilities for each item. The monthly analytics chart visualizes comparative movement volumes on a bar chart, facilitating quick insights into material flow trends. To ensure secure access, the system incorporates OTP-secured, email-based user authentication with role-based access control, allowing only authorized personnel to perform material management tasks and access sensitive operational data.

3.4.2 Non-Functional Requirements
The SI-MATRE application incorporates several non-functional features to ensure secure, reliable, and user-friendly operation. Security is enforced by restricting access to registered users, with OTP authentication preventing unauthorized entry. In terms of performance, the system supports up to three concurrent users per warehouse subunit under the Glide Apps free-tier limitations. The application maintains high availability, providing 24-hour access through cloud hosting. Usability is enhanced by an intuitive interface that allows operators to perform tasks efficiently without extensive training. Regarding maintainability, monthly data backups are required to mitigate storage constraints associated with the free-tier plan, ensuring that critical inventory data remains protected and recoverable.

4. Results and Discussions
4.1 Feasibility Assessment
Table 2. System feasibility assessment

No.	Feasibility Dimension	Assessment
1	Technical Feasibility	PT PLN Indonesia Power UBP Keramasan's IT infrastructure (networked laptops and stable internet connectivity) supports Glide Apps web application access. The barcode scanning capability of the Glide Apps supports rapid material identification.
2	Operational Feasibility	The system aligns with existing material recording procedures, reducing rather than disrupting the current workflows. A user-friendly interface minimizes the retraining burden. A maximum of three users per subunit is sufficient for current operational staffing.
3	Economic Feasibility	The development was achieved at zero direct cost using the Glide Apps free tier. Potential future costs are related to storage capacity upgrades or premium feature access, which are optional and proportional to the operational scale.

Table 2 show the feasibility assessment of the SI-MATRE application was conducted across three dimensions: technical, operational, and economic. In terms of technical feasibility, PT PLN Indonesia Power UBP Keramasan possesses the necessary IT infrastructure, including networked laptops and stable internet connectivity, to support web access via Glide Apps. Additionally, the platform's barcode scanning capability facilitates rapid material identification, enhancing efficiency in warehouse operations. Regarding operational feasibility, the system aligns closely with existing material recording procedures, minimizing workflow disruptions and maintaining continuity in current operations. Its user-friendly interface reduces the need for extensive retraining, and the limitation of a maximum of three concurrent users per subunit matches the existing staffing levels. From an economic feasibility perspective, development was achieved at zero direct cost through the use of Glide Apps' free-tier features. While potential future costs may arise from optional storage upgrades or access to premium features, these expenses are proportional to the operational scale and do not pose a barrier to initial deployment. Collectively, these assessments indicate that SI-MATRE is technically viable, operationally compatible, and economically sustainable for implementation in the used material return warehouse.

4.2 System Design

4.2.1 Data Model and Entity Relationship Diagram

The SI-MATRE data model comprises five primary entities: Data Barang (material master), Barang Masuk (material intake), Barang Keluar (material outflow), History (transaction log), and User (system user). Table 3 presents the material master table schema.

Table 3. Data barang (material master) table schema

No.	Field Name	Data Type	Max Length	Description
1	Item material	Varchar	12	Material identifier (PK)
2	Material descriptions	Varchar	50	Material name/description
3	Valuation type	Varchar	150	Material classification detail
4	Unit	Varchar	15	Unit of measure
5	Unit price	Int	—	Unit price
6	Contract identity	Varchar	50	Contract reference number
7	Project cost	Varchar	50	Project cost reference
8	Task number	Varchar	50	Work order task reference
9	Expenditure type	Varchar	50	Expenditure classification
10	No WO/MR	Int	—	Work order/material requisition number
11	No issue pro-inventory	Varchar	50	TUG-9 inventory release reference

Table 3 show the inventory database for SI-MATRE is structured to efficiently manage material records and associated transaction details. Each Item Material serves as a unique identifier (Primary Key) for the materials stored in the warehouse. The Material Description field provides the name or description of each item, while Valuation Type classifies materials according to relevant inventory or accounting criteria. The Unit field specifies the measurement unit for each item, and Unit Price records the cost per unit. Contractual and project associations are captured through Contract ID and Project Cost, linking materials to procurement contracts and project budgets. Operational tracking is facilitated by Task Number, which references specific work orders, and Expenditure Type, which classifies the nature of the transaction. For internal tracking, the Work Order / Material Requisition Number uniquely identifies the requisition or work order associated with material movements, while the Inventory Issue Number corresponds to TUG-9 inventory release documentation. Collectively, these fields provide a comprehensive framework for capturing, storing, and managing detailed material information, supporting real-time tracking, reporting, and operational decision-making within the warehouse system.

4.2.2 System Data Flow

The Context Diagram identifies two external entities interacting with SI-MATRE: (1) Admin, who inputs incoming and outgoing material data and receives transaction receipts (*bukti penerimaan/pengeluaran*) and (2) *Kepala Gudang* (Warehouse Head), who receives consolidated used material movement reports generated by the system. The DFD Level 1 decomposes system processing into three primary processes: *Barang Masuk* (1.0), handling intake recording and generating intake receipts stored in the database; Barang Keluar (2.0), handling outflow recording and generating dispatch receipts; and History Barang (3.0), aggregating intake and outflow receipts into consolidated reports for the Warehouse Head (Yuyut, Atqia, & Alyani, 2024).

4.3 Application Implementation

The SI-MATRE application was successfully deployed on the Glide Apps cloud-hosting infrastructure, which is accessible via a web browser without local software installation. The implemented application comprises six primary interface screens.

Table 4. SI-MATRE application screens and functionality

No.	Screen	Functionality
1	Login	Email-based authentication: access restricted to registered users only.
2	OTP Verification	One-Time Password sent to registered email; required for full system access. The resend option is available if the OTP is not received.
3	Product Catalogue (Halaman Produk)	Displays all materials registered in the master database with a searchable and filterable interface.
4	Material Input Form	The admin enters the material code, and the system automatically retrieves item details from the master database, minimizing manual transcription. Additional fields include quantity, rack location, date, category, and photograph.
5	History	Chronological log of all incoming and outgoing material transactions; item-level drill-down for transaction details.
6	Analytics Chart	Monthly bar chart visualizing comparative volumes of incoming versus outgoing materials, enabling trend analysis and disposition planning.

Table 4 show the SI-MATRE application comprises several key functional modules designed to streamline material management in the warehouse. The Login module provides email-based authentication, restricting access to registered users only. The OTP Verification module sends a One-Time Password to the registered email, required for full system access, with a resend option if the OTP is not received. The Product Catalogue (*Halaman Produk*) displays all materials registered in the master database, featuring a searchable and filterable interface. Through the Material Input Form, administrators enter the material code, and the system automatically retrieves item details from the master database, reducing manual transcription; additional fields capture quantity, rack location, date, category, and photographs. The History module maintains a chronological log of all incoming and outgoing material transactions, allowing item-level drill-down to review specific transaction details. Finally, the Analytics Chart visualizes monthly comparative volumes of incoming versus outgoing materials using bar charts, supporting trend analysis and facilitating informed disposition planning. Together, these modules ensure accurate, efficient, and transparent management of warehouse materials, enhancing operational reliability and decision-making.

A notable design feature is the auto-retrieval mechanism on the Material Input Form: upon entering a material code, the system queries the Glide Table master database and automatically populates all associated item attributes (description, unit, price, contract number), reducing the data entry burden on warehouse operators and eliminating transcription errors that characterized the prior manual process. This functionality directly addresses the operational efficiency objective described in the problem statement.

4.4 Functional Testing Results

Black-box functional testing was conducted to verify the correctness and completeness of all the primary system workflows. Table 5 presents the full test scenario matrix and the results.

Table 5. Black-Box functional testing results

No.	Function Tested	Test Procedure	Expected Outcome	Result
1	Login	User enters registered email address	OTP input page displayed	✓ Pass

No.	Function Tested	Test Procedure	Expected Outcome	Result
2	OTP Verification	User enters OTP received at registered email	Product catalogue page displayed	✓ Pass
3	Add Incoming Material	User enters required material data fields	Data saved to database; entry appears in History and Chart pages	✓ Pass
4	Record Outgoing Material	User selects material to be dispatched from warehouse	Updated record in database; displayed in History and Chart	✓ Pass
5	History View	User navigates to History page and clicks a transaction entry	Transaction detail panel displayed correctly	✓ Pass
6	Monthly Analytics Chart	User navigates to Chart page after material entries	Bar chart displays correct monthly in/out comparison	✓ Pass
7	Logout	User clicks three-dot menu in sidebar and selects Logout	Session terminated; user redirected to Login page	✓ Pass

Table 5 show all seven test scenarios passed without errors, confirming the functional integrity of the implemented application across all primary user-interaction pathways. The OTP authentication mechanism (Tests 1 and 2) validated the access security design; the material transaction modules (Tests 3 and 4) confirmed the correctness of the auto-retrieval and database storage logic; and the analytics chart (Test 6) verified the accuracy of the monthly aggregation computations.

4.5 Operational Impact and Comparative Assessment

Prior to SI-MATRE implementation, the return warehouse at PT PLN Indonesia Power UBP Keramasan suffered from three chronic operational problems: (1) physical material accumulation resulting from the absence of timely disposition tracking; (2) poor item-level traceability preventing efficient identification of materials ready for repair or auction; and (3) delayed reporting to the Warehouse Head due to manual record compilation. The SI-MATRE addresses each of these problems directly.

Material accumulation is reduced because digital recording enables real-time stock visibility, allowing warehouse managers to identify items approaching disposition thresholds before physical pileups become critical. Item traceability is improved through a searchable product catalogue and category-filtered history views, enabling the rapid identification of items by condition category (repairable, actionable, or non-repairable). Reporting latency is eliminated through the automated aggregation of transaction histories into the Warehouse Head report view, replacing manual compilation with on-demand digital access.

Compared to prior digital inventory implementations in analogous PLN contexts byBaihaqi et al. (2021) at PT PJB Muara Karang and Suhada et al. (2023) at PLN ULP Kisaran, SI-MATRE no-code development approach distinguishes itself by achieving deployment without conventional programming, significantly reducing development time, and enabling local operational staff to participate meaningfully in design iteration. This citizen development advantage is consistent with the argument in the broader no-code platform literature that NCDPs democratize application development in organizational settings (Rokis & Kirikova, 2022).

4.6 Limitations of the Current Implementation

Several limitations of the current implementation warrant explicit acknowledgement. First, the Glide Apps free tier imposes storage capacity constraints, requiring monthly manual data backup, a maintenance dependency that introduces human error risk and represents a single point of failure for historical data preservation. Second, the concurrent user limit of three per subunit may become a bottleneck if operational staffing at the individual subunits increases beyond the current levels. Third, no formal user acceptance study was conducted with warehouse operators, leaving the perceived usability and adoption experience of the system unquantified empirically. Fourth, the system currently lacks barcode scanning integration for material code input; although Glide Apps supports this feature, its implementation was deferred to future development phases.

5. Conclusions

5.1 Conclusion

This study successfully designed, developed, and validated SI-MATRE, a no-code web application for used material management at PT PLN Indonesia Power UBP Keramasan, using the Extreme Programming agile methodology and the Glide Apps no-code development platform. The application implements six functional modules covering OTP-secured authentication, material intake and outflow recording with auto-retrieval from the master database, transaction history logging, and monthly movement analytics. All seven black-box functional tests were passed without errors, confirming the correctness and operational completeness of the system.

SI-MATRE improves the prior manual recording process by reducing material accumulation, increasing traceability, accelerating reporting, and eliminating transcription errors through auto-retrieval mechanisms. The no-code development approach achieved deployment at zero direct cost, demonstrating the viability of citizen development strategies for operational support applications in Indonesian state-owned enterprises. The documented system architecture, ERD, data dictionary, and test results provide a replicable development reference for comparable material management applications across the PLN Indonesia Power network.

5.2 Research Limitations

The primary limitations of this study were as follows. The application scope is restricted to the material return warehouse of PT PLN Indonesia Power UBP Keramasan and its direct subunits; generalizability to other PLN business units or different industry contexts requires validation. This study did not conduct formal user acceptance testing with warehouse operators, omitting empirical usability and adoption data. The Glide Apps free tier storage and concurrent user constraints represent operational risks that were not quantitatively assessed under realistic load conditions. The system's performance under network connectivity degradation, a realistic risk in industrial field environments, has not been evaluated. Finally, the study period was limited to the internship duration, preventing a longitudinal assessment of the system's impact on material disposition rates or warehouse space utilization.

5.3 Suggestions and Directions for Future Research

Based on the findings and limitations of this study, several directions for future work are recommended. A formal user acceptance and usability evaluation using validated instruments, such as the System Usability Scale or Technology Acceptance Model, should be conducted with warehouse operators across all SI-MATRE-enabled subunits to provide empirical evidence of perceived ease of use, usefulness, and adoption intention. Implementing barcode or QR code integration via Glide Apps' native scanning functionality could further reduce manual data entry, enhancing recording speed and accuracy, particularly during high-throughput periods. Additionally, upgrading to the Glide Apps premium tier or migrating to a self-hosted backend such as MySQL or PostgreSQL would address storage and concurrent user constraints, enabling full-scale deployment without dependence on free-tier limitations and backup procedures.

Future development should also explore integration with PLN Enterprise Asset Management (EAM) and SAP Material Management (MM) systems, allowing automated synchronization of used material records with corporate procurement and asset disposition workflows. A longitudinal impact assessment measuring material disposition cycle time, return warehouse space utilization, recording error rates, and operator time savings would provide quantitative evidence of operational improvements beyond functional testing. Finally, expanding the system to cover primary warehouses, including general, chemical, and lubricant storage within the OPHAR logistics division, would establish a fully integrated materials management platform for the entire UBP Keramasan facility, improving transparency, efficiency, and decision-making across all material handling operations.

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Author Contributions
DAI contributed to conceptualization, system design, application development, functional testing, original draft preparation, and manuscript revision. FNS contributed to system design (DFD, ERD, flowcharts), UI mockup development and application testing. DA contributed to supervision, methodology review, and critical review of the system design and manuscript. NN contributed to supervision, project administration, review of the literature framework, and final approval of the manuscript.

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