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Problem Analysis and Manual Warehouse System Improvement Strategy Towards Smart & Sustainable Warehouse

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ABSTRACT

Conventional warehouse management systems are still widely applied in the construction and heavy manufacturing industries in Indonesia, including at PT ABC which is engaged in the fabrication of steel bridges. This research aims to analyze the main problems in the conventional warehouse system in the company and provide recommendations for improvement towards a smart & sustainable warehouse system. The research method used is qualitative case study, with data collection techniques through observation, in-depth interviews, Focus Group Discussions (FGD), and documentation. The analysis techniques used include Root Cause Analysis and the 5W1H approach. The results of the study showed a number of systemic weaknesses, such as the absence of a dedicated warehouse admin, the absence of a labeling system, the weak implementation of Standard Operating Procedures (SOPs), and an inefficient warehouse layout. This study recommends five steps for improvement: (1) appointment of special warehouse admins, (2) activation of labeling and Bin Card systems, (3) consistent enforcement of SOPs, (4) implementation of barcode systems, and (5) rearrangement of zoning-based warehouse layouts. This change effort is expected to improve warehouse operational efficiency and support the principles of Sustainable Supply Chain Management (SSCM) in the framework of industry 4.0.

INTRODUCTION

Warehouse management is an important part of the supply chain system, especially in heavy construction manufacturing industries such as steel fabrication and bridge construction. In this context, a warehouse is not just a storage place, but a logistics node that supports smooth production, integrated distribution, and project sustainability. Effective warehouse management can improve the accuracy of stock control, minimize material waste, and ensure timely meeting of material needs. However, in reality, the warehousing system in many national companies still relies heavily on manual processes. This traditional approach often leads to irregularities, recording errors, loss of goods, and high operational risks, especially in dynamic and high-risk project organizations.

PT ABC is a national company engaged in the fabrication of bridges and steel structures. Despite having a large production capacity and a wide project scope, the company's warehouse record-keeping system still uses conventional methods, such as paper forms, Word documents, and Excel spreadsheets that are not integrated. These systems do not support real-time tracking, are prone to human error, and complicate accountability. Based on the company's internal data from 2021 to 2024, there were many incidents of loss of goods, both in the form of raw materials, technical documents, measuring instruments, and occupational safety equipment. Delays in the discovery or non-rediscovery of the goods indicate the weakness of the tracking and control systems of stock in the warehouse.

Field observations show that the arrangement of goods in warehouses, both indoor and outdoor, has not followed a good classification system or storage standards. Many finished goods storage areas are open without weather protection, while warehouses of consumables and accessories are still managed manually without labeling or grouping systems. In fact, the company already has an official Standard Operating Procedure (SOP) in material management (RSU/VI/PPIC/02). Unfortunately, this SOP has not been implemented consistently. The labeling system is not implemented, the documents are incomplete, and internal audits are not carried out to evaluate the implementation of warehouse procedures on a regular basis.

Changes in the warehousing system are seen as a solution to overcome these problems. Technologies such as barcode systems, Warehouse Management Systems (WMS), and real-time dashboard-based tracking have been proven to improve recording accuracy, distribution efficiency, and support logistics sustainability. However, in practice, changes in traditional companies often encounter non-technical obstacles such as low organizational readiness, limited human resources, and the absence of a transformation roadmap. Based on interviews with PT ABC's warehouse personnel, most of the staff expressed readiness to learn the new system, but the company has not provided the tools, training, or leadership to support the change.

According to Christopher (2016), warehouse management is an integral part of supply chains, directly contributing to customer satisfaction and cost efficiency and Richards (2017) argues that modern warehouses act as strategic nodes in distribution rather than mere storage facilities. several previous studies have discussed the benefits of warehouse digitalization and the application of lean principles in logistics efficiency. However, most focus on technical aspects and have not examined in depth the failure of implementation in the context of organizations with conventional work cultures. In addition, there have not been many studies that integrate warehouse management theory, SOPs, and sustainability principles in the condition of organizations that are not yet digitally ready and resources are limited. This gap demonstrates the importance of research that not only focuses on technology, but also includes an analysis of institutional readiness and systemic barriers.

Thus, while various studies have highlighted the benefits of digital systems, few have highlighted the causes of digital change failures in practice. There is still limited research examining the integration between SOPs, digital readiness, and sustainability in traditional manufacturing industry environments. Therefore, this study aims to evaluate the manual warehousing system that runs and formulate improvement strategies towards smart & sustainable warehouses contextually. The objectives of this study are (1) to identify the factors that cause untraceable documentation of goods and non-compliance with warehouse SOP implementation, and (2) to formulate recommendations for manual system changes towards a smart and sustainable warehousing system.

LITERATURE REVIEW

Previous research highlights that one of the core weaknesses of conventional warehouse management is the inconsistent enforcement of Standard Operating Procedures (SOPs). Caldas et al. (2014) observed that the absence of discipline in implementing SOPs leads to documentation errors and distribution delays, which undermine overall warehouse efficiency. Similarly, Jaggi and Verma (2010) stressed the importance of the FIFO (First-In-First-Out) principle in maintaining orderly stock flow and preventing the deterioration of stored goods. These studies suggest that strengthening procedural adherence is central to improving both accuracy and reliability in warehouse operations. Baker and Canessa (2009)

highlighted that structured warehouse layout design significantly reduces handling costs and improves efficiency.Human resources have also been identified as a crucial factor in determining the effectiveness of warehouse systems. According to Tarudin et al. (2021), the competence, training, and discipline of staff play an important role in achieving effective inventory management. In the context of traditional companies, limited digital literacy and weak awareness of administrative accuracy often hinder the adoption of new warehouse practices. This demonstrates that successful transformation requires not only technological change but also a cultural shift within the workforce. Gu et al. (2010) emphasized that warehouse performance should be evaluated in terms of material flow efficiency, space utilization, and error rates.

The digitalization of warehouse systems has received considerable scholarly attention in recent years. Kubáňová et al. (2022) found that the implementation of barcode technology and Warehouse Management Systems (WMS) can significantly improve accuracy in tracking goods and reduce operational inefficiencies. However, qualitative perspectives reveal that the challenge lies not only in technology adoption but also in organizational readiness and cultural resistance. Without leadership commitment, adequate training, and a clear transformation roadmap, digitalization initiatives are prone to failure despite their technical potential. Ramaa et al. (2012) demonstrated that implementing Warehouse Management Systems (WMS) improves recording accuracy and minimizes inventory losses.Another important aspect concerns the layout and physical work environment of warehouses. Tarigan et al. (2021) showed that inefficient layouts increase material handling costs and prolong delivery times, making warehouse operations less effective. In qualitative investigations, layout problems are not only associated with technical arrangements but also reflect organizational practices, work habits, and the absence of standardized planning. A poorly structured environment exacerbates irregularities in stock management and complicates the transition toward more sustainable systems.

Research Focus and Proposition Development

This study focuses on several interrelated areas that influence warehouse performance, namely the implementation of SOPs, the competence and discipline of human resources, the role of technology such as barcode systems and WMS, the warehouse environment and layout, and the diversity of stored materials. These areas are treated as thematic focal points rather than measurable variables, in line with the qualitative nature of the research.Based on the literature, several propositions are developed to guide the exploration. The consistent implementation of SOPs is expected to improve documentation accuracy and streamline material distribution. The competence and discipline of human resources are assumed to determine the success of warehouse transformation efforts. The adoption of digital technologies such as barcode systems and WMS has the potential to enhance efficiency, but its success depends largely on organizational readiness. A systematic and standardized warehouse layout is anticipated to reduce delays and inefficiencies in distribution processes. At the same time, organizational culture and limited resources are expected to act as significant barriers to transformation.

Research Framework

he conceptual framework of this study illustrates how multiple factors interact in shaping warehouse management performance. Standard operating procedures, human resource competence, technological readiness, layout design, and material diversity serve as key determinants that influence the efficiency and accuracy of warehouse operations. These interacting factors represent not only technical challenges but also cultural and organizational barriers that affect system performance. The framework positions these determinants as inputs that collectively shape warehouse management outcomes. The ultimate goal is to understand how improvements in these areas can contribute to the transformation of a conventional warehouse into a smart and sustainable system, in line with the broader principles of supply chain sustainability and industry 4.0 readiness.

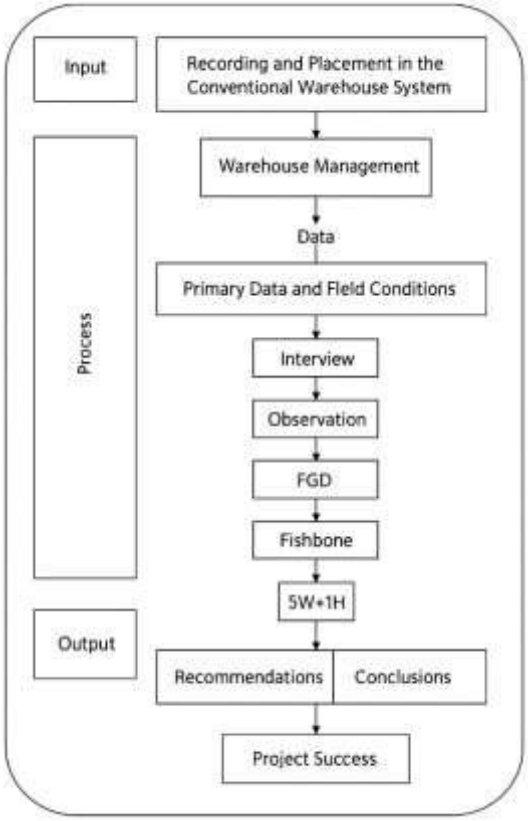


Figure.1 : Framework

METHOD

This study employed a **qualitative case study approach** to explore the systemic problems and improvement strategies of the manual warehouse system at PT ABC, a steel bridge fabrication company. The research paradigm emphasized an in-depth understanding of the social and organizational context rather than statistical generalization.

Research Design and Setting

The study was conducted at PT ABC's main production and warehouse facilities in Jakarta. The warehouse operations were chosen as the primary social setting due to their central role in material flow and project sustainability.

Key Informants and Sampling

Five key informants were purposively selected based on their direct involvement in warehouse operations: the Head of Storage, Foreman of Raw Material Storage, Foreman of Consumable & Accessories Storage, Head of Production Planning and Inventory Control (PPIC), and the Warehouse Administrator. Purposive sampling ensured that participants had relevant knowledge and operational experience.

Data Collection Techniques

To enhance the richness of data, this study applied multiple collection techniques. In-depth interviews were conducted with key informants to obtain detailed insights into operational challenges and the daily realities of warehouse management. These interviews were complemented by participatory observations of warehouse activities, which allowed the researcher to directly validate the information provided and to capture practices as they occurred in real time. Document analysis was also carried out on internal Standard Operating Procedures (SOPs), inventory records, and warehouse reports to provide a formal reference point for evaluating existing processes. In addition, Focus Group Discussions (FGDs) were organized with warehouse personnel to encourage collective identification of problems and the formulation of potential solutions through shared perspectives. Finally, visual documentation of warehouse conditions was used as supporting evidence to illustrate the physical environment, storage practices, and overall operational context.

Research Instruments and Validation

The researcher acted as the primary instrument, supported by interview guides and pilot studies to refine data collection tools. Data validity was ensured through triangulation of sources (informants), methods (interview, observation, documents), and theories. Credibility, transferability, dependability, and confirmability were applied to strengthen research trustworthiness.

Data Analysis

The data were analyzed using Root Cause Analysis (RCA), including Fishbone Diagrams and Why–Why Analysis, to systematically trace underlying causes of inefficiencies. Subsequently, the 5W1H framework (What, Why, Where, When, Who, and How) was employed to formulate contextual and implementable improvement strategies.

RESULT AND DISCUSSION

Overview of Research Locations

PT ABC is a national private company engaged in the fabrication of steel bridges, steel culverts, steel structures, and general contractor services. Established in 2007 and headquartered in Jakarta, the company has shown significant growth in the national construction industry, particularly in infrastructure projects using steel materials. With more than a decade of experience, PT ABC has been trusted to work on various projects in different regions of Indonesia such as Java, Sumatra, and Kalimantan.

The company operates production facilities and workshops located in strategic industrial areas in the Greater Jakarta area. This location provides a logistical advantage in supporting the delivery of materials and steel components to the project site. In addition to production facilities, PT ABC also has an administrative and engineering headquarters that functions as a project planning and control center.

The success of business processes is greatly influenced by the availability of competent human resources (HR). PT ABC's organizational structure consists of several main divisions, such as designers, implementers, supervisors, and controllers. Management has developed a structured workflow to minimize errors and deviations. This research is focused on PT ABC's main facilities, especially the production area and steel material storage warehouse, as these are central to warehousing and material flow analysis.This is included in the research method as part of site profiling, where data collection was conducted through direct observation, in-depth interviews with key personnel, and review of company documents. To validate the data, triangulation was applied by cross-checking information from multiple sources, comparing observational findings with company records, and confirming interview results with other stakeholders to ensure accuracy and reliability.

Data Analysis

This study employed a combination of direct observation, documentation review, and primary data collection through Focus Group Discussions (FGD) and in-depth interviews with warehouse personnel, namely the Head of Storage, Foreman of Raw Material Storage, Foreman of Consumable & Accessories Storage, Head of PPIC, and the Warehouse Administrator. These informants were purposively selected because of their direct involvement in warehouse operations and their knowledge of the existing manual processes. The information obtained from the FGD and interviews was systematically analyzed using the Fishbone Diagram approach, which facilitated the identification of the root causes of problems across multiple dimensions.The analysis revealed that the problems in the warehouse system are concentrated in five major categories: human factors, machinery and work environment, methods and procedures, materials, and the overall environment. Human factors refer to issues of competence, discipline, and the performance of duties by employees in warehouse operations. Machinery and work environment factors are related to the lack of adequate tools, supporting facilities, and poor layout design that fail to meet operational standards. Procedural factors highlight the weak and inconsistent implementation of SOPs, which were often poorly socialized and not regularly supervised. Material-related factors concern the absence of a classification and labeling system, which complicates tracking and recording of diverse stock items. Finally, environmental factors describe both the physical and organizational conditions that influence the performance of employees and the overall efficiency of warehouse operations. These categories were further visualized in Figure 1 through a Fishbone Diagram, which clearly illustrates how each dimension contributes to systemic inefficiencies in PT ABC's warehouse system.

Forum Group Discussion (FGD)

The Forum Group Discussion (FGD) served as an important method of validating findings and generating collective insights from warehouse personnel at PT ABC. The session involved key informants who were directly responsible for warehouse operations, including supervisors, foremen, and the warehouse administrator. The FGD allowed participants to openly discuss recurring problems, share experiences, and collectively identify the root causes of inefficiencies in the manual warehouse system.During the discussion, participants confirmed that the absence of a dedicated warehouse administrator, weak enforcement of SOPs, and reliance on manual recording systems were major factors contributing to stock discrepancies and operational delays. They emphasized that labeling and zoning were not properly implemented, which often resulted in misplaced items, difficulty in retrieval, and increased risk of material loss. The FGD also revealed that staff were aware of these shortcomings and expressed readiness to adopt digital tools such as barcode systems and Warehouse Management Systems (WMS), provided that the company supplied adequate training and resources.

The outcomes of the FGD reinforced the results obtained through interviews and observations, strengthening the validity of the findings. It also highlighted the importance of participatory approaches in problem-solving, as warehouse personnel contributed practical suggestions based on their daily experiences. These included the introduction of a structured labeling system, clearer zoning of storage

areas, and periodic training to ensure consistent SOP implementation. By integrating these perspectives, the study was able to propose realistic and context-based strategies for the transformation toward a smart and sustainable warehouse.

To ensure the validity and reliability of the data, triangulation techniques were applied. Findings from FGDs and interviews were cross-checked with direct field observations and documented evidence such as SOP manuals, inventory reports, and warehouse records. This multi-source verification minimized the possibility of bias and confirmed that the data reflected actual operational conditions rather than isolated incidents. The results of the interview are summarized in *the following Fishbone Diagram* :

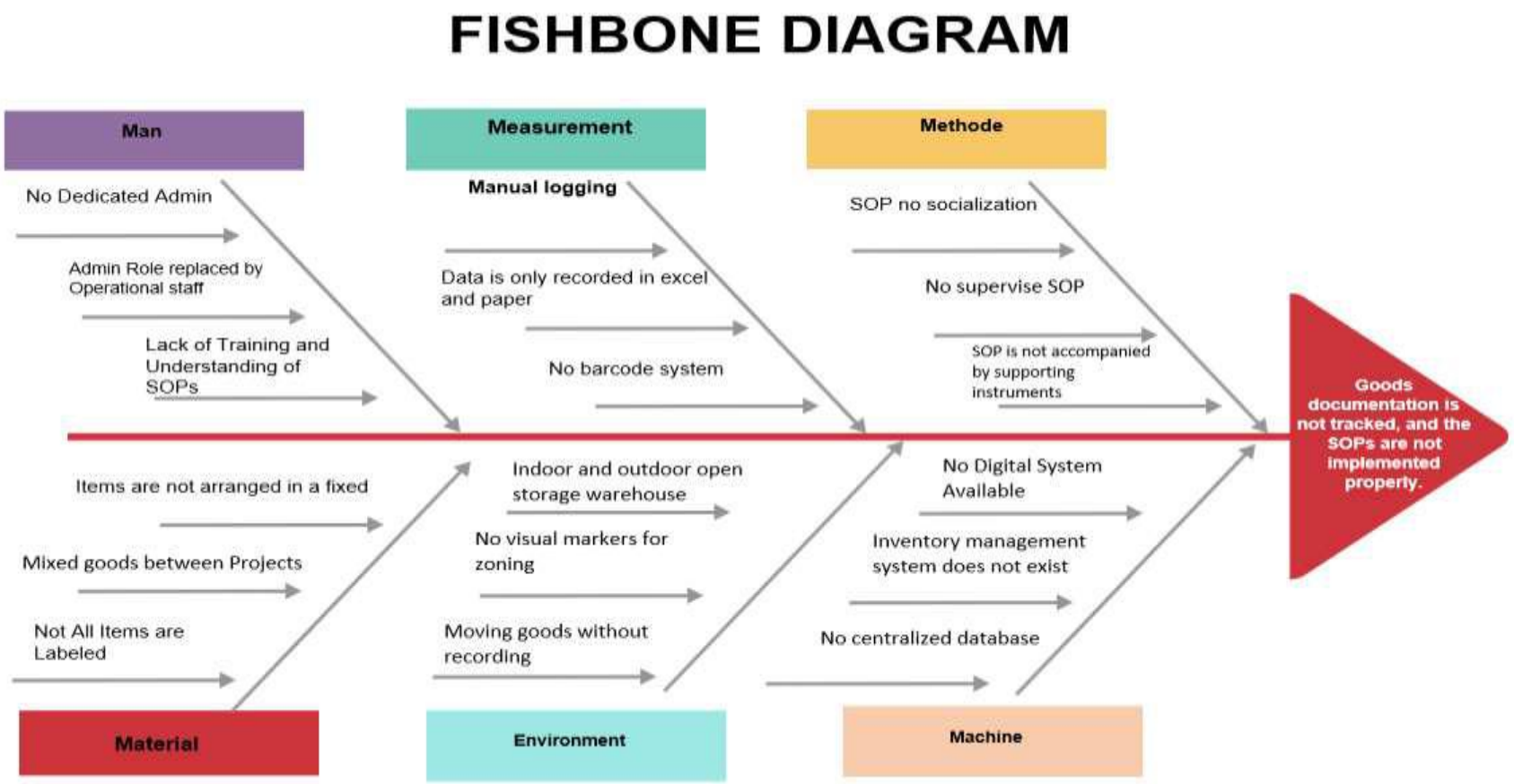


Figure 1 Fishbone Diagram
Source: Interview Processing Results Data (2025)

5W1H Analysis

The application of the 5W1H framework provided a systematic approach to translating the findings of the Root Cause Analysis into practical improvement strategies for PT ABC's warehouse system. By examining the problems through the lens of "What, Why, Where, When, Who, and How," the study was able to move beyond identifying root causes and formulate actionable solutions that were contextually relevant.

The analysis revealed that the main problem (What) was the inefficiency and unreliability of the manual warehouse system, particularly in documentation, stock tracking, and layout organization. The reason (Why) for these shortcomings was linked to the absence of a dedicated warehouse administrator, weak enforcement of SOPs, and lack of investment in digital technologies such as barcodes or Warehouse Management Systems (WMS). These problems were most visible in specific locations (Where) such as the receiving area, the consumable and accessories warehouse, and outdoor finished goods storage zones, where the absence of labeling and zoning created significant inefficiencies. The issues were found to occur frequently and continuously (When) during daily operations, particularly at points of material inflow and outflow. The actors involved (Who) included both warehouse personnel and management, with staff bearing the immediate operational burden while management was responsible for resource allocation and oversight. Finally, the strategies for improvement (How) involved appointing a dedicated warehouse administrator, revitalizing and consistently enforcing SOPs, implementing labeling and zoning systems, and gradually transitioning from manual records to digital solutions such as barcodes and cloud-based WMS.

Through this structured analysis, the study not only identified why systemic weaknesses persisted but also outlined step-by-step measures that could realistically be adopted within the company's current organizational context. The 5W1H approach therefore served as a bridge between diagnostic insights and actionable recommendations, ensuring that the proposed solutions were both practical and aligned with the principles of smart and sustainable warehouse management.

Root Cause Analysis

The Root Cause Analysis (RCA) was employed to systematically identify and understand the underlying causes of inefficiencies in PT ABC's manual warehouse system. Using Fishbone Diagrams and Why–Why Analysis, the research categorized the problems into interrelated dimensions, namely human resources, methods and procedures, materials, physical environment, and organizational readiness. This analytical approach revealed that the issues observed were not isolated incidents, but rather symptoms of deeper structural and cultural shortcomings within the company's warehouse management practices.

From the human resource perspective, the absence of a dedicated warehouse administrator created gaps in accountability, as documentation tasks were often handled by operational staff without clear responsibility. In terms of methods and procedures, Standard Operating Procedures (SOPs) were not consistently implemented, largely due to poor socialization, lack of training, and minimal supervision. Material-related problems stemmed from the absence of labeling and classification systems, which made inventory control inaccurate and time-consuming. Environmental and layout issues, such as unorganized storage areas and open-air facilities, further exacerbated inefficiencies by complicating the flow of goods and increasing the risk of damage or loss. At the organizational level, the lack of a strategic roadmap for digitalization reflected limited readiness to adopt technologies such as barcodes or Warehouse Management Systems (WMS), which are essential for modern warehouse operations.

The RCA confirmed that these weaknesses were interconnected and reinforced one another, producing a systemic pattern of inefficiency. For example, the lack of labeling was tied to both material management failures and organizational unwillingness to allocate resources for procurement, while poor SOP enforcement was linked to insufficient training and weak managerial oversight. By mapping these causal chains, the RCA provided a clear foundation for designing targeted solutions that addressed not only the surface-level problems but also the root organizational and procedural deficiencies. This analytical process strengthened the validity of the study's recommendations, ensuring that the proposed strategies for improvement were based on a comprehensive understanding of the warehouse system's underlying challenges.

Field Findings and Analysis

The analysis of field observations, interviews, and documentation highlighted several systemic weaknesses that persist in PT ABC's warehouse system. Stock recording activities are still managed manually using forms and Excel spreadsheets, which results in delays in updating data and frequent recording errors. The absence of digital technologies such as barcode systems, RFID, or Warehouse Management Systems (WMS) further aggravates the inefficiency, making the process of item identification and tracking both slow and unreliable. The physical arrangement of the warehouse was also found to be suboptimal, as goods were not categorized or arranged according to frequency of use, leading to difficulties in locating items and prolonged distribution times.

In addition, Standard Operating Procedures (SOPs) that had been formally established were not consistently implemented. Many staff members were unfamiliar with the content of these procedures, and enforcement by supervisors was weak. The limited competence of human resources further complicated the system, as many employees lacked adequate training in digital systems and modern warehouse management practices, including the principles of lean warehousing. Moreover, the absence of sustainability aspects, particularly in waste management and occupational safety, reflects a lack of integrated attention to long-term operational resilience and environmental responsibility.

These findings are consistent with earlier studies, such as Caldas et al. (2014) and Tarudin et al. (2021), which emphasize that the lack of procedural discipline and inadequate human resource competence are central barriers in achieving effective warehouse management. By triangulating data across interviews, FGDs, observations, and documents, the study demonstrates a high degree of validity and reliability in its results, showing that the identified problems are not incidental but systemic.

Findings in the Appendix

Further explanation of the root causes is detailed in the appendix, which contains a comprehensive Why-Why Analysis. The tables in the appendix illustrate the causal chain behind each major problem. For example, the absence of a dedicated warehouse administrator can be traced to the lack of formal regulations governing the role and a general lack of awareness about the importance of administrative functions in documentation systems. Similarly, the inconsistency in SOP implementation was found to originate from the absence of structured training, poor supervision, and the perception of SOPs as mere formal documents rather than operational guidelines. The continued reliance on manual recording methods is explained by the lack of investment in digital systems, insufficient technological resources, and the absence of a strategic roadmap for gradual warehouse digitization. The absence of labeling and zoning systems is linked to the lack of budget allocations and the absence of a layout management team, which has resulted in a disorganized warehouse environment.

By presenting these detailed causal explanations in the appendix, the study strengthens the argument that the inefficiencies in PT ABC's warehouse system are not isolated operational problems but rather systemic issues rooted in organizational, procedural, and cultural shortcomings. This detailed breakdown also underscores the importance of developing comprehensive solutions that integrate structural, procedural, technological, and cultural changes in order to achieve a transformation towards a smart and sustainable warehouse.

These problems require a comprehensive change solution towards smart and sustainable warehouses. The analysis using the 5W1H approach and RCA (Root Cause Analysis) identified the root causes of the following problems:

Table 1. Why - why analysis

Major Problems (Fishbone)	Why 1	Why 2	Why 3	Why 4	Why 5
No dedicated warehouse admin *(Man)*	Admin roles are replaced by operational staff	No admin task structure	The person in charge is not formally designated	There are no internal regulations regarding admins	There is no awareness of the importance of the admin position in the documentation system
SOP not carried out *(Method)*	SOPs are not socialized to the implementing staff	No training and monitoring sessions	The implementation of SOPs is not routinely supervised	There is no PIC in charge of ensuring the SOP runs	SOPs are only a formal document, not operational habits
Recording is still manual *(Measurement)*	Note-taking using excel and paper only	No barcode system or digital tracking	Digital systems have not yet been proposed to management	No technology resources available in the warehouse	No planning for gradual digitization of warehouses
Unlabeled goods *(Material)*	No labeling procedure	Labelling SOP has not yet been drawn up	No labeling admin	Labels not yet provided by the company	No budget for procurement of labels and marking tools
The warehouse does not have	No visual boundaries between areas	The layout of the warehouse is not	Placement of goods is done carelessly	No layout management team yet	Management has not yet set

clear zoning *(Environment)*		designed according to the function of the goods			a storage zone design
Mixed goods between projects *(Material)*	No project code on incoming goods	Items unmarked since receipt	The classification system of goods is not implemented	Receipt of goods not through project validation	No SOP for identifying goods projects

Source: Interview processing data (2025)

Discussion

Table 1 presents the results of a Why-Why Analysis which was conducted to trace the root causes of systemic problems in PT ABC's warehouse management system. This analysis identifies major problems across five dimensions—man, method, measurement, material, and environment—and explains them through a chain of causal factors.

The first major problem relates to the absence of a dedicated warehouse administrator. Administrative roles are often replaced by operational staff, and there is no formal structure that assigns responsibility for documentation tasks. As a result, no individual is officially designated as the person in charge, and there are no internal regulations regarding warehouse administration. This situation reflects a lack of organizational awareness about the importance of having a dedicated admin function in maintaining documentation accuracy.

The second problem concerns the inconsistent implementation of Standard Operating Procedures (SOPs). Although SOPs exist, they are not properly socialized among employees. Training and monitoring sessions are rarely conducted, and there is no designated person in charge of ensuring compliance. Consequently, SOPs are perceived merely as formal documents rather than as operational guidelines, resulting in a culture where procedures are often ignored in daily practice.

A third problem is that stock recording is still carried out manually. The process relies on Excel spreadsheets and paper-based notes, without the use of barcode systems or digital tracking tools. Digital solutions have not yet been proposed to management, and the warehouse lacks the necessary technological resources. Moreover, there has been no systematic planning for the gradual digitization of warehouse operations, leaving recording vulnerable to errors and inefficiencies.

The fourth problem involves the absence of a labeling system for goods. There are no formal procedures for labeling, and no SOPs have been prepared to guide the process. Furthermore, the company has not appointed a labeling administrator, and the provision of labels and marking tools has never been budgeted for. This condition has led to a lack of standardization in identifying and managing stock items, complicating inventory control.

Another critical issue is the warehouse's lack of clear zoning. There are no visual boundaries between different storage areas, and the overall layout of the warehouse has not been designed according to the function of stored goods. Placement of materials is often done carelessly without standardized guidelines. The absence of a layout management team and the lack of managerial decisions regarding zoning design further exacerbate the disorder, reducing efficiency in locating and distributing goods.

Finally, the analysis also highlights the problem of mixed goods between projects. Incoming goods are not consistently assigned project codes, and items often remain unmarked from the moment they are

received. A classification system for goods has not been implemented, and there is no SOP for identifying which project a particular item belongs to. In addition, receipts of goods are not systematically validated against project requirements, creating confusion and increasing the risk of misallocation.

This detailed explanation of the Why-Why Analysis demonstrates that the problems in PT ABC's warehouse system are not isolated but deeply rooted in structural and procedural shortcomings. Each issue is interconnected, reinforcing inefficiencies and highlighting the urgent need for comprehensive reforms in warehouse administration, digitalization, layout management, and procedural discipline.

Proposed Improvement Design

Based on the results of the Root Cause Analysis and 5W1H framework, this study formulated a set of improvement strategies to address the systemic weaknesses of PT ABC's manual warehouse system. The proposed design emphasizes both short-term corrective actions and long-term transformational changes that align with the principles of smart and sustainable warehouse management.

One of the first recommendations is the appointment of a dedicated warehouse administrator to ensure accountability in documentation and stock control. This structural adjustment aims to reduce the reliance on operational staff for administrative tasks and to establish clear responsibility for record accuracy. Alongside this, the revitalization and consistent enforcement of Standard Operating Procedures (SOPs) are essential to instill discipline in warehouse operations. Training sessions and regular supervision are suggested to ensure that SOPs are not merely treated as formal documents but are embedded as operational guidelines.

The second recommendation involves the implementation of a labeling and bin card system to standardize inventory identification and improve traceability. By introducing systematic labeling and classification, the process of locating, retrieving, and distributing goods can be streamlined, thereby reducing operational delays and minimizing the risk of misplacement. This step also lays the foundation for the gradual transition to digital systems.

In terms of technological advancement, the study proposes the phased adoption of barcode systems and eventually cloud-based Warehouse Management Systems (WMS). A gradual integration strategy is recommended to align with the company's resource constraints and staff readiness. This transition would enable real-time tracking of inventory, improve the accuracy of documentation, and enhance operational transparency.

Furthermore, the redesign of the warehouse layout through zoning is proposed to improve space utilization and material flow efficiency. Clear zoning based on material type and frequency of use will minimize handling time and prevent the mixing of goods across projects. This spatial reorganization is critical for both operational efficiency and occupational safety, particularly in reducing risks associated with open storage areas.

Collectively, these proposed improvements are designed not only to resolve the immediate inefficiencies but also to prepare PT ABC for a sustainable transformation toward a smart warehouse system. The combination of structural, procedural, technological, and spatial changes reflects an

integrated approach that addresses both the root causes of the problems and the organizational readiness for digitalization. By adopting these strategies, PT ABC can enhance its warehouse performance, reduce the risk of stock loss, and support long-term supply chain sustainability in line with Industry 4.0 initiatives.

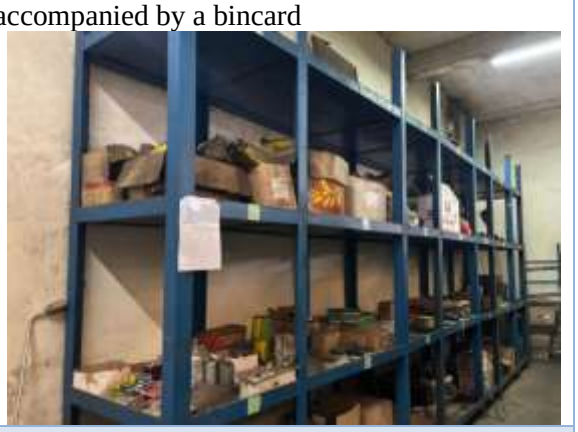
Table Managerial Implications

No	Activity	Before	After
Physical Improvements			
1	Green Line (Safety Path)	The operational area still contained heavy equipment or trucks parked on the green line.	The green line area is sterile, with no trucks or heavy equipment placed in this zone.
2	Raw Material Racks	The racks were disorganized and unlabeled.	The racks are now labeled, equipped with Bin Cards, and provided with warning signs and additional instructions.
3	Outdoor Finished Goods Warehouse	There were no signs or specific identification markers in the area.	Identification boards have been installed to clearly designate the finished goods storage area.
4	Indoor Consumable Warehouse	There were no labeling codes or designated areas.	Area labels and item codes have been applied, and each rack is equipped with a Bin Card.
5	Tools Warehouse	There were no rack labels, Bin Cards, or hazard warnings.	Bin Cards and rack labels have been installed, including warning signs for flammable liquids.
Non-Physical Improvements			
1	Warehouse SOPs	SOPs existed but were not implemented.	SOPs are now implemented according to the flow of inbound and outbound processes.
2	Recording System	Items were recorded directly in the Stock Card, but Bin Cards were not used.	Bin Card recording has been reactivated, and a comprehensive stock opname has been carried out.

Implikasi managerial

1. Green Line

Before: in the operational area there were still heavy equipment vehicles parked on the green lane 	After: the green lane no longer has any trucks or heavy equipment placed in that zone. 
2. Rack Raw Material	
Before: Irregular and unlabeled 	After: labeling on shelves and bincards are provided in the shelf area and additional warnings and instructions are provided. 
3. Outdoor Warehouse for Finished Goods	
Before: there were no signs in the area 	After: a sign has been made for the finished goods area in the outdoor warehouse. 
4. Indoor Consumable Warehouse	

Before: no code and area labeling yet 	After: There is an area label on each shelf accompanied by a bincard 
5. Work Tool Warehouse	
Before: no code and area labeling yet 	After: bincards are installed, shelf labeling is installed, and flammable liquid warnings are also installed. 

Non-Physical Improvements			
1	Warehouse SOP	Yes, but not implemented according to SOP	Start running according to existing SOP and flow
2	Recording	Goods are recorded directly on the stock card, bincard recording is not carried out	Recording on the bincard starts again and carries out overall Stock Opname

Discussion

The findings of this study confirm that the main factor causing untraceable documentation and inconsistent implementation of Standard Operating Procedures (SOPs) is the absence of a structured digitalization system, limited staff training, and weak procedural discipline. This supports the statement of Sagala et al. (2024), who found that negligence of warehouse officers often results in discrepancies between physical stock and administrative records, particularly among new employees who require additional time to adapt to procedural accuracy. In the context of PT ABC, as illustrated in Table 1, the lack of socialization, monitoring, and enforcement of SOPs has transformed them into formal documents with little operational significance, thereby reinforcing the systemic weaknesses of the manual warehouse system.

The spatial and operational dimensions of the warehouse also play an important role in shaping these inefficiencies. The study found that the most severe problems occur in the goods reception area, open storage sites, and distribution processes. These findings align with the results of Verawati et al. (2022), who identified that disruptions often arise in the flow of materials entering and leaving the supply chain. Similarly, Amelia and Wijaya (2023) emphasized that inventory recording must be closely linked to appropriate placement within the warehouse to facilitate effective internal control. At PT ABC, the absence of zoning and classification systems, as shown in Table 1, has created disorder in storage practices, thereby prolonging retrieval and distribution times.

From a human resource perspective, the affected parties include warehouse staff, production managers, logistics teams, and project units, all of whom depend heavily on the accuracy and timeliness of stock data. Ikhwana et al. (2022) stress that draft SOPs should serve as practical guidelines for daily warehouse operations. However, in this case study, the lack of a dedicated warehouse administrator and the absence of staff specialization have limited the reliability of documentation, as confirmed in the Why-Why Analysis presented in Table 1. This reinforces the notion that effective SOP implementation is inseparable from clear role designation and administrative accountability.

The analysis also reveals that periods of heightened project demand, stock audits, and workforce turnover intensify existing warehouse inefficiencies. This finding resonates with the observations of Sianturi et al. (2024), who argued that improvements in warehouse governance, better equipment provision, and systematic management practices are essential to maintaining operational efficiency. The RCA results summarized in Table 1 highlight how recurring failures, such as manual record-keeping and the absence of labeling systems, are rooted in both technological neglect and managerial inaction, thereby requiring long-term structural solutions rather than temporary adjustments. Zhong et al. (2017) argue that big data integration in warehouse systems is a critical enabler for Industry 4.0 transformation. Overall, the findings of this study substantiate earlier theoretical propositions developed in the literature review, particularly regarding the role of consistent SOP enforcement, human resource competence, and the integration of digital technologies in improving warehouse performance. The evidence presented in Table 1 underscores that the challenges faced by PT ABC are not incidental but systemic, consistent with the broader conclusion that sustainable transformation requires a comprehensive approach addressing human, procedural, technological, and environmental dimensions simultaneously.

Appropriate and contextual recommendations to transform manual warehouse systems towards *smart & sustainable warehouses*

In terms of methods, the application of the FIFO (First In First Out) principle is a top priority that must be enforced more strictly. So far, irregularities in the order of picking up goods have caused old stock to accumulate and risk being damaged. Therefore, supervision of the implementation of FIFO must be carried out consistently so that the flow of goods runs according to the correct procedures (Jaggi & Verma, 2010).

In terms of materials, the recording of goods that have only been done verbally or casually needs to be changed to a routine and structured process. This record should include all types of materials, including remnants that are often overlooked. The application of disciplined recording will create harmony between administrative data and real conditions in the field (Caldas et al., 2014).

The problem in the machine aspect is marked by the failure of the implementation of the barcode system that was previously planned. The recommended solution is to revive the barcode system and ensure its implementation runs with the support of the appropriate equipment. This barcode system is

expected to be a key tool in improving the accuracy of tracking goods in warehouses (Kubáňová et al., 2022).

The work environment also contributes greatly to the irregularity of warehouse management. Nowadays, storage layouts often change without standard procedures, so the placement of goods becomes disorderly. Therefore, a standard and documented rearrangement of warehouse layouts is absolutely necessary, so that the movement of goods is more orderly and not mixed with production activities that risk damaging goods (Tarigan et al., 2021).

Finally, in the human aspect, the main problem is the absence of special personnel who focus on the administration of warehouse documentation. The recommended solution is to establish a dedicated warehouse admin position that is fully responsible for the recording of goods in and out. The existence of this special admin is expected to improve data accuracy and reduce the burden of recording that has been situationally imposed on field workers (Tarudin et al., 2021). With the consistent and integrated implementation of the five recommendations, it is hoped that the problems of the documentation system and warehouse management can be overcome comprehensively and sustainably.

CONCLUSION

This study set out to identify the factors causing untraceable documentation and inconsistent implementation of warehouse SOPs at PT ABC and to formulate recommendations for transforming its manual warehouse system into a smart and sustainable model. The findings confirm that the weaknesses of the current system are not incidental but systemic, rooted in the absence of dedicated administrative personnel, reliance on non-uniform manual recording, weak enforcement of SOPs, and the lack of digital tools such as labeling and tracking systems. These results support the initial research propositions and align with the objectives of the study, showing that effective warehouse transformation requires an integrated approach that addresses human, procedural, technological, and environmental dimensions simultaneously.In comparison with previous studies, the results resonate with the findings of Caldas et al. (2014), who emphasized that poor adherence to SOPs leads to frequent documentation errors and inefficiencies, and with Tarudin et al. (2021), who stressed the importance of human resource competence and discipline in warehouse operations. Similarly, the absence of a digital system at PT ABC echoes the challenges described by Kubáňová et al. (2022), who noted that without proper leadership commitment and technological readiness, digitalization efforts often fail despite their potential benefits. The inefficient warehouse layout observed in this study also reinforces the conclusions of Tarigan et al. (2021), who highlighted that poorly structured physical arrangements exacerbate irregularities in material handling. Taken together, these comparisons strengthen the argument that the challenges at PT ABC are representative of broader patterns found in traditional warehouse systems in developing contexts.The evidence gathered indicates that the transformation of PT ABC's warehouse system should begin with the appointment of a dedicated warehouse administrator, the revitalization of SOPs through training and regular audits, and the implementation of digital technologies such as barcodes or a Warehouse Management System (WMS). Furthermore, the warehouse layout must be redesigned with clear zoning, and human resources should be developed through targeted training and cultural shifts toward efficiency and accountability. These strategies, if integrated into a realistic and phased transformation roadmap, would enhance operational efficiency and support the broader principles of sustainable supply chain management in line with Industry 4.0 readiness.

Future research should build on these qualitative findings by employing quantitative methods to measure the effectiveness of proposed solutions once implemented, particularly in terms of cost

reduction, error minimization, and sustainability outcomes. Comparative studies across industries and countries could also provide deeper insights into how organizational readiness and cultural factors shape the success of warehouse digitalization. Additionally, longitudinal research examining the process of gradual adoption of WMS and barcode systems would be valuable in understanding the dynamics of technological transformation in traditional manufacturing environments.

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