Warehouse Management

Anton.Boonstra@simplesolidsolutions.nl, April 2025

Introduction

This article is the second in a series of four articles on Warehousing & Transport. Before you can define a possible future (To-Be) for your company and determine which systems might support it, you first need to map out the current state (As-Is). This article explains how to do that mapping—both for the As-Is and the To-Be—and how to bridge the gap between them. We apply this method first for Warehousing and next for Transport. The third article will focus on selecting the software required to realize the To-Be, and the fourth will discuss how to run a tender to select the best service provider for Warehousing and Transport.

It is crucial to clearly separate the As-Is from the To-Be. They should be as distinct as black and white. If you don't, they'll get mixed too early. We often know what's not going well and have ideas for improvement, but we tend to overlook what is working. Without realizing it, we risk not incorporating those positives into the new design. That's why it's valuable to start with some "navel-gazing" into the As-Is. Once that's well understood, you can start dreaming about the To-Be—what the ideal future might look like, unconstrained by current limitations. Of course, reality must eventually return, and you'll need to define practical steps to transition from As-Is to To-Be.

The reference model is developed in parallel with the As-Is analysis and ultimately becomes a summary of the To-Be. The main goal of a reference model is to provide a yardstick against which to evaluate the As-Is: "Why don't we do it this way?" It helps map the current situation and potential improvements objectively. A reference model is also helpful for practical purposes, such as ensuring that no processes are overlooked. Once the As-Is is mapped, you should fully shift to the To-Be and imagine how the future could look. Then define the roadmap to that future, complete with timelines and responsibilities.

If you have significant experience, you may be able to build a detailed reference model. If not, try researching and reading to find or develop one. It doesn't need to be perfect from the start and can be refined as you map the processes.

Before diving into the details of a generic reference model for Warehousing, let's first go through the steps to define the To-Be: Preparation, As-Is Workshop, To-Be Workshop, and Synthesis.

Mapping the As-Is and To-Be in Steps

Intake

1. Identify the process to be assessed and the key steps you expect to be present. Ideally, you already have a basic reference model in mind. The reference model should stay ahead of the As-Is and reflect the challenges you foresee.
2. Observe the process in action. Accept what you see without judgment. Ask "why" repeatedly: "Why do you do it this way? Why not another way?" Try to empathize

with the people involved and understand their reasoning. Be a chameleon—step into the shoes of the process owners.
3. Check whether you've seen all the physical and procedural details. Ask yourself, "Do I fully understand this process?"
4. Document each step in detail and continue refining the reference model.

As-Is Workshop

5. Plan a half-day workshop with a group of recognized process owners (ideally 7–10 people). Fewer than 7 may cause gaps in representation, and more than 10 can become unmanageable. Of course, it depends on the size of the warehouse and number of FTEs.
6. Review each process step with the group and verify that nothing has been overlooked. Ensure everything is well documented.
7. Conduct a brainstorming session to identify problems. Discuss each problem one by one and suggest potential solutions. Avoid jumping ahead to the To-Be. The goal is to fully understand and agree on the As-Is and identify known problems. Summarize everything and send it to the participants for confirmation.

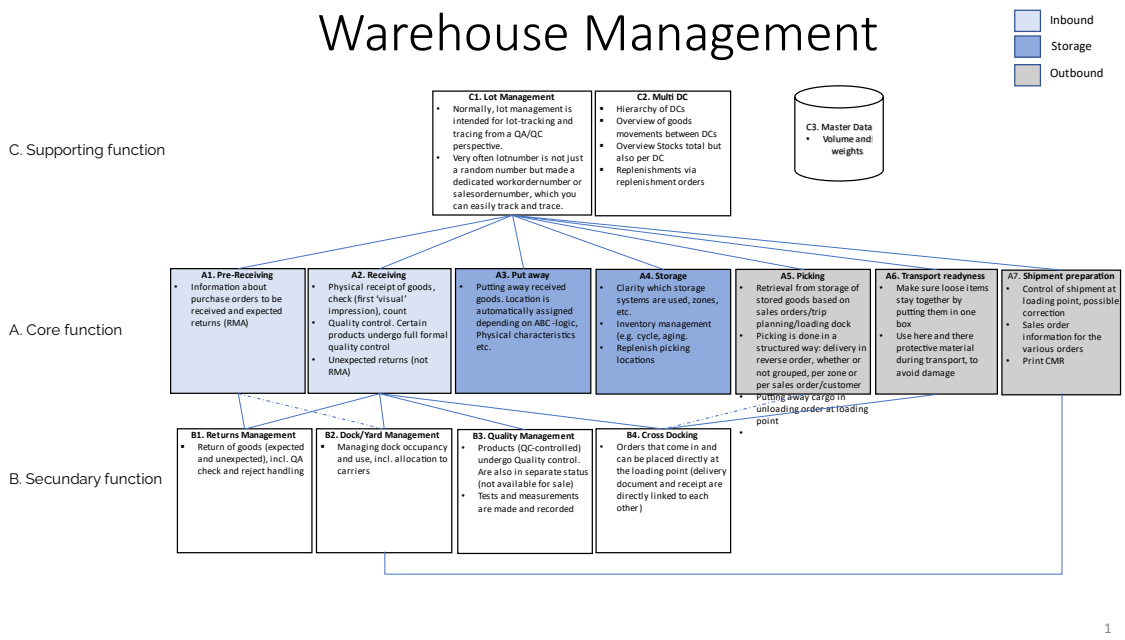
To-Be Workshop

8. Use the same group from the As-Is workshop. In the To-Be workshop, shift completely away from the current situation. "Dream" together about how the warehouse should operate in 4–5 years. Spend time crafting this vision, then work to bring it closer to reality by identifying what must happen to achieve it.
9. The result should be a clear vision of the dream state, the steps required to get there, and a first draft of a timeline.

Synthesis

10. Document the To-Be in detail: the new process steps, a reference model summarizing the To-Be, a roadmap with a timeline, and a rough financial plan including ROI. Ensure the group fully supports the vision, then present it to stakeholders and decision-makers to drive implementation.

Core Functions (A1–A7)



This is an example of a reference model for warehousing. You don't need to follow this format exactly—use what works best for your audience. The model includes three layers:

1. **Core Function** – These are the essential transportation processes.
2. **Secondary Function** – These support the core functions by informing or influencing decisions (e.g. planning).
3. **Supporting Function** – These are general processes that support transportation but are not exclusive to it.

In the following sections, we'll elaborate on the 'blocks' within this reference model to illustrate the kinds of topics you might include and discuss. These are simply suggestions—adapt them as needed to fit your own situation.

A1. Pre-Receiving

Pre-receiving involves tracking purchase orders before goods physically arrive. You want to know whether shipments are on time, complete, and conforming to the agreed order. Modern systems should follow the 'only alert on deviation' principle. Business Intelligence (BI) dashboards can provide insights as well.

Another growing need is the ability to sell goods while still in transit. By linking purchase and sales orders, stock that hasn't yet arrived can already be committed. This is particularly useful in international trade where goods may be in transit for weeks. Though systems are traditionally designed to only allow sales from physical stock, this mindset is increasingly outdated.

A2. Receiving

Goods should be registered in your system immediately upon physical receipt. Delaying entry until a quality check is complete can create administrative confusion, especially in tightly integrated systems. Every physical movement should have a corresponding administrative transaction to avoid loss or miscommunication. Barcoding simplifies this process.

A3. Put Away

Put away refers to transferring received goods to designated storage locations. Goods may initially be blocked for sale, pending quality checks. Changing a product's status (e.g., from blocked to sellable) can be done administratively without physical movement. The principle: every physical move is recorded administratively, but not every status change involves a physical move.

A4. Storage

Conventional Warehousing vs. Robotization

Despite ongoing advancements in automation and robotics, many warehouses today still rely on conventional storage systems. By "conventional," we refer to standard pallet racking designed to accommodate either three Euro-pallets (80x120 cm) or two block pallets (100x120 cm) on one shelf. Uniformity in pallet dimensions and racking heights remains a challenge, depending heavily on industry standards. Increasingly, trailer trucks are optimized for internal heights up to 2.80 meters, and pallets are often limited to a maximum height of 1.35 meters to enable double stacking during transport. The Euro-pallet continues to gain widespread acceptance.

Back in the 1980s, there were active discussions around *handlingunit-modularity*—standardized packaging sizes that fit efficiently on pallets. Unfortunately, this concept never reached full-scale adoption (see central photo below). I still believe in its potential as a practical, efficient, and sustainable solution, stacking pallets.

Despite discussions on Robots and Automation, lots of Warehouses are pretty 'conventional'

Example of collo-modularity of packaging

Example of double stacked trailors

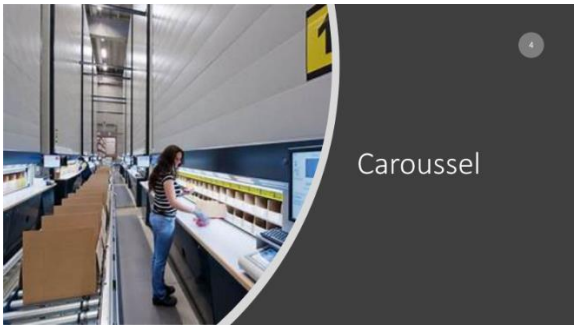
Over the years, I have encountered highly automated warehouse systems, including experiments with carousel systems. While there have certainly been successes, there have also been many disappointments. A key issue with automation is its inherent inflexibility. In environments where product portfolios frequently change—due to acquisitions, market

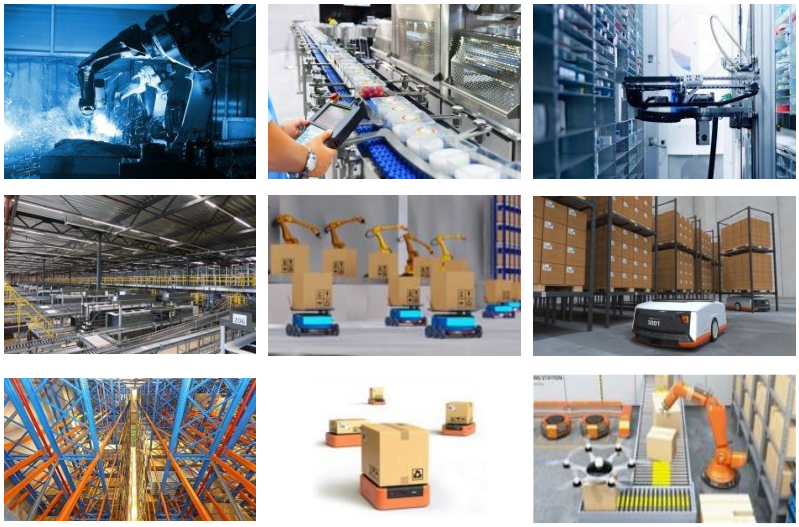
dynamics, or customer demands—automation can be a limitation rather than an advantage. Conventional storage solutions, on the other hand, offer greater adaptability in such scenarios.

This calls for a more strategic approach: do not attempt to interconnect every component of your system. Instead, design distinct zones and make clear choices about where and how automation is implemented. Flexibility must be built into automated systems, preferably through modular configurations, flexible robotics, and decoupled components. When automation becomes more adaptable, the associated risks and investment burdens will decrease.

The pressure to automate is increasing due to rising labour costs and a shrinking pool of qualified personnel. Robotics are becoming more advanced, affordable, and flexible, although adoption is progressing more slowly than anticipated. Automation remains a significant and high-risk investment, but it is ultimately inevitable.

ARTICLEWAREHOUSINGSMART WAREHOUSINGROBOTIZATIONMATERIAL HANDLINGDIGITALIZATIONAUGMENTED REALITYARTIFICIAL INTELLIGENCE
First published 13 Dec 2019Last modified 23 Apr 2021
Peter de Weerd, **Robots,** Material handling systems and robots in particular play an increasingly important role in this process. **Distribution centers with robots** are now even more the exception than the rule, but that will soon change. Currently, around 4,000 distribution centers worldwide work with robots. By 2025, more than 4 million commercial robots will **be operating in 50,000 warehouses.** This is evident from a report by research agency ABI Research. The global market for warehouse robotics accounted for more than 2.5 billion dollars in 2017. In 2026, this will be more than 7.8 billion dollars, according to a recent report by research firm Research and Markets. Now that with the coronavirus the dependence on the human factor appears to be clearer than ever and e-commerce continues to grow, it is **not inconceivable that smart warehousing will get a big boost.**





Just a selection of robotization in warehousing

6

In regard to storage there are certain themes that always play in this respect to a greater or lesser extent: - physical characteristics, storage algorithms, ABC, picking locations and supplementing them, cycle counting, Inventory-management (aging). Let's touch them one for one.

physical characteristics
Physical constraints within warehouses—such as sprinklers and support columns—require careful planning. Sprinkler systems, often installed above aisles for fire safety and insurance purposes, are vulnerable to damage by forklifts. Their accidental activation can cause substantial damage. Therefore, consider alternative fire protection solutions (e.g., concrete walls, fire curtains, or fire doors) where possible.

Structural columns also pose layout challenges. Unfortunately, building design and column placement often precede racking design, whereas ideally, the two should be aligned from the start.

Zones. If you have items with special dimensions or treatments, it makes sense to define different zones. Within a zone you can optimize. Just keep that in mind.

Furthermore, the courses themselves are always the subject of discussion. Make sure you register the dimensions properly (Master Data!), the fewer deviations, the fewer problems. Furthermore, it is important that you record the volumes well in the item data (so Master Data again!).

Why is it important to include volume data? If you can trust the available volumes and the incoming volumes, you can set up automatic allocation into the racking in the system. The employee or robot does not have to look for an empty spot, but it is determined in advance based on the volumes. But that only worked if the dimensions are registered the right way, maintenance is key.

Increasingly you see software that supports your suppliers to supply better data of 'their and your' products which feed into your systems directly. Of course, you have to see that you can give your authorization to automatic feed in this information into your systems. But at least

you should come in a situation that you don't have to obtain that data and type in your systems yourself. In the end it's also in the interest of the supplier they can trust you have the right information of 'your' products in your systems as well.

Storage Algorithms

Automated allocation of incoming goods to appropriate storage locations is one of the most efficient strategies for streamlining warehouse operations. The foundation for this process is a robust algorithm.

Key algorithm elements include:

- ABC Classification (based on turnover rate)
- Assignment of fixed vs. dynamic picking locations
- Refill logic for fixed locations

For example, if you assign fixed picking locations, ensure that replenishment inventory is stored directly above the pick face. This dramatically improves order picking efficiency and ergonomics.

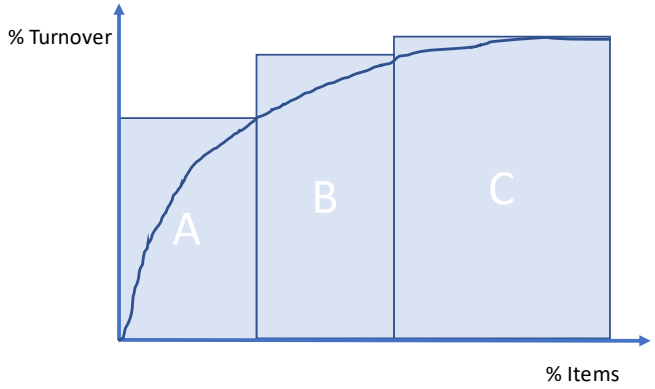
ABC Logic

ABC logic is a cornerstone of warehouse optimization. It follows the Pareto principle: a small percentage of items often drives the majority of activity.

- A-items are the fast movers, 20% of the items responsible for 80% of the turnover. So, a high turnover rate, practically in every sales order, so a high pick frequency. From an inventory standpoint you should try to minimize relative stock cover (in weeks cover 1-2wks for instance), in absolute sense this can be still high. The frequency of replenishment can be also high etcetera. From a picking-standpoint, you want this item to be on a location near to your loading point, walking distance should be minimized because you have to walk this distance more often than for a C-item. Therefore, determine a fixed pick location for this item. See that the refill location is directly above the fixed one. So, organize everything in a way that distances as a low as possible.
- C-items are you slow movers, 80% of the items are responsible for 20% of the turnover. So, a low turnover rate, only for specific customers, so a low pick frequency. From an inventory standpoint you should try to optimize relative stock cover (in weeks cover something like 3-4wks), in absolute sense this can be still relatively low. The frequency of replenishment should be lower etcetera. From a picking-standpoint, you don't want this item to be on a location near to your loading point, walking distance can be higher than for an A-item, but because you don't walk this distance as many times a day, compared to an A-item. So don't determine a fixed pick location.
- B-items: this is an intermediate category, often also seasonally determined e.g. Here you want to have a little more flexibility, so occasionally you reorganize the warehouse to make it logical again in terms of turnover speed, distances, and the like.

Fixed pick locations. So, determine for your main items a fixed location with the refill location directly above the ground-position. The logical order of fixed items is very often based on weight. So, the highest weight item is picked first on a pallet. Sometimes you see

flexible fixed locations, this for instance for seasonal products, which are in the high season behaving like an A-item but in the low-season like a C-item.



Pareto analysis, also called 80-20 rule. Most powerful and simple applicable measure to increase efficiency in Warehouse. In terms of stock policy/warehousing:-

- A-items: low stock, high frequency of replenishment, turnover rate; In terms of walking distance near loading; fixed pick locations
- C-items: more stock, low frequency of replenishment, turnover rate; In terms of walking distance further away from loading; no fixed pick locations
- B-items: are in between A and C items

5

In some cases, flexible fixed pick locations are applied—especially for seasonal items that behave as A-items in high season and C-items otherwise.

Cycle Counting

Cycle counting is a continuous and integrated inventory control method designed to maintain alignment between system and physical stock without full inventory shutdowns.

Benefits:

- Prevents unpleasant surprises during order picking due to stock discrepancies
- Integrates seamlessly into daily warehouse operations
- Requires only short time investments (15–30 minutes) by regular warehouse staff
- Is ideally tied to ABC classification (A-items counted more frequently than B or C)

Modern ERP systems often support cycle counting as a standard function. Companies must decide whether to integrate it into the picking process or schedule it during quieter warehouse periods.

Inventory Aging & FIFO

Inventory aging refers to ensuring older stock is used before newer arrivals, typically managed via **First In, First Out (FIFO)** principles.

This usually involves:

- Managing inventory via lot or batch numbers
- Tracking production or arrival dates
- Aligning stock rotation with shelf life or best-before dates (BBD)

In retail food logistics, for example, a common rule of thumb is that 1/3 of the BBD is allocated to the supplier and 2/3 to the retailer. Managing by lot number and BBD ensures optimal freshness and waste reduction.

A5. Order Picking

Creation of order picking order

In the Transport Management environment, a trip planning has been made. A trip schedule indicates which car or type of car will drive out, which trips in the coming day or tomorrow. Often A is planned for B as it is called, or ABC is also common. And of course, there are all kinds of other variants possible. A is day 1 on which the sales order is definitively booked, day 2 (B) is used to pick what has to be loaded and that day C is the driven day. In the case of A for B, it is meant that on day 1 both the Sales Order is booked and picked and day 2 (B) is then the driving day. It will be clear that there are all kinds of variants of these methods, certainly depending on the type of good and type of customer, but also the distribution area plays a role.

When we start picking orders, there has usually been a trip optimization taken place in which the trips are spread as efficiently as possible over the available cars. Based on the planned trips, a dock schedule is made, so which car must be at the dock at what time to be loaded. This is then the starting point to plan the order pick. For the dock is usually an imaginary size of the car drawn. In that box, the order picker must place the orders in the order as later delivered by car. Then the Order picker starts with his assignment. This can be per trip; it can also be that the load goes partly with batch picking.

There are several order picking methods to think of: -

1) Per trip. Here the numbers per item per trip are totalized to be picked in one go;
2) Per customer. You pick all the goods for one customer in one go;
3) Batch picking. Similar as per trip only you do this for all trips summarized. So, basically per article for all planned trips.

Often people speak of order picking about waves, so e.g., in the morning is picked for loading this afternoon or something similar. The morning is then the wave.

There are undoubtedly other methods to think of or differently ways of waves, but that depends so much on article or sector and the distances that must be covered.

An order picker usually works with a list that states which item should be picked.

The picking itself is certainly done in large warehouses with voice picking nowadays. The order picker then gets communicates how much of which item he has to pick from which box. All kinds of control measures have been put around it, such as if he takes out an article, is it indeed the right article from the right box? The kinds of controls are there to prevent errors as much as possible.

Meanwhile, there are all kinds of other forms of automation. Amazon is turning order picking completely upside down. They leave the order picker on the place and the racks come to the order picker. That is of course also a possibility.

A6. Transport-readyness

Goods are made transport-ready—stacked, boxed, and wrapped. Ensure the load can withstand transport conditions.

A7. Shipment Preparation

Final checks ensure completeness. The driver confirms the load, reviews documentation, and ensures the delivery sequence is correct. Digital consignment notes (e.g., e-CMR) reduce errors and paperwork.

Secondary Functions (B1–B4)

B1. Returns (RMA)

Returns, both expected and unexpected, should be handled through a clear Return Merchandise Authorization (RMA) process.

Returnsmanagement

	Inbound	Outbound
Expected Returns	Contact Supplier, what they would like. In many cases, returns are requested with an RMA number, which is also the safest for both parties. Often because of distances, downgrading (price reduction) or destruction is requested. In case of destruction, make sure you have photo material of the goods and document them properly, to avoid whining afterwards.	Would always request to use RMA procedure as much as possible. In those cases, the link with Sales order/ customer is clear. Upon arrival of goods, this relationship is also easy to establish.
Unexpected Returns	At the very least, write down the license plate number of the car and company with which shipments are delivered. If papers are missing, you may still be able to retrieve them via license plate and company name.	That is an advantage if you provide goods with a lot number. Especially if that lot number is also very specific. The more generic, the more difficult it is to see who has ordered those goods.

8

- **Inbound – Expected**: If goods are rejected upon receipt, an RMA is created based on consultation with the supplier&purchaser. This RMA includes photos, justifications,

and clear instructions for the supplier. Often, items are returned to learn from the failures, for statistical reasons, to prevent fraud and ensure traceability.

- **Inbound – Unexpected**: Without an RMA, suppliers may not understand the reason for the return, leading to confusion. Large organizations especially benefit from formal RMA procedures.
- **Outbound – Expected**: Customers should have access to an easy return form that generates an RMA number. This number links the return to the original sales order, streamlining the reverse logistics process.
- **Outbound – Unexpected**: Unplanned returns without an RMA can disrupt processes and create uncertainty. Applying RMA principles to both inbound and outbound flows is essential.

B2. Dock/Yard Management

This function focuses on managing dock occupancy and yard logistics. It includes:

- Allocating dock slots to internal and external vehicles
- Enabling carriers to reserve timeslots via online portals
- Optimizing throughput in both inbound and outbound flows

Proper Dock/Yard Management reduces bottlenecks and enhances coordination between warehouse and transportation activities.

B3. Quality Management

Quality Control (QC) can follow two primary approaches:

- **Status-Based**: Items are stored with a status like "to be inspected." They are not available for sale until released. This method avoids extra physical movement.
- **Zone-Based**: Goods requiring formal inspection are stored in a quarantine zone until cleared. This is common in regulated sectors like pharma.

In more critical environments, dedicated QC modules or software are used to manage inspection reports, test results, and product release.

B4. Cross-Docking

Cross-docking is when goods bypass storage and move directly from receiving to shipping. This approach is used to:

- Reduce handling time
- Improve delivery speed
- Consolidate shipments from multiple sources for one destination

A typical use case is when multiple orders are routed through the same distribution center and shipped together to a customer. True cross-docking links inbound receipts directly to outbound delivery documents.

Supporting Functions (C1–C3)

C1. Lot Management

Lot management enables full traceability throughout the supply chain. A supplier assigns a lot number to each production batch, which is then linked to purchase orders, production orders, and sales orders in your system.

- **Tracking** follows the path downstream—where the product has been shipped.
- **Tracing** works upstream—from a consumer product back to the materials used in production.

This is especially critical in food and pharma sectors for safety and regulatory compliance, but it also applies in maintenance and manufacturing environments.

C2. Multi-DC (Distribution Centers)

A Multi-DC setup allows multiple warehouses to operate with their own inbound, storage, and outbound flows. Distribution centers can supply each other based on demand, using replenishment and transport orders generated by the ERP system.

Each DC can operate with its own inventory levels and policies (e.g., min-max stock), enabling a flexible and responsive supply network.

C3. Master Data Management

Master Data is foundational to warehouse operations. In a narrow sense, it refers to item-level data such as weight, dimensions, and volume. More broadly, it includes storage locations, racking dimensions, and zone definitions.

Accurate Master Data is essential for automation and efficiency. Poor data quality leads to incorrect storage assignments, picking errors, and wasted resources.

Maintaining good Master Data requires discipline, but the return on effort is substantial. Grouping items logically and attaching attributes helps create programmable rules and scalable processes. Automating data exchange with suppliers can also boost consistency and reduce manual work.

A structured Master Data approach is the backbone of any high-performing warehouse system.

Closing Words

Try to separate the As-Is and the To-Be as much as possible. It’s important to understand why the As-Is is the way it is. While it's easy to point out flaws, it's equally important to preserve what works well. When you change, start with a full understanding of where you're coming from.

The reference model helps challenge and shape both your current state and your future ambitions. Once both are mapped, outline clear steps with timelines to move from A to B. And then—take the first step.

-/-/-