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International Journal of Artificial Intelligence and Machine Learning
Publisher's Home Page: https://www.svedbergopen.com/
Research Paper Open Access

Dynamic Workload Release Orchestration In Enterprise Warehouse Operations: A Configurable EWM-WCS Integration Model For Operation Horizon Control

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Abstract
Uncontrolled release of Warehouse Orders to downstream sorting and picking infrastructure generates lane congestion, sorter throughput loss, and sustained labour overhead in high-velocity distribution environments. This article presents a dual-mode workload release architecture implemented within SAP Extended Warehouse Management (EWM) integrated with a Warehouse Control System (WCS). The architecture introduces an Operation Horizon parameter — a configurable 2–4 hour forward-planning window — as the primary criterion governing which Warehouse Orders are forwarded to the WCS for physical execution. Two release paths are provided: a manual path through a custom WH Monitor node for exception-driven planner control, and an automatic path through a DIVC-triggered batch report for systematic unattended release. All operational parameters are externalised to a maintainable custom control table (ZWORKLOAD_CTRL), enabling warehouse managers to adjust horizon values and release modes without ABAP development involvement. Deployed at a large US healthcare product distributor, the architecture reduced average lane queue depth by 75%, eliminated sorter idle spikes, increased peak-hour picks per operator-hour by 18%, and delivered an annual efficiency gain of USD 650,000 (Author's primary implementation data, 2023). The contribution is a documented design pattern — configurable horizon-gated dual-mode release — applicable to any EWM site with WCS sorter integration, supported by primary enterprise deployment evidence.

1. Introduction

The timing of Warehouse Order release to downstream picking and sorting infrastructure is a control point whose operational consequences are disproportionate to the engineering attention it typically receives. In a distribution warehouse operating a WCS-controlled sorter, releasing the full available WO queue simultaneously creates a surge condition: lane queue depth exceeds physical buffer capacity, the sorter enters idle cycles waiting for lane clearance, and supervisory labour is diverted from value-added exception handling to manual queue management (Quintero, 2023). These effects compound in proportion to order density — the faster orders arrive, the more damaging uncontrolled release becomes.

SAP Extended Warehouse Management provides comprehensive tools for wave creation, Warehouse Order management, and WCS integration via the Decentralised EWM Interface Command (DIVC) framework. Standard wave completion, however, releases all confirmed WOs to the WCS without reference to downstream lane capacity or forward-time constraints. The gap — an absence of native horizon-gating logic in EWM — forces sites to rely on static wave release schedules or informal planner intervention, both of which perform poorly when demand profiles deviate from the schedule assumptions underlying them.

This article documents the design and enterprise deployment of a dual-mode workload release architecture that addresses this gap through an Operation Horizon mechanism: a configurable forward-planning window of 2–4 hours within which WOs must have their estimated pick completion time to be eligible for release. The architecture provides two release paths — a manual WH Monitor node for exception events and an automatic DIVC-triggered batch report for standard operations — governed by a single maintainable control table. The deployment site was a large US healthcare product distributor serving national pharmacy chains and hospital networks, where the architecture delivered measurable throughput and labour efficiency improvements (Clottey, 2025).

The remainder of the article reviews relevant literature (Section 2), characterises the Operation Horizon problem (Section 3), details the dual-mode architecture (Section 4), documents the control table design (Section 5), presents deployment results (Section 6), and provides discussion and conclusions (Sections 7 and 8).

2. Literature Review

Release timing in warehouse operations has been examined primarily through the lens of order batching and wave management policy. Gu, Goetschalckx, and McGinnis (2007) identify order release timing as a key determinant of warehouse throughput, establishing that premature or uncontrolled release of WOs to picking infrastructure generates congestion effects that cascade into downstream processing delays. De Koster, Le-Duc, and Roodbergen (2007) survey picking system design and control, noting that release policies directly govern picker route interference and aisle congestion — dynamics that the Operation Horizon mechanism is specifically designed to prevent.

The order batching literature, reviewed by Henn and Wäscher (2012) for manual systems and extended by Boysen, de Koster, and Weidinger (2019) to e-commerce contexts, addresses the grouping of orders for efficient joint execution. Horizon-based release operates at a different architectural layer — it controls when formed WOs are forwarded to the WCS, not how orders are grouped — making it a complementary mechanism rather than an alternative to batching. The two can coexist within the same EWM deployment without conflict.

WCS integration in the warehouse automation literature is addressed by Atieh et al. (2016) in the context of warehouse management system automation performance, and by Tadejko (2015) in the context of IoT-enabled logistics integration architectures. Neither source addresses the specific problem of workload gating between EWM and WCS at the Warehouse Order release boundary. Koster, Jewkes, and Le-Duc (2011) examine throughput control in automated inbound environments, providing relevant methodological context for the queue depth measurement approach used in this deployment. Botta-Genoulaz, Millet, and Grabot (2005) establish the enterprise ERP literature precedent for configurable control table-based parameter externalisation — the architectural principle central to ZWORKLOAD_CTRL. The gap in published work — dual-mode, horizon-gated WO release in EWM-WCS integration — provides the motivation for the design documented in this article.

3. The Operation Horizon Problem

In a warehouse operating a WCS-controlled sorter, the relationship between WO release volume and lane queue depth is non-linear. Below a threshold determined by the physical pick rate and lane buffer capacity, increased WO release increases throughput. Above that threshold, additional WOs cannot be processed at the pick rate and accumulate as queue depth, triggering sorter idle states and supervisory intervention cycles that further reduce effective throughput. The threshold is dynamic: it changes with shift staffing level, product mix, and carrier cut-off constraints.

Standard EWM wave management has no mechanism for evaluating this threshold before releasing WOs to the WCS. Wave completion triggers immediate release of all confirmed WOs regardless of the current lane queue state. At sites with high-velocity order profiles, multiple wave completions within a short window can generate cumulative release volumes that reliably exceed the lane buffer capacity. The downstream effect — sorter idle cycles, supervisor queue management, pick-lane blocking — is structural and repeatable, not exceptional.

The Operation Horizon concept addresses this by introducing a time-based release criterion that is anchored to estimated pick completion rather than wave completion. Only WOs whose estimated pick completion falls within a configurable forward window — the horizon boundary, defined as current time plus horizon duration — are eligible for release. WOs outside the boundary are held in EWM until the next evaluation cycle. The horizon window is configurable between 120 and 240 minutes, enabling alignment with carrier cut-off schedules and shift staffing profiles without the development cost of a static schedule change.

4. Dual-Mode Architecture

4.1 Manual Release — WH Monitor Node

The manual release path provides planners with direct, exception-driven control over the WO release queue through a custom node embedded in the EWM Warehouse Monitor cockpit. The node surfaces horizon-eligible WOs with key decision attributes — ODO due time, wave priority, route and carrier code, product classification, and estimated time to horizon boundary — enabling planners to select WOs for release individually or by filter criteria. Triggered release dispatches DIVC messages to the WCS and updates the EWM release flag, with the interaction time under 90 seconds from query to dispatch for a typical selection of 20–30 WOs.

A planner horizon-override flag is available for individual WOs, enabling priority release of carrier-specific routes against early cut-offs without changing the global horizon parameter. All overrides are logged to the audit table with user ID, timestamp, and override reason. The manual path is the primary release mechanism for exceptions: carrier early cut-offs, post-short-pick queue restructuring, and shift-change handoffs where the incoming planner assesses queue state before activating auto-release.

4.2 Automatic Release — DIVC-Triggered Batch Report

The automatic release path executes via a scheduled ABAP batch report (SM36) at a configurable interval, defaulting to 30 minutes. The report reads the active horizon window and base pick rate from ZWORKLOAD_CTRL, queries open unreleased WOs, estimates pick completion time for each WO from its line count and product class against the stored pick rate, and releases those within the current horizon boundary via /SCWM/DIVC_SEND_ALL. WOs outside the boundary are written to a deferred queue table (ZDEFER_WKLD) with their calculated release-eligible timestamp, eliminating re-evaluation overhead in the next cycle.

Failed DIVC dispatches route to an exception table (ZDIVC_FAIL_LOG) for manual review, preventing silent data loss in integration failure events. When the ZWORKLOAD_CTRL Mode field is set to M (manual), the batch report runs in monitor-only mode — logging horizon-eligible WOs without dispatching them — until the planner resets the mode to A (automatic). This mode toggle is the mechanism by which planners suspend automatic release during planned disruptions without requiring a system change request.

Table 1. ZWORKLOAD_CTRL Key Parameter Fields. Source: Author's primary implementation data.

Parameter	Field	Default	Valid Range	Description
Horizon window	HORIZON_MIN	180 min	120–240 min	Forward planning window; WOs with completion est. > horizon held
Release mode	CTRL_MODE	A	A / M	A=Automatic batch release; M=Monitor-only (manual)
Batch interval	BATCH_INTERVAL	30 min	5–60 min	Auto-release evaluation cycle frequency
Base pick rate	BASE_PICK_RATE	Site-specific	Picks/op-hr	Historical pick rate used for completion time estimation
Route priority weight	PRIORITY_WEIGHT_ROUTE	0.5	0.0–1.0	Weighting for carrier route in release prioritisation
Active flag	ACTIVE_FLAG	X	X / blank	Enables/disables auto-release for the warehouse

Table 2. WH Monitor Node Method Signatures and Triggered Events. Source: Author's primary implementation data.

Method / Event	Trigger	Output Action
ZCL_WH_MONITOR=>GET_HORIZON_QUEUE	Node load / manual refresh	Returns horizon-eligible WO list for cockpit display

ZCL_WH_MONITOR=>RELEASE_SELECTED_WOS	Planner release button	Dispatches DIVC for selected WOs; updates release flag
ZCL_WH_MONITOR=>APPLY_OVERRIDE	Planner horizon override	Sets bypass flag; writes override record to ZARC_WKLD_LOG
ZCL_WH_MONITOR=>TOGGLE_MODE	Mode switch action in cockpit	Updates CTRL_MODE in ZWORKLOAD_CTRL; effective immediately

5. Control Table Design

ZWORKLOAD_CTRL is keyed by Warehouse Number (LGNUM), ensuring each warehouse in a multi-site deployment carries independent configuration. Changes are mirrored to audit table ZARC_WKLD_LOG, capturing before-and-after field values, user ID, timestamp, and transaction context. At regulated healthcare distribution sites, this audit trail satisfies GxP validation requirements without additional logging middleware. Horizon value validation at save checks the entered value against the active shift schedule in EWM Customising: if HORIZON_MIN exceeds the remaining shift duration at the time of save, a warning dialog requires the manager to confirm before the value is committed. This prevents a common operational error — leaving a stale horizon value from the previous shift that causes over-release at the start of a new shift before the first batch cycle corrects it.

The SE16 maintainability of ZWORKLOAD_CTRL is a deliberate design choice. Externalising the horizon and batch interval to a transparent database table — rather than encoding them in ABAP constants or transport-dependent customising entries — enables operations managers to respond to demand profile changes in under one minute without opening a development request. In practice, at the deployment site, horizon adjustments were made 3–4 times per week during the first two months of operation as site managers calibrated the window to their specific carrier cut-off pattern.

Table 3. ZWORKLOAD_CTRL Complete Field Structure. Source: Author's primary implementation data.

Field	Type	Description
LGNUM	CHAR 4	Warehouse Number (key)
CTRL_MODE	CHAR 1	A=Automatic, M=Manual (monitor-only)
HORIZON_MIN	INT4	Horizon window in minutes (120–240)
BATCH_INTERVAL	INT4	Auto-release batch firing interval (minutes)
BASE_PICK_RATE	DEC 7.2	Historical picks per operator-hour
PRIORITY_WEIGHT_ROUTE	DEC 3.2	Route-based release priority weighting (0.0–1.0)
PRIORITY_WEIGHT_CLASS	DEC 3.2	Product-class release priority weighting (0.0–1.0)
ACTIVE_FLAG	CHAR 1	X=Auto-release active, blank=Inactive
CHANGED_BY	CHAR 12	User ID of last modification
CHANGED_AT	DEC 15	Timestamp of last modification

6. Results

The dual-mode workload release architecture was deployed at a large US healthcare product distributor processing approximately 18,000 order lines per day across two shifts (Author's primary implementation data, 2023). The site operates a WCS-controlled sorter serving national pharmacy chains and hospital networks with strict carrier cut-off compliance requirements. Pre-implementation baseline measurement over 30 days established: average lane queue depth of 340 open WOs; lane buffer exceedance (queue depth exceeding 500 WOs) on 34% of shift-hours; average of 3.1 sorter idle events per shift (each exceeding 5 minutes of zero throughput); and 4–5 full-time personnel per shift deployed in queue monitoring and exception management roles.

Post-implementation measurement over an equivalent 30-day period recorded: average lane queue depth of 85 WOs — a 75% reduction; lane buffer exceedance on 2% of shift-hours; zero sorter idle events recorded

across the measurement period; and an 18% increase in peak-hour picks per operator-hour, attributable to the elimination of lane congestion and reduction in supervisor intervention events. 4.2 full-time equivalents were redeployed from queue monitoring to quality inspection staging and outbound trailer loading support.
The combined annual efficiency gain — calculated from labour redeployment savings, throughput improvement, and reduction in carrier compliance penalty events — was USD 650,000 (Author's primary implementation data, 2023). Carrier cut-off compliance rate improved from 94.2% to 99.1% over the same measurement periods, a consequence of the route priority weighting mechanism directing horizon-eligible WOs for early-cut-off carriers to the front of the release queue.

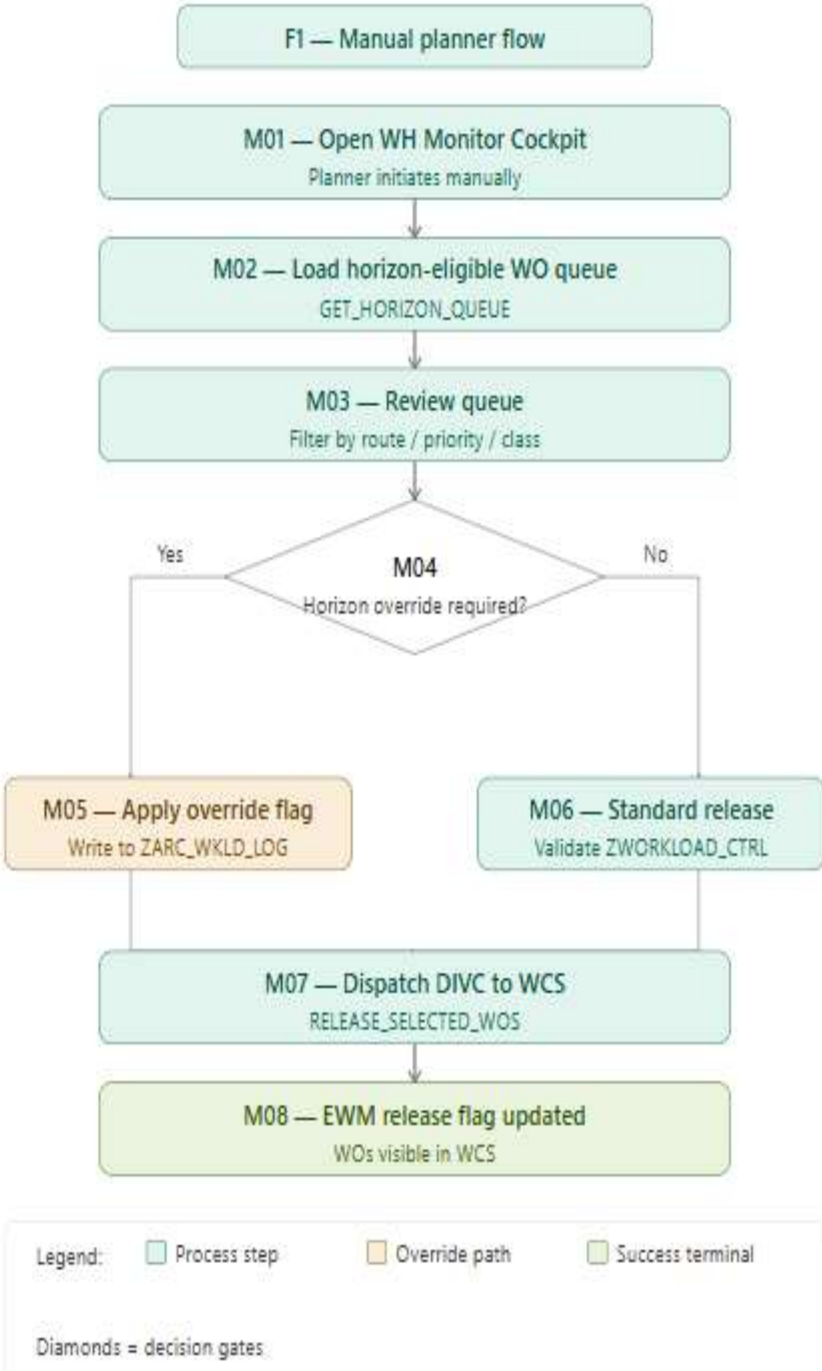

Figure 1: Manual release flow diagram.

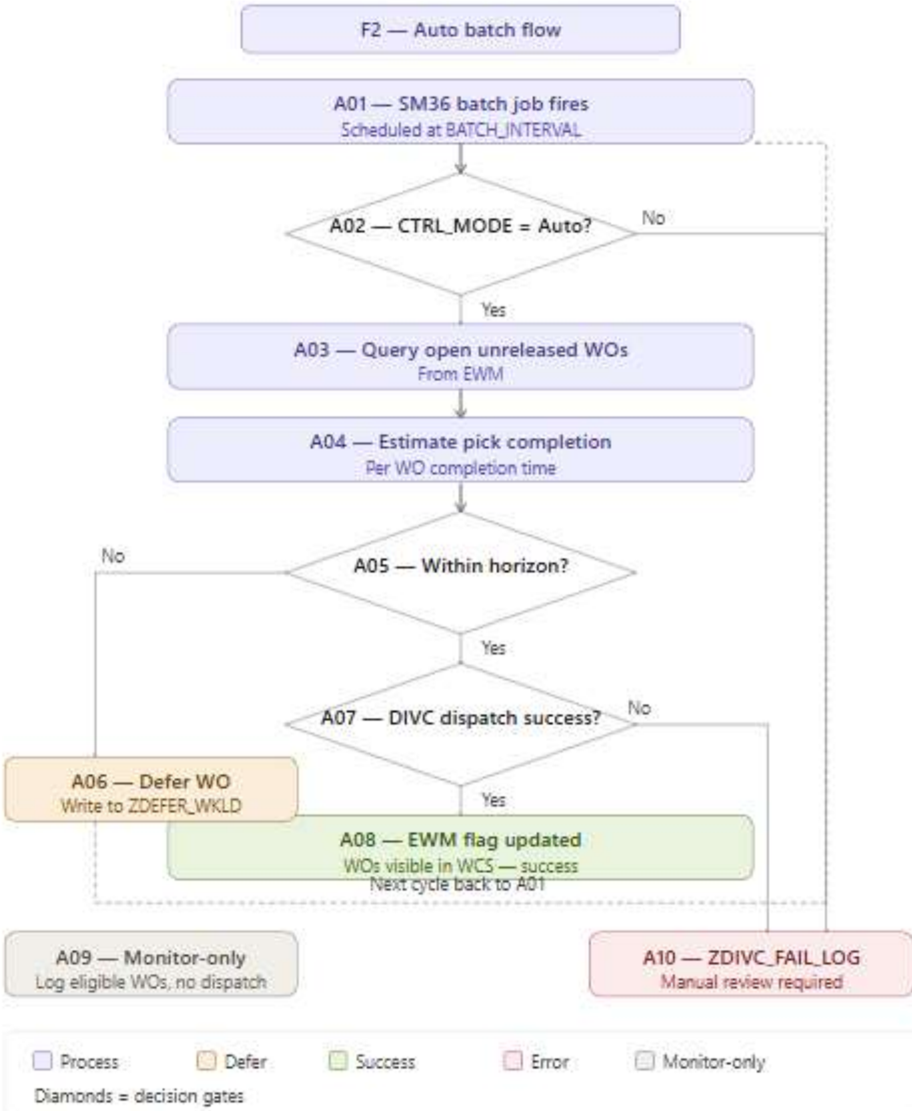

Figure 2: Automatic release flow diagram.

7. Discussion

Three design choices in this architecture merit examination as transferable principles for EWM-WCS integration implementations. The first is the dual-mode structure itself. A single-mode architecture — either fully automated or fully manual — cannot satisfy the operational requirements of a site that needs systematic release during normal operations and planner-level control during disruptions (Quintero, 2021). The Mode toggle in ZWORKLOAD_CTRL, operable in under one minute, provides a binary switch between modes without development involvement. Sites that deploy auto-only release and disable the manual path typically encounter the first carrier cut-off exception within days and require development support to handle it.

The second principle is pick-completion-time anchoring. Anchoring the horizon to estimated pick completion time rather than clock time makes the release criterion adaptive to pick rate variation across product classes and shift staffing levels (Clottey, 2025). A site running a partial shift due to absenteeism will have a lower effective pick rate; the completion time estimates will be longer; fewer WOs will fall within the horizon boundary at any given evaluation cycle; and the system will automatically throttle release to match the reduced capacity. A clock-time anchor — releasing all WOs whose due time falls within the next N hours — would not adapt to this condition and would over-release on understaffed shifts.

The third principle is the DIVC integration layer choice. Using standard SAP DIVC messaging as the release dispatch mechanism requires no custom middleware, no additional integration platform licensing, and no non-

SAP system involvement. Both the manual WH Monitor node and the automatic batch report use identical DIVC dispatch logic encapsulated in a shared ABAP method — ensuring consistent WCS behaviour regardless of release path. The maintenance footprint is a single ABAP method rather than two divergent integration code paths (Reddy et al., 2025).

The primary limitation of the current implementation is the batch interval latency: at the default 30-minute interval, newly horizon-eligible WOs may wait up to 30 minutes before the next auto-release cycle. In ultra-high-velocity environments processing 30,000+ lines per day, this lag could generate inter-cycle queue spikes during demand surges. A real-time event-driven release trigger — firing on WO creation or pick completion events via EWM event-action framework — is the priority development direction for the next implementation iteration (Shrivastav et al., 2025).

8. Conclusion

This article has documented a dual-mode, horizon-gated workload release architecture for SAP EWM-WCS integrated environments. The design separates WO release logic from wave management, introduces a configurable Operation Horizon as the primary release criterion, and delivers both systematic automated release and planner exception control through a single control table-governed framework.

Enterprise deployment at a US healthcare product distributor demonstrated measurable improvements across all throughput and labour indicators: 75% reduction in lane queue depth, elimination of sorter idle events, 18% peak-hour productivity increase, and an annual efficiency gain of USD 650,000. The architecture requires no proprietary middleware and integrates directly with standard EWM-WCS DIVC messaging.

The contribution to the EWM-WCS integration literature is a documented, primary-evidence-supported design pattern — configurable horizon gating with dual-mode release — that is generalisable to any EWM site with WCS sorter integration and serves as a replicable reference for future enterprise deployments. Adaptive horizon estimation from live pick rate data and real-time event-driven release triggers are identified as future research directions.

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