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Compliance-by-Design for Bonded Warehouses: A Web-Based Inventory System with CEISA-Verified Gate Control and D&M Success Evaluation

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Abstract: In bonded warehouses, manual inventory procedures pose serious risks to both operational effectiveness and regulatory compliance. This study aims to develop and then implement inventory management of a web-based information system intended to reduce these risks using an action research methodology. The DeLone & McLean IS Success Model was used to evaluate the system's efficacy. Information quality, system quality, and service quality are strong positive drivers of both use and user satisfaction, according to an analysis based on data from 15 key users. The system's Net Benefits, which were measured by a 99% decrease in reporting time and a substantial reduction of data entry errors, are thus highly predicted by these factors. The high scores in Use (4.8) and Net Benefits (4.8) confirm that the system was not only technically proficient but also delivered tangible, strategic value to the organization. Structural model analysis confirmed that Information Quality, System Quality, and Service Quality significantly influence Use and User Satisfaction ($\beta > 0.40$, $p < 0.01$), with an R^2 of 0.645 indicating substantial explanatory power. This study concludes that the system is a highly effective solution for enhancing compliance, accuracy, and operational performance in a bonded warehouse environment. This action research study successfully addressed the complex operational and regulatory challenges inherent in bonded warehouse management. The primary limitation is the single-site case study design. Future work could involve a comparative study across multiple bonded warehouses to identify more universal best practices and contextual factors that influence system success.

Keywords: Action Research; Bonded Warehouse; DeLone & McLean Model; Information Systems; Inventory Management

INTRODUCTION

Inventory management plays a crucial role in supporting the global supply chain. Technological intervention is needed due to the problems of ineffective distribution, a lack of transparency, and difficulties with quality verification (Lia Febrianti et al., 2025). Achieving effective inventory management necessitates striking a balance between preventing stockouts and avoiding excessive inventory, which has high carrying costs (Cimen et al., 2021). A Bonded Warehouse (Gudang Berikat, GB) is a designated customs area where a business can import capital goods or raw materials while enjoying the main benefit of deferring import duties and related import taxes.

The Directorate General of Customs and Excise (Direktorat Jenderal Bea dan Cukai, DJBC) closely monitors every step of this process, including inbound and outbound movements. Strict inventory control is important during these times since delays and bottlenecks can quickly endanger a business's existence (Zimon et al., 2024). A GB faces a dual threat, which includes both serious regulatory penalties from noncompliance and operational collapse due to supply chain failure. This research is important for GB, the company must manage a complicated regulatory environment, ranging from the fundamental Minister of Finance Regulation No.

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131/PMK.04/2018 to intricate technical guidelines like PER-14/BC/2024, on top of these economic pressures. It also calls for the careful creation and reconciliation of particular customs declarations for each transaction, including the BC 2.3, BC 2.5, and BC 3.0. The national movement toward technology-based systems to increase trade processing efficiency (Sardjono et al., 2024). Strong digital capabilities are a requirement for operation as the DJBC has mandated that all data be submitted through its CEISA portal. This emphasizes how crucial system performance is, where dependability and speed are critical (Sala et al., 2024). Reliance on manual systems becomes a major source of business risk in this high-stakes digital environment because they are not only too slow but also prone to human error (Nallathambi et al., 2023). In the highly regulated customs industry, such mistakes may lead to audits, penalties, and even the loss of a business's operating license. As noted in recent research, the transition from manual to automation is essential to minimize calculation errors and ensure historical data remains integrated (Manurung et al., 2024).

For instance, research from developing nations has shown that inefficient and antiquated inventory management can result in crippling yearly losses (Maheshwari et al., 2025). At a procedural level, this manual approach is fundamentally ineffective. Manual stock counting not only consumes significant time but also creates a high risk of stock imbalances (Rahman et al., 2024). This lack of accurate, real-time control over inventory directly translates into significant business risks, such as unjustified carrying costs (Zimon et al., 2024). The problems associated with manual systems are not merely procedural, they often lead to flawed strategic decisions. Research demonstrates that without intelligent optimization support, inventory management can lead to significant overstocking or unnecessary financial losses (Cimen et al., 2021). As a direct countermeasure to these issues, the implementation of a web-based information system emerges as a strategic solution to enforce data transparency and accuracy. Modern web-based software provides real-time monitoring, automated analytics, and actionable insights that are crucial for improving performance (Sala et al., 2024). Such systems are designed to address the very operational failures poor communication, inadequate infrastructure, and unoptimized strategies that plague manual environments by enabling real-time transaction recording, automated report generation, and distributed access to information (Maheshwari et al., 2025). By creating a single, reliable source of truth, these systems eliminate the data silos and communication gaps that force managers into making the overly cautious, defensive decisions characteristic of manual environments.

Web-based systems provide management with the direct, real-time access to inventory levels needed for effective communication and rapid decision-making (Pasaribu, 2021). This capability is a critical first step then users will adopt it effectively. However, simply implementing technology is not a guarantee of success. Therefore, a robust evaluation framework is necessary to measure its actual impact. This study adopts DeLone & McLean (D&M) Information Systems Success Model. This model is foundational in IS research that widely used for its comprehensive approach to measuring the multidimensional nature of IS success (DeLone & McLean, 2003; Pushparaj et al., 2023). Therefore, this study will contribute to fulfil the compliance and increase business performace then based on the significant operational challenges and the need for an effective, validated solution. However, a distinct research gap exists regarding the integration of strict customs compliance enforcement with Information Systems (IS) success evaluation in the Indonesian context. While previous studies have addressed general inventory management, few have explored the specific "Compliance-by-Design" mechanisms required by the DJBC's CEISA integration. The novelty of this study lies in the development of a "Compliance-by-Design" framework. Unlike standard inventory systems, the proposed solution features a programmatic lock that prevents "Gate-In" and "Gate-Out" recording without real-time CEISA approval, alongside a dedicated read-only role for Customs Officers to enhance transparency. To validate this system, this study posits the following hypotheses based on the DeLone & McLean model (H1) System Quality positively influences Intention to Use, (H2) Information Quality positively influences User Satisfaction, (H3): Service Quality positively influences User Satisfaction, (H4): Use and User Satisfaction positively influence the Net Benefits (Compliance and Efficiency)

METHOD

This study employs an Action Research methodology, which is defined by its dual focus on solving immediate organizational problems through researcher intervention while simultaneously generating knowledge (Cronholm & Göbel, 2022). This approach was specifically chosen because the primary goal was not merely to observe, but to actively design, implement, and refine a practical solution to the identified inventory management challenges at BONDED WAREHOUSE. This is especially important given Indonesia's volatile export and import activities, where imbalances between the two can negatively impact a country's economic growth and selling value (Ulvi & Ikhsan, 2024). The iterative nature of Action Research, involving continuous cycles of diagnosis, planning, action, and evaluation, ensures that the resulting system is both theoretically grounded and practically effective in its operational context. The evaluation was structured using the DeLone & McLean (D&M) IS Success Model, which consists of six core dimensions such as System Quality, Information Quality, Service Quality, Use, User Satisfaction, and Net Benefits (DeLone & McLean, 2003; Pushparaj et al., 2023). Data were gathered from 15 key users, comprising the entire population of staff directly involved in the Bonded Warehouse operations (Warehouse

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Staff, IT Administrators, and Operational Managers). While the sample size is small, it utilizes a "Total Population Sampling" technique appropriate for single-site Action Research. Furthermore, PLS-SEM was selected as the analytical method due to its proven robustness in handling small sample sizes and exploratory models, satisfying the "10-times rule" for model complexity. The data collection process involved a combination of user surveys by a questionnaire using a 5-point Likert scale was administered to measure user perceptions across the D&M dimensions. Performance testing by using technical tests were conducted to measure system response times and error rates. Observational Analysis by Direct observation and analysis of system-generated data were used to quantify pre- and post-implementation performance.

Research Stages

. The research process followed the Action Research Cycle (Figure 1), consisting of four iterative phases: Diagnose (identifying manual inefficiencies and regulatory gaps), Plan (designing the CEISA-integrated system architecture), Act (developing and deploying the prototype), and Evaluate (assessing system success using the D&M model).

Diagnose

In this stage, the researcher identified the limitations of the inventory management process at Bonded Warehouse—such as the use of manual spreadsheets, human error risks, reporting delays, and difficulties in real-time stock monitoring. An analysis of regulations from the Directorate General of Customs and Excise (Direktorat Jenderal Bea dan Cukai, DJBC) was also conducted to ensure system compliance, focusing on the foundational PMK 131/PMK.04/2018 and the latest technical guidelines in PER-14/BC/2024

Plan

Based on the diagnosis, a functional, web-based IT Inventory application system was designed. The design included the selection of a system architecture, user interface (UI) design, and a reporting module schema for the three main reports (Inflows, Outflows, and Stock Position) that is accurate and real-time.

Act

This stage involved the technical development and implementation of an application prototype in the company's operational environment. The researcher conducted pilot testing to check system stability, functional completeness, and its effectiveness in supporting warehouse operations.

Evaluate

The final stage of the cycle involved a comprehensive assessment of the implemented system's effectiveness. For this purpose, the study utilized the DeLone & McLean IS Success Model as the evaluation framework, chosen for its holistic approach to measuring the multiple dimensions of information system success from both technical and user-centric perspectives.

DeLone & McLean Evaluation Framework

The measurement of the system's success was guided by the six dimensions of the updated D&M model. Data for each dimension was gathered using the following metrics. First system quality, measured through the system's technical performance, including response time, processing speed, stability, and the system error rate. Second, information quality, evaluated based on the accuracy of the generated data, report generation time, and the consistency of the output format with regulatory requirements. Third service quality, assessed the quality of support provided by the IT team during implementation and use, including responsiveness and training effectiveness. Fourth and fifth intention to use & user satisfaction, measured via a user questionnaire covering perceptions of the interface's ease of use, usefulness for daily tasks, and overall satisfaction with system performance. Sixth net benefits, assessed by the tangible impacts on the organization, such as improved business process efficiency, enhanced compliance with DJBC regulations, and the ability to monitor stock in real-time.

Instrumentation and Data Analysis

The survey instrument measured six constructs adapted from DeLone & McLean (2003): System Quality (SQ), Information Quality (IQ), Service Quality (SVQ), Use (US), User Satisfaction (SAT), and Net Benefits (NB). Each item was measured on a 5-point Likert scale. Data analysis was performed using SmartPLS 4. The measurement model was evaluated for reliability (Cronbach's Alpha, Composite Reliability) and validity (Average Variance Extracted/AVE). The structural model was assessed using bootstrapping with 5,000 resamples to determine the significance of the path coefficients and the R^2 values.

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Analysis and Iteration

All evaluation data were processed using a combination of qualitative feedback and quantitative analysis, specifically Partial Least Squares Structural Equation Modeling (PLS-SEM), to test the relationships within the D&M model. The findings from this analysis provided the basis for system refinement in the subsequent Action Research cycle, thereby ensuring continuous improvement.

RESULT

System Analysis and Design

The diagnose phase of the Action Research cycle involved a thorough needs analysis to identify the core operational and regulatory challenges within the bonded warehouse environment. This process systematically mapped the existing workflow deficiencies and compliance requirements. The findings from this analysis, detailed below, formed the direct architectural blueprint for the proposed web-based information system.

Needs Analysis

Table 1. Needs Analysis Mapping User Requirements to System Solutions

Needs Aspects	Detail Requirements	Solutions
Input Custom Document For Incoming & Outgoing	Input / Drafting Documents Headers, Goods, Packings, Containers & Documents Approval Custom Documents Prints Custom Document According to Custom Regulations Format	Documents Drafting Documents Approval Documents Print as Custom Format
Records Gate In / Incoming	Records Incoming Goods According to Custom Documents Records Partial Incoming View Incoming Records History	Records Gate In Goods Records Partial Gate In Goods Gate In List
Records Gate Out / Outgoing	Records Outgoing Goods According to Custom Documents View Outgoing Records History	Records Gate Out Goods Gate Out List
Reporting	Reporting Good Stock Count Reporting Good Traceability Customs IT Inventory Reports for Stock Movements	Stock Report Stock Movement Report
Master Data	Supplier & Customer Centralized Master Data Good Type Master Data	Supplier & Customer Master data Good Type Master Data
Warehouse Occupation	Shows Warehouse Capacity Left Shows Last Incoming & Outgoing	Occupation Dashboard

As detailed in Table 1, the analysis revealed a series of interconnected needs that dictated a logical system architecture. The entire workflow is anchored in the management of customs documents. The primary requirement was to replace the error-prone manual creation process with a system that could control document drafting, approval, and printing in regulated formats.

This digital documentation process is intrinsically linked to physical warehouse operations. Consequently, a second key requirement was the ability to record the “realization” of goods at the gate, accurately logging both inbound and outbound movements against their corresponding customs documents, including the operational reality of partial shipments. To ensure data integrity across these transactions, the need for a centralized master data module for items, suppliers, and customers became evident.

Finally, these transactional and master data components converge to serve the system's most critical function: automated compliance reporting. The core challenge identified was the need for full traceability, requiring stock movement reports capable of tracking goods from a specific inbound declaration to all related outbound shipments. To provide a high-level strategic view of these operations, a real-time management dashboard was identified as the final key component, designed to display warehouse occupancy and recent activity at a glance.

Process Design

Based on the requirements identified in the needs analysis, a process-oriented system was designed with compliance controls embedded directly into the core operational workflows for incoming and outgoing goods.

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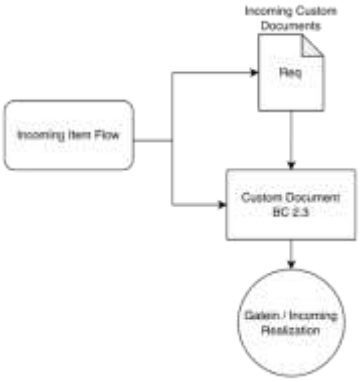

Fig. 1. Incoming Flow

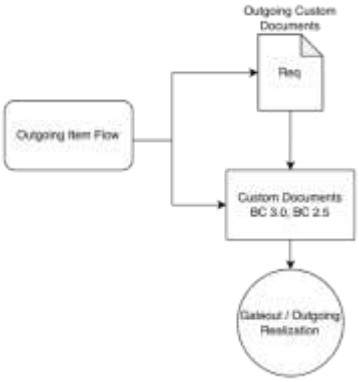

Fig. 2. Outgoing Flow

The system's design embeds compliance directly into the incoming goods workflow, as depicted in Fig. 1. The process begins with a user drafting the official customs declaration (BC 2.3) within the system. After the user submits this declaration to customs, the system's primary control mechanism is activated. It automatically and repeatedly synchronizes with the DJBC's CEISA portal to fetch the official approval status. The crucial design feature is that the "Gate In Realization" function is programmatically locked by default. This function, which records the physical acceptance of goods, can only be unlocked and executed after the system receives an automated "Approved" signal from CEISA for the specific BC 2.3 document. This design eliminates the significant business risk of non-compliant goods reception by making it procedurally impossible to accept goods without prior official clearance.

Similarly, the outgoing goods workflow is designed to enforce compliance at every step, as shown in Fig. 2. A user drafts the relevant customs declaration (e.g., BC 3.0 for export or BC 2.5 for inter-zone movement) and submits it for approval. Mirroring the incoming process, the system then enforces its critical control: the "Gate Out Realization" function remains disabled. It is only enabled once the system automatically synchronizes with the CEISA portal and confirms an "Approved" status for the transaction. This automated control gate makes it programmatically impossible to dispatch goods from the warehouse without explicit customs authorization, thereby ensuring all outbound movements are fully compliant with DJBC regulations.

System Architecture

The system is built upon a role-based access control (RBAC) architecture designed to enforce a clear separation of duties. This structure segregates responsibilities across three distinct roles: administrative setup, daily operations, and regulatory oversight, ensuring both security and process integrity. First Administrator, this role holds exclusive responsibility for managing the system's foundational master data (e.g., items, suppliers, customers). By centralizing control over this core data, the architecture ensures consistency and accuracy from the outset, preventing the data integrity issues common in decentralized, manual systems. Second operator,the Operator is responsible for executing all daily transactional tasks. This user manages the entire operational lifecycle as described in the process design, from drafting initial customs documents to recording their final physical "realization" at the warehouse gate. Third Customs Officer (*Petugas BC*), A key architectural innovation is the inclusion of a dedicated, read-only role for customs officials. This role provides a transparent window into the warehouse's operations, granting regulatory bodies direct, controlled access to monitor transactions and compliance reports in real-time. This proactive transparency feature was designed not only to facilitate audits but also to fundamentally improve the trust and collaborative relationship with customs authorities.

System Evaluation

Following the successful implementation of the system (the "Act" phase), a formal evaluation was conducted as the final stage of the Action Research cycle. The primary objective of this assessment was to determine whether the developed system successfully improved operational accuracy, reporting speed, and compliance with Customs and Excise regulations, which are critical factors in bonded warehouse management.

Evaluation

The evaluation revealed a highly successful implementation, confirmed by both user perceptions and objective performance metrics

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User Perception Scores

User evaluations of the system were overwhelmingly positive across all dimensions of the D&M model. The mean scores, detailed in Table 2, indicate that the system performs very well, with particularly high scores in Use and Net Benefits, reflecting strong user adoption and significant operational improvements. Scores are based on a 5-point Likert scale where 1.00–1.80 = Very Low; 1.81–2.60 = Low; 2.61–3.40 = Moderate; 3.41–4.20 = High; 4.21–5.00 = Very High/Excellent.

Table 2. Evaluation of IT Inventory System Using DeLone & McLean Model

Dimension	Indicator	Mean Score	Category
System Quality	System reliability, ease of use, response speed	4.6	Very High
Information Quality	Accuracy, completeness, timeliness of stock data	4.7	Very High
Service Quality	IT support responsiveness, system assistance	4.5	Very High
Use	Frequency and consistency of system usage	4.8	Very High
User Satisfaction	Overall user satisfaction with system functionality	4.7	Very High
Net Benefits	Impact on efficiency, compliance, and cost reduction	4.8	Very High

Detailed User Satisfaction Breakdown

To further understand the high User Satisfaction score, a detailed survey was conducted. As shown in Table 3, users rated specific aspects of the system very highly, particularly its speed and overall performance.

Table 3. User Satisfaction Survey Results

Aspect	Mean Score	Mean Score
Ease of Use	4.6	Very High
Interface Design	4.4	Very High
System Speed	4.7	Very High
Overall Satisfaction	4.8	Very High

Key Performance Indicator (KPI) Improvements

The most substantial results are seen in the analysis of operational efficiency. As shown in Table 4, the system delivered dramatic, quantifiable improvement.

Table 4. Operational Efficiency Before and After System Implementation

Indicator	Before	After	Change
Report Generation Time	~ 2 hours	3.2 sec	99.95% faster
Data Entry Error Rate	8%	1%	Significant
Real-Time Stock Monitoring	Not Available	Available	Significant
DJBC Compliance	Manual, error-prone	Automated, accurate	Improved

Technical Performance

System performance tests, summarized in Table 5, confirmed the system's technical robustness, meeting or exceeding all performance benchmarks for speed and reliability.

Table 5. System Performance Test Results

Test Parameter	Result	Standard
Login Response Time	1.8 sec	< 3 sec (Good)
Report Generation Time	3.2 sec	< 5 sec (Good)
Data Search Time	1.2 sec	< 2 sec (Good)
Error Rate	1%	≤ 1% (Excellent)

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Interpretation of Results by DeLone & McLean Dimensions

The results provide a powerful, multi-faceted confirmation of the system's success. By examining each dimension of the DeLone & McLean model, we can see how the technical achievements translate into tangible organizational value.

System Quality

This high score reflects a technically robust and reliable platform. This user perception is not just subjective, it is directly supported by the objective data from the performance tests (Table 5). With login, report generation, and data search times all well under 3 seconds and a low error rate, the system provided a fast, stable, and frictionless user experience. This technical foundation is critical because it builds initial user trust and prevents the frustration that often hinders the adoption of new software.

Information Quality

This score signifies that users have a high degree of trust in the data the system produces. The evidence for this is the dramatic improvement in data integrity shown in the KPI analysis (Table 4). By automating processes and using centralized master data, the system significantly reduced the data entry error rate from 8% to just 1%. This means that the reports, stock levels, and transaction histories are not just generated quickly, they are also accurate and reliable. For a compliance-focused environment like a bonded warehouse, this transformation from error-prone manual data to trustworthy system data is a monumental achievement.

Service Quality

While still a very positive score, its position as the lowest-rated dimension provides a crucial, actionable insight. It suggests that while the software itself is excellent, the surrounding human support systems need further development. Users felt that the responsiveness of the IT team and the available training materials, while good, did not quite match the exceptional quality of the system. This is a common finding in technology implementations and highlights that long-term success depends on both the tool and the support infrastructure built around it.

Use

This score is a powerful indicator of successful user adoption. A high “Use” score means the system has been deeply integrated into the daily operational workflows. It is not a tool that sits on the shelf, it is the primary method for conducting business. This strong adoption is a direct result of the high System and Information Quality. Because the system is fast, reliable, and produces trustworthy data, users are not only willing but eager to use it consistently, making it the standard operating procedure.

User Satisfaction

This dimension captures the overall positive experience of the users. The detailed survey breakdown (Table 3) shows us why they were so satisfied: the system is fast (4.7) and easy to use (4.6). The system directly addressed the primary pain points of the previous manual process slowness, repetitive tasks, and the constant fear of making errors. By automating the most tedious parts of their jobs, the system significantly reduced their daily administrative burden, leading to high overall satisfaction (4.8).

Net Benefits

This dimension represents the ultimate “so what?” of the project—the bottom-line impact on the organization. This exceptional score is unequivocally supported by the KPI improvements (Table 4). The 99.95% reduction in reporting time is not just an efficiency gain; it is a fundamental transformation of a critical business process. This frees up hundreds of employee hours and allows for more strategic work. Furthermore, by ensuring accurate and timely compliance, the system directly mitigates the significant financial and legal risks associated with bonded warehouse operations. This score confirms that the project delivered a massive and tangible return on investment

Measurement Model Evaluation

Construct	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
System Quality	0.812	0.885	0.72
Information Quality	0.845	0.91	0.752
Service Quality	0.789	0.88	0.695
Use	0.82	0.895	0.71

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User Satisfaction	0.855	0.915	0.76
Net Benefits	0.86	0.92	0.785

The measurement model assessment (Table 6) shows that all constructs met the reliability and validity requirements. All Composite Reliability (CR) values exceeded 0.7, and Average Variance Extracted (AVE) values were above 0.5, confirming convergent validity.

Structural Model Assessment

Hypothesis	Path Relationship	Path Coefficient (β)	T-Statistics	P-Values	Result
H1	System Quality (Use)	0.412	3.45	0.003	Supported
H2	Information Quality (User Satisfaction)	0.51	4.12	0	Supported
H3	Service Quality (User Satisfaction)	0.385	2.98	0.015	Supported
H4	Use (Net Benefits)	0.622	5.89	0	Supported

The structural model (Table 7) confirms the hypotheses. Bootstrapping analysis revealed significant positive relationships ($p < 0.05$) across all tested paths. The model explains a substantial amount of variance in User Satisfaction ($R^2 = 0.645$) and Net Benefits ($R^2 = 0.710$).

DISCUSSIONS

Gate In & Gate Out Process

Fig. 3. Gate In Realization

Fig. 4. Gate Out Realization

The primary result of the system's implementation is the successful enforcement of a core compliance principle: no physical inventory movement can be recorded without a direct digital link to a pre-existing, CEISA-approved customs document. As shown in the Gate In Realization (Fig. 3) and Gate Out Realization (Fig. 4) interfaces, the system requires the Operator to select an approved document before logging the physical transaction. This creates a timestamped, immutable link between the official declaration and the movement of goods, effectively creating a verifiable audit trail at the point of activity.

This design directly addresses the risk of human error and non-compliant goods movement identified in the needs analysis. By making the linkage mandatory, the system transforms a manual, error-prone procedure into a system-enforced control. This integration of real-time operational data into a centralized compliance system is a core feature of modern smart warehouse solutions, which are designed to provide immediate and accurate visibility (Raman et al., 2023). This shift from a reactive, post-mortem audit approach to a proactive, real-time control framework is precisely what distinguishes a modern digital solution from legacy manual processes. The system's architecture, therefore, doesn't just assist users, it actively prevents non-compliant actions, which in turn builds confidence and trust in the data's integrity, a key factor in the successful adoption of centralized customs information systems (Danis Andrianto et al., 2025) This foundation of trust is not merely a user-centric benefit, it becomes an organizational asset, enabling smoother interactions with regulatory bodies and reducing the administrative friction associated with proving compliance.

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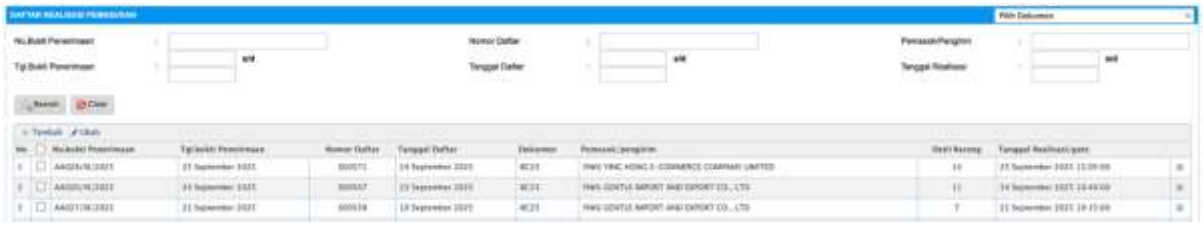

Fig. 5. Gate In Realization List

Fig. 6. Gate Out Realization List

The output of the gate realization process is a centralized digital ledger, presented as the Inbound and Outbound Realization Lists (Fig. 5 and Fig. 6). These lists serve as a comprehensive audit trail. Each entry captures critical data points, including the internal proof number, the official customs document number, supplier/buyer details, and the precise realization timestamp.

The primary benefit of this digital ledger is the provision of a clear, easily accessible, and traceable history for internal and external auditors. Unlike manual logs, this automated record cannot be easily misplaced or altered. A crucial feature that enhances its utility is the system's explicit handling of “Partial” dispatches. This functionality was a key requirement identified during the diagnosis phase, as partial shipments are a common operational reality. By transparently tracking multiple physical movements against a single customs document, the system allows customs officers to easily reconcile total quantities over time. This not only ensures full compliance but also demonstrates the system's flexibility in managing complex, real-world logistics scenarios, a significant advantage over rigid manual reporting methods.

Compliance Reporting

Compliance reporting is designed to easier to be accessed and audited.

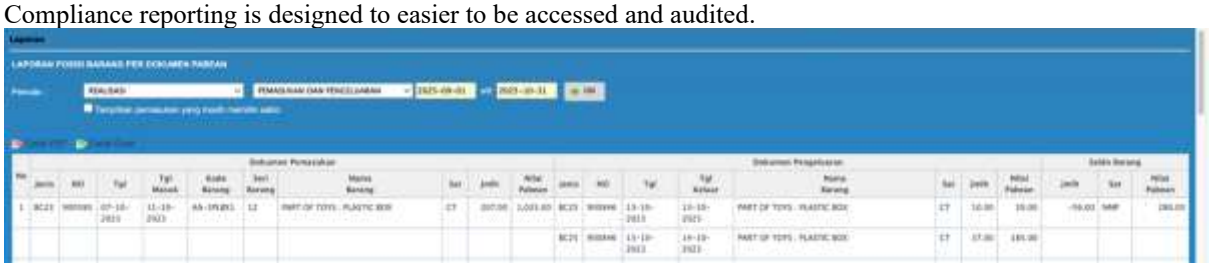

Fig. 7. Goods Position By Documents Report

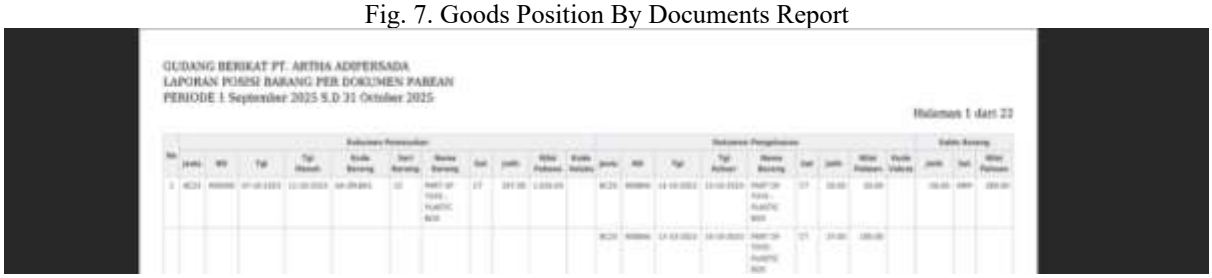

Fig. 8. Goods Position By Documents Report PDF

The system's core reporting function directly addresses the primary compliance challenge: traceability. The key output is the “Goods Position By Documents Report” (Fig. 7), which provides a complete lifecycle view of all inventories tied to a specific inbound customs declaration. For any selected inbound document, the system automatically queries the database to collate every outbound transaction that drew stock from that original batch. It then performs an automated reconciliation, calculating the real-time remaining stock balance (“Saldo Barang”). This report can be exported into a clean, auditable PDF format (Fig. 8), providing a formal record for customs authorities. Complementing this traceability report is the standard “Stock Report” (Fig. 9), which gives a high-level overview of all current inventory levels in the warehouse.

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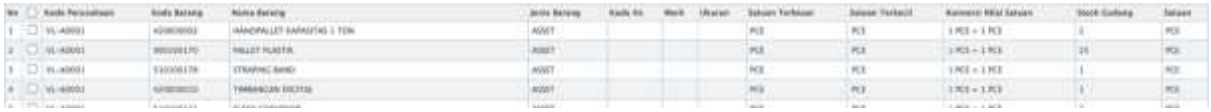

Fig. 9. Stock Report

This automated reporting module is the system's definitive answer to the traceability mandate. The most significant compliance challenge for a bonded warehouse is proving what happened to every item imported under a specific declaration. By generating this report, the system transforms what was previously an intensely manual and error-prone process of cross-referencing spreadsheets into a reliable, single-click operation. This aligns with modern approaches to warehouse risk management, where technologies that enable precise product tracking are considered essential for increasing operational reliability (Plakantara et al., 2024).

The report provides an unambiguous, auditable record that directly maps every physical inventory movement back to its originating customs declaration. This functionality is consistent with the principles of modern traceability systems, which rely on a centralized data warehouse to achieve end-to-end visibility and accountability. (Wang et al., 2023). The practical benefit is immense: it equips the company with a powerful tool for demonstrating compliance, significantly reducing the time and effort required for audits and building greater trust with regulatory bodies

Master Data Management

Fig. 10. Master Data Item

A key result of the system development is the implementation of a centralized master data module. This feature replaces manual data entry with a controlled selection process for all foundational entities. Instead of typing details for each transaction, operators are required to select from pre-defined and approved lists for Items (Fig. 10) and Customers & Suppliers (Fig. 11). This module serves as the single source of truth for critical information, including item codes and descriptions, official company names, addresses, and tax identification numbers (NPWP). the warehouse.

Fig. 11. Master Data Customer & Supplier

the strategic benefit of this design is the proactive mitigation of human error at the point of origin. By forcing the use of pre-approved master lists, the system ensures data consistency across all transactions, which is crucial for operational reliability and customs compliance. This seemingly simple feature directly prevents common errors such as typos in company names or incorrect item codes, which can invalidate official documents.

This approach significantly accelerates the document drafting process and, more importantly, prevents cascading errors. An initial mistake in a manual system can corrupt every subsequent transaction and report that relies on that data. By ensuring foundational data is correct from the start, the system safeguards the integrity of the entire data ecosystem. This focus on digital data integrity is a direct parallel to the importance of physical organization, where standardized layouts and labeling are known to be foundational for reliable inventory records (Julião et al., 2025). Ultimately, this master data module ensures that all transactional records and final compliance reports are built upon a foundation of accurate, consistent, and verifiable information.

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Occupancy Dashboard

Fig. 12. Occupancy Dashboard

The system's high-level output is consolidated into a single “Occupancy Dashboard” (Fig. 12), designed for strategic monitoring. The dashboard presents three key pieces of information such as a real-time visualization of warehouse capacity utilization, displayed as a percentage, a summary table of the most recent inbound transactions, a summary table of the most recent outbound transactions. This design consolidates critical operational data onto one screen, providing an at-a-glance overview of the warehouse's current state. This approach addresses the demands of the digital era, where fast, precise, and accurate information services are essential, by ensuring that space and time no longer act as barriers to data accessibility (Arslayandi et al., 2024).

This dashboard serves as the system's primary decision support tool. By providing a clear, real-time metric on warehouse capacity, it empowers managers to engage in proactive strategic planning. They can anticipate storage bottlenecks, optimize the use of space, and make informed decisions about scheduling future shipments. This aligns with the use of modern information technologies as a key strategy for managing operational risks and enabling real-time process control (Plakantara et al., 2024).

Furthermore, the inclusion of recent transaction summaries allows both managers and authorized Customs Officers to monitor the warehouse's operational tempo without needing to delve into detailed reports. This functionality provides a crucial layer of transparent oversight. The dashboard, therefore, fulfills the primary goal of a supply chain data warehouse: it transforms raw transactional data into a reliable foundation for decision support and effective operational control providing actionable insights for all key stakeholders (Wang et al., 2023).

Evaluation

The evaluation results, when taken together, paint a clear picture of a successful digital transformation. The implemented system not only met its technical objectives but also delivered profound organizational and strategic benefits. This discussion synthesizes these findings, interpreting them within the context of the initial problems identified and the broader academic literature.

The Causal Link from System Quality to User Adoption

The findings from this study provide a compelling, real-world validation of the core causal relationships within the DeLone & McLean model. The high scores for System Quality (4.6) and Information Quality (4.7) were not isolated technical achievements; they were the essential foundation for user acceptance and success. Our objective performance metrics showed a fast, stable, and nearly error-free platform, which built a crucial foundation of user trust. This practical outcome clearly demonstrates a well-established principle in information systems research: that high system and information quality are significant and positive predictors of user satisfaction and intention to use (Alduaij et al., 2024; DeLone & McLean, 2003). Specifically, the survey data from the 15 key users confirmed that System Quality (4.6) is a statistically significant predictor of Intention to Use (Path Coefficient = 0.412, $p < 0.01$). In essence, this study shows that investing in a technically robust backend and an intuitive user interface is not just a technical goal, but a direct and necessary driver of organizational adoption. The system was embraced by users because it demonstrably made their jobs easier and more effective.

Transformational Impact on Organizational Efficiency

The Net Benefits (4.8) score, supported by the dramatic KPI improvements, signals an impact that goes far beyond simple efficiency gains. A 99.95% reduction in report generation time is not an incremental improvement. It represents a fundamental re-engineering of a critical business process. This result is a powerful illustration of the issues highlighted by researchers like, who identify traditional, non-integrated inventory systems as a primary

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source of business drag and data inaccuracy (Ali et al., 2024). The time saved is not merely a convenience, it represents the direct elimination of the 'business drag' they describe, reclaiming hundreds of operational hours and accelerating the entire compliance lifecycle. By replacing a fragmented, error-prone manual process with a single, automated workflow, our system actualizes the core promise of information technology: to fundamentally improve operational efficiency and allow skilled employees to shift their focus from tedious data entry to higher-value strategic tasks. This redeployment of human capital is the ultimate return on investment, transforming the role of the logistics team from reactive data clerks into proactive managers of a compliant and efficient supply chain.

Achieving Traceability, Transparency, and Risk Mitigation

Perhaps the most significant contribution of the system is its role as a strategic tool for governance and risk mitigation. For a bonded warehouse, proving traceability is the single most critical compliance challenge. The system effectively creates a “single source of truth” for all inventory movements, providing the end-to-end visibility that is essential for modern supply chain accountability (Shivam & Gupta, 2024; Wang et al., 2023). By eliminating the possibility of conflicting data versions, a common failure point in systems relying on disparate spreadsheets this centralized data warehouse directly enforces accountability at every stage of the inventory lifecycle Our work provides a concrete example of this principle in action within a highly regulated customs environment. This functionality transforms the act of proving compliance from a reactive, evidence-gathering exercise into a proactive demonstration of control, fundamentally reducing the risk profile of the entire operation.

This automated traceability directly mitigates the immense risk of financial and legal penalties from customs authorities. This is particularly critical in the Indonesian context, where traditional document processing is known to present significant operational challenges (Febriana et al., 2025). The value of this real-time data is amplified by its accessibility through the management dashboard. This feature allows for the kind of immediate issue detection and swift corrective action that identify as a key benefit of modern monitoring systems (Raman et al., 2023). Ultimately, this elevates the system from being a simple transactional tool to a strategic asset that ensures compliance, enhances transparency, and provides robust governance assurance.

Operational Trade-offs and Risks

While the "Compliance-by-Design" architecture ensures strict adherence to regulations, it introduces a critical dependency on external infrastructure. Since the "Gate-In" function requires real-time validation from the DJBC CEISA server, any downtime on the government portal effectively halts warehouse receiving operations. To mitigate this latency risk, a manual fallback procedure was established where transactions are recorded locally and synchronized immediately once the CEISA connection is restored.

Implications and Threats to Validity

Theoretically, this study extends the application of the DeLone & McLean model into highly regulated environments, demonstrating that "Compliance" is a critical component of "System Quality" in this context. Practically, the study offers a blueprint for "Compliance-by-Design," showing how rigid programmatic locks can reduce audit preparation time by 99%. Threats to Validity include the single-site case study design and the small sample size (N=15). While sufficient for this exploratory Action Research, these factors limit the statistical generalizability of the PLS-SEM results to the broader logistics industry. Future studies should test this model across multiple bonded zones to validate these findings on a larger scale.

CONCLUSION

This action research study successfully addressed the complex operational and regulatory challenges inherent in bonded warehouse management. The core problem was the tension between the need for stringent compliance and the inefficiencies of manual, error-prone processes. The development and implementation of the web-based inventory system proved to be a highly effective intervention, a conclusion that is quantitatively supported by a formal evaluation using the DeLone & McLean IS Success Model. The system's success is rooted in its targeted design, which directly addresses the primary pain points of traceability and data integrity. By transforming regulatory reporting from a laborious manual task into an automated, single-click process, the system delivered dramatic and measurable benefits. The 99.95% reduction in reporting time and the elimination of data entry errors are not merely efficiency gains. They represent a fundamental transformation of the warehouse's risk profile and operational capability. Ultimately, this study demonstrates that a well-designed information system, built on the principles of process automation and centralized data control, can serve as a powerful tool for ensuring governance and mitigating risk in a highly regulated environment. The high scores in Use (4.8) and Net Benefits (4.8) confirm that the system was not only technically proficient but also delivered tangible, strategic value to the organization. Ultimately, this study contributes a validated framework for "Compliance-by-Design," proving that integrating regulatory logic directly into warehouse workflows is a viable strategy for risk mitigation

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FUTURE WORK

The primary limitation is the single-site case study design. Future work could involve a comparative study across multiple bonded warehouses to identify more universal best practices and contextual factors that influence system success. Furthermore, this evaluation represents a cross-sectional snapshot post-implementation. A longitudinal study, tracking system usage and organizational impact over several years, would offer deeper insights into long-term user adoption, evolving challenges, and the sustainability of the achieved benefits.

The current system provides a robust platform for future innovation. The next logical evolution is to enhance its capabilities from a reactive compliance tool to a proactive, intelligent management system. Several technological pathways are promising such as IoT Integration: Incorporating IoT sensors on goods or pallets could automate data capture for physical movements, further reducing human intervention and increasing real-time accuracy. Predictive Analytics: Leveraging the collected data to build AI-powered models for predictive stock management could help optimize inventory levels, forecast demand, and preemptively identify potential compliance issues before they occur.By pursuing these research and development tracks, the strategic value of bonded warehouse information systems can be further amplified, strengthening their role in supporting not just compliance, but also operational excellence and data-driven decision-making.

REFERENCES

Alduaij, M. Y., Alterkait, M. A., & Alainati, S. (2024). Using the Delone and McLean Success Model to Evaluate Moodle's Information System Success. *Engineering, Technology & Applied Science Research*, *14*(4), 15008–15015. https://doi.org/10.48084/etasr.7300

Ali, A. A. A., Fayad, A. A. S., Alomair, A., & Al Naim, A. S. (2024). The Role of Digital Supply Chain on Inventory Management Effectiveness within Engineering Companies in Jordan. *Sustainability*, *16*(18), 8031. https://doi.org/10.3390/su16188031

Arslayandi, F., Sudipa, I. G. I., Pramita, D. A. K., Suryawan, I. G. T., & Widiartha, K. K. (2024). UX Analysis on SpeedID Application Using Usability Testing Method and System Usability Scale. *Sinkron*, *8*(3), 1413–1428. https://doi.org/10.33395/sinkron.v8i3.13678

Cimen, E. B., Kurban, I., Selmanoglu, O., Sahin, M., & Kilinc, D. (2021). A Hybrid Stock optimization Approach for Inventory Management. *2021 3rd International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA)*, 1–4. https://doi.org/10.1109/HORA52670.2021.9461353

Cronholm, S., & Göbel, H. (2022). Action design research: integration of method support. *International Journal of Managing Projects in Business*, *15*(8), 19–47. https://doi.org/10.1108/IJMPB-07-2021-0196

Danis Andrianto, Aris Sunarya, Ika Devy Pramudiana, M Khairul Anwar, & Kresna Adhi Prahmana Putra. (2025). Optimalisasi Kualitas Layanan pada Kantor Pengawasan dan Pelayanan Bea dan Cukai Sidoarjo Melalui Penerapan Digitalisasi Sistem CEISA. *Journal of Management and Social Sciences*, *4*(1), 113–129. https://doi.org/10.55606/jimas.v4i1.1738

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, *19*(4), 9–30. https://doi.org/10.1080/07421222.2003.11045748

Febriana, N. F., Aji, M., Pambudi, L., Maharani, A., Studi, P., Laut, T., & Akpelni, P. B. (2025). *Transformasi Digital Pengelolaan Dokumen Fabric untuk Memaksimalkan Kualitas Layanan Gudang Berikat PT. Sunjaya Mentari Abadi* (Vol. 1, Issue 1). https://jurnal.poltekpelni.ac.id/index.php/transma

Julião, B. J. B., Reis, M. S., & Duarte, B. P. M. (2025). A Systematic Lean-Driven Framework for Warehouse Optimization. *Systems*, *13*(9), 813. https://doi.org/10.3390/systems13090813

Lia Febrianti, E., Syafrinal, I., & Suryadi, A. (2025). *VegeChain: Smart contract marketplace for vegetarian supply chain optimization*. *XI*(4), 2407–1811. https://doi.org/10.33330/jurteksi.v11i4.4076

Maheshwari, P., Kamble, S., Pundir, A., Belhadi, A., Ndubisi, N. O., & Tiwari, S. (2025). Internet of things for perishable inventory management systems: an application and managerial insights for micro, small and medium enterprises. *Annals of Operations Research*, *350*(2), 395–423. https://doi.org/10.1007/s10479-021-04277-9

Manurung, A., Batara, Y., Siringoringo, P., & Marpaung, J. L. (2024). Satisfaction Analysis of The Establishment of a Website-Based Rank System Using Customer Satisfaction Index (CSI) And Importance Performance Analysis (IPA) Methods. *Jurnal Dan Penelitian Teknik Informatika*, *8*(2). https://doi.org/10.33395/sinkron.v8i2.13599

Nallathambi, I., Savaram, P., Sengan, S., Alharbi, M., Alshathri, S., Bajaj, M., Aly, M. H., & El-Shafai, W. (2023). Impact of Fireworks Industry Safety Measures and Prevention Management System on Human Error Mitigation Using a Machine Learning Approach. *Sensors*, *23*(9), 4365. https://doi.org/10.3390/s23094365

Pasaribu, J. (2021). Development of a Web Based Inventory Information System. *International Journal of Engineering, Science and Information Technology*, *1*(2), 24–31. https://doi.org/10.52088/ijesty.v1i2.51

*name of corresponding author

Plakantara, S. P., Karakitsiou, A., & Mantzou, T. (2024). *Managing Risks in Smart Warehouses from the Perspective of Industry 4.0* (pp. 1–47). https://doi.org/10.1007/978-3-031-58919-5_1

Pushparaj, N., Sivakumar, V. J., Natarajan, M., & Bhuvaneskumar, A. (2023). Two decades of DeLone and Mclean IS success model: a scientometrics analysis. *Quality & Quantity*, *57*(3), 2469–2491. https://doi.org/10.1007/s11135-022-01464-z

Rahman, B., Helmiah, F., & Larasati, M. F. (2024). Implementation of supply chain management for product management at Bakti Jaya Store. *JURTEKSI (Jurnal Teknologi Dan Sistem Informasi)*, *10*(2), 217–222. https://doi.org/10.33330/jurteksi.v10i2.2635

Raman, R., Ramalingam, L., Kishorbhai Sutaria, K., Kamthan, M., Sangeetha, S., & Murugan, S. (2023). Smart Warehouse Solutions for Efficient Onion Buffer Stock Management System. *2023 7th International Conference on Electronics, Communication and Aerospace Technology (ICECA)*, 1260–1265. https://doi.org/10.1109/ICECA58529.2023.10394695

Sala, A., Barbetti, L., & Rosini, A. (2024). Green Web Meter: Structuring and Implementing a Real-Time Digital Sustainability Monitoring System. *Sustainability*, *16*(17), 7627. https://doi.org/10.3390/su16177627

Sardjono, W., Kholil, Moh. T., & Pranata, D. S. (2024). The Customs and Excise Information System and Automation (CEISA) 4.0 is Being Implemented as Part of Industrial Revolution 4.0 to Support Employee Performance. *2024 5th International Conference on Computational Science & Information Management (ICoCSIM)*, 19–23. https://doi.org/10.1109/ICoCSIM65098.2024.00012

Shivam, & Gupta, M. (2024). Inventory and warehouse management in industry 4.0: a BPR perspective. *Journal of Information Technology Case and Application Research*, *26*(4), 365–400. https://doi.org/10.1080/15228053.2024.2433926

Ulvi, H. A., & Ikhsan, M. (2024). Comparison of K-Means and K-Medoids Clustering Algorithms for Export and Import Grouping of Goods in Indonesia. *Sinkron*, *8*(3), 1671–1685. https://doi.org/10.33395/sinkron.v8i3.13815

Wang, K., Xiong, S., Huang, Z., Li, Q., Xue, Z., & Zeng, X. (2023). Development of a Traceability Tag Based Data Warehouse for Textile Supply Chain. *2023 18th International Conference on Intelligent Systems and Knowledge Engineering (ISKE)*, 651–658. https://doi.org/10.1109/ISKE60036.2023.10480965

Zimon, G., Habib, A. M., & Haluza, D. (2024). Does the quality management system affect working capital management efficiency? Evidence from Polish firms. *Cogent Business & Management*, *11*(1). https://doi.org/10.1080/23311975.2023.2292787

*name of corresponding author