

OUTBOUND DELIVERY PROCESSING AND SHIPMENT INTEGRATION IN SAP EXTENDED WAREHOUSE MANAGEMENT

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Abstract

Order picking is the single most labor-intensive and most heavily studied function in warehouse operations research. Yet, the literature has largely treated it as a set of separable planning problems batching, routing, zoning, and slotting rather than as a connected execution flow that also has to cover wave release, packing, staging, load building, and dock scheduling as one continuous process. This paper examines how SAP Extended Warehouse Management (EWM) configures outbound delivery processing to connect these steps and relates the configuration to the extant operations research literature on order picking, wave planning, and truck scheduling. The paper discusses two outbound architectures: sales-order-driven outbound delivery from ERP and warehouse-created outbound processes used for internal transfers, replenishment, and ad hoc issues. It describes wave management; the three principal picking strategies EWM supports natively: discrete, cluster, and zone/pick-and-pass; packing and handling unit building; and the transportation unit and staging logic that consolidates picked stock into loads. The comparison shows that EWM's outbound configuration is a practical implementation of decades of order-picking and dock-scheduling research, not a replacement for it. The paper concludes with a discussion of the operational company benefits to report after moving from manual, paper-directed picking and loading to RF-directed, wave-managed outbound execution, including gains in order-fill rate, picking productivity, and dock-to-departure cycle time.

Keywords: Warehousing, supply chain, order picking, wave planning, picking strategy, loading dock scheduling, packing, outbound delivery.

1. INTRODUCTION

Everything downstream of the warehouse the customer's on-shelf availability, the production line's component supply, and the carrier's trailer utilization depends on outbound execution getting three things right. Open sales or stock transfer requirements into picking work a warehouse worker can actually do. Sequencing and batching to improve travel time and labor efficiency. Consolidating picked and packed stock into loads that leave the dock on time. Order picking specifically has attracted more operations-research attention than almost any other warehouse function, since it typically accounts for roughly half of total warehouse operating cost [1], [3]. But most of that literature studies batching, routing, zoning, and slotting as separate, largely independent planning problems, and comparatively less has been written about how those planning problems connect end-to-end inside a commercial warehouse management system, from wave release through RF confirmation to dock loading.

SAP EWM creates warehouse orders that guide pickers through the picking process using RF devices. Pickers confirm each step as goods move from picking to staging and loading area. This reduces reliance on paper pick lists and manual load-planning decisions while providing a more controlled, system-directed outbound process.



Fig. 1. Outbound processing: Consolidation of deliveries in wave picking, RF picking, and consolidation into staged/docked and loaded shipments.

2. LITERATURE REVIEW

A companion paper examined SAP EWM's inbound configuration against the cross-docking and storage-assignment literature. Outbound execution sits at the intersection of a related but distinct set of research streams, worked through below.

2.1. Order picking, batching, and routing

Order picking has been the most studied problem in warehouse operations research. De Koster, Le-Duc and Roodbergen [3] provide a survey of the field and organize it around decisions about storage, routing, batching and zoning, pointing out that

each of these decisions interacts with the others rather than being solved independently. Henn, Koch and Wäscher [6] limit themselves to order batching, i.e. grouping customer orders into a picking run, and review heuristic and metaheuristic solution approaches developed for it. Van Gils, Ramaekers, Caris and de Koster [7] extend this line of research by showing, through a full factorial analysis, that the decisions on storage, batching, zoning and routing interact to a measurable extent, and that optimizing them sequentially, as many warehouses are configured in practice, leaves performance on the table compared to a jointly considered design.

2.2. Wave planning and system-directed release

A related but different question is how picking work is sequenced after release, not at release. Releasing too many orders to the floor at one time will result in congestion and blocking between pickers; releasing too few orders will underutilize available labor. One practical way to make this decision is the wave concept of EWM. Instead of processing orders one by one as they come in, it consolidates open orders up to the outbound requirements into one coordinated release.

2.3. Loading dock and truck scheduling

Once stock is picked up and packed, it still has to leave the building on schedule. Yu and Egbelu [8] model the joint problem of sequencing inbound and outbound trucks at a shared dock with a temporary storage buffer, showing that the two sides of the dock cannot be scheduled independently without leaving performance on the table, the same coupling between inbound and outbound activity that the cross-docking literature identifies at the receiving side. [2]

2.4. Warehouse performance

As Faber, de Koster, and Smidts [4] find, the warehouse control over planning and execution decisions, picking among them, predicts warehouse performance better than facility size or layout does, a finding directly relevant to why RF-directed picking outperforms paper-based picking even when the underlying storage layout and slotting are unchanged.

2.5. Positioning SAP EWM in literature

The order-picking process includes batching, routing, zoning, and storage assignment. However, these studies do not always explain how such methods are applied in a commercial warehouse management system. This paper uses SAP EWM to show how these planning concepts are supported in real outbound operations. It also discusses practical system elements, including wave templates, packaging specifications, and transportation unit planning, which theoretical models often in not address.

3. SCOPE AND METHOD

This is a conceptual synthesis and not an empirical investigation. This paper describes SAP EWM based on standard and publicly documented functionality such as outbound delivery processing, wave management, and warehouse task management. It intentionally does not address any customer implementation but instead focuses on the configuration constructs. The operations research framing is based on the peer-reviewed literature described in Section 2.

This approach treats each EWM configuration construct as an implementation of a logistics problem already studied in the literature, mapping it to the trade-off it addresses and highlighting the practical constraints imposed by EWM that are often neglected in abstract models. The benefit numbers in Section 12 are based on published industry benchmarks and are for illustration only relative to a hypothetical baseline. EWM functionality changes across S/4HANA releases. Please refer to the current SAP documentation for the target release to check the release-specific behavior.

4. TWO OUTBOUND ARCHITECTURES

SAP EWM supports two fundamentally different ways of releasing stock out of a warehouse-managed process, and which one is used shapes how much of the shipping decision sits in ERP versus EWM, and which downstream capabilities, such as wave planning and value-added services, are even available.

4.1. Sales Outbound Overview

The normal sequence of events is to create an ERP sales order or stock transport order. When the order is ready for fulfillment, ERP creates an outbound delivery. This is replicated to EWM so that both systems stay in sync. EWM uses the replicated document to identify the warehouse process type, assign the item to a wave, and suggest staging and door before picking. RF ensures every warehouse task – picking, packing, and loading is completed so the goods issue back to ERP is based on reality, not on the original planning.

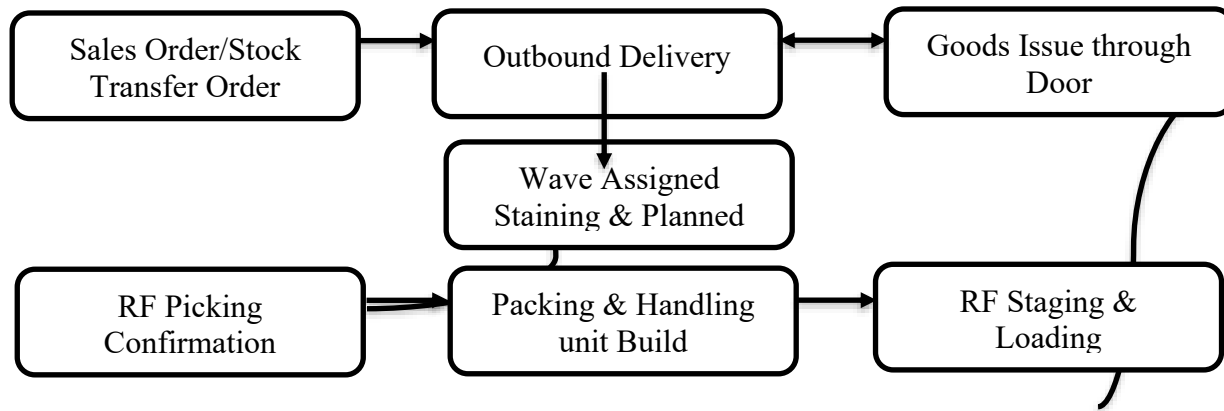
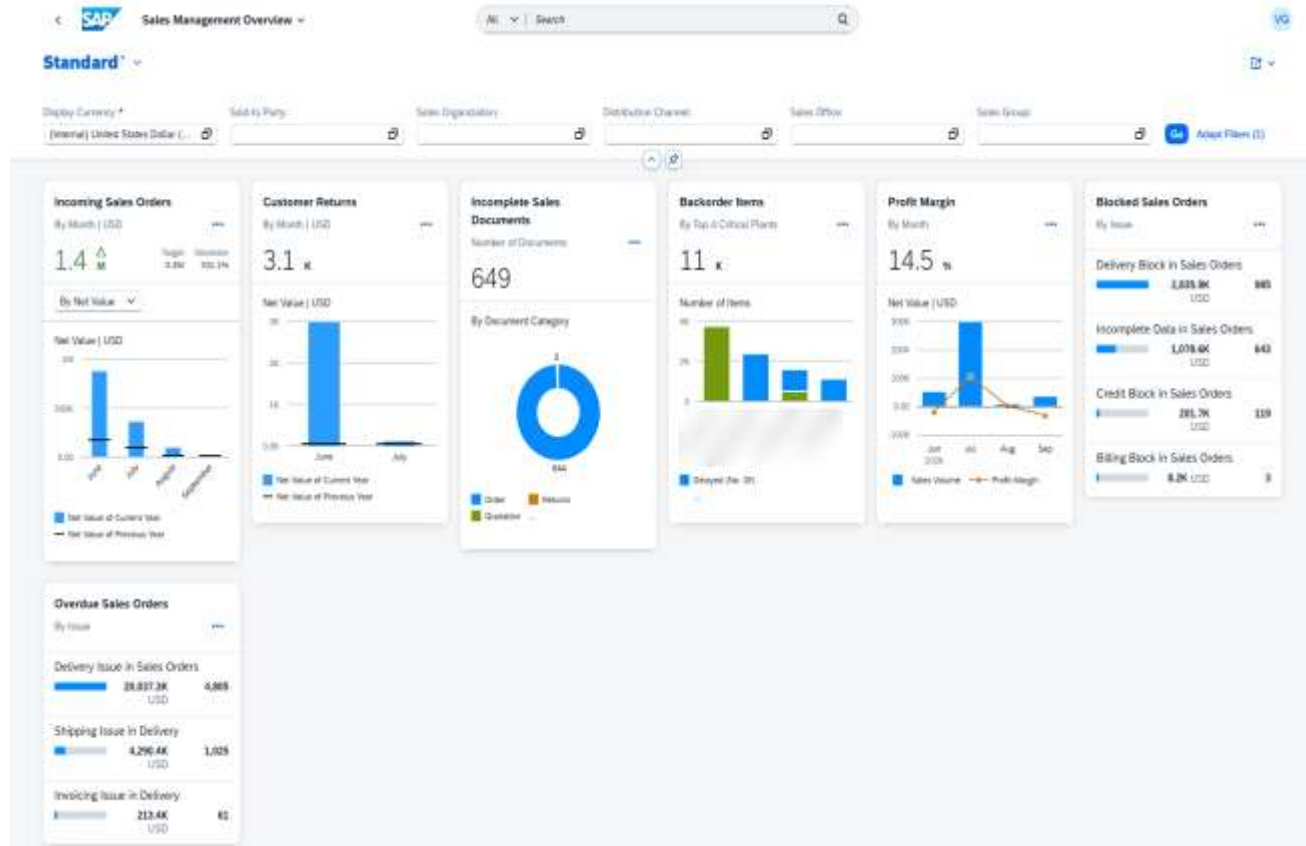
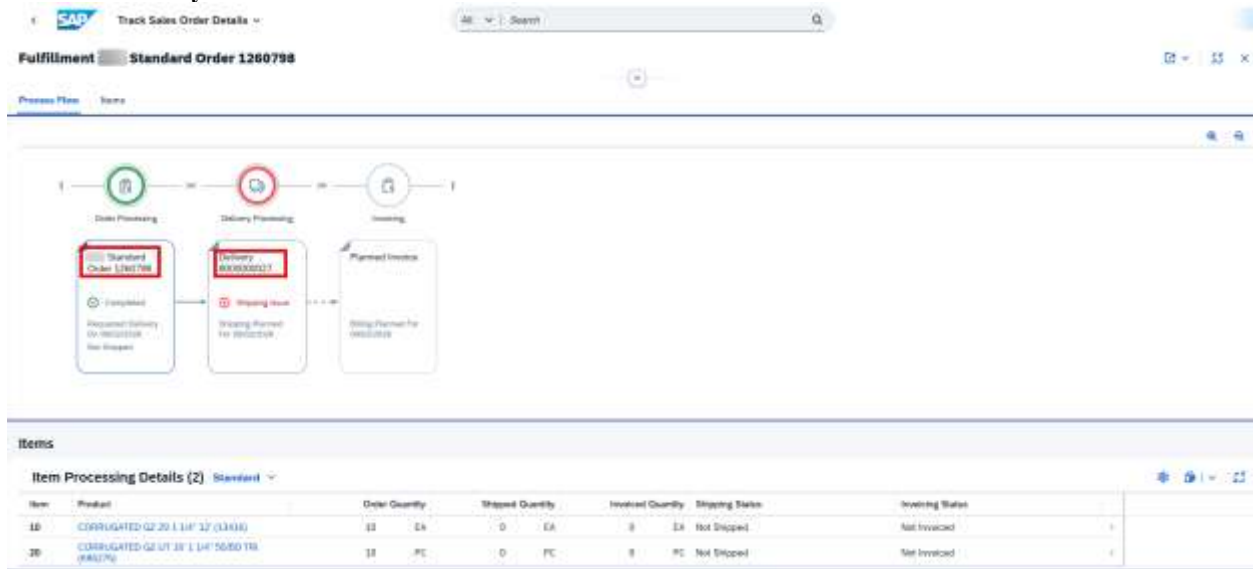


Fig. 2. Outbound delivery view. The sales order stock of an outbound delivery is waved and plans staging, then executes picking, packing, and RF-confirmed loading against the replicated document.

Sales Management Dashboard Overview:



Sales Order/Delivery Overview:**4.2. Warehouse-created outbound processes**

The outbound need can be produced directly in EWM for movements that do not come from a sales or transfer order, such as internal stock transfers between storage bins, ad hoc issues for consumption, replenishment initiated from within the warehouse, or decentralized EWM stock transport. Instead of exchanging multiple intermediate documents, EWM handles picking, packing, and loading internally. After the movement is over, it sends a lean goods issue message back to ERP. This is similar to the lean communication logic used for inbound receipts generated by warehouses: ERP receives a summary result rather than a series of intermediary documents, and EWM manages more of the process.

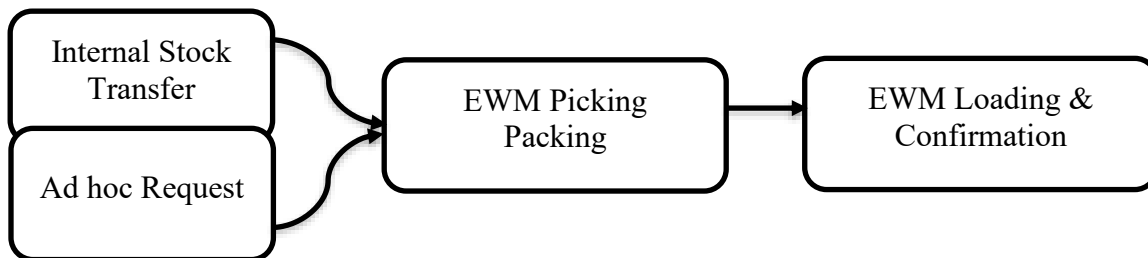
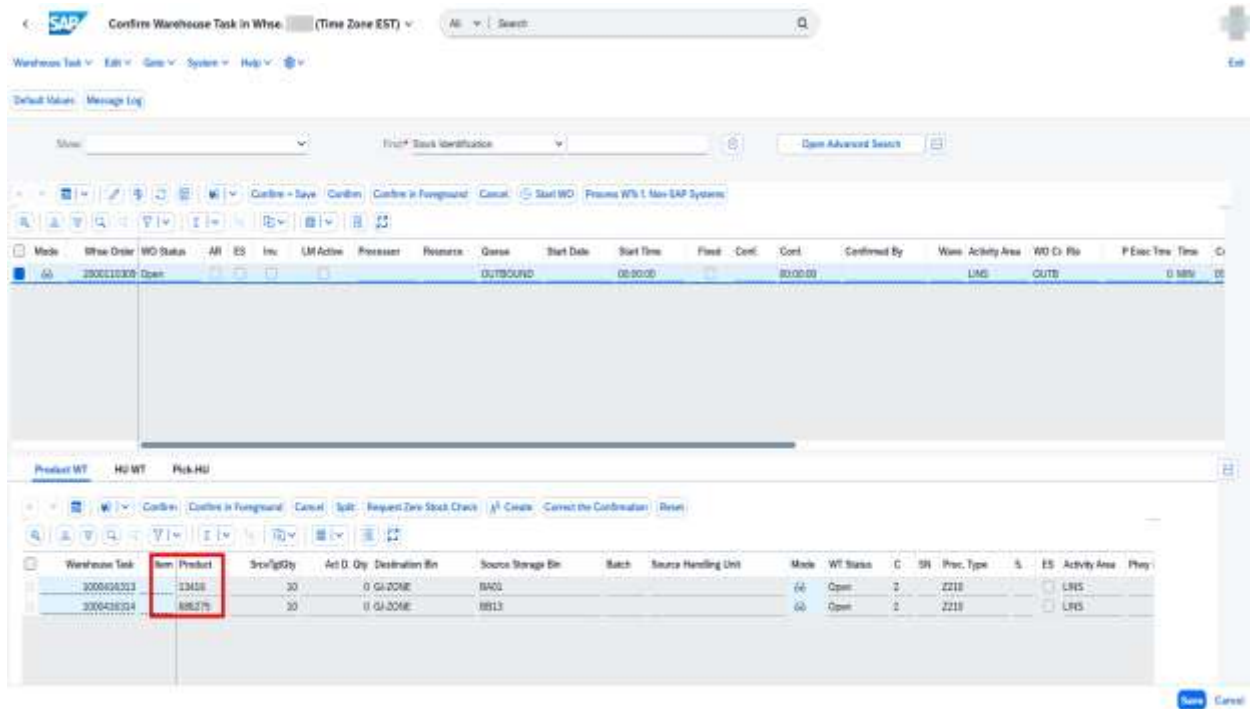


Fig. 3. Warehouse internal movement of stock transfer or ad hoc issue request, controls picking and confirmation internally, and returns goods movement message to ERP.

Wave Released Order:

There are two Items to be picked, packed, loaded, and goods issued.



RF Picking Process:

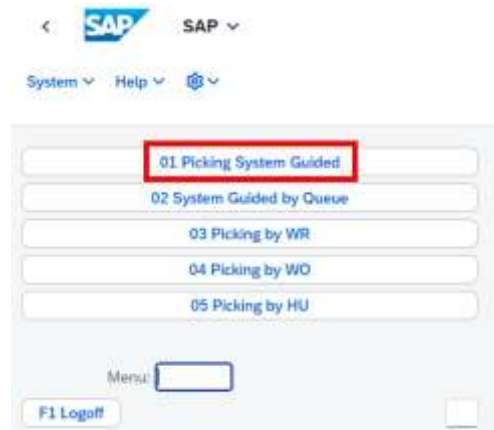
Picker logs in to the Device to navigate the outbound process



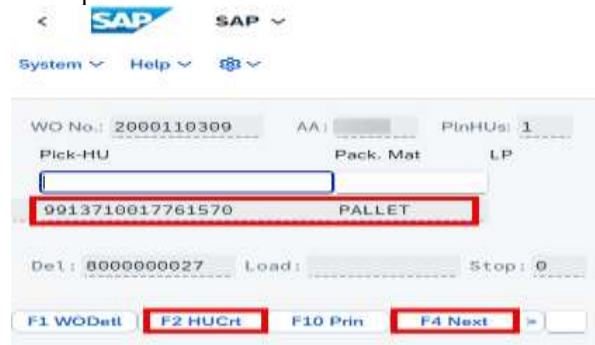
Pickers start picking



System guides the item to pick



Picker creates the Pallet handling unit to pick the items from the RF.



1st item: Pickers walk through the aisles to scan the bin, product, and quantity



2nd item: Pickers walk through the aisles to scan the bin, product, and quantity



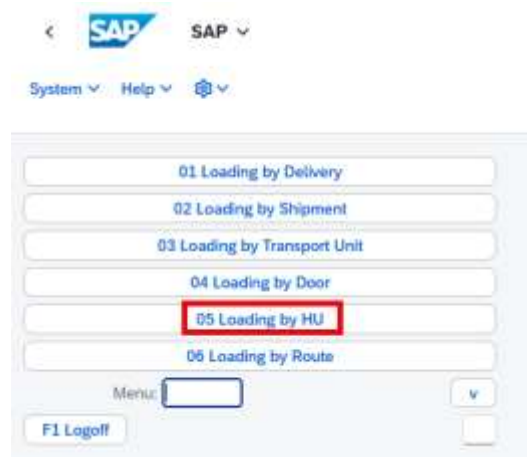
RF Loading Confirmation

Picker logs in to the Device to navigate the Loading process



The screenshot shows the SAP RF Loading Confirmation screen. At the top, there is a navigation bar with the SAP logo and a dropdown menu. Below the navigation bar, there are several menu items: "01 Picking", "02 Packing", "03 Loading" (highlighted with a red box), "04 Pick Point", "05 Consumption", and "06 Distribution Equipment". At the bottom, there is a "Menu:" label, a text input field, and a button labeled "F1 Logoff".

Loading by HU



The screenshot shows the SAP Loading by HU screen. At the top, there is a navigation bar with the SAP logo and a dropdown menu. Below the navigation bar, there are several menu items: "01 Loading by Delivery", "02 Loading by Shipment", "03 Loading by Transport Unit", "04 Loading by Door", "05 Loading by HU" (highlighted with a red box), and "06 Loading by Route". At the bottom, there is a "Menu:" label, a text input field, and a button labeled "F1 Logoff".

Scan the Pallet HU from the Label



The screenshot shows the SAP HU ID screen. At the top, there is a navigation bar with the SAP logo and a dropdown menu. Below the navigation bar, there is a large barcode with the number "9913710017761570" below it. Below the barcode, there is a label "HU ID:" followed by a text input field containing the same number. To the right of the input field, there is a small "0 / 0" indicator. At the bottom, there is a button labeled "F2 Total".

Scan the Door to confirm loading into the Truck through the door.

< **SAP** SAP ▾

System ▾ Help ▾  ▾

HU ID: 9913710017761570

DstBin: DOOR-OUTB DC


 DOOR-OUTB

F12 Queries

Shipment is confirmed

Warehouse Picking, Packing, Loading & goods issue completed

< **SAP** Maintain Outb. Deliv. Order - Warehouse No. [] [Time ...] All ▾ | Search

Outbound Delivery Order ▾ ECR ▾ Goto ▾ Environment ▾ Settings ▾ System ▾ Help ▾ 

Default Values Outbound Delivery Message Log

Show ▾ First* Outbound Delivery Order ▾ Open Advanced Search

Transit Procedure ▾ Route ▾ Load ▾ Goods Issue ▾

Mode	Blocked	Document	Manually	Document Category Description	Document Type Description	Whse No.	Shipping Office	Picking Status	Packing Status	Loading	Goods Issue Status	Incident
64		8000000027		Outbound Delivery Order	Outbound Delivery Order			Completed	Completed	Completed	Completed	PPD

Items Status Dates/Times Locations Partner Reference Documents Additl Quantities Tests HU Transportation Unit Validation PPF Actions

Subitem ▾ Delivery Group ▾ Outbound Delivery ▾ Process Codes ▾ GTS ▾ Selection ▾ Insurance ▾

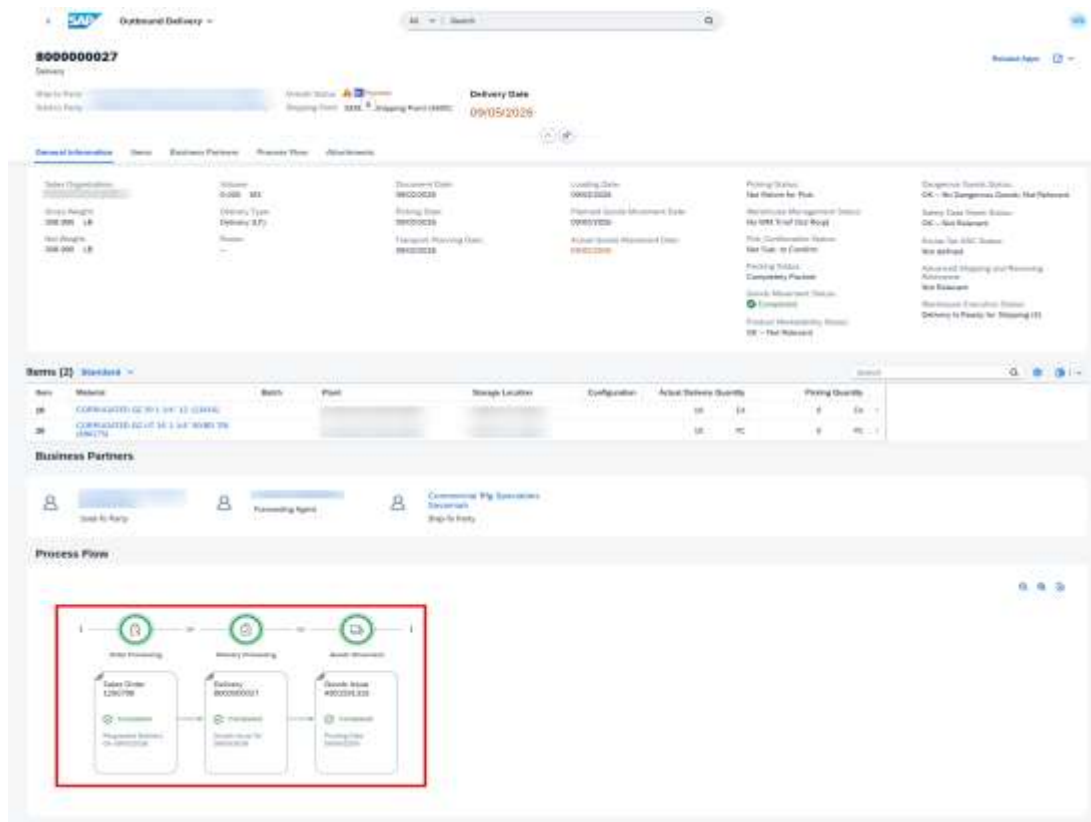
QM Bt	Quantity	Mode	Blocked	Item	Manually	Level	Delivery Group	Item Category Description	Item Type Description	Doc. No.	Product	External Product	Prod. Entd	St
	10	60		10				Standard Delivery Item	Standard Item - Outbound Delivery	8000000027	13405	13405	13415	OK
	10	60		20				Standard Delivery Item	Standard Item - Outbound Delivery	8000000027	686275	686275	686275	OK

No changes made. No save required.

Save Cancel

Final Confirmation:

Customer sales orders have been fulfilled



4.3. Choosing between them

Table 1. Comparison of ERP-driven and warehouse-created outbound processes

Typical trigger	Sales order, stock transport order	Internal transfer, ad hoc issue, replenishment
Document of record	ERP outbound delivery, replicated to EWM	EWM-internal warehouse request
Quantity source	Order quantity, adjustable on picking confirmation	System-proposed or manually entered in EWM
System communication	Delivery-level synchronization	Lean goods movement message only
Wave eligibility	Full wave planning and release strategies	Typically, immediate or manual release
Typical use case	Customer shipments, plant-to-plant transfers	Internal replenishment, decentralized transfers

The distinction follows the same practical rule of thumb as inbound: demand that originates outside the warehouse customer order or a planned transfer is handled as a delivery replicated from ERP. In contrast, movements the warehouse itself decides to make are created directly in EWM. Either way, both paths converge on the same EWM picking, packing, and loading logic once the requirement reaches the floor.

5. PLANT STRUCTURE AND MASTER DATA

5.1. Wave with release strategies

A wave picking can group open outbound delivery items based on common criteria such as ship-to location, carrier, door, or required shipping date. Instead of releasing picking work one order at a time, planners can release a group of orders together as a wave. When certain requirements are met or a certain time requirement is set, the wave can be released manually or automatically. This helps balance the picking workload and use warehouse labor more efficiently throughout the shift.

5.2. Handling unit with pack configuration of case/pallet

For a product that requires handling-unit packing, packspec ship by case or full pallet is required. Consistent expectations for a known process automate and thus reduce manual pack-station decisions and dock rework for a customer or channel.

5.3. Rearranging, pack station and resource management

Storage type arrangement stores products in the right location to improve picking efficiency. Gu, Goetschalckx, and McGinnis [5] discuss how fast-moving products are assigned to pick zones that are often accessed or close to staging areas. Warehouse putaway decisions directly affect the travel effort for subsequent outbound picking. This relationship confirms the statement of De Koster, Le-Duc and Roodbergen [3] that storage assignment and order-picking performance should be considered together, not as independent warehouse decisions.

6. OUTBOUND DELIVERY PROCESSING IN DETAIL**6.1. Delivery creation and warehouse request determination**

When an outbound delivery is replicated from ERP to SAP EWM, the document type is the main mapping used to process it further in the respective location. SAP EWM applies this document-based logic consistently across outbound, inbound, and production processes, helping maintain a standardized process design within the same warehouse number.

6.2. Wave Release

In SAP EWM, Outbound delivery items are picked together based on a wave release template, for example, delivery time, route, customer, or workload. Once the wave is created, it is released for execution, and the system can generate warehouse tasks for picking. It helps schedule outbound work and coordinate picking operations with staging and shipping requirements.

6.3. Picking strategies: discrete, cluster, and zone

In line with strategies studied in the literature on batching and zoning, EWM natively supports three picking strategies. [3], [6]:

Discrete (single order) picking: one picker completes one delivery at a time; simplest to confirm but usually the highest travel time per unit picked.

Cluster (batch) picking: one picker collects several orders in one pass using a picking cart or multi-position tote, reducing travel time per order at the cost of a downstream sortation step.

Zone / pick-and-pass picking: the warehouse is divided into fixed zones, and each order passes through the zones where it has items while each picker stays within a zone; this is the approach Van Gils and colleagues [7] find benefits most from being planned jointly with storage and batching decisions rather than in isolation.

The wave template determines the picking strategy. It is not a fixed decision for the entire warehouse. Different waves within the same warehouse can therefore follow different picking strategies based on factors such as order size, product characteristics, delivery priority, and workload.

6.4. RF picking confirmation

The RF guides the picker to the bin and quantity, then creates the handling unit in RF, so manual paper pick lists are not needed. If there is a partial pick, quantity difference, or bin issue, it is recorded immediately during picking instead of corrected later. This shift from manual to system-directed picking is consistent with the findings of Faber, de Koster and Smidts [4] and improves warehouse accuracy, control and performance.

6.5. Packing and handling unit building

The picked items are packed into shippable cases or pallets. Once stock is packed in a handling unit, the necessary labels are printed for RF scanning to move the HU to the staging area or shipping dock for carrier pickup.

7. VALUE-ADDED SERVICES AND QUALITY INTEGRATION

Some outbound processes require additional activities beyond picking and packing, such as Assembling, labeling, or final quality inspection managed through Value-Added Services (VAS) and included in the warehouse execution flow instead of being handled as separate manual steps. When an outbound quality inspection is required, the Quality Inspection Engine requires a usage decision to be recorded and can prevent goods issue until the inspection is completed. This is similar to inbound quality inspection, but it takes place before the product leaves the warehouse.

8. LOAD CONSOLIDATION AND SHIPMENT BUILDING

8.1. Transportation unit building

Packed handling units are assigned to a Transportation Unit (TU), which represents the truck, trailer, or container used for shipment. However, a planned load is created in Transportation Management or built directly in EWM using staged handling units and the assigned shipping door.

8.2. Route/shipment consolidation

Outbound deliveries are based on routes, destinations, carriers, or shipping schedules by the supervisor. The shipper can process picked and packed items, staging & loading together. Consolidation reduces movement in the warehouse in an efficient way and helps coordinate shipments better and deliver on time more reliably.

8.3. Pack Staging and Loading

Packed unit moves to the staging area near the shipping door. During loading, each handling unit is scanned using RF to confirm that it is loaded onto the assigned vehicle. All packed items are accounted for before the vehicle physically leaves the warehouse.

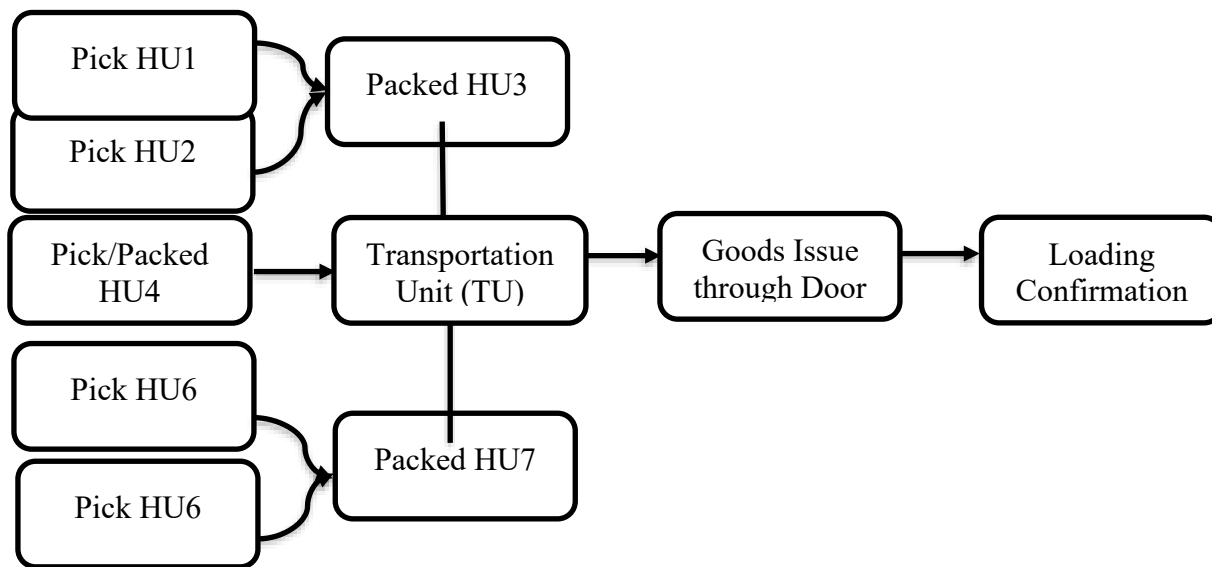


Fig. 4. Outbound handling units are consolidated into transport units and staged by door. RF-confirmed loading closes the loop between pick, pack, and goods issue.

9. YARD AND DOOR ASSIGNMENT

Where EWM yard management is active on the outbound side, a carrier's trailer checks in at the gate and is held in a yard position until its assigned door and staged load are ready, rather than occupying a door while still being loaded. This trailer-arrival-from-door-readiness works in the same way it does for inbound receiving and addresses the same truck-to-door assignment problem Yu and Egbebu [8] model on the outbound side of a shared cross-dock.

10. PROCESS VARIATION ACROSS INDUSTRIES

In warehouse operations, customer grouping and pick or zone picking are often used to handle a large number of small orders managed in waves and minimize trip time. Discrete and process manufacturing plants ship finished goods.

Ship fewer, larger orders and use discrete picking with less wave consolidation, as each shipment may require a different packing design. For third-party logistics operations serving multiple clients from a single site, all three selection processes are usually applied together, with additional client-specific packing and labeling requirements.

11. DECISION APPROACH

Figure 5 shows the overview of the process. Low-density or highly configured shipments are better suited for picking all items at once. At the same time, outbound requirements with high order density and shared destinations favor wave consolidation with cluster or zone picking. Whatever approach is chosen, the task is associated with flow when value-added services or an outbound quality check is required.

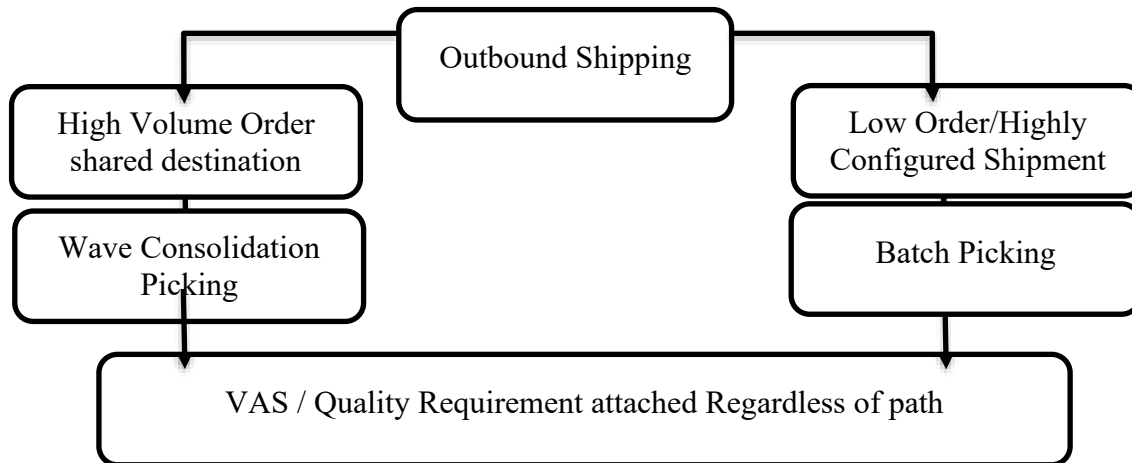


Fig. 5. Outbound shipping wave consolidation for higher-volume order destinations and common destinations.

Low-volume shipments are routed via batch picking. VAS and quality requirements are attached regardless of path as optional.

12. BUSINESS CASE BENEFITS

SAP EWM improves warehouse and business performance. Moving from manual, paper-based picking and loading to system-guided, RF-confirmed processing can improve performance, productivity, and visibility into your processes.

Table 2 highlights improvements organizations may see after implementing this type of outbound process. Benefits will depend on factors such as warehouse size, current process maturity, transaction volume, and overall implementation scope. Therefore, the values shown should be considered general planning estimates rather than guaranteed results.

Table 2. Illustrative benefits of system-directed SAP EWM outbound processing

Picking labor productivity	~15 to 30% gain	Wave-optimized batching and RF-directed travel replace paper pick lists and manual sequencing	Fewer picking labor-hours per order shipped
Order fill rate / pick accuracy	Up to 99.5%	RF pick and pack confirmation reduces mis-picks reaching the dock	Fewer shipping errors and returns
Dock-to-departure cycle time	20 to 35% reduction	Wave release, staging, and RF-confirmed loading replace manual load-building	Faster trailer turnaround
Trailer/dock dwell time	Fewer door-wait delays	Yard check-in decouples trailer arrival from door readiness	Reduced carrier detention charges

12.1 Illustrative Business Case: Distribution Center

For a mid-sized distribution center shipping around 250,000 outbound units annually with \$2.1 million in annual picking and packing labor costs, the expected benchmark ranges are:

Table 3. Illustrative distribution center business case

20% productivity gain on \$2.1M in annual picking/packing labor	~\$0.42M per year
Reduced mis-pick returns and re-ships on ~1 to 2% of order lines	Variable, often meaningful at volume
Reduced carrier detention from faster trailer turnaround	Variable, often meaningful at high-volume docks

For illustration only. The figures apply published benchmark ranges to a hypothetical base. These ranges are based on the Warehousing Education and Research Council (WERC) benchmarking studies, APQC process benchmarking data, and SAP EWM benefit studies published between 2023 and 2026. A specific facility's labor spend, dock throughput, detention costs, and implementation scope will change a real business case.

13. DISCUSSION

Pulling the sections above together points to a straightforward conclusion: SAP EWM outbound processing is a practical way to address the picking, wave-planning, and load-consolidation problems the operations research literature has been working on for decades. It is more than a pile of unrelated configuration settings. The ERP-driven and warehouse-created models represent two different answers to where the outbound requirement is documented and controlled—ERP-driven outbound delivery keeps ERP as the trigger and system of record. In contrast, the warehouse-created process gives EWM more control and supports leaner communication for internal transfers and replenishment.

The three picking strategies discrete, cluster, and zone are the practical mechanisms behind the batching, routing, and zoning trade-offs that De Koster, Le-Duc, and Roodbergen [3] framed and Henn, Koch, and Wäscher [6] extended into concrete solution approaches. The wave template and release strategy are EWM's implementation of the release-timing decision that sits alongside those batching and zoning problems. The finding from Van Gils and colleagues [7] that storage, batching, zoning, and routing decisions interact rather than optimize independently is exactly why a wave template ties picking strategy, staging, and door assignment together rather than leaving each to be configured in isolation.

The difference between EWM and the abstract models is most apparent in the case of dynamic demand. Research models typically assume a known fixed set of orders. At a live distribution center, in the meantime, new orders are coming in throughout the day, along with schedule uncertainty at the dock that Yu and Egbelu [8] model on the truck-sequencing side. Wave release strategies and manual overrides are designed to address that gap, batching what is known while allowing urgent orders to be added to a later wave rather than reworking a plan on a fixed order set.

There are two caveats worth noting. First, the benefit figures are ranges benchmarked against industry benchmarks, not results from a controlled implementation, so they show potential direction and magnitude, not a guaranteed outcome. Second, much of the underlying order-picking literature is based on manual picker-to-parts warehouses and treats the problem as a static optimization. Relatively little has been written about how batching, zoning, and routing decisions interact once embedded in a live, continuously releasing, wave-managed WMS. The gap points to an opportunity for future research; empirical studies of SAP EWM outbound processing in real-world facilities could help bridge the order-picking and dock-scheduling literature and the systems used to manage these processes.

14. CONCLUSION

SAP EWM outbound processing provides a flexible way to manage key warehouse activities such as order selection, picking workload management, and dock scheduling.

In general, outbound processing can follow two approaches. The first is a warehouse-driven process, commonly used for internal stock transfers, replenishment, and other warehouse-initiated movements. The second is an ERP-driven process, where outbound activities are triggered by sales orders or stock transfer orders created in ERP. The right approach depends on business needs such as order volume, shipment complexity, delivery priorities, and value-added service requirements.

While discrete picking and configuration flexibility are more important for manufacturing and highly configured shipments, wave consolidation and cluster or zone picking shorten travel times for distribution and retail businesses with high order density and shared destinations. In either case, careful outbound process design keeps carrier costs under control and fulfills customer commitments. In addition to the benchmark ranges covered here, switching from manual to system-directed outbound processing can lead to a significant decrease in dock-to-departure cycle time as well as an increase in picking labor productivity and order correctness.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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