

Integration Of Quality Control Tools and Mixed-Method Warehouse Layout Redesign for Return-Material Management at PT PLN UP3 Indramayu

Fazri Ilfi Ramdansyah¹, Rendiyatna Ferdian²

^{1,2} Program Studi Teknik Industri, Fakultas Teknik, Universitas Widyatama
e-mail: fazri.ramdansyah@widyatama.ac.id , rendiyatna.ferdian@widyatama.ac.id

Abstrak

Tingginya tingkat cacat dalam pengelolaan material retur menimbulkan hambatan operasional dan kerugian finansial yang signifikan pada sistem logistik balik perusahaan kelistrikan. Penelitian ini bertujuan mengatasi tingkat cacat rata-rata sebesar 10% yang melebihi batas perusahaan sebesar 5% pada material Alat Pembatas dan Pengukur (APP) hasil retur di PT PLN (Persero) UP3 Indramayu. Penelitian mengembangkan kerangka integratif yang mengombinasikan alat pengendalian kualitas (Quality Control/QC Tools) dan perancangan ulang tata letak gudang dengan pendekatan Mixed-Method untuk menganalisis akar penyebab cacat serta mengurangi kerusakan material. Prioritas cacat melalui analisis Pareto dan penilaian kapabilitas proses menunjukkan bahwa kerusakan kabel (65,16%; 2,03 Sigma) dan kerusakan casing MCB (21,30%; 2,73 Sigma) merupakan penyumbang cacat terbesar dengan kinerja yang masih berada di bawah standar industri. Identifikasi akar masalah menggunakan analisis 5 Why menunjukkan bahwa penumpukan material di lantai, beban statis berlebih, penanganan yang belum terstandarisasi, serta praktik penyimpanan campuran menjadi penyebab utama percepatan kerusakan fisik material. Untuk mengatasi permasalahan tersebut, dirancang tata letak baru dengan mengombinasikan prinsip Dedicated Storage dan aliran material berbentuk U-Shaped. Desain usulan meliputi penggunaan rak bertingkat tiga berkapasitas tinggi, alokasi ruang vertikal khusus, serta sistem manajemen visual tiga warna, yaitu kuning untuk penerimaan dan inspeksi, hijau untuk penyimpanan utama material layak pakai, dan merah untuk isolasi material scrap. Aliran material yang baru menerapkan mekanisme First-In, First-Out (FIFO), menghilangkan pergerakan silang, serta mengurangi risiko kerusakan material selama proses logistik balik. Pendekatan terintegrasi ini memberikan kerangka praktis yang dapat diterapkan oleh perusahaan utilitas untuk mengoptimalkan operasi logistik balik, mengurangi biaya pengerjaan ulang, dan menjaga integritas persediaan.

Kata Kunci: Dedicated Storage; Kapabilitas Proses; Manajemen Material Retur; Tata Letak Berbentuk U; Alat Pengendalian Kualitas.

Abstract

High defective rates in return-material management pose severe operational bottlenecks and financial losses in electric utility reverse logistics. This study addresses a critical defect rate averaging 10% (exceeding the 5% corporate limit) in returned Limiting and Measuring Devices (APP) at PT PLN (Persero) UP3 Indramayu. An integrative framework combining Quality Control (QC) tools and a Mixed-Method Warehouse Layout Redesign was developed to analysed defect root causes and eliminate material degradation. Defect prioritization via Pareto analysis and process capability assessment revealed that cable breakage (65.16%, 2.03 Sigma) and MCB casing damage (21.30%, 2.73 Sigma) were the primary defect contributors, performing significantly below industrial benchmarks. Root-cause identification using 5 Whys Analysis confirmed that floor stacking, static load overload, unstandardized handling, and mixed-storage practices directly accelerated physical damage. To resolve these issues, a mixed-method layout combining Dedicated Storage principles and a U-Shaped material flow was engineered. The proposed design features three-level heavy-duty racking, dedicated vertical space allocation, and a three-tier color-coded visual management system (Yellow for Receiving/Inspection, Green for Usable Main Storage, and Red for Scrap Isolation). This restructured flow enforces a strict First-In, First-Out (FIFO) mechanism, eliminates cross-movement, and mitigates material damage risk during reverse handling. The integrated approach provides a scalable practical framework for utility companies to optimize reverse logistics operations, reduce rework costs, and maintain inventory integrity.

Keywords : Dedicated Storage; Process Capability; Quality Control Tools; Return-Material Management; U-Shaped Layout

INTRODUCTION

PT PLN (Persero) is Indonesia's state-owned electricity utility, responsible for the entire electricity supply chain, from power generation to distribution to end users. PT PLN (Persero) UP3 Indramayu is one of PLN's operational units responsible for electricity distribution in part of West Java Province. Among its operational duties, UP3 Indramayu manages the circulation of Limiting and Measuring Devices (APP) devices, commonly known as kWh meters, which measure and limit the amount of electrical energy delivered to residential, office, and commercial customers.

To maintain the quality of APP products delivered to customers, the company closely monitors the defect rate of returned units. Preliminary data collected from August to December 2025 show that returned-product defects reached an average of 10%, exceeding the company's internal tolerance limit of 5%. This condition indicates an underlying weakness in the existing quality-control and material-handling system.

The dominant defect categories found in the returned APP units are broken cable, damaged MCB, kWh error, and cracked meter body. The high volume of damaged components disrupts the smoothness of material flow in the storage area and increases the risk of unidentified material accumulating in the warehouse. This condition narrows the available

storage space and interferes with effective item placement. If the underlying causes of the defects are not properly analysed and addressed, material accumulation is likely to continue, potentially eroding customer confidence in product reliability and increasing rework costs for the company.

Existing literature on facility layout design predominantly focuses on forward logistics environments (Silitonga & Nicholas, 2026), such as finished-goods distribution centres (A. S. Rahayu & Suprayitno, 2023), where material inflow is structured, predictable, and demand-driven (Faustina et al., 2022; Isnaini et al., 2025). Conversely, return-material facilities particularly in the electrical utility sector face unstructured inflows, high uncertainty in item physical conditions, and severe risks of mixed-storage contamination (Ambilkar et al., 2022). Although prior studies have extensively investigated quality enhancement through Six Sigma frameworks (Oxamudra et al., 2025; Rofiq, 2025) and facility layout optimization using mathematical algorithms (Erlangga et al., 2024; Moligay & Oktiarso, 2022), in isolation, there is a distinct lack of research integrating quantitative process capability metrics (DPMO and Sigma levels) with root-cause analysis directly into physical layout redesign within reverse logistics operational contexts (Aflah et al., 2025). To bridge this gap, this study proposes an integrative framework combining Quality Control Tools with a Mixed Method Layout approach (Dedicated Storage and U-Shaped Layout). This research aims to evaluate the process capability and identify root causes of returned APP device defects, and design an optimized return-material warehouse layout to minimize material degradation at PT PLN (Persero) UP3 Indramayu.

METHOD

This research was conducted at PT PLN (Persero) UP3 Indramayu. Data collection and field observation were focused on the August–December 2025 period to analyze the trend of APP product defects during that time. The object of the study is the APP unit managed by the company, with the main observation directed at four defect categories: MCB damage, cable breakage, kWh error, and cracked meter body.

The research procedure consists of four stages. The first stage is problem identification, based on the operational condition at PT PLN (Persero) UP3 Indramayu where the average defect rate of 10% exceeds the 5% company threshold. The second stage is data collection and a literature study covering shipment volume, defect type, defect percentage, APP product specifications, and reference theories on product quality, 5 Whys, warehouse layout, dedicated storage, and U-shaped layout. The third stage is data processing, consisting of 5 Whys analysis to uncover the root causes of product damage and Mixed Method layout design to produce an efficient, safe, and well-organized warehouse. The final stage is drawing conclusions and formulating practical recommendations expected to help UP3 Indramayu management reduce rework costs, minimize material waste, and optimize inventory arrangement in the warehouse.

Data Collection

Two main data sources were used. Secondary data included the monthly shipment volume of APP products, the volume of returned products by defect category, and the resulting defect percentage relative to shipment volume. Primary data were obtained through direct

observation of the material-return inspection process in the warehouse, identification of the physical condition of returned products, and a structured interview with the warehouse supervisor of UP3 Indramayu regarding sorting procedures, rack facilities, handling equipment, staff compliance with standard operating procedures, and the condition of returned material upon receipt.

Data Analysis Framework

The analytical process followed a systematic four-stage quality-and-layout improvement framework:

Process Capability and Defect Prioritization

The defect opportunities were defined using the SIPOC diagram. Defect categories were prioritized using Pareto analysis based on the 80/20 rule. Process capability was quantified using Defects Per Million Opportunities (DPMO), assuming a defect opportunity (O) of 1 per returned unit, as expressed in Equation (1).

$$DPMO = \frac{D}{U \times O} \times 1.000.000 \quad (1)$$

where D represents the total number of observed defects, U denotes the total volume of units processed, and O is the number of defect opportunities per unit.

Root-Cause Analysis

Dominant defects were evaluated using Fishbone Diagrams across five factors (Man, Method, Material, Machine, Environment) and further interrogated using 5 Whys Analysis (Kumah et al., 2024; Y. S. Rahayu & Rachmawati, 2025).

Layout Redesign (Mixed Method)

The layout redesign integrated Dedicated Storage principles (fixed-location assignment based on item dimensions and throughput) and a U-Shaped Layout configuration (unidirectional flow sharing adjacent receiving and shipping docks) (Diwangkoro, 2025; Himawan & Ernawati, 2023; Yulia & Miharja, 2025).

Operational Control

The 5S methodology (Seiri, Seiton, Seiso, Seiketsu, Shitsuke) was structured via visual management, audit checklists, and daily monitoring logs (Dewy et al., 2023).

RESULTS AND DISCUSSION

Return Product Data

PT PLN (Persero) UP3 Indramayu manages three main APP-related materials that are frequently found among returned products: the Miniature Circuit Breaker (MCB), an electromechanical device that protects electrical circuits from overcurrent and short-circuit conditions; the Twisted Insulated Cable (TIC) 2x10 mm, consisting of aluminum conductors individually wrapped in thermoplastic insulation and twisted together, widely used in low-voltage distribution networks; and the single-phase postpaid kWh meter, the most common energy-measurement device for small- to medium-power household customers.

Return-product data for the August–December 2025 period are presented in Table 1. The data show that the monthly defect percentage exceeded the company's 5% tolerance threshold in every month observed, ranging from 8% to 12%, with cable breakage consistently the most dominant defect category, followed by MCB damage.

Table 1 Return product data for APP units (Aug–Dec 2025)

Month	MCB Damage	Cable Breakage	kWh Error	Meter Body Crack	Total Return	Defect (%)
August	290	575	97	71	1,033	10%
September	200	650	110	50	1,010	8%
October	175	800	89	63	1,127	12%
November	230	720	75	58	1,083	9%
December	280	850	66	68	1,264	11%

Defect Prioritization and Process Capability Analysis

Data collected between August and December 2025 (Table 1) revealed an overall defect rate ranging from 8% to 12%, consistently exceeding the corporate tolerance limit of 5%. As summarized in Table 2, analysis identified Broken Cable as the primary contributor to total defects, accounting for 65.16% (cumulative 86.46%), followed by Damaged MCB (21.30%).

Table 2 Defect Distribution and Sigma Level Calculation (Aug–Dec 2025)

Defect Category	Total Defect (Units)	Shipment Volume	Defect %	DPU	DPMO	Sigma Level
Broken Cable	3,595	12,400	65.16%	0.2899	289,919.35	2.03
Damaged MCB	1,175	10,800	21.30%	0.1087	108,796.29	2.73
kWh Error	437	9,200	7.92%	0.0475	47,500.00	3.17
Cracked Body	310	12,300	5.62%	0.0252	25,203.25	3.45

The baseline Sigma level for Broken Cable was calculated at 2.03, significantly below the national industrial benchmark in Indonesia (3.5 – 4.0 Sigma). This performance gap confirmed that cable breakage and MCB casing damage required immediate structural intervention.

Root Cause Analysis Using 5 Whys

The interview with the warehouse supervisor of UP3 Indramayu revealed several recurring operational issues. No specific sorting SOP is available, causing new and returned items to accumulate together in mixed storage and creating difficulty during the picking process. The warehouse is already overloaded and lacks sufficient heavy-duty racking, forcing staff to stack materials directly on the floor, which produces excessive static load and leads to cracked or broken items. Handling equipment such as trolleys and forklifts is old and manually operated, and staff often work hurriedly, increasing the risk of collision during material movement. A surge in vendor orders further increases workload and reduces staff attentiveness to unloading and loading procedures. In addition, MCB units returned from customer sites are frequently already brittle due to prolonged exposure to alternating heat and

rain, making the casing prone to cracking during unloading, while cables exposed to the same conditions show peeling insulation and connector corrosion. Based on these findings, 5 Whys Analysis was applied to the two dominant defect categories, cable breakage and MCB damage, as summarized in Table 3.

Table 3 Five Whys analysis of cable breakage and MCB damage

Analysis Level	Problem 1: Cable Breakage	Problem 2: MCB Damage
Problem statement	Why does cable breakage occur?	Why is cracked or broken casing found on the MCB?
Why 1	Corrosion at connection points and degradation of the insulation layer.	Excessive static load pressing on the material during storage.
Why 2	Use of worn connectors and exposure to extreme weather.	Materials are stacked irregularly in large quantities directly on the floor, inside and outside the warehouse.
Why 3	Improper installation technique by staff and non-standard material handling.	Absence of adequate storage racks, such as heavy-duty racking, for vertical arrangement.
Why 4	Minimal supervision from team leaders and no strict quality gate or inspection.	Continued practice of mixed storage that combines new and returned material without separation.
Why 5	No periodic technical training and no integrated work checklist system.	No standardized warehouse layout and no established visual zoning management.

Proposed Mixed-Method Warehouse Layout Design

To address the root causes identified (floor stacking, static overload, and mixed storage), a new layout was engineered using heavy-duty racking and a U-Shaped unidirectional flow. The storage rack was designed based on capacity requirements and operational ergonomic standards. The multi-level heavy-duty rack is optimized to accommodate large cable rolls, MCB units, and kWh meters. Table 4 presents the technical dimensions derived from anthropometric calculation, handling-equipment reach, and work-safety considerations.

Table 4 Technical Specifications and Capacity Allocation of Proposed Racking System

Parameter	Technical Specification	Functional Allocation
Overall Rack Dimensions	Height: 600 cm; Length: 3,000 cm (5 bays); Width: 140–150 cm	Heavy-Duty Structural Steel Frame
Level 1 (Bottom)	Height clearance: 268.5 cm	Holds up to 60 large wooden cable spools (110–150 cm diameter) across 3 rack lines

Level 2 (Middle)	Height clearance: 166.7 cm	Holds up to 50 MCB & kWh meter units (ergonomic picking height)
Level 3 (Top)	Height clearance: 133.3 cm	Holds up to 50 MCB units and lighter auxiliary return items
Rack type	Heavy-duty racking system	
Frame material	Structural steel with anti-corrosion coating	

The lifting equipment was selected to match the rack specification, particularly the 600 cm total height and 140–150 cm rack width. A reach truck (three-stage mast) with a lifting capacity of 1,500–2,000 kg and a maximum lifting height of 6.5–7 m was selected because it can reach Level 3 with adequate clearance while requiring a narrower aisle width (approximately 2.7–3.2 m) than a counterbalance forklift, which fits the tighter aisle configuration of the U-Shaped layout. A 2-ton counterbalance forklift remains a more economical alternative, at the cost of a wider minimum aisle requirement of approximately 3.5–4 m.



Figure 1 Proposed warehouse layout integrating dedicated storage and U-shaped material flow

Storage capacity was calculated by multiplying material dimensions by bay length and the number of available rack rows, as summarized in Table 5.

Table 5 Storage capacity of cable rolls (Level 1) and MCB / kWh meters (Levels 2–3)

Description	Quantity	Notes
Cable rolls per modular bay (6 m)	4 rolls	Diameter 110–150 cm
Cable rolls per rack row (5 bays)	20 rolls	Large cable rolls
Cable rolls per warehouse (3 rack rows)	60 rolls	Total Level 1 capacity
MCB per rack bay	5 units	Placed on Levels 2 and 3
MCB per rack row (5 bays, 2 levels)	50 units	Combined Levels 2 and 3

MCB total (2 full rack rows)	100 units	Maximum MCB capacity
kWh meter per rack bay	5–8 units	Arranged along rack depth
Maximum safe stacking	4 units high	To prevent falling and damage

Storage Zone Division and FIFO Flow Mechanism

The warehouse redesign integrates dedicated-storage principles with the U-Shaped Layout concept to produce a clear, structured zoning system, in which every zone has a specific function within the return-material flow, from receiving and inspection to storage and isolation of defective items. Colour-based zoning facilitates visual identification and ensures that material is handled according to its status and condition, as summarized in Table 6

Table 6 Storage zone division (Dedicated Storage + U-Shape)

Zone	Colour	Function	Material / Items
Receiving zone	Yellow	Initial area where returned material is received and inspected	All returned material from the field
Main storage zone	Green	Storage of usable material on heavy-duty racks	Usable MCB, usable cable, kWh meters
Isolation zone	Red	Separate storage for fully defective material	Totally damaged MCB, broken cable, kWh error units

This design is consistent with the reverse-logistics literature, which emphasizes that warehouse layouts handling material inflow of variable quality must integrate efficient sorting and staging activities into the overall flow design.

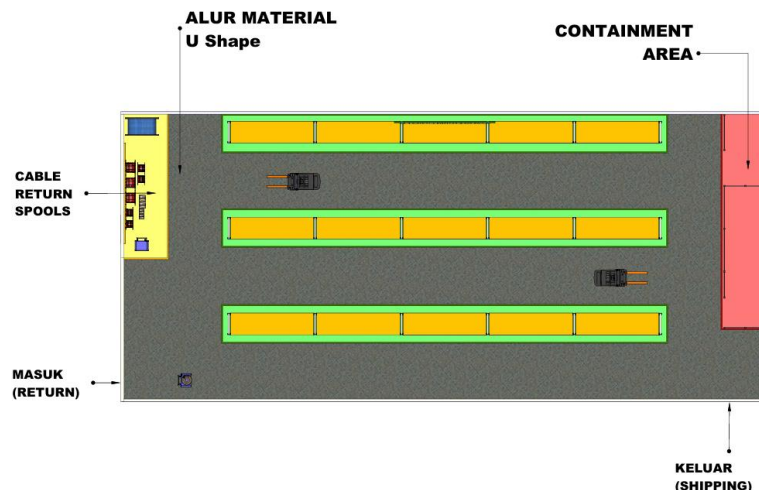


Figure 2 Proposed U-shaped layout supporting a First in First Out (FIFO) material flow

The rack positions are arranged parallel to the direction of the U-shaped flow to fully support the FIFO mechanism. Material is arranged sequentially by arrival date, and material that arrives earlier is placed at the front of the flow so that it is redistributed first. This mechanism prevents material from remaining in the warehouse for an extended period, thereby reducing the risk of quality degradation caused by prolonged environmental exposure. The material flow can be described in three stages. Receiving and sorting takes place in the Yellow Zone, located near the entrance, where incoming return material undergoes sorting and inspection before being moved to the main stock area; this placement ensures that returned material is never merged with existing stock without prior inspection, eliminating the risk of usable and damaged items becoming mixed. Material declared usable is then moved to the Green Zone, which uses multi-level heavy-duty racking to distribute static load evenly, removing the excessive physical pressure on cables that had previously been a major cause of cable breakage. Material declared fully defective is placed in the isolated Red Zone, preventing damaged material from accumulating in the main storage area and disturbing overall warehouse efficiency.

Visual management is enforced through three distinct operational colour zones:

1. Yellow Zone (Receiving & Inspection): Dedicated to initial unloading, sorting, and Quality Gate verification upon arrival from field units.
2. Green Zone (Main Storage): Dedicated to reusable/repaired APP materials arranged in fixed dedicated rack positions managed under First-In, First-Out (FIFO) movement.
3. Red Zone (Isolation Area): Securely isolates scrap or non-repairable materials to prevent accidental mixing with usable inventory.

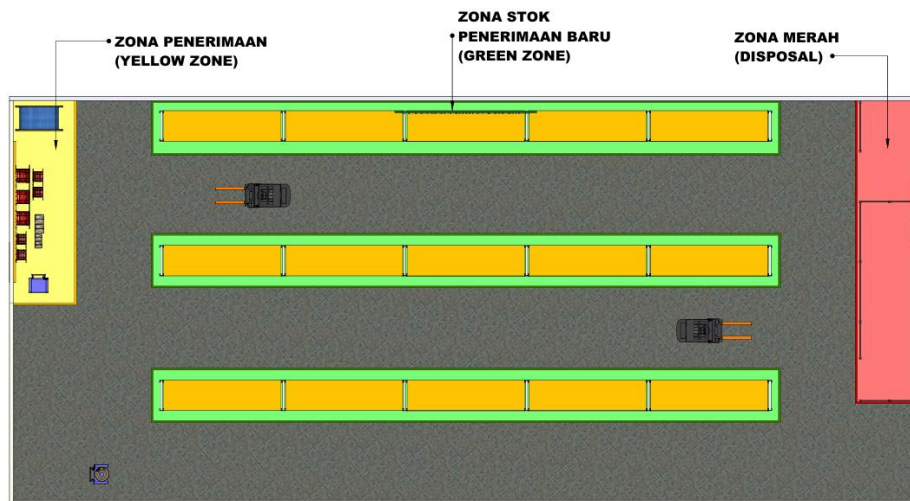


Figure 3 Color-coded warehouse zone division

By synthesizing dedicated storage principles with a U-shaped material flow into a unified design framework, the proposed layout systematically mitigates the operational risks associated with chaotic return handling. This empirical integration aligns with the theoretical

assertions of (Ambilkar et al., 2022), demonstrating that structured visual zoning and unidirectional routing significantly reduce material degradation caused by static load overcapacity and cross-contamination in reverse logistics environments. Assigning a fixed, dedicated location within the U-shaped flow effectively prevents overcapacity and mixed-storage conditions, which had been the underlying cause of physical material damage in the UP3 Indramayu warehouse.

CONCLUSIONS

The 5 Whys analysis of returned APP products at PT PLN (Persero) UP3 Indramayu shows that the root cause of material damage, particularly cable breakage and MCB damage, is the absence of a structured warehouse arrangement system, characterized by the lack of a sorting SOP, insufficient heavy-duty racking, aging handling equipment, and unregulated mixed-storage practices. As a solution, a proposed warehouse layout was designed using a Mixed Method approach that integrates Dedicated Storage and U-Shaped Layout principles. The design applies a single, unidirectional material flow that eliminates cross-movement and reduces the risk of material collision, supported by color-coded visual zoning that clearly divides the warehouse into a Yellow Zone for sorting and inspection, a Green Zone for storing usable material on vertical heavy-duty racks, and a Red Zone for isolating damaged material to prevent mixed storage. A FIFO mechanism was also applied to maintain healthy stock rotation and minimize the risk of quality degradation caused by stagnant stock. Future research is recommended to apply Failure Mode and Effect Analysis (FMEA) to weight component-failure risk through the Risk Priority Number, enabling a more precise prioritization of handling measures. A Kaizen-based improvement approach covering the Man, Method, Material, and Environment factors could also be explored to reduce defect rates in production and material handling on a continuous basis, alongside a Lean Warehousing approach supported by Value Stream Mapping to identify and reduce non-value-adding activities in overall warehouse operations.

REFERENCES

- Aflah, R. M., Pulansari, F., & Nugraha, I. (2025). Analisis Aliran Reverse Logistics Pada Industri Perlengkapan Medis Untuk Meminimalisir Biaya Retur Produk. *JISI: Jurnal Integrasi Sistem Industri*, 12(2), 199–210. <https://doi.org/10.24853/jisi.12.2.199-210>
- Ambilkar, P., Dohale, V., Gunasekaran, A., & Biloliar, V. (2022). Product Returns Management: A Comprehensive Review And Future Research Agenda. *International Journal Of Production Research*, 60(12), 3920–3944. <https://doi.org/10.1080/00207543.2021.1933645>
- Dewy, C. K., Dewanti, D. W., & Farhan, M. (2023). Implementasi Metode 5 S Pada Unit Logistics PT XYZ. *Jurnal Ilmiah Teknologi Infomasi Terapan*, 9(2). <https://doi.org/10.33197/jitter.vol9.iss2.2023.996>
- Diwangkoro, T. G. (2025). Analisis Kapasitas Gudang Menggunakan Metode Dedicated Storage Dan Shared Storage Di PT Soka Cipta Niaga. *Jurnal Logic: Logistics & Supply Chain Center*, 3(2), 50–58. <https://doi.org/10.33197/jlsc.v3i2.2487>
- Erlangga, E., Zaki, M. R., Hermawan, R. C., & Fauzi, M. (2024). Optimalisasi Lokasi Gudang

- Menggunakan Metode Center Of Gravity Pada PT ABC. *Jurnal LOGIC (Logistics & Supply Chain Center)*, 3(1), 1–8. <https://doi.org/10.33197/Jlsc.V3i1.2099>
- Faustina, I., Oktiarso, T., & Ekawati, Y. (2022). Usulan Rancangan Tata Letak Fasilitas Produksi Di PT NS Bluescope Lysaght Indonesia. *Jurnal Teknik Industri UMC*, 2(2). <https://doi.org/10.33479/Jtiumc.V2i2.30>
- Himawan, D. T., & Ernawati, D. (2023). Minimasi Jarak Tempuh Aktivitas Pergudangan Dengan Metode Dedicated Storage (Studi Kasus: Perusahaan FMCG Kosmetik). *Jurnal Teknik Mesin, Industri, Elektro Dan Informatika*, 2(2), 245–256. <https://doi.org/10.55606/Jtmei.V2i2.1923>
- Isnaini, W., Masrurroh, N. A., & Dharma, I. B. (2025). Dynamic Planning Approach Of Facility Layout From Industry Perspectives: A Systematic Literature Review. *Production Engineering Archives*, 31(1), 27–40. <https://doi.org/10.30657/Pea.2025.31.3>
- Kumah, A., Nwogu, C. N., Issah, A.-R., Obot, E., Kanamitie, D. T., Sifa, J. S., & Aidoo, L. A. (2024). Cause-And-Effect (Fishbone) Diagram: A Tool For Generating And Organizing Quality Improvement Ideas. *Global Journal On Quality And Safety In Healthcare*, 7(2), 85–87. <https://doi.org/10.36401/JQSH-23-42>
- Moligay, O. R. X., & Oktiarso, T. (2022). Perancangan Layout Dan Biaya Material Handling Menggunakan Metode Computerized Relationship Layout Planning (CORELAP) Pada Fasilitas Produksi PT SASL And SONS Indonesia. *Jurnal Teknik Industri UMC*, 1(1), 47–58. <https://doi.org/10.33479/Jtiumc.V1i1.5>
- Oxamudra, L., Noya, S., Ekawati, Y., Putrianto, N. K., Oktiarso, T., & Purnomo, P. (2025). Quality Improvement Of X Brand Tube Packaging PT XYZ Using The Six Sigma Method And Failure Mode And Effect Analysis (FMEA). *Jurnal Sains Dan Aplikasi Keilmuan Teknik Industri (SAKTI)*, 5(02), 111–122. <https://doi.org/10.33479/Sakti.V5i02.167>
- Rahayu, A. S., & Suprayitno, D. (2023). The Effectiveness Of The Dedicated Storage Method On Building Layout At PT Puninar Anji Kyk Logistik Indonesia. *Sinergi International Journal Of Logistics*, 1(1), 1–16. <https://doi.org/10.61194/Sijl.V1i1.11>
- Rahayu, Y. S., & Rachmawati, F. (2025). Root Cause Analysis Of Delays In The XYZ Toll Road Design And Construction Project Using The RCA Method. *Journal Of Management Economic And Financial*, 3(6), 5694–5706. <https://doi.org/10.59261/Jmef.V3i6.181>
- Rofiq, M. F. I. (2025). Analisis Kualitas Produk Outsole Rubber Dengan Pendekatan DMAIC Di PT XYZ. *Jurnal Logic: Logistics & Supply Chain Center*, 4(1), 31–40. <https://doi.org/10.33197/Jlsc.V4i1.3063>
- Silitonga, R. Y. H., & Nicholas, N. (2026). Redesign Of The Layout Of An Integrated Logistics Facility Using Systematic Layout Planning At KALOG Express Cirebon Prujakan. *Journal Of Integrated System*, 9(1), 89–105. <https://doi.org/10.28932/Jis.V9i1.15669>
- Yulia, S., & Miharja, R. (2025). Analisis Perancangan Tata Letak Gudang Bahan Baku Menggunakan Metode Dedicated Storage Pada PT. XYZ. *JSMA (Jurnal Sains Manajemen Dan Akuntansi)*, 17(1), 71–88. <https://doi.org/10.37151/Jsma.V17i1.230>