



ESSENSIUM

Safety isn't just for humans anymore.

The hybrid warehouse

2026



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Why the hybrid warehouse needs a new safety language

Warehouses are entering their most ambitious automation phase in fifty years. Autonomous mobile robots, automated guided vehicles and traditional manned forklifts increasingly share the same floor, sometimes the same aisle.

The promise is clear: higher throughput, lower labour cost, round the clock operations.

The risk is equally clear: collisions, downtime, damaged robots and a measurable rise in near miss incidents.

Most warehouses are not failing at automation. They are failing at coexistence.

This whitepaper argues that the hybrid warehouse is no longer a 2030 vision. It is operational reality in 2026.

And it requires a new safety logic.

Tags, anchors and proximity beepers were designed for human only fleets. They cannot govern the millimetre precise, predictive interactions needed when a two ton forklift turns a corner into an AMR carrying €40,000 of pharma stock. **The vehicles have evolved. The safety language has not.**



Essensium RoboTrack™ is built for that reality. It extends Essensium's tagless, infrastructure free positioning platform to autonomous vehicles, letting forklifts, robots and pedestrians share situational awareness in real time. There are no retrofitted markers on the robot and no special infrastructure on the floor.

Just one shared safety layer across the whole mixed fleet.

Safety is only the start. In the hybrid warehouse, it is also the only way productivity scales.

60%

of EU warehouses will run hybrid fleets by 2030

4x

higher incident risk in mixed traffic zones

< 24 mo

ROI on integrated hybrid safety

The hybrid warehouse is already here

Ten years ago, automation in the warehouse meant a fixed conveyor or a pallet shuttle.

Five years ago, it meant a fleet of AGVs running a closed loop, fenced off from the rest of the operation.

Today it means something far more complex: autonomous mobile robots that share open floor with manned forklifts, electric pallet trucks and pedestrians, making real time routing decisions and responding to dynamic priorities.

The cage has come down. The shared floor is here.

This shift is not theoretical. In FMCG, seasonal peaks force operators to add AMR capacity alongside legacy forklift fleets, so coexistence rather than replacement becomes the strategy. In pharma and healthcare, cold chain pressure and audit requirements favour AMRs for repeatable tasks while manned vehicles still handle inbound, outbound and exception work.

In automotive, JIT logistics push robots toward production lines while forklifts continue to move bulk in the same building. In 3PL, the labour shortage and 24/6 operations make mixed fleets the only viable structure. And in industry and manufacturing, AGV integration with production lines means that line side robots routinely cross paths with forklifts moving raw stock.

The pattern is consistent across every sector Essensium serves: **hybrid is rarely a deliberate choice.** It is the residue of automation strategies that meet operational reality.

You bought five AMRs. You still have forty forklifts.

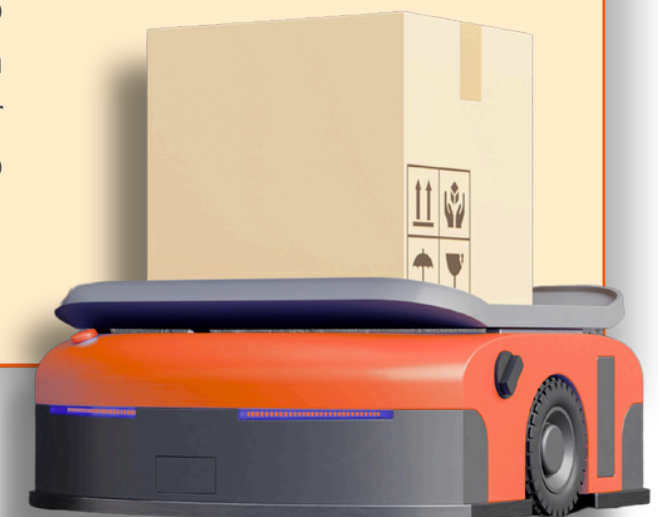
They have to coexist today, not in 2030.

THE NEW FLOOR DYNAMIC

A manned forklift moves at human pace, with human eyes, human judgement and human responsibility. An AMR moves at programmed pace, with sensor bounded awareness and rule based judgement. Neither is wrong. But the rules each system was designed for were written in isolation, back when forklifts ruled the floor or when robots ran caged loops.

The hybrid warehouse breaks that isolation, and every blind spot between the two systems becomes a measurable risk.

The challenge is no longer that one type of vehicle is unsafe. The challenge is that two safe systems, operating side by side, can still produce unsafe outcomes when neither understands what the other intends to do next.



The hidden cost of unsafe hybrid fleets

Hybrid risk does not show up in a single line item. It hides across a dozen of them, which is why it stays invisible until something breaks.

The cost is real, but distributed: a damaged robot here, a hesitating driver there, a downtime cascade on a Tuesday afternoon that nobody traces back to the underlying coexistence problem.



Start with capital exposure.

A mid range AMR represents somewhere between €40,000 and €120,000 of investment. A single forklift sideswipe can write off the unit or trigger weeks of waiting for replacement parts. But the robot itself is rarely the biggest line item. AMRs operate in fleets, and when one is offline, throughput planning across the whole flow breaks.

The real cost is not the broken robot.

It is the missed shift, the rerouted orders and the planning team explaining to operations why output dropped fifteen percent on a normal Wednesday.

Then there is the cost that never gets reported.

Forklift drivers who do not trust AMR behaviour quietly slow down or stop entirely. They take longer routes, hesitate at intersections, choose to wait rather than commit. Throughput drops invisibly because no incident report ever gets filed. There was no incident. There was just an experienced operator deciding the safe move was not to move. Multiply that across a shift, across a fleet, across a year, and the cumulative productivity loss dwarfs the headline grabbing collisions.

Insurance and audit exposure form a third layer. Hybrid environments without integrated safety data are increasingly flagged by underwriters and ISO auditors as elevated risk. The premium goes up, the audit takes longer, and the questions get harder.

Finally, and most worryingly, there is the **pedestrian dimension**. Warehouse operators have spent decades learning to anticipate forklifts. They have not learned to anticipate silent, low profile robots.

The combination of an AMR a pedestrian does not see and a forklift the AMR cannot predict is the most under discussed risk on hybrid floors today.

What CFOs are starting to see

When automation projects miss their ROI window, the root cause is often not the automation. It is the unplanned coexistence cost (slowdowns, damage, downtime) that nobody priced into the original business case. Hybrid safety is no longer a HSE line item. It is a productivity guarantee.

Why traditional safety systems break in hybrid traffic

Three generations of warehouse safety technology coexist in the market today, and each one was designed for a problem that no longer fully exists. Understanding why they fall short in a hybrid environment is the prerequisite for understanding what should replace them.

The first generation is built around proximity beepers and warning lights. These systems are **reactive by design**: they notify after detection, not before. In hybrid traffic, by the time a beeper sounds, the AMR has already adjusted its path and the forklift driver has already committed to a manoeuvre. The system alerts everyone to a problem it cannot help solve.

Alarm fatigue is the predictable outcome, and operators learn to filter the noise rather than respond to it.

The second generation moved from reaction to **localisation**, using tag and anchor based real time location systems built on UWB or Bluetooth. These are a meaningful step forward for forklift only environments.

But they were designed for known assets carrying tags, and AMRs from different vendors rarely accept retrofitted tags. Even when they do, the tag tells you where the robot is, not what it intends to do next.

Add to that the cost of installing and maintaining anchor infrastructure across every zone of the warehouse, and **the technology becomes both incomplete and expensive**.

The third generation comes from the robot vendors themselves. Every AMR brand ships its own collision avoidance stack, and each one is excellent at protecting its own robots from its own robots. None of them speak to your forklifts, and none of them speak to each other. A site running three AMR vendors and a forklift fleet ends up with four separate safety systems, four separate dashboards and four versions of the truth. The result is not safety. It is fragmentation pretending to be safety.

The fundamental issue is not detection. It is shared language. In a hybrid warehouse, every vehicle, manned or autonomous, needs to operate inside the same field of awareness.

What hybrid environments actually need is the opposite of what each generation delivered.

- They need **prediction before risk forms**, not detection at the moment of risk.
- They need a **cross fleet view** that covers forklifts, robots and pedestrians together, not asset specific silos.
- They need deployment that is **tagless and infrastructure free**, not dependent on per zone hardware.
- They need **vendor agnostic compatibility**, not vendor lock in.
- And they need **continuous shared situational awareness**, not single event alerts.
- Above all, the **safety data needs to feed productivity decisions** instead of sitting isolated in a HSE report that nobody reads after the quarterly review.

What RoboTrack™ does differently

RoboTrack™ extends Essensium's tagless, vision based positioning platform, already proven on forklifts at scale, to autonomous mobile robots and AGVs. It does not replace the robot's onboard safety stack, which continues to handle the close range obstacle avoidance the robot was designed for. Instead, RoboTrack™ adds the layer that has been missing from hybrid operations until now:

Shared awareness across the entire mixed fleet.

The mechanism is straightforward in principle. Every Essensium equipped vehicle, whether a forklift, an EPT, an AMR or an AGV, broadcasts and receives positional and predictive data through the same Essensium Positioning System. The robot's own navigation continues to do its job exactly as before. **RoboTrack™ contributes the awareness layer:** continuous knowledge of every other moving object that the robot's sensors cannot see fast enough or far enough to react to in time.

The Essensium principle

Safety belongs to the warehouse, not to the vehicle. Whoever made the forklift, whoever made the robot, they all operate inside one shared field of awareness. That is the only way hybrid scales.

Four characteristics make the approach distinctive:

1

It is **tagless on the robot itself**. There is no retrofitted hardware on the AMR, which means the robot stays warranty compliant and the integration happens at the data layer rather than the chassis.

2

It is **infrastructure free**, with no anchors, no UWB grid and no reflectors to install or maintain; deployment time is measured in days per site rather than months.

3

It is **vendor agnostic**. Essensium does not compete with the robot, it amplifies it, which means a site can change AMR vendors next year without rebuilding its safety platform.

4

It is **predictive rather than reactive**: RoboTrack™ does not wait for proximity, it anticipates path conflicts seconds before they form and issues coordinated slowdowns or reroutes.

All of this surfaces in a single place.

Every interaction, whether forklift to forklift, forklift to robot, or vehicle to pedestrian, appears in the same **Customer Cockpit**. One heatmap, one log, one source of truth, regardless of how many vehicle types or how many vendors are running on the floor.

The safety story and the productivity story stop being told in different rooms by different people. They become the same story, with the same data behind it.

Proof point: Essensium and Lowpad

Lowpad designs and builds compact autonomous transport robots used in distribution centres across Europe. Their AMRs are precise, low profile and fast, which makes them exactly the kind of vehicle that becomes invisible to a forklift driver focused on a pallet load. The technology is excellent. The coexistence problem it inherits is universal.

Essensium and Lowpad began collaborating to answer a question their joint customers kept asking:

'How do you guarantee that a Lowpad robot and a manned forklift can safely cross paths in a live, productive aisle, without either of them having to slow down to a crawl?'

The customers were not asking for a thicker safety manual. They were asking for a way to make hybrid work at full speed.

The technical challenge had three dimensions:

- **Lowpad's onboard sensors** handle near field obstacles excellently but cannot anticipate a forklift accelerating around a blind corner.
- **Forklift drivers**, even highly trained ones, struggle to spot a low profile AMR in their peripheral vision while reversing or turning, and the geometry of a typical reach truck makes that worse, not better.
- And **site managers** wanted shared visibility across the operation rather than two separate dashboards from two separate vendors that disagreed about what had just happened in aisle seven.

The approach Essensium and Lowpad piloted is the practical expression of the RoboTrack principle. Lowpad robots operate alongside Essensium equipped forklifts inside the same EPS field, with both fleets sharing predictive position and intent data in real time. The Customer Cockpit shows every interaction, whether manned or autonomous, on a single congestion map, with the same definitions of near miss, slowdown and productivity affecting event applied uniformly across vehicle types.

The Lowpad collaboration validates the core RoboTrack thesis. When robots and forklifts share a positioning layer, coexistence stops being a risk and starts being an advantage.

Joint operational findings

Mixed traffic interactions were **continuously visible** from day one, surfaced in a single dashboard rather than reconstructed after the fact from two separate logs.

Forklift driver hesitation around AMR zones dropped sharply once drivers could trust that the system was watching both directions on their behalf.

Site managers gained a unified view of mixed fleet activity, including heatmaps showing where forklift to robot interactions concentrated, which directly informed layout and routing decisions that would have been invisible without the shared data layer.



A four phase rollout framework

Hybrid safety projects fail when they try to do everything at once. The temptation is understandable. You want the full picture from day one, every vehicle visible on every dashboard. But that approach delays value, overwhelms the change management capacity of the site, and gives you nothing to anchor the business case against when the inevitable budget review arrives.

Essensium's recommended sequence is deliberately incremental, with each phase delivering measurable value before the next begins.

OPERATING PRINCIPLE

Start with the forklifts. You already have them and they cause most incidents.

Add the robots second. They amplify the productivity gain.

End with continuous optimisation. That is where the compounding ROI lives.

1

Phase 1. Baseline (weeks 1 to 4)

Equip the manned forklift fleet with SafeTrack™ and capture six to eight weeks of operational data. **This phase is about evidence**, not transformation. *Where do near misses cluster? Where do drivers slow down? Where are the congestion hotspots?* The data captured here becomes the reference point for everything that follows, and it almost always reveals patterns that the site team suspected but could not prove.

2

Phase 2. Cockpit Alignment (weeks 5 to 8)

Activate the Customer Cockpit and bring HSE, operations and automation leads into the same dashboard. **The work in this phase is not technical, it is definitional.** *What counts as a near miss? What counts as a productivity affecting interaction?* Hybrid safety only delivers value when these definitions are shared across the functions that will use them, and getting that agreement before AMRs enter the picture is dramatically easier than negotiating it afterwards.

3

Phase 3. Hybrid integration (weeks 9 to 14)

Activate RoboTrack™ across the AMR or AGV fleet. Robots and forklifts now share predictive awareness, and the Cockpit heatmaps automatically distinguish between manned only zones, autonomous only zones, and mixed traffic zones. The mixed traffic zones are usually where the largest optimisation opportunities live, and they are also where most sites discover they had been under investing in shared safety logic without realising it.

4

Phase 4. Continuous optimisation (ongoing)

Use Cockpit data to redesign aisles, adjust priority lanes, schedule AMR work outside forklift peak hours, and feed driver analytics back into operator coaching. **This is where the compounding ROI lives.** Customers consistently report that the improvement curve accelerates after the first quarter rather than flattening, because each iteration of layout and process change produces fresh data that informs the next iteration.



The hybrid safety business case

Hybrid safety investments justify themselves through three reinforcing categories of value. None of them is hypothetical. They reflect outcomes Essensium has measured across deployed sites in FMCG, pharma, automotive and 3PL. What matters for the business case is that they reinforce each other: the cost you avoid funds the productivity you recover, and the productivity you recover funds the strategic optionality that protects the next investment cycle.

Avoided cost

The most immediate financial impact comes from costs that simply stop occurring. Robot damage and replacement avoidance is the most visible line, but it sits alongside downtime cascade prevention, where one offline AMR can halt an entire flow and stopping that cascade is worth more than the robot itself. Pedestrian incident exposure drops in parallel, with the insurance and audit implications that follow. In regulated sectors, the lower audit and compliance overhead alone often justifies the deployment.

Recovered productivity

The less visible but larger impact is on productivity that was being lost without anyone noticing. Forklift drivers stop hesitating around AMR zones, which shows up directly in cycle time data. Empty forklift runs, which sit at around sixty percent of routes in a typical warehouse, drop toward thirty percent once shared visibility allows for dynamic routing. AMR fleets begin operating at their design throughput rather than at the conservative slowdown speeds the planning team had quietly set to manage risk. And as pallet visibility carries across the hybrid fleet, stock counts get faster and outbound errors decline.

Strategic optionality

The third category is the hardest to quantify in the first business case but the most valuable over a five year horizon. Future AMR vendor switches no longer require a safety system rebuild, because **Essensium is vendor agnostic.** Layout changes become data driven rather than intuition driven. And new automation use cases such as drones, autonomous tugs or exo skeletons plug into the same EPS field rather than requiring a parallel safety stack. The platform you install for today's hybrid problem becomes the platform that absorbs tomorrow's hybrid additions.

Metric	Pre Essensium baseline	After full RoboTrack rollout
Near miss incidents	Industry average	Measurable reduction within 3 months
Forklift empty runs	~60% of routes	~30% of routes
Outbound errors	Industry average	Down to a fraction of baseline
AMR damage events	Recurring	Significantly reduced
Payback period	n/a	Under 24 months at most sites

Essensium customers consistently see full ROI within twenty-four months, and operationally relevant safety improvements within the first quarter of deployment. The numbers above are conservative. Sites with high vehicle density or particularly complex hybrid layouts often outperform the benchmarks by a meaningful margin.

The 2030 outlook

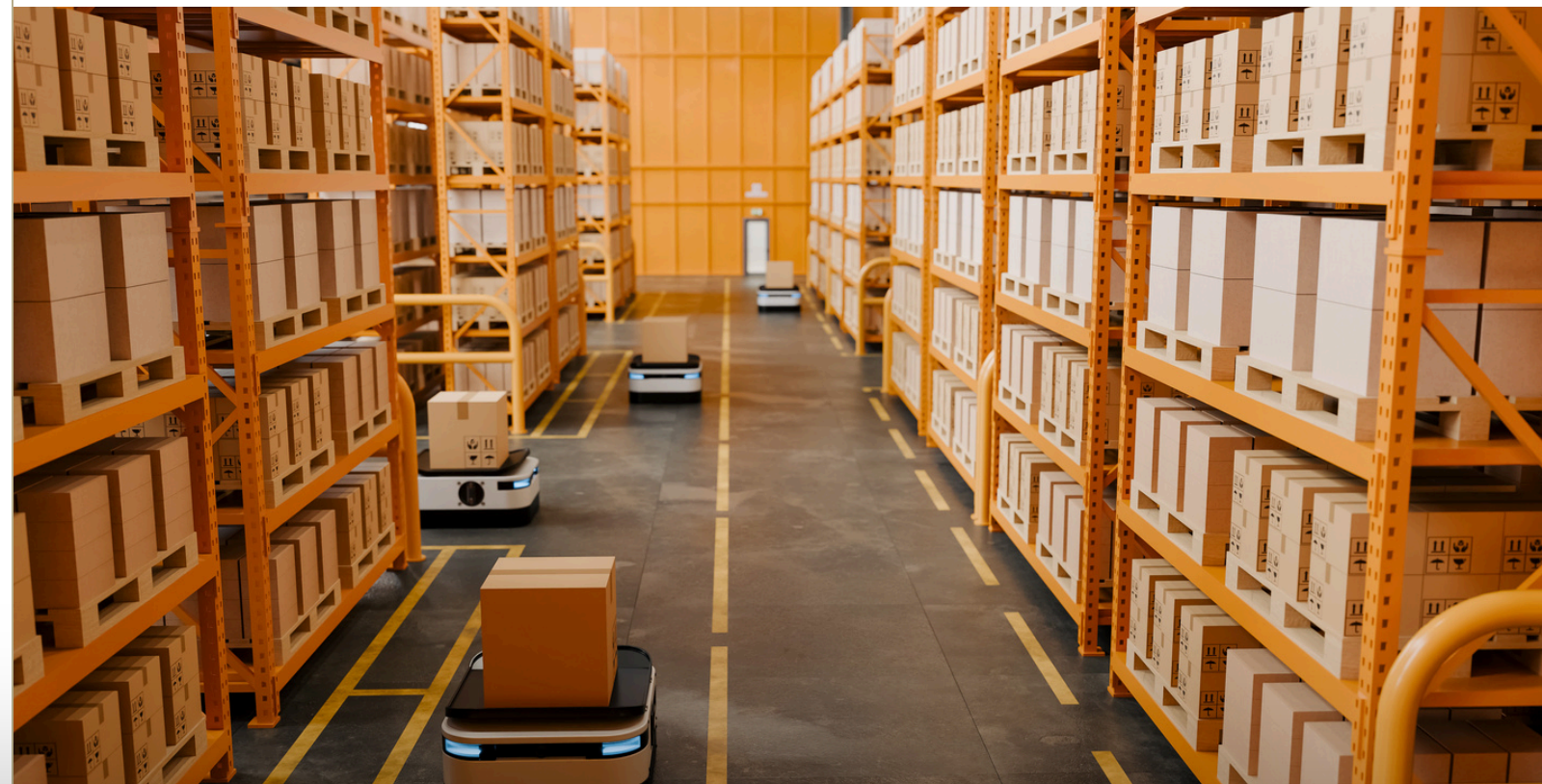
Hybrid is not a destination. It is a transition state on the way to a more deeply intelligent warehouse, and the next five years will harden the case for an open, vendor agnostic safety platform considerably.

The clearest shift is that **AMR density will not simply grow, it will diversify**. The number of robots per site will increase, but the number of vendors per site will increase faster. By 2030, most warehouses are likely to run three to five robot vendors simultaneously, each optimised for a specific task: one for tote handling, another for pallet movement, a third for line feeding, perhaps a fourth for inventory. In that environment, **the need for a unifying safety layer stops being optional and becomes structural**. No single vendor's proprietary safety stack can govern an aisle that contains three other vendors' robots and a forklift.

Alongside that, **the boundary between safety data and operational data is dissolving**. Near miss patterns, congestion maps and driver to AMR interaction data are already being used not just for HSE reporting but for layout design, shift scheduling and capacity planning. **By 2030, the idea that safety dashboards and operations dashboards are separate tools serving separate audiences will look as outdated as separate customer files for sales and support**. The data is the same. The decisions it informs are connected. The platform that recognises that earliest wins.

Both of those shifts will be reinforced by external pressure. EU and US underwriters are already differentiating insurance premiums based on integrated safety data, and regulators are moving in the same direction. **By 2030, hybrid sites without an auditable, cross fleet safety platform are likely to face quantifiable insurance penalties on top of the operational cost.** The warehouse that can produce, on demand, a complete record of every mixed traffic interaction across every vehicle type will be operating on a fundamentally different cost base from the one that cannot.

By 2030, the question will not be whether your warehouse is hybrid. It will be whether your hybrid warehouse can prove, every shift, every incident, every audit, that it is genuinely under control.



Next steps

The right time to think about hybrid safety is *before* the next AMR purchase, not *after* the first incident.

Several signals tend to indicate that the conversation about RoboTrack™ is timely.

- You already run a mixed fleet of forklifts and AMRs, or you will within twelve months.
- Your automation business case assumed clean coexistence and reality has proved more complicated.
- Forklift drivers are hesitating, slowing down or rerouting around AMR zones.
- You operate two or more separate safety dashboards across forklift, AMR and pedestrian systems.
- Or you are planning an AMR vendor expansion and want safety to be vendor agnostic from the start.

If two or more of those describe your operation today, the cost of waiting is already accumulating.

A four week assessment

Essensium can deliver a structured assessment of your hybrid floor in under four weeks: traffic mapping, near miss baseline, AMR and forklift interaction analysis, and a phased rollout plan with measurable success criteria. **No commitment to a full deployment is required.** Just clarity on what hybrid safety would deliver at your site, and what the realistic payback profile looks like for your specific operation.





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From no sight - To full insights

Safer people. Smarter warehouses. Stronger results.