



EBOOK

The Private Network Impact

Warehousing in Industry 4.0



Warehousing plays a vital role in the modern supply chain, acting as both a logistical nerve center and a critical bridge between manufacturers, suppliers, and consumers. As e-commerce growth has redefined fulfillment expectations — faster deliveries, tighter inventories, and real-time visibility — the demands placed on warehouses have intensified. Once viewed as static storage facilities, warehouses are now dynamic, high-throughput environments requiring precision, speed, and scalability.

But with this evolution comes complexity: high labor turnover, rising operational costs, space constraints, and technology fragmentation all threaten profitability. As overhead continues to climb, warehouse operators are increasingly turning to automation — not just as a tool for efficiency, but as a strategic imperative. Automation is reshaping the warehousing sector as part of the broader Industry 4.0 movement, helping operators adapt, compete, and thrive in the complex supply chain and logistics ecosystem.



The Rising Overhead Costs in Warehousing

The cost of operating a warehouse has risen sharply in recent years, driven by a convergence of persistent labor shortages, rising wage expectations, and inflationary pressure across real estate and materials.

Demand for industrial space remains high, especially in urban centers and transportation hubs, which keeps occupancy rates tight, and rents elevated despite broader commercial vacancies. At the same time, workforce instability has pushed average hourly rates upward, while stricter service-level expectations require more intensive staffing, training, and performance monitoring.

But it hasn't been increases in labor, real estate, or materials alone. The rise of e-commerce, same-day delivery expectations, returns processing and just-in-time inventory strategies has transformed warehouses into logistics hubs. This shift requires more space, faster cycle times, and a more agile workforce.

A recent industry survey from WarehousingAndFulfillment.com reveals a sharp uptick in warehouse operating costs between 2022 and 2024¹, highlighting the financial pressures driving automation and operational efficiency across the sector. The data, drawn from eight years of confidential responses — primarily from U.S. warehouse operators — offers insight into key pricing, wage, and performance trends.



Key Highlights

- ✔ Cost per square foot rose from \$7.96 in 2022 to \$8.31 in 2024, driven by tight warehouse occupancy despite higher commercial vacancies elsewhere.
- ✔ Hourly wages for warehouse staff jumped 13.2 percent over two years, from \$14.97 (2022) to \$16.95 (2024).
- ✔ Corporate profit margins declined to 9.37 percent in 2024, down from 10.58 percent in 2022, signaling tighter financial pressure across the industry.
- ✔ A typical 100,000 sq. ft. warehouse with 30 employees saw a \$159,720 cost increase over two years, an 8.31 percent rise.
- ✔ Performance tracking fell slightly, with 85 percent of warehouses monitoring KPIs in 2024, down from 89 percent in 2023.
- ✔ Minimum monthly order requirements dropped slightly (from 48 percent to 46.67 percent), but the average minimum value increased significantly.
- ✔ Pick and pack costs increased:
 - B2C orders rose to \$3.18 per item
 - B2B orders climbed from \$4.31 to \$4.79
- ✔ Only 31.48 percent of warehouses now include box fees, down from 71 percent in 2023, with an average markup of 16 percent.

The option to turn to digital solutions to mitigate rising costs has logistics leaders seeking ways to reduce costs and optimize efficiency.

WHERE AUTOMATION WORKS

Key Use Cases in Warehousing

The pressure on warehouses to do more with fewer people, tighter margins, and faster cycles has made automation not just a competitive advantage but a strategic requirement. Yet automation isn't a monolithic solution; it's a flexible toolkit that can be applied across every stage of warehouse operations. Whether improving speed, reducing errors, or unlocking better labor utilization, automation delivers a measurable impact when aligned with clear, high-friction use cases.

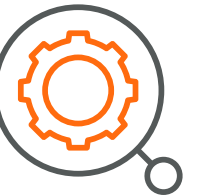
Numerous automation use cases can support warehousing operations to help boost efficiency, productivity, and reduce overhead.

Picking and Order Fulfillment

Order picking is labor-intensive and often one of the most significant costs in a warehouse, especially in e-commerce environments that demand speed and accuracy at scale.

Automation in action

- Autonomous Mobile Robots (AMRs) navigate aisles to bring items to human or robotic packers, reducing walking time and human fatigue.
- Robotic arms handle piece picking from bins or shelves with increasing dexterity and reliability.
- Voice-pick and vision-pick systems guide workers with wearable tech for faster, error-resistant performance.



Outcome

- ✓ Faster throughput
- ✓ Reduced labor costs
- ✓ Improved pick accuracy

Inventory Management and Cycle Counting

Accurate, real-time inventory is essential for replenishment, order accuracy, and profitability, but manual cycle counts are time-consuming and error-prone.

Automation in action

- Drones and mobile robots scan barcodes and shelf labels autonomously to conduct real-time cycle counts.
- RFID integration enables the passive, continuous tracking of goods in motion without requiring manual scans.
- IoT sensors can monitor inventory levels in bins and trigger automated replenishment alerts.



Outcome

- ✓ Improved inventory accuracy
- ✓ Reduced shrinkage
- ✓ Minimized operational disruptions during counts



Inbound Receiving and Putaway

The faster goods are processed and shelved, the quicker they're available to fulfill orders. Bottlenecks here delay the entire workflow.

Automation in action

- Conveyor-fed scan and sort systems receive goods, weigh and identify them, and direct them to appropriate locations.
- Automated forklifts and tuggers handle putaway for high-velocity SKUs in large facilities.
- AI-powered slotting ensures goods are stored in optimal zones for speed and retrieval efficiency.



Outcome

✓ **Reduced** dock-to-stock time

✓ **Better** use of space

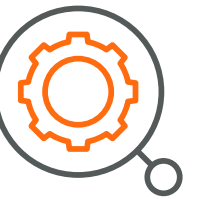
✓ **Increase** putaway

Sortation and Packing

Once items are picked, they need to be accurately sorted, packed, and labeled for shipment with speed and precision.

Automation in action

- Automated sortation systems handle high-volume B2C and B2B workloads, routing items to the correct chute or lane.
- Box optimization machines custom-fit packaging to the product, reducing void fill and shipping costs.
- Labeling and sealing robots finalize outbound packaging with speed and consistency.



Outcome

✓ **Faster** outbound cycle times

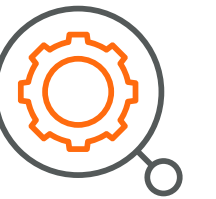
✓ **Fewer** packaging errors

✓ **Reduced** shipping costs



Material Handling and Transport

Manually moving goods across a large facility is slow, unsafe, and unscalable. Autonomous transport improves flow and safety.



Automation in action

- AGVs (Automated Guided Vehicles) and AMRs move goods from receiving to storage to shipping docks without human intervention.
- Conveyor and shuttle systems automate the vertical and horizontal transport of goods across complex zones.

Outcome

- ✓ **Safer** work environment
- ✓ **Reduced** congestion and delays
- ✓ **Lower** dependency on forklifts and pallet jacks

Environmental and Predictive Monitoring

For temperature-sensitive or high-value goods, real-time monitoring can prevent loss, spoilage, or regulatory issues.

Automation in action

- IoT sensors monitor humidity, temperature, vibration, or light exposure on product pallets or within warehouse zones.
- Edge-based analytics trigger alerts or corrective action locally without waiting for cloud processing.
- Predictive analytics model equipment wear, flag maintenance needs, and help prevent unexpected downtime.



Outcome

✓ **Reduced** product loss

✓ **Improved** compliance (FDA, ISO, etc.)

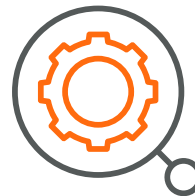
✓ **Greater** equipment uptime

Labor Augmentation and Workforce Safety

With labor shortages and rising injury costs, automating risky or repetitive tasks helps protect both the bottom line and workers.

Automation in action

- Cobots (collaborative robots) work safely alongside humans, lifting heavy items or assisting with tasks.
- Exoskeletons and wearable tech enhance worker safety and endurance in physically demanding environments.
- AI-powered scheduling and task management systems optimize labor deployment based on real-time demand and worker availability.



Outcome

✓ **Reduced** injury rates

✓ **Better** labor allocation

✓ **Improved** morale and retention



Automation as a Strategic Lever, Not Just a Tool

Warehouse automation is no longer confined to a single machine or workflow — it's a system-level strategy that unlocks efficiency across the full lifecycle of warehouse operations. Whether you're looking to streamline picking, improve inventory accuracy, or mitigate labor challenges, automation offers clear, measurable value when applied with purpose.

As the cost of doing business continues to rise and customer expectations show no sign of slowing, automation is no longer a future-proofing option, it's an operational necessity.

Capturing ROI in Private Networks

Conceptualizing the benefits of automation in warehouse settings can be helpful, but return on investment (ROI) will likely be one of the most critical questions to answer when considering the implementation of automation. This, of course, introduces risk and creates hesitation in deciding to integrate digital tools into the warehouse floor.

For example, using industry information to test a scenario reveals that a robust return on investment (ROI) can be achieved by leveraging automation in warehousing.

In this example, a mid-size warehouse decides to introduce robotic pickers and relocate its dedicated workforce to another area of warehousing.

Using generic, high-level numbers, the ROI can be calculated as such:

Initial Investment	\$500,000* (robotics pickers + deployment)
Annual Benefit	\$250,000/year (\$200,000** in labor savings + \$50,000*** in productivity gains)
Payback Period	2 years
5-Year ROI	150 percent

The Math

*Based on standard industry estimates for a 10-robot deployment in a mid-size warehouse, total automation investment typically ranges from \$400,000 to \$600,000. For this model, we use a \$500,000 midpoint to illustrate the return on investment (ROI) of representation.

**This estimate assumes a reallocation or reduction of 4-6 full-time (FTE) employees from manual picking roles due to the implementation of robotic picking systems.

Based on the WarehousingandFulfillment.com¹ findings, with an average wage for warehouse workers of \$16.95/hour and assuming 2,000 working hours per year:

- 1 FTE: \$33,900/year in wages (not including overhead)
- 6 FTEs = roughly \$203,400/year

This aligns with the \$200,000/year estimate and reflects a moderate shift in the workforce, rather than a total replacement.

***Based on industry information, this figure reflects increased throughput and order accuracy, which directly reduces return processing, costs, downtime, and delayed shipments.

- Industry information indicates that robotic pickers typically operate 2 to 3x faster and can operate longer hours, leading to faster fulfillment cycles
- They also reduce error rates, which can lower the cost of reverse logistics, customer service overhead, and inventory miscounts
- With this information, a modest assumption of a 5-10 percent increase in throughput across a mid-sized warehouse operation can be valued at a generic \$50,000 to \$100,000/year, depending on volume and product margins

Automation Is Only as Good as Its Network

Warehouse automation delivers a powerful return on investment (ROI), but only when it's backed by reliable, high-performance connectivity. In today's digital-first operations, a warehouse's network is just as critical as its forklifts, conveyor belts, or pick-and-pack systems. Without strong, consistent connectivity, even the most advanced automation tools can fail to deliver.

The Connectivity Challenge in Warehousing

Warehouses are notoriously complex environments for wireless communication. Tall shelving, thick walls, metal structures, and constantly moving machinery create dense signal interference and shadow zones. Traditional Wi-Fi, while cost-effective and familiar, often struggles with coverage, reliability, and congestion in these demanding environments. It's also not inherently designed to support time-sensitive or mobile automation systems, such as robotic pickers or AGVs, which require seamless handoffs and uninterrupted connections.

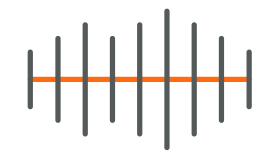
Similarly, public cellular networks offer broad coverage, but they weren't designed for indoor industrial settings. These networks share bandwidth with consumers and nearby businesses, resulting in frequent congestion, latency, and unpredictable performance. Worse, they may not extend reliably to every corner of a warehouse, especially in rural or metal-dense buildings.



The Rise of Private Cellular Networks

To solve these connectivity challenges, many forward-thinking warehouse operators are turning to private cellular networks. These are dedicated LTE or 5G networks deployed and managed on-site by the enterprise or a managed service provider.

Unlike Wi-Fi or public cellular, private networks offer:



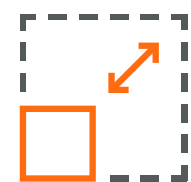
Dedicated spectrum and capacity: No bandwidth competition from neighboring users or consumer traffic.



Industrial-grade reliability: Ultra-low latency and high throughput, even in harsh environments.



Secure control: Enterprises manage their own user devices, traffic, and data, ensuring complete visibility and policy enforcement.



Mobility and scalability: Designed to handle large numbers of moving devices with seamless handovers, which is perfect for mobile robotics and autonomous systems.

Private networks, particularly those based on 5G, are also designed for deterministic communication, meaning you can predict and guarantee network performance, which is essential for time-critical automation workflows.

What Are Private Cellular Networks, Exactly?

A private cellular network functions much like a miniature version of a telecom operator's network, but its purpose is to serve a single organization. It includes its own radio access network (RAN), core network, and often uses licensed (like Band n53) or shared spectrum (such as CBRS). These networks empower warehouses to tailor connectivity to their unique needs, offering customizable QoS (Quality of Service), priority for critical devices, and seamless integration with automation platforms at the edge.

As automation becomes increasingly sophisticated, driven by AI, machine learning, and real-time analytics, the demand for robust, scalable, and reliable networks will continue to grow. For warehouses ready to unlock the next level of efficiency, safety, and intelligence, private cellular networks offer the foundation to build on.



WI-FI, SHARED LICENSED CELLULAR,
AND LICENSED CELLULAR

A Comparative Look at Warehouse Connectivity

How do networks support the connectivity demands in warehousing, and what are the various choices? While private networks are becoming more commonplace in warehouse and industrial settings, Wi-Fi remains a familiar choice.

Wi-Fi: Familiar, But Fragile

Wi-Fi is the default in many warehouse environments and for good reason. It's inexpensive, easy to deploy, and most devices are already built to support it. But that familiarity comes at a cost.

- **Congestion and interference:** Wi-Fi operates on unlicensed spectrum, meaning your network shares channels with every neighboring business, truck, or mobile hotspot in range. This makes performance unpredictable, especially in urban or industrial zones.
- **Limited mobility:** Wi-Fi networks weren't designed for moving endpoints like AMRs or robotic pickers. Seamless handoffs between access points are unreliable, resulting in dropped connections or lags.
- **Poor scalability:** As the number of connected devices grows, especially with IoT sensors and edge devices, Wi-Fi networks often buckle under the strain.
- **Security gaps:** While Wi-Fi can be secured, enforcing enterprise-grade security and policy control is more complex compared to cellular alternatives.

Wi-Fi is well-suited for office use or lightweight device communications but increasingly outmatched in the dynamic and data-heavy world of automated warehousing.

Cellular connectivity is gaining traction for private networks, but there is a significant difference between shared licensed and licensed spectrum.

Shared Licensed Cellular (e.g., CBRS GAA): A Step Forward, But Still Shared

The Citizens Broadband Radio Service (CBRS) offers mid-band spectrum (3.5 GHz) for private networks under three tiers: Incumbent, Priority Access License (PAL), and General Authorized Access (GAA). Most enterprises build their networks using the GAA tier, which is shared licensed but lightly regulated.

- + **Greater range and capacity:** CBRS GAA outperforms Wi-Fi in terms of signal propagation and stability, making it a popular bridge between Wi-Fi and licensed cellular.
- + **Better mobility:** Cellular standards (like LTE and 5G) natively support handoffs, ensuring mobile devices stay connected.
- + **Still shared:** Despite better performance, GAA is still shared licensed, meaning interference from nearby CBRS users is possible, and performance may fluctuate.
- + **Complex spectrum management:** Deploying CBRS requires SAS (Spectrum Access System) integration to manage interference and ensure compliance. This adds cost and technical overhead.

CBRS GAA is a strong intermediate step for enterprises seeking more reliability than Wi-Fi, but it lacks the predictability and exclusivity many automation use cases demand.





Licensed Cellular: Guaranteed Performance, Industrial-Grade Resilience

Licensed spectrum, such as Globalstar's Band 53/n53 or MNO-leased spectrum, gives enterprises full control over their airwaves. No interference. No unexpected neighbors. No SAS.

- ✓ **Guaranteed access and SLAs:** Licensed networks offer dedicated channels with no risk of contention, ensuring consistent throughput and ultra-low latency.
- ✓ **Carrier-grade security:** Licensed networks provide fine-tuned control over traffic priorities, enabling mission-critical automation to take precedence.
- ✓ **Massive scalability:** Licensed 5G can support thousands of endpoints per square kilometer, ideal for sensor-dense, high-traffic warehouse operations.
- ✓ **Edge-ready:** These networks are often paired with edge processing to enable real-time decision-making, AI inferencing, and faster automation feedback loops.

For enterprises building the future of logistics, manufacturing, or distribution, licensed private cellular networks are the most future-proof option. They offer the performance, predictability, and security required to power the full potential of Industry 4.0.

XCOM RAN: Unlocking the Full Power of Private 5G for Industrial Automation

Network infrastructure is no longer a behind-the-scenes component — it's the foundation of warehouse automation success. As robotic systems, IoT sensors, and AI-driven applications converge in fast-paced, high-volume environments, the demand for low-latency, ultra-reliable wireless connectivity is non-negotiable.

XCOM RAN was built for this exact challenge.

What is XCOM RAN?

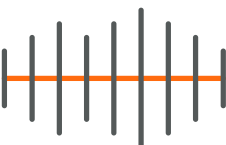
XCOM RAN is a next-generation, software-defined radio access network (RAN) that delivers true private 5G performance for industrial use. Unlike traditional wireless setups or even early private 5G models, XCOM RAN was engineered from the ground up to handle the demands of modern automation: high device density, real-time responsiveness, dynamic mobility, and always-on resilience.

It solves the systemic challenges posed by shared and legacy networks by offering a tightly integrated, licensed-spectrum 5G solution designed for high performance at scale.



Solving the Bottlenecks of Shared and Wi-Fi Networks

Where Wi-Fi and shared-spectrum cellular solutions like CBRS struggle, XCOM RAN delivers:



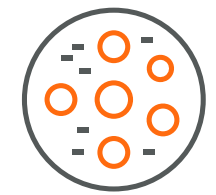
Dedicated Spectrum, No Interference

By operating on licensed mid-band spectrum, such as Band n53, XCOM RAN eliminates the guesswork and unpredictability associated with shared networks. There's no SAS to contend with, and no risk of performance degradation from neighboring traffic.



Superior Mobility and Handovers

In warehouse environments with moving robots, forklifts, and AMRs, seamless connectivity is essential. XCOM RAN supports smooth mobility and rapid handoffs across access points without the latency hiccups commonly found in Wi-Fi systems.



Engineered for Density and Scale

XCOM RAN supports up to 32 antennas and 16 simultaneous data streams across 10 MHz, 40 MHz, and 100 MHz channels. That means it can comfortably handle dense environments packed with smart sensors, video surveillance, mobile assets, and autonomous machines.




Edge Processing-Ready

XCOM RAN enables real-time, on-site decision-making. No need to push data to the cloud and wait for a response. This is essential for latency-sensitive tasks like predictive maintenance, object avoidance, and high-speed automation.

Private 5G: Optimized, Not Overbuilt

Traditional 5G was designed for consumer scale, not enterprise precision. XCOM RAN flips that paradigm: it delivers the power of 5G in a system custom-tailored for enterprise environments, free from public network congestion and carrier control.

Whether you're launching your first automated picking system or expanding toward a fully autonomous logistics operation, XCOM RAN gives you the network infrastructure to grow with confidence, securely, and with scalability, built to withstand the demands of mission-critical workflows.



Capturing Efficiency and Productivity in Warehousing with Private Networks

The rise in labor costs, space constraints, and fulfillment pressure has made warehouse automation not just a competitive advantage but a necessity. Intelligent automation can address these challenges head-on, boosting efficiency, accuracy, and agility across operations.

But automation is only as effective as the network it runs on. Not all connectivity is created equal. While Wi-Fi might have sufficed in the past, it often falls short in delivering the reliability, scalability, and performance required for today's high-speed, high-density environments. That's where private cellular, and more importantly, XCOM RAN, comes in. Purpose-built for demanding industrial workflows, XCOM RAN delivers the low-latency, high-capacity, ultra-reliable network foundation that modern automation systems need to thrive.

[Consult with our experts](#) to discover how XCOM RAN can drive your warehouse transformation.

GlobalstarTM

1. <https://www.warehousingandfulfillment.com/resources/2024-warehouse-costs-and-pricing-survey/>