ISSN: 2096-3246
Volume 58, Issue 04, 2026

COST-OBJECT-DRIVEN CROSS-DOCKING IN EXTENDED WAREHOUSE MANAGEMENT: A MOBILE-INTEGRATED ARCHITECTURE FOR NON-STOCK MATERIAL EXECUTION IN INDUSTRIAL MAINTENANCE ENVIRONMENTS

Praveen Kumar Yeruva
Independent Researcher, USA

Abstract
Industrial maintenance facilities managing large non-stock material portfolios face a persistent architectural gap: standard Extended Warehouse Management (EWM) cross-docking does not natively support cost-object allocation -- the direct linkage of inbound materials to Plant Maintenance Orders, Network Orders, Work Breakdown Structure (WBS) Elements, and Cost Centers at the point of goods receipt. This article presents a mobile-integrated cross-docking architecture that resolves this gap through a nine-variant process model executed via Radio Frequency (RF) handheld technology. A custom process code, a Business Add-In (BADI) for extended table population, and RF-driven warehouse task execution form the three integrated layers of the solution. The architecture eliminates intermediate storage for non-stock materials, compresses order cycle time, and establishes real-time financial accountability across maintenance and project logistics -- contributing to operational agility and to the broader digital transformation of industrial supply chain and asset-management ecosystems.
Keywords: Extended Warehouse Management; cross-docking; cost object; Plant Maintenance Order; non-stock materials; mobile-integrated execution; warehouse process digitization; inbound logistics.

1. Introduction
Warehouse operations at petroleum refineries, chemical terminals, and large-scale industrial project sites process thousands of non-stock material receipts annually, each tied to specific cost objects governing financial accountability within enterprise resource planning (ERP) systems [1]. When inbound parts are not immediately allocated to their cost objects at the point of receipt, they accumulate as unlabeled warehouse stock, inflating working capital and delaying the maintenance activities they were procured to support. Research on cross-docking identifies inventory elimination and order cycle time compression as the two primary mechanisms through which direct transfer strategies generate operational value [1], [14] -- findings directly applicable to industrial maintenance logistics, where non-stock carrying costs compound across hundreds of concurrent work orders.

The structural gap this article addresses is both architectural and practical. Standard EWM cross-docking does not natively support cost-object allocation to Plant Maintenance (PM) Orders, Network Orders, WBS Elements, or Cost Centers, and is absent from certain EWM license configurations entirely. Without a system-supported path from inbound receipt to cost-object consumption in a single transaction chain, facilities default to manual staging and post-hoc allocation -- generating the delays and financial exposure the architecture described here is designed to eliminate [3]. The literature on Industry 4.0 warehouse technologies confirms that digitization gains depend on integrating physical execution with ERP transaction posting, and that mobile execution platforms are the enabling mechanism [4]; yet a formalized, multi-variant process model governing all inbound scenarios under a unified cost-object-driven framework has not previously been documented.

This article argues that a custom cross-docking architecture in EWM -- driven by cost-object determination at goods receipt and executed through mobile RF technology -- constitutes a strategically superior model for industrial non-stock material flows because it unifies logistics execution, financial accountability, and maintenance scheduling into a single, real-time transaction chain. The architecture is formalized as a nine-variant process model covering every inbound scenario at industrial maintenance facilities: stock and non-stock flows, inspection-required variants, kitting requirements, field-drop scenarios, and late-arriving kit components. Sections 2 through 6 present the theoretical framework, process architecture, solution design, performance outcomes, and strategic implications in turn.

AES
ISSN: 2096-3246
Volume 58, Issue 04, 2026

2. Theoretical Framework: Cost-Object Allocation and Mobile Execution as Architectural Imperatives

2.1 Deferring Cost-Object Assignment Creates Structural Carrying Cost Without Operational Justification

In enterprise asset management systems, cost objects -- PM Orders, Network Orders, WBS Elements, and Cost Centers -- are the financial anchors through which material consumption is attributed and reported. The conventional warehouse model defers cost-object assignment to the goods issue step, after materials traverse a full receive-store-pick-issue cycle [6]. For stock materials held against uncertain future demand, this deferral is operationally justified. For non-stock materials procured against known, active work orders, it is not: the cost object is determined at purchase order creation, making intermediate storage a pure carrying cost with no information value. Research on spare parts management data models demonstrates that consolidating maintenance, logistics, and inventory data into a unified structure measurably reduces reconciliation overhead and improves maintenance execution responsiveness [7] -- evidence that cost-object linkage at the point of receipt is the architectural principle enabling real-time accountability. Table 1 summarizes the capability gap between standard and cost-object-driven approaches across eight operational dimensions, demonstrating that standard EWM lacks four of the eight capabilities essential to industrial maintenance environments.

Table 1: Standard EWM Cross-Docking vs. Cost-Object-Driven Architecture. Source: Author's own analysis; synthesized from [1], [3], [7].

Capability Dimension	Standard EWM Cross-Docking	Cost-Object-Driven Architecture
Cost-object allocation at GR	Not supported natively	PM Order, Network, WBS, Cost Center linked at receipt
Non-stock material routing	Manual staging to general bins	Automated via process code Z005 to OUTB-GI Zone
Inspection variant support	Generic QM integration only	9-variant model with OK/QUAR routing at usage decision
Kitting BADI traceability	Not available	/SCWM/AQUA extended fields populated at put-away confirmation
Mobile RF execution	Optional add-on	Core interface -- GR, WT creation, GI posting on device
Field-drop paperwork GR	Unsupported	Variant 7: paperwork receipt triggers cost-object GI posting
Late-arrival kitted parts	Manual exception handling	Variants 8 and 9: immediate cross-dock to OUTB-GI Zone
Financial audit traceability	Post-hoc period-end reconciliation	Real-time linkage from inbound delivery to consumption posting

Three cost-object categories govern the architecture, each with distinct traceability requirements. PM Orders demand urgent, precisely timed material availability tied to maintenance windows. Network Orders require materials allocated to specific project activities within approved scope. WBS Elements track consumption against budget lines at each level of a capital project hierarchy. Assigning materials to these objects at goods receipt converts the inbound transaction from a logistics milestone into a simultaneous financial posting, eliminating the period-end reconciliation that conventional non-stock flows systematically require [3]. This conversion is the architectural principle that drives all three technical layers of the solution -- the process code, the BADI, and the RF execution interface -- each of which is designed to make cost-object registration an inevitable consequence of correct physical execution rather than a separate downstream activity.

2.2 Mobile RF Execution Closes the Gap Between Physical Movement and Financial Posting

Cost-object determination at goods receipt is architecturally sound but operationally inert without the execution interface that delivers it. Research on robust and real-time cross-docking models identifies execution latency -- the gap between physical dock activity and system transaction -- as the primary source of scheduling unreliability in cross-docking environments [5]. This finding establishes that the

ISSN: 2096-3246
Volume 58, Issue 04, 2026

financial benefits of cross-docking are only fully realized when physical execution and ERP posting occur in the same transaction, at the same location, at the time of the physical event. A systematic review of Industry 4.0 warehouse technologies identifies real-time data availability and digital process integration as the two most consistently reported operational benefits of mobile execution platforms [4] -- confirming that the RF layer is a structural requirement, not a peripheral convenience. Bibliometric analysis of smart warehouse research further identifies ERP integration and mobile execution as the two highest-productivity research clusters in the field [9], positioning this architecture at their convergence and within an established scholarly tradition rather than at an experimental frontier. Section 3 details how this positioning is operationalized across nine inbound material variants.

3. The Nine-Variant Process Model: A Complete Taxonomy of Industrial Maintenance Inbound Flows

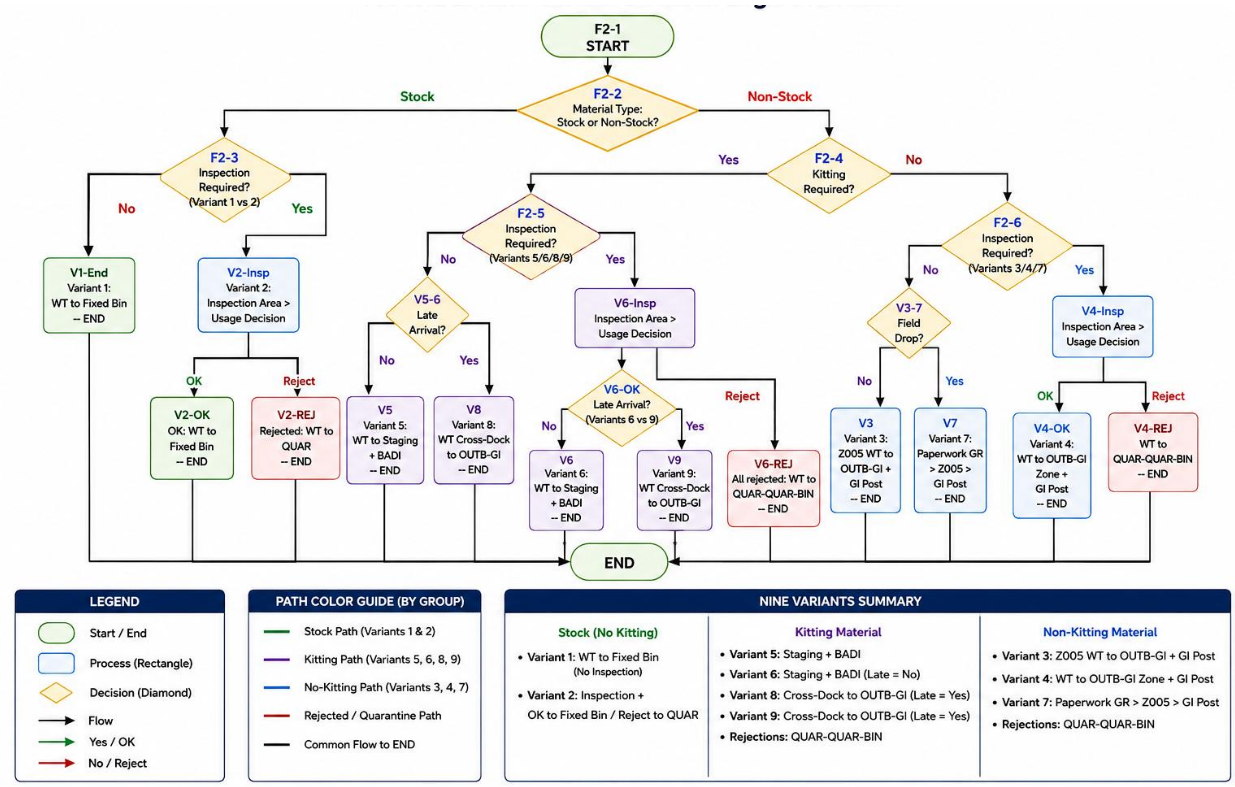

Figure 1 -- Nine-Variant Decision Logic Flowchart -- client-provided or model-generated flowchart -- insert after Section 3 opening]

Table 2: Nine-Variant Process Classification Matrix. Source: Author's own analysis.

Variant	Material Category	Kitting	Inspection	Destination Zone	Process Code	BADI
1	Stock (ERSA, UNBW)	No	No	Fixed Bin	Standard	No
2	Stock with QM flag (MARC-QMATV =X)	No	Yes	Fixed Bin / QUAR	Standard	No

ISSN: 2096-3246
Volume 58, Issue 04, 2026

3	Non-stock, no kitting	No	No	OUTB-GI Zone	Z005	No
4	Non-stock, no kitting	No	Yes	OUTB-GI Zone / QUAR	Z005	No
5	Non-stock with kitting	Yes	No	Staging by Cost Object	Z005	Yes
6	Non-stock with kitting	Yes	Yes	Staging / QUAR-QUAR-BIN	Z005	Yes
7	Non-stock, field drop (oversized)	No	No	OUTB-GI Zone (paperwork)	Z005	No
8	Non-stock kitted, late arrival	Yes	No	OUTB-GI Zone	Z005	No
9	Non-stock kitted, late arrival	Yes	Yes	OUTB-GI Zone / QUAR-QUAR-BIN	Z005	No

3.1 Stock Variants 1 and 2 Establish the Baseline and the Inspection Logic

Variants 1 and 2 govern stock materials -- primarily types ERSA (spare parts) and UNBW (non-valuated materials) -- and define the operational baseline against which all non-stock variants are analytically contrasted. Upon goods receipt, a warehouse task (WT) is created to move materials from the Receiving zone to the designated fixed bin [6]. This is the correct process for materials held against uncertain future demand; the fixed bin assignment and inventory management cycle are justified by the inability to predict, at receipt, which work order will consume the part. Variant 2 introduces the quality inspection gate that recurs across four of the nine variants: materials flagged with the indicator MARC-QMATV=X are directed to the inspection area at goods receipt, with approved quantities put away to fixed bins and rejected quantities routed to the QUAR zone for return or scrap processing after the usage decision [2]. Two architectural principles embedded here carry through to all inspection variants: the quality gate is an embedded decision point within the warehouse task sequence rather than an exception bypass, and the quarantine bin QUAR-QUAR-BIN is the universal terminal destination for all rejected quantities -- ensuring consistent disposition traceability across every scenario and vendor return scenario regardless of variant complexity.

3.2 Non-Stock Variants 3, 4, and 7: The Core Cross-Docking Path Without Kitting

Variant 3 define the foundational cross-docking execution path. Upon goods receipt on the RF device, process code Z005 is invoked, triggering cost-object determination from the purchase order account assignment and creating a WT to the OUTB-GI Zone. The operator confirms the task on the device; the system posts goods issue in S/4HANA, fetches the outbound delivery, creates a pick WT, and executes Post Goods Issue at physical pickup -- without returning to a workstation [3]. This chained sequence achieves same-day delivery by making goods issue posting a consequence of physical dock activity rather than a separate back-office step. Variant 4 adds the inspection gate: approved quantity proceeds to the OUTB-GI Zone via Z005, while rejected quantity follows the quarantine path to

QUAR-QUAR-BIN -- embedding quality traceability within the cross-docking flow even for urgent deliveries [2]. Variant 7 addresses oversized field-drop parts that never physically enter the warehouse: the RF operator processes a paperwork-only goods receipt, invoking Z005 to post goods issue to the cost object based on shipping documentation [3]. This variant closes a financial accountability gap that conventional processes leave open -- capturing field deliveries in real time with the same cost-object precision as standard dock receipts and preventing the period-end posting deficiencies that characterize untracked field deliveries.

3.3 Kitting Variants 5, 6, 8, and 9: Staging, BADI Traceability, and Late-Arrival Logic

Kitting variants require temporary staging by cost object rather than immediate cross-docking, introducing the highest architectural complexity. Variant 5 governs non-stock kitting materials without inspection: upon goods receipt, the RF operator creates a WT directing material to a Staging bin designated by cost object. At put-away confirmation, the BADI fires automatically, populating PM Order number, Network Order, WBS Element, or Cost Center into custom enhancement fields of the /SCWM/AQUA extended table [3]. This atomic population converts the put-away event from a physical transaction into a simultaneous financial registration, preserving cost-object linkage through the staging period without a separate posting step. Variant 6 adds inspection to the kitting path, following the same approval and quarantine logic as variant 2. Variants 8 and 9 handle late-arriving components -- including parts identified as needed during equipment dismantling after a kit has already been delivered. Because the kit has departed, these parts cannot be staged; they are cross-docked immediately to the OUTB-GI Zone (variant 8 without inspection, variant 9 with), with cost-object linkage carried by the goods issue posting rather than the BADI. The nine-variant model provides complete coverage: every inbound scenario terminates in either a confirmed cost-object goods issue or a defined quarantine disposition, with no ambiguous intermediate state remaining.

4. Solution Architecture: Three Integrated Technical Layers

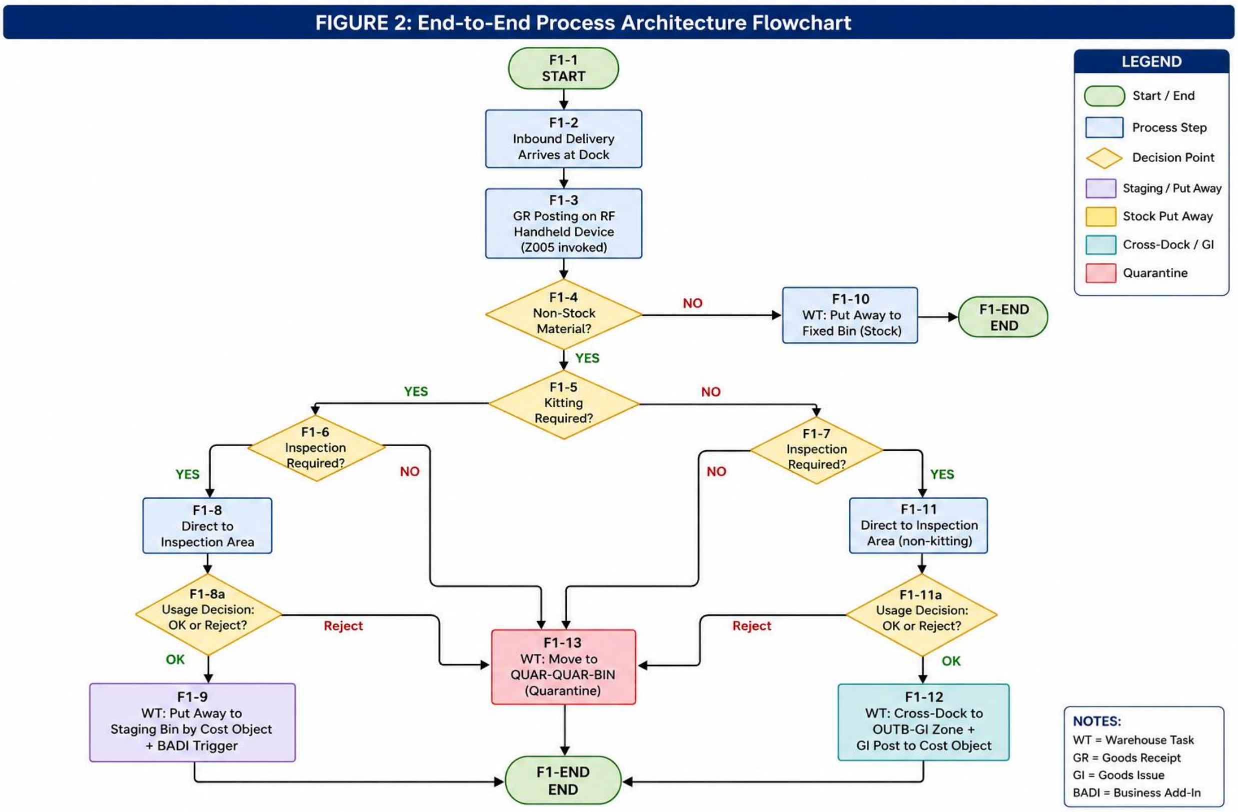

Figure 2 -- End-to-End Process Architecture Flowchart -- client-provided or model-generated flowchart -- insert after Section 4 opening]

4.1 Process Code Z005 and Activity Area Configuration: Routing Each Variant Correctly

Process code Z005 is the EWM configuration element that differentiates non-stock cross-docking from standard put-away at the RF execution level. It determines WT types generated, activity areas involved, and system events triggered at each step [6]. Three warehouse activity areas underpin the architecture: Receiving, OUTB-GI Zone (for cross-docked materials), and Staging (for kitted materials by cost object). The EWM-S/4HANA interface synchronizes WT confirmations with financial postings in real time: when the operator confirms a WT in the OUTB-GI Zone, goods issue posts automatically in S/4HANA, updating the material ledger, reducing the purchase order open quantity, and debiting the cost object [3]. Research on integrated cross-dock planning confirms that synchronization between physical confirmation and ERP posting is the defining characteristic of high-performance cross-docking implementations, distinguishing them from physically accelerated but financially lagged alternatives [3]. The architecture is implemented entirely through custom configuration and BADI development with no modification to standard SAP objects, enabling forward compatibility with future EWM upgrades and reducing the total cost of ownership as facility requirements evolve.

4.2 BADI on /SCWM/AQUA: Atomic Cost-Object Registration at Staging Put-Away

The BADI triggered at put-away confirmation is the traceability mechanism for kitting variants 5 and 6. Standard /SCWM/AQUA warehouse task records carry no financial object references; the BADI populates custom enhancement fields -- PM Order, Network Order, WBS Element, Cost Center -- at the precise moment of put-away confirmation, creating a persistent linkage between staging bin and cost object [3]. Atomicity is architecturally critical: alternative implementations using separate posting steps or batch programs introduce a timing gap during which staged material has a known physical location but an unregistered financial identity, creating misallocation risk when a single staging area holds components for multiple concurrent work orders [7]. The BADI trigger is scoped exclusively to Staging bin destinations, ensuring standard put-away and OUTB-GI Zone processing are unaffected -- a modular design preserving the performance characteristics of all non-kitting variants and minimizing regression risk associated with system upgrades.

4.3 RF Handheld Integration: Converting Process Logic Into Real-Time Field Execution

The RF handheld device chains all four transaction steps -- GR confirmation, cost-object determination, WT creation and confirmation, and goods issue posting -- into a single on-device sequence through the Z005 process code. Research on IoT applications in warehouse management identifies real-time data capture at the point of physical activity as the most significant contributor to inventory accuracy and error reduction across connected warehouse implementations [8]. RF-driven execution eliminates three specific failure modes present in manual processing: transcription errors between physical receipt and system entry; incorrect routing of non-stock materials to fixed bins through operator habit; and omission of the goods issue posting step that is the most frequently delayed element of manual non-stock workflows. For variant 7, the mobile platform extends execution to the field, enabling supervisors to process paperwork-only receipts at the delivery location without returning to the warehouse dock [3]. For inspection variants 2, 4, 6, and 9, the platform supports quality management decision processing within the same RF environment, ensuring the entire nine-variant model is accessible through a single consistent interface -- reducing training overhead and enforcing process code logic uniformly across all operators and scenarios.

5. Performance Outcomes and Operational Implications

5.1 Working Capital Elimination, Cycle Time Compression, and Real-Time Visibility

The primary financial outcome is the elimination of inventory carrying cost for non-stock materials: when parts are cross-docked and goods-issued to cost objects at receipt, they never enter warehouse-managed stock [10]. Cross-docking simulation research demonstrates that optimized direct transfer reduces operational handling costs and increases throughput by eliminating intermediate storage cycles [10], an effect that is proportionally greater in industrial maintenance environments where non-stock parts are frequently high-value and low-frequency -- repairable spares, project components, and specialized maintenance consumables. Order cycle time is compressed from a multi-day staging-allocation-pick-issue sequence to a single RF-driven transaction, enabling same-day goods issue for standard variants and immediate field delivery for variant 7 [5], [14]. Empirical research consistently reports that cycle time reduction is a direct function of execution integration -- the degree to which physical dock activity and ERP posting are synchronized [5], [15]. Table 3 summarizes six outcome dimensions across which the architecture delivers measurable change, with each dimension representing the closure of a specific gap that conventional non-stock processing creates and sustains.

Table 3: Operational Performance Outcomes. Sources: [2], [5], [8], [10], [12], [14].

Outcome Dimension	Baseline Condition	Post-	Supporting

		Implementation State	Evidence
Order cycle time	Multi-day staging and manual GI processing	Same-day or next-day delivery enabled	[2], [5], [14]
Inventory carrying cost	Non-stock held as warehouse stock pending GI	Goods bypass storage -- no carrying cost incurred	[3], [10]
Material visibility	Tracking gap between GR and GI posting	Real-time visibility from receipt to consumption	[8]
Maintenance scheduling	Logistics and PM work orders managed separately	Warehouse tasks synchronized with PM order schedules	[12]
Transaction accuracy	Paper-based WT creation prone to identity errors	RF-driven WT with automated GI posting at confirmation	[8]
Financial accountability	Post-period reconciliation for cost-object attribution	Cost object assigned at GR -- real-time financial linkage	[7], [12]

5.2 Maintenance Scheduling Alignment and Organizational Reporting

When non-stock materials are goods-issued to PM Orders in real time, the maintenance scheduling system receives immediate confirmation of material availability, enabling work order release without the uncertainty of pending allocation [12]. A case study on integrated SAP S/4HANA production planning and warehouse management reports measurable improvement in backlog clearance time and inventory accuracy when EWM and ERP planning systems are coupled through real-time transaction synchronization [12] -- a finding directly applicable here, as the goods issue posting triggered at RF WT confirmation advances PM Order status from material-pending to material-available in S/4HANA without human intervention. The reporting architecture delivers differentiated value to three stakeholder groups: warehouse supervisors gain real-time pipeline visibility across the OUTB-GI Zone, Staging area, and quarantine zone; maintenance supervisors and Reliability engineers gain bin-level material cost allocation at work order level for repair cost analysis and reliability-centered maintenance decisions [7]; and plant controllers gain real-time financial accountability for consumption against PM Orders, Network Orders, and WBS Elements, reducing period-end reconciliation effort. Research on spare parts management data models confirms that integrated, real-time maintenance and logistics data directly reduces administrative burden and improves management decision quality [7] -- reinforcing that the architecture delivers organizational intelligence, not only operational throughput.

6. Strategic Implications and Future Directions

The cost-object-driven cross-docking architecture is significant not only as a solution to a specific EWM configuration gap but as a replicable architectural pattern for industrial maintenance organizations managing large non-stock portfolios against active work orders. The core design principle -- cost-object determination at receipt, RF-executed transaction chaining, and BADI-driven staging traceability -- is applicable across oil and gas, utilities, heavy manufacturing, defense, and capital construction without fundamental redesign, because the nine-variant parameterization accommodates facility-specific material types, inspection requirements, and cost-object structures through configuration rather than custom code [4]. As industrial organizations advance digital transformation programs, the convergence of EWM, Enterprise Asset Management (EAM), and mobile execution platforms is emerging as the defining architectural pattern for maintenance-intensive operations [9]. Future development within this convergence might incorporate predictive maintenance triggers -- where incoming parts receipts advance PM Order schedules based on condition-monitoring data -- or IoT-enabled receiving, where sensor data from inbound logistics platforms initiates EWM goods receipt without manual RF interaction [8]. Both extensions are technically feasible within the architecture described: the BADI structure and process code configuration are explicitly parameterized for expansion without standard SAP object modification.

From a supply chain sustainability perspective, eliminating intermediate storage cycles reduces energy consumption, labor hours, and handling equipment use per material unit processed -- outcomes that research on warehouse management systems and environmental sustainability identifies as primary WMS contributions to sustainability performance [11]. The Order-on-Demand procurement model supported by the architecture further eliminates inventory obsolescence risk, reducing both financial write-offs and the environmental cost of disposing of surplus materials. Research on cross-docking and vendor-managed inventory integration confirms that combined direct transfer strategies deliver compounding cost reductions across the supply chain beyond what either strategy achieves independently [15] -- a convergence effect that industrial maintenance organizations can realize by extending the cost-object-driven model to supplier-side integration in future architecture iterations. The architecture presented here demonstrates that meaningful advances in supply chain digitization are most durably achieved through targeted, integration-driven solutions that close specific execution gaps with architectural precision -- and that the compounding value of such solutions grows over time as execution discipline and data integrity improve with each operational cycle.

7. Conclusion

This article has presented a cost-object-driven cross-docking architecture for Extended Warehouse Management that addresses a structural gap in non-stock material management at industrial maintenance facilities. The nine-variant process model -- implemented through process code Z005, a BADI on the /SCWM/AQUA extended table, and RF handheld execution -- provides comprehensive coverage of all inbound material scenarios, from standard dock receipt through inspection-gated kitting to field-delivered oversized parts. The architecture achieves real-time linkage of physical material movement with cost-object financial posting, eliminating intermediate storage, manual allocation steps, and period-end reconciliation overhead as systemic consequences of architectural design rather than operational discipline. The contribution is structural: it does not accelerate a deficient process but replaces it with one in which correct financial outcomes follow inevitably from correct physical execution.

The operational and organizational outcomes -- elimination of non-stock carrying costs, same-day goods issue to active work orders, real-time material visibility across the inbound pipeline, and maintenance scheduling alignment -- collectively represent a qualitative advancement in the management of industrial maintenance logistics at the intersection of warehouse execution and enterprise asset management. Qualitative improvements in maintenance responsiveness, financial traceability, and sustainability performance are sustained through transaction discipline built into the architecture, not through periodic manual effort. Future research might explore extension to additional cost-object types, integration of predictive maintenance triggers at the goods receipt decision point, and application of the nine-variant framework to non-EWM warehouse environments facing analogous execution gaps -- directions that the configurable, parameter-driven design of this architecture is well positioned to support.

References

1. R. K. Mavi, M. Goh, N. K. Mavi, F. Jie, K. Brown, S. Biermann, and A. A. Khanfar, "Cross-docking: A systematic literature review," Sustainability, vol. 12, no. 11, pp. 4789, 2020. [Online]. Available: https://www.mdpi.com/2071-1050/12/11/4789
2. R. Shahabi-Shahmiri, S. Asian, R. Tavakkoli-Moghaddam, S. M. Mousavi, and M. Rajabzadeh, "A routing and scheduling problem for cross-docking networks with perishable products, heterogeneous vehicles and split delivery," Computers & Industrial Engineering, vol. 157, pp. 107299, 2021. [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/S0360835221002035
3. T. Potoczki, A. Holzapfel, H. Kuhn, and M. Sternbeck, "Integrated cross-dock location and supply mode planning in retail networks," International Journal of Production Economics, vol. 276, pp. 109349, 2024. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0925527324002068

4. L. N. Tikwayo and T. N. D. Mathaba, "Applications of industry 4.0 technologies in warehouse management: A systematic literature review," Logistics, vol. 7, no. 2, pp. 24, 2023. [Online]. Available: https://www.mdpi.com/2305-6290/7/2/24
5. B. Torbali and G. Alpan, "A literature review on robust and real-time models for cross-docking," International Journal of Production Research, vol. 61, no. 7, pp. 2372-2401, 2023. [Online]. Available: https://www.tandfonline.com/doi/abs/10.1080/00207543.2022.2062580
6. A. Khakbaz, H. K. Alfares, A. Amirteimoori, and E. B. Tirkolaee, "A novel cross-docking EOQ-based model to optimize a multi-item multi-supplier multi-retailer inventory management system," Annals of Operations Research, 2024. [Online]. Available: https://link.springer.com/article/10.1007/s10479-023-05790-9
7. Author et al., "An empirical data model for spare parts management: Linking maintenance, logistics, inventory, and equipment data to bridge information silos and reduce data-gathering efforts," Applied Sciences, vol. 16, no. 1, pp. 94, 2026. [Online]. Available: https://www.mdpi.com/2076-3417/16/1/94
8. A. Jarasuniene, K. Ciziuniene, and A. Cereska, "Research on impact of IoT on warehouse management," Sensors, vol. 23, no. 4, pp. 2213, 2023. [Online]. Available: https://www.mdpi.com/1424-8220/23/4/2213
9. S. Tiwari, "Smart warehouse: A bibliometric analysis and future research direction," Sustainable Manufacturing and Service Economics, vol. 2, pp. 100014, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2667344423000063
10. A. Lorenc, "Cross-docking layout optimization in FlexSim software based on cold chain 4PL company," Sustainability, vol. 16, no. 22, pp. 9620, 2024. [Online]. Available: https://www.mdpi.com/2071-1050/16/22/9620
11. D. Minashkina and A. Happonen, "Warehouse management systems for social and environmental sustainability: A systematic literature review and bibliometric analysis," Logistics, vol. 7, no. 3, pp. 40, 2023. [Online]. Available: https://www.mdpi.com/2305-6290/7/3/40
12. K. Chenna, "Integrated SAP S/4HANA production planning with AGI warehouse management system and laboratory information management system," The International Journal of Advanced Manufacturing Technology, 2026. [Online]. Available: https://link.springer.com/article/10.1007/s00170-026-17542-7
13. B. Wisniewska, J. Kluz, and A. Pacana, "Intelligent warehouse in industry 4.0 -- systematic literature review," Sensors, vol. 23, no. 8, pp. 4105, 2023. [Online]. Available: https://www.mdpi.com/1424-8220/23/8/4105
14. Z. Lyu and G. Q. Huang, "Cross-docking based factory logistics unitisation process: An approximate dynamic programming approach," European Journal of Operational Research, vol. 311, no. 1, pp. 56-72, 2023. [Online]. Available: https://www.sciencedirect.com/science/article/abs/pii/S0377221723003144
15. Y. Benrqya, "Impact of combining cross-docking and vendor managed inventory in a retail supply chain," International Journal of Logistics Systems and Management, vol. 42, no. 4, pp. 469-483, 2022. [Online]. Available: https://www.inderscienceonline.com/doi/abs/10.1504/IJLSM.2022.125388