



Automating Inventory Tracking in the Warehouse

Using Autonomous Indoor Drones

Overview

Over the past 20 years, supply chain innovation has enabled retailers, third-party logistics providers (3PLs), and manufacturers to accelerate the movement of goods across the supply chain, reduce costs, and achieve dramatic improvements in customer service. Despite the prevalent use of technology and the availability of precise data, one area of the supply chain that has been left behind is inventory tracking.

In the warehouse, sophisticated Warehouse Management Systems (WMS) have played a key role in turning inventory data into insights that help improve operations. Even so, the costly, labor-intensive chore of tracking and accurately recording inventory data has failed to evolve. Lacking a better option to get the job done, warehouse employees are required to take time away from higher-value tasks to manually track pallets and boxes on racks in the warehouse. It is a monotonous, tedious, and often dangerous job that is universally unpopular among warehouse personnel. As a result, employee satisfaction drops, process compliance suffers, and inventory errors are seen as an 'acceptable failure' within an otherwise exceptional operation.

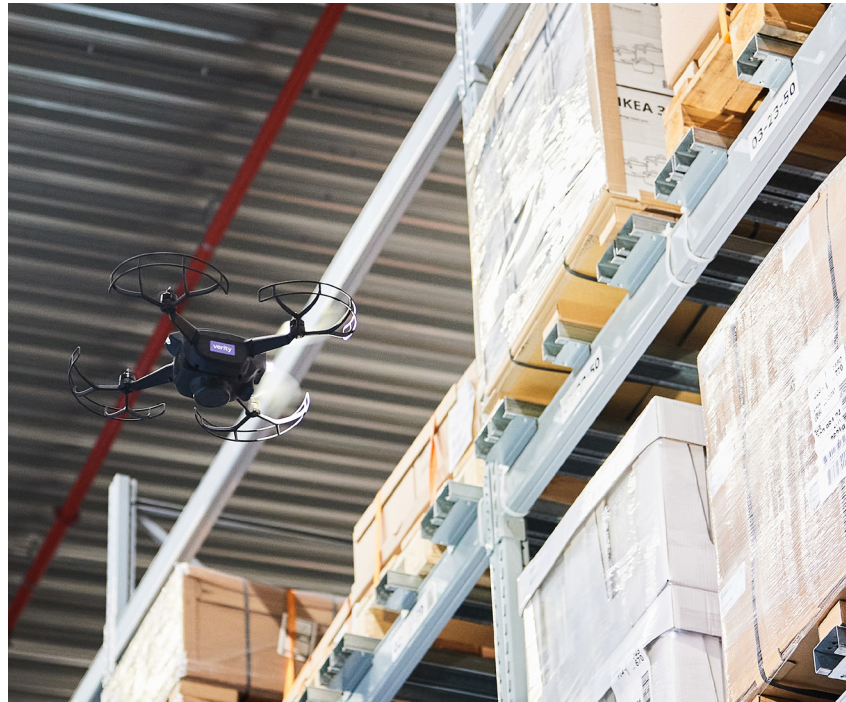
Inventory tracking is not something that should be overlooked in the quest to fully optimize the supply chain. It is a vital process for companies striving to achieve supply chain excellence, but it is no easy task. Errors in large warehouses are difficult to find, and that challenge scales in direct relationship to the size and height of the warehouse. The continuous movement of goods introduces new errors constantly—often before existing errors are resolved. This means that many errors are only discovered at the point of fulfillment, causing interruptions of normal operations, the potential for partially completed orders, and delays or unfulfilled orders that negatively impact customer service.

What is 'fully autonomous'?

By definition, 'autonomous' means that something is capable of performing a task without assistance. The Verity system delivers exactly that: it carries out tasks on nights and weekends—with no human interaction required. It's that simple.

A better approach to inventory tracking

Advancements in automated tracking systems using indoor drone technologies are enabling today's most innovative retailers, 3PLs, and manufacturers to fully automate the process of inventory tracking. By capturing accurate inventory data without human interaction, these systems help detect and correct inventory errors, omissions, and discrepancies before they disrupt operations or compromise customer service. By providing frequent and consistent feedback, these systems also provide management with the insights needed to identify and eliminate process errors that can impact upstream and downstream operations. Ultimately, fully automated inventory tracking systems powered by self-flying drones enable the zero-error warehouse.



1 | Cost Savings

At some level, inventory errors are unavoidable. What can be mitigated, however, are the costs associated with those errors. In general, these costs fall into two categories: **costs caused by inventory errors** (such as shipping delays and write-offs), and **costs of identifying inventory discrepancies** before they impact operations (such as cycle counting and pallet hunting). Often, organizations opt to track inventory less frequently (even just annually) to save the labor costs of identifying discrepancies—but at the greater expense of increasing the hidden impacts of unmitigated inventory errors.

Using a sophisticated inventory system to collect data throughout the warehouse addresses both issues simultaneously. The Verity system facilitates more frequent cycle counts to help identify and enable the correction of putaway errors. And because the system is fully autonomous (human interaction is required only to change batteries occasionally and perform periodic maintenance), labor costs associated

with manual scanning and error handling are eliminated. Automating inventory tracking using autonomous drones is fast, efficient, and delivers immediate value.

There are a number of providers that offer indoor drones for the purpose of inventory tracking. However, Verity is the only system available today that is fully autonomous, functions without the need for a human pilot/operator, and is delivering value today at more than 35 commercial installations in 13 countries. While a system that requires human support may provide some of the benefits linked to automation, such as improved data quality or process consistency, it cannot reduce the high direct costs of human labor, and it cannot address operational constraints that exist when an operator must be present. For example, such a system cannot scan inventory every night to track moved or misplaced pallets, nor complete full warehouse scans during the weekend when the warehouse is dark. The Verity system can operate 365 days a year, in complete darkness, without human interaction.

Delivering real-world savings

Depending on the size of the warehouse and the specific use case, estimated savings in labor, equipment, and error-related costs ranges from \$150,000 to over \$500,000 per year.

To deliver that savings, the Verity system targets multiple sources of inventory management-related costs. At one global third-party logistics provider, the client was scanning inventory less than 4x/year prior to implementing the system. Even at that level, the labor required to complete the scans at a single ~30,000 sqm/~320,000 sqft warehouse with ~60,000 storage locations totaled more than 3,500 hours per year.

In addition to the hours lost to the task of scanning, a lack of accuracy resulted in more than 1,500 misplaced pallets each year—and about 20 minutes of time for an employee to track down each missing pallet. Using the Verity system, the client was able to address an estimated 75% of this cost by reducing warehouse errors and autonomously locating pallets, amounting to tens of thousands of dollars in additional savings. Direct equipment cost savings added an additional \$36,500 to the tally.

Tangible costs reveal just a portion of the total savings

In addition to documented cost savings, the intangible cost savings of the Verity system include improved employee safety (thanks to reduction in the use of lifting equipment, scanning at heights, and repetitive motion), reduced warehouse disruptions (due to misplaced items), and significant improvements in customer service (resulting from consistently having the right product in the right place at the right time).



2 | Accuracy

The importance of accurate inventory tracking in the warehouse should not be underestimated. As discussed above, errors drive direct and indirect operational costs. As supply chains become more streamlined and accelerated, extremely tight expense management is a high priority. And in an era when leaner inventories are the rule of the day, every piece of merchandise counts.

In the retail space, innovations such as RFID, electronic shelf labels, weight sensors, and more are rapidly being introduced to facilitate accurate inventory in physical stores. In the warehouse space, this focus on increasing accuracy to decrease costs has failed to take on the same level of focus and importance. Just as in consumer-facing environments, it is vital that all goods in the warehouse are accounted for precisely so customer orders can be fulfilled on time—every time.

The Verity system enables faster, more frequent cycle counts to identify inventory errors, omissions, and discrepancies before they disrupt normal operations. The drones scan inventory throughout the warehouse or in a designated area, typically at night or over the weekend, using onboard cameras to scan multiple barcodes at the same time. Unlike traditional barcode scanners, this method also provides a visual archive of inventory management tasks. (Cameras are also highly reliable and offer the possibility of other use cases in the warehouse.)

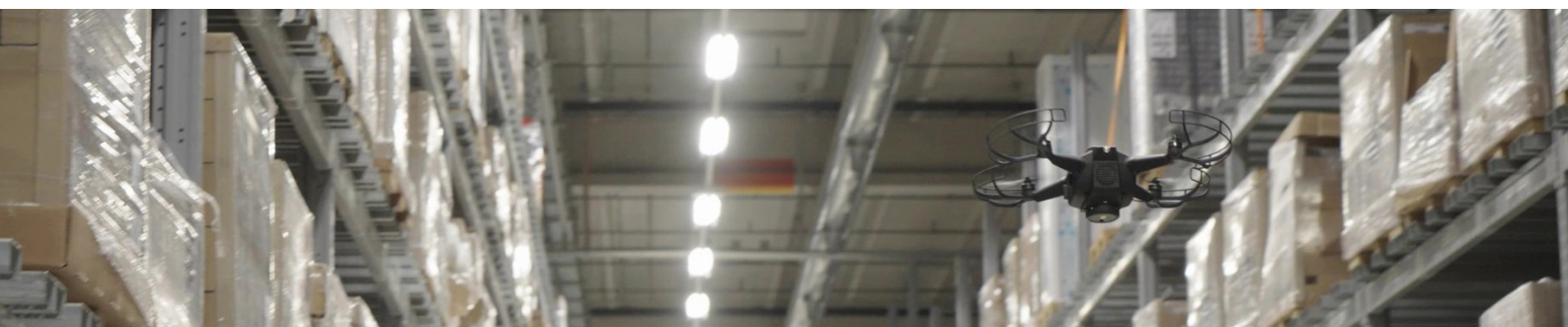
Once the data is collected, results of the scan are visible in the user dashboard at the start of the next shift. By delivering actionable insights to warehouse managers for rapid follow up before small issues manifest into impactful customer service issues, the system turns greater accuracy into real competitive advantage.

3 | Efficiency

Prior to the pandemic, complete supply chain efficiency was largely reserved for the largest global players: retailers, 3PLs, and manufacturers that enjoyed a luxury of scale that enabled them to focus on innovation and continuous improvement. The supply chain disruptions that occurred during the pandemic made greater efficiency and reliability mandates for companies of every size. To retain customers, protect margins, and survive, companies have scrambled to update existing channels and drive supply chain improvements whenever and wherever possible.

From a technology perspective, this urgent drive toward supply chain optimization couldn't have come at a better time. Exponential advancements in robotics, automation, and artificial intelligence have fueled the development of better, faster systems—from collaborative robots on the factory floor, to automated last-mile delivery, to warehouse automation. Rather than having to rely on outdated or manual processes, companies have been able to take immediate action to implement automated, data-driven solutions. The most notable change has been improved forecasts that help reduce stockouts and eliminate incorrect demand assumptions that result in overstocks and stale inventory.

Unfortunately, most of these advancements exist outside the walls of the warehouse. As supply chain optimization evolved at hyper-speed, operations in the warehouse remained largely stagnant. By applying the advanced technologies available today, companies of every size can now bring greater efficiency to the all-important yet often neglected point in the supply chain: the warehouse.



Using the combination of autonomous indoor drones and sophisticated system design, Verity offers a turnkey upgrade to warehouse inventory tracking. The drones are capable of scanning complete pallets that are stored on racks of any height, in standard and very narrow aisles (VNA), as well as broken pallets. In environments that require a greater level of accuracy, item-level counts can also be achieved. Because the drones can scan barcodes from floor to ceiling—even when goods are not placed on a pallet—no racking adjustments are needed. In unique circumstances, such as when barcodes have poor print quality, the drones can be programmed to fly closer to the pallet to decode hard-to-read barcode labels. The drones also carry their own lighting, enabling them to operate in any lighting condition, including in complete darkness.

Efficient inventory tracking enables a more reliable and efficient supply chain. By streamlining this vital process, the Verity system helps increase margins, improve revenues, optimize carrying costs, and ensure the right products are in the right place at the right time.

4 | Autonomy

Technology has been applied to help automate the supply chain since the first Supply Chain Management (SCM) systems came to market in the early 1990s. The initial goal was to design, plan, execute, control, and monitor supply chain activities more effectively to create value and to build infrastructures that synchronize supply with demand. It is a goal that has continued to evolve and which companies of every size continue to pursue relentlessly. As robotics technology has advanced, this pursuit has expanded to include the automation of physical tasks—including the time-consuming, labor-intensive task of inventory tracking.

The key to success is to implement a system that utilizes fully autonomous drones. To date, the Verity system is the only solution available that offers this advantage. While routine maintenance is required, such as swapping batteries that are fully cycled every few months, occasionally cleaning camera lenses, etc., there is no need for warehouse staff to operate the system.

Warehouse employees need only lock and unlock the system. Once the system is enabled, it runs continuously, allowing the drones to collect data according to a schedule determined by the user. Collision detection and avoidance sensors on every drone further support full autonomy. Collected inventory data is automatically sent to the user dashboard (or, if preferred, an existing WMS) to provide real-time data and insights—with no data processing or data massaging required.

More than a fifth of warehouse operators invested in automation to help address the labor shortages and increase in ecommerce brought on by the pandemic.¹ A recent Gartner survey predicts that 75% of large enterprises will adopt some form of smart robots in their warehouses by 2026.²

5 | Customer Service

Creating competitive advantage is a goal for every retailer, 3PL provider, and manufacturer. One key differentiator is the ability to deliver consistently outstanding customer service.

Achieving this goal requires frequent, accurate cycle counts. *This is true even if customers don't demand higher levels of frequency.*

From Kiva to Verity: a focus on warehouse excellence

**Kiva robots transformed Amazon's warehouses.
Autonomous indoor drone systems are now creating the
same level of disruption for warehouse inventory tracking.**

Kiva robots transformed Amazon's warehouses by enabling 'goods-to-man' operations, retrieving modular pods, and then delivering the pods to the workers. This streamlined warehouse operations by eliminating the need for workers to walk through the warehouse to retrieve goods themselves.

Developed by the team behind the Kiva robots, the Verity system enables a similar transformation for warehouse inventory tracking. The innovative system powered by self-flying drones reduces human workload by automating the process of collecting inventory data in large warehouses and delivering that data directly to the WMS—all to enable a zero-error warehouse.



As discussed previously, the frequency of cycle counts is typically determined by the time and costs associated with the amount of human labor needed to complete the task. To deliver the highest possible level of customer service, however, this equation must be reversed. While freeing up warehouse workers to focus on higher-value tasks is beneficial, completing frequent inventory counts to identify discrepancies as they happen is even more crucial. With the availability of real-time inventory data, errors can be corrected long before the point of fulfillment to eliminate delays, unfulfilled orders, and operational disruptions due to missing or misplaced inventory. The result: customer expectations can be met and exceeded—every time.

By enabling inventory to be scanned at a much higher frequency, the Verity system enables companies to meet and exceed customer expectations —without introducing additional costs. Once the system is implemented, the drones can operate autonomously to provide real-time inventory data as often as needed. More frequent cycle counts ensure errors are identified and corrected before they create damaging service issues to deliver a win-win scenario for warehouse workers and the customers they serve.

6 | Safety

Employee safety in the warehouse is a critical concern. Warehouse processes that require employees to be at heights present the greatest risk of serious injury and fatality, and the number of workplace injuries is increasing every year. Work-related deaths for full-time workers in warehousing and storage had been rising for years, and shockingly doubled in 2021.³ The average work-related injury results in \$38K in direct expenses and \$150K in indirect costs.⁴



In a recent report projecting the growth of the worldwide logistics automation market, the need to improve employee safety was called out as a key driver of adoption and one of the reasons this market is estimated to nearly double in the next five years.⁵ Safety is immediately improved by any solution that automates warehouse processes and reduces the need for employees to work at heights. By eliminating dangerous tasks, a fully automated system can help to significantly reduce the more than 95 million days that are lost annually worldwide due to injury.



In the warehouse specifically, the increase in heights of racking equipment makes the need for automation urgent. A typical 50,000 sqm/550 sqft facility with a 12-meter/40-foot clearance height may have as many as 55,000 pallets stored above floor level. It's a problem that will grow. Over the last two decades, clear heights have increased by 25%.⁶ This trend is expected to continue as warehouses and DCs are constructed closer to major cities where space is limited and real estate costs are high.

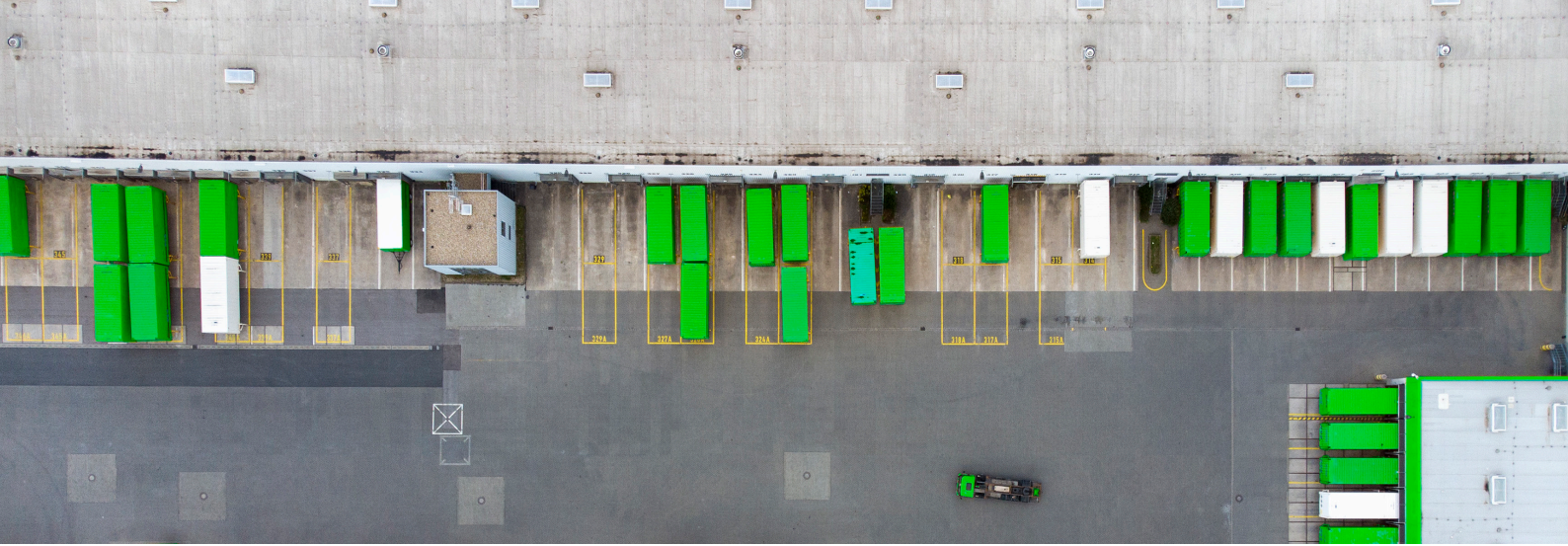
The Verity system reduces the potential for work-related injuries and fatalities in these larger, more dangerous warehouses. The system uses autonomous drones to track inventory from floor level to ceiling level, eliminating the need for employees to reach pallets at heights in the warehouse. When employees must use lifts and

other warehouse equipment (reach lifts, walkie stackers, pallet jacks, etc.), the Verity drones use onboard sensors to detect obstacles and avoid collisions.

The trickle-down effect of the COVID-19 pandemic introduced unexpected new health risks to the warehouse. Extreme growth in online shopping put pressure on warehouses to help keep supply chains in motion just as labor shortages became commonplace. The result: companies were forced to hire inexperienced workers to fill the gap, creating greater risk of injury when completing dangerous tasks—including scanning inventory high off the warehouse floor. Using self-flying drones to scan inventory throughout the warehouse helps keep workers safely on the ground and out of harm's way.



NEARLY
1 OUT OF EVERY 20
WAREHOUSE WORKERS FALLS VICTIM
TO A WORKPLACE INJURY OR
ACCIDENT EVERY YEAR
U.S. BUREAU OF LABOR STATISTICS.



6 | Sustainability

Across the supply chain, companies are focused on increasing sustainability by reducing waste and CO2 emissions. Automating inventory tracking is proving to be a particularly effective way to achieve both goals, especially in large warehouses.

Lost and misplaced inventory requires stock to be written off and/or replaced. For this reason, the most significant CO2e savings is typically achieved by warehouses that hold products that require substantial CO2e to produce, as well as inventory that expires or is made redundant when inventory tracking errors occur. By minimizing inventory inaccuracies, automated inventory tracking reduces costly write-offs and, in turn, eliminates emissions resulting from the reproduction of goods. Overstocks have long been used to cover errors and ensure the timely delivery of goods. Greater inventory accuracy eliminates the need for overstocks which, in turn, reduces the emissions related to the reproduction and transportation of goods.

Self-flying drones further support sustainability by eliminating the need to operate machinery required to manually scan pallets on upper levels, and by significantly reducing electrical consumption and general maintenance. Automating inventory tracking reduces facilities operating costs (heating, lighting, cafeteria, amenities), and no-pilot operation reduces the environmental impact of workers driving to the warehouse to perform added shifts. Automation also eliminates the repetitive task of manual

scanning, which reduces healthcare-related emissions and lost hours, and greatly reduces the risk of injury which also impacts emissions and sustainability.

By improving inventory accuracy by as little as 2%, the quantity of CO2 and CO2-equivalent (together CO2e) emissions that can be saved is striking. Our analysis shows that warehouses utilizing these systems can massively shrink their output of CO2 emissions.

When using the Verity system in a 100,000 pallet-location warehouse, we're seeing up to 20,000 tons of CO2e emissions savings per year. For an average warehouse, that savings is equivalent to taking up to 1,000 cars off the road annually.



Creating the Zero-Error Warehouse

At the highest level, the goal of supply chain optimization is to ensure inventory is in the right place at the right time across the supply chain, and to do so as efficiently as possible. When this is achieved in the warehouse—accurately and in real-time—the results include lower operational and labor costs; greater accuracy, efficiency, and autonomy; as well as enhanced customer service levels and reductions in safety risks.

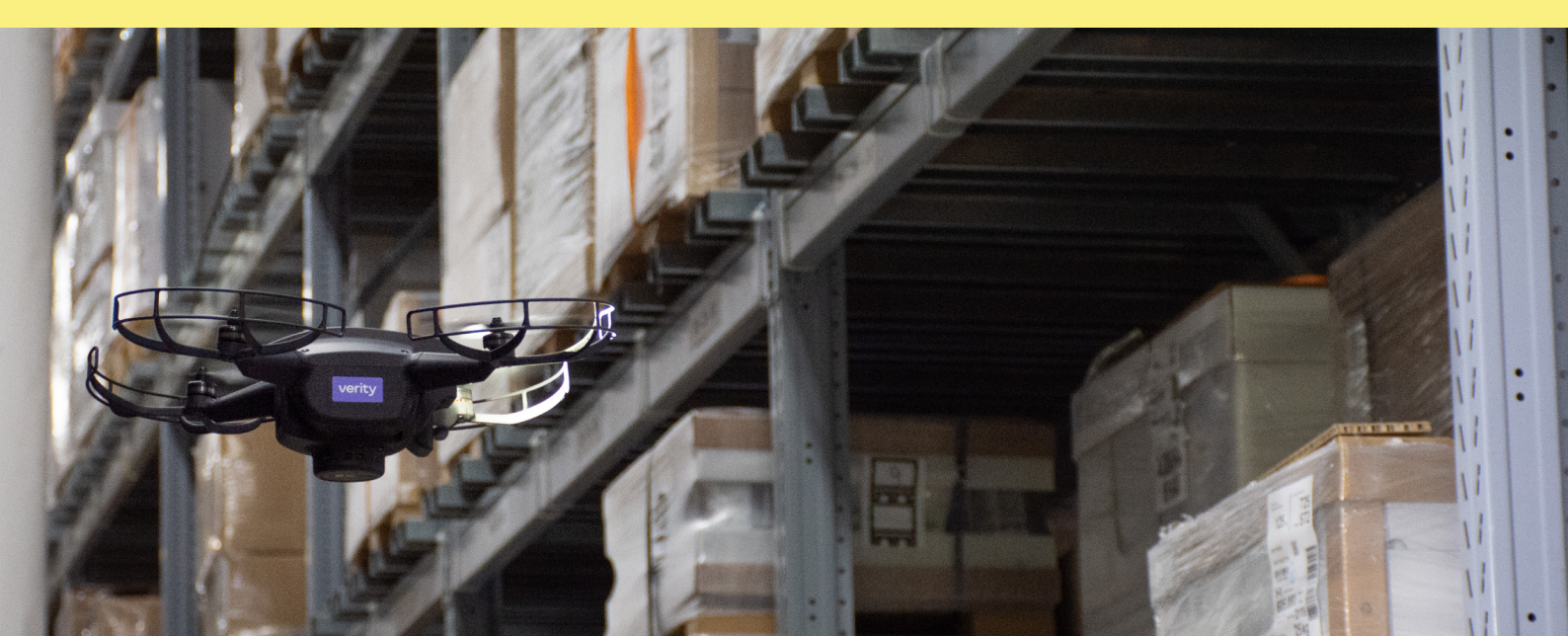
The Verity system supports these goals while providing retailers, 3PLs, and manufacturers with a fast and proven path to creating a zero-error warehouse. Organizations should consider implementing an autonomous inventory system when they are seeking to:

- Eliminate lost hours spent manually scanning inventory
- Increase margins by reducing equipment costs, scrap, obsolescence, and write-offs
- Identify discrepancies in real-time to prevent issue escalation
- Reduce lost inventory and stock-outs
- Optimize carrying costs by eliminating the need to carry unnecessary overstock
- Conduct faster, more frequent cycle counts to ensure availability of the right products at the right time
- Boost customer satisfaction by ensuring on-time deliveries
- Improve employee safety and increase staff retention by eliminating unfulfilling tasks
- Reduce CO2 emissions to increase sustainability

In the quest for supply chain optimization, inventory tracking is a critical component that has been neglected for far too long. Warehouse automation is no longer a luxury—it is a competitive mandate that will separate the next wave of industry leaders and disruptors from those that fall behind in both innovation and competitive advantage. A fully integrated inventory management system powered by self-flying drones can support inventory management excellence and create the zero-error warehouse of tomorrow.

Verity's most successful clients share 2 or more of these attributes:

- Value frequent, accurate information on status of goods
- Manage facilities with inventory stored on full pallets in high-bay racking
- Experience a rapid flow of goods or high turnover of inventory
- Handle high-value goods
- Located in a region with relatively high local labor rates



Why Verity?

Founded in 2014, deep-tech scale-up Verity delivers fully autonomous indoor drone systems that are trusted in environments where failure is not an option. Based in Zurich, Switzerland, with global operations, Verity's system is used in warehouses to gather valuable insights that enable greater operational efficiencies. The Verity system is built in Switzerland and engineered to optimize safety, reliability, and performance from the ground up.

The Verity system has completed more than 13 million inventory checks and is installed and delivering benefits at 35 sites across 13 countries on 3 continents. Current projects include large implementations at DSV, Ingka, Maersk, and Samsung SDS.

Verity has a strong track record in the warehousing and logistics industry, with its roots going back to Kiva Systems (now Amazon Robotics), which disrupted an entire industry and helped Amazon become the world leader it is today. Developed by the world's leading experts in robotics and machine learning. The company is dedicated to applying advanced automated systems to enable the zero-error warehouse.

¹ "Companies Are Slow to Adopt Robot-Operated 'Dark' Warehouses", *The Wall Street Journal*, February 17, 2023

² "Increasing your investment in materials handling automation", *The Manufacturer*, March 24, 2022

³ U.S. Bureau of Labor Statistics, December 2022

⁴ Safopedia, April 27, 2022

⁵ "Logistics Automation Market", *Research and Markets*, March 2021

⁶ National Real Estate Investor, December 2017

⁷ Bureau of Labor Statistics News Release, November 9, 2022