Warehouse Automation : Rise of Warehouse Robots

A Cambrian explosion in autonomous mobile robots driven by eCommerce

ROBO Business

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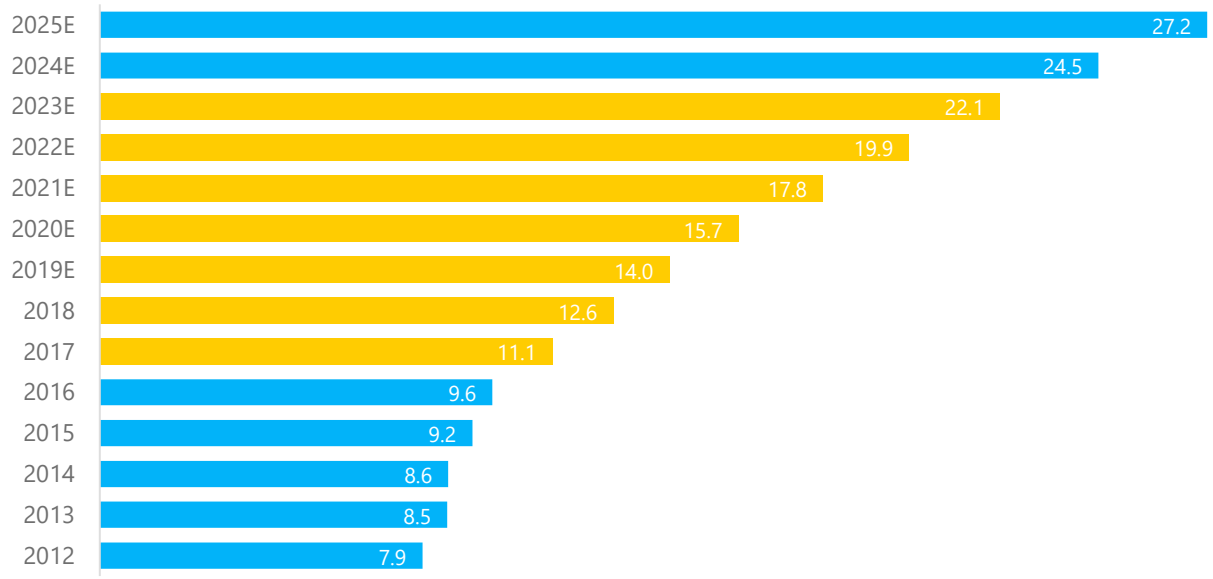
1 Global Warehouse Automation Market

In 2018, the warehouse automation market grew by more than 13% globally to record sales in excess of USD 12.5 billion. Warehouses are experiencing a continuous increase in investment, driven by increasing levels of automation within the warehouse as well as the integration of supply chains. DHL reports that[1], 80% of warehouses are "still manually operated with no supporting automation". Mechanized warehouses (those that use conveyors, sorters, goods-to-picker solutions, and other mechanized equipment, but not necessarily "automated") account for 15% of total warehouses, while only 5% of total current warehouses are automated, according to the DHL report.

EXHIBIT 1: Global Warehouse Automation Market (in USD billion)



Sources:,LogisticsIQ

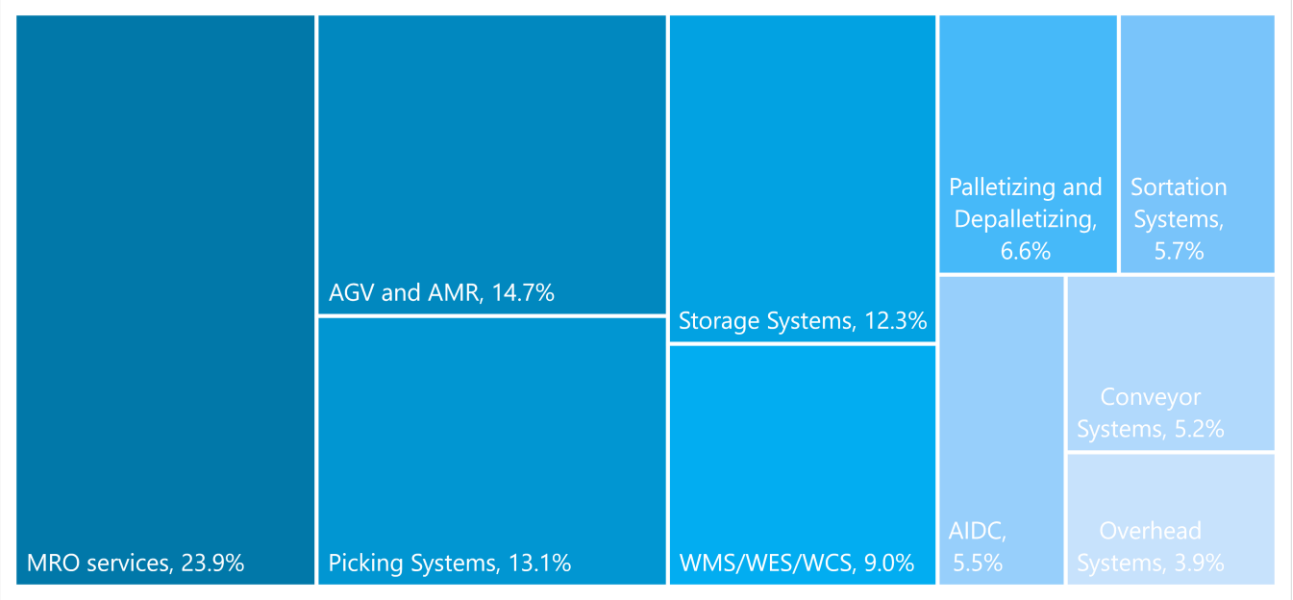
We forecast the global warehouse automation market to grow more than 2x from 2019 to 2025, on the back of strong macro and industry growth drivers of eCommerce fulfillment and increasing warehousing labour costs.

Warehousing operations being a critical factor for the success of any supply chain centric business especially low margin, high volume businesses such as eCommerce and retail, competitiveness comes down to reputation for excellence in execution and installation, in addition to the physical capabilities of equipment. Buyers of automated warehouse equipment often accept to pay a premium for a proven execution track record and reputation rather than squeeze an additional 1-2% on the price of the system, as failure can jeopardise operations and bottom line far more than the cost of system.

There are no off-the shelf solutions in warehouse automation – each system is customised to the individual customer's business needs. In the figure above, we outline the "sweetspots" of the relevant goods-to-man solutions outlined in this report with a similar figure for traditional picker-to-parts for reference. What system the retailer opts for will depend on its desired throughput and range of SKUs on offer, as well as the level of organisational flexibility it wants for its warehouse (note that the instalment of fixed conveyors requires careful deliberation of how it will impact movement of people and goods around the warehouse, whereas AGV solutions are more adaptable).

[1] Robotics In Logistics, March 2016

EXHIBIT 2: Global Warehouse Automation Market breakdown by technology in 2025



Sources:,LogisticsIQ

According to our research study, *Global Warehouse Automation Market – Forecast to 2025*, AGV/AMR and Picking systems will contribute more than a quarter of the overall revenue driven by the increase in demand for faster and reliable order fulfilment in the eCommerce sector. Another quarter of the overall revenue contribution will come through MRO services that remain the constant source of revenue for global warehouse automation providers.

- **Autonomous Guided Vehicles (AGV, AMR)** are a new asset in supply chain to optimize the warehouse operations and to validate the inventory quality assurance. AGV market has doubled in last 3 years and is as per our estimates will witness a 35% CAGR in the next 5 years.
- **Picking systems are still largely manual**: The order picking is the most labour intense part of the warehouse/DC and ideal for automation, however automation becomes increasingly challenging as the number of SKUs goes up. Barcode scanning can minimize errors but RFID (radio frequency) is quicker and more accurate for product identification. Manual picking is being increasingly complemented and supplemented by goods-to-person (G2P) picking solutions, thereby cutting down on a lot of labour time and costs. Technologies like pick-to-light or pick-to-voice can also increase the efficiency of the human worker even if the task is not truly automated.
- **Automated sorting already widely adopted**: These systems are used to sort cartons coming off the production line or packages out of the warehouse conveyor system before shipping. They are already widely adopted for small packages and parcels, and remain a necessary component of a fully automated warehouse solution.
- **Palletizing systems**: Palletizing systems automatically load pallets into and out of the warehouse. While palletizing robots are not a new concept, there is now an increasing demand for smarter systems that consider product weight, size, and crushability before palletizing goods. Connecting palletizing systems to other parts of the warehouse is also an opportunity.
- **Automated storage and retrieval systems (AS/RS)**: AS/RS systems are one of the most complex part of warehouse automation, and enable the automated storage of crates and pallets after delivery from supplier and the retrieval for the order picking process. It also includes automated racking, shelving, and shuttle systems and allows for far denser warehouses.

2 e-Commerce fulfilment driving up demand for Robots in Warehouse

The boom in e-commerce is compounding the major labor challenges faced by the USD 5 trillion global logistics industry. Shipment volumes are growing rapidly, and online retail also requires more logistical work per item than brick & mortar retail. Online purchases require individual picking packing and shipping, as opposed to the bulk transportation models of traditional brick & mortar retail.

Jack Ma, Alibaba founder famously said in 2013 that "For e-Commerce firms, the three most important infrastructure items are information flow, cash flow, and delivery."

U.S. companies employ 2 million people just to do stock and order fulfillment work and over 90% of warehouse picking is currently done by hand. Migrating to automated picking gives productivity gains of 2x–3x that as compared to pick-to-conveyor operations and 5x–6x as compared to manual pick-to-pallet fulfillment centers. Online business models need 300% more warehousing space compared to store-based fulfillment. Based on forecasts from Euromonitor for global e-Commerce growth, over 2.3 billion square feet of new warehousing space will be required by 2035.

Traditional retail is undergoing a major transition to omni-channel

Meanwhile, the $22trn traditional retail industry is undergoing a major transition as it strives to respond to the Internet, social-media and mobility-driven change in consumer buying behavior. The overwhelming trend today is omni-channel marketing, which seeks to integrate physical and digital channels to offer a unified customer experience and meet demand from every channel (webstore, ERP, point-of-sale, call center, mobile app, etc.). All brick-and-mortar retailers, as well as online retailers expanding their brick-and-mortar presence, are in the process of upgrading their supply-chain operations to provide better inventory visibility and deliver highlevel consumer experience.

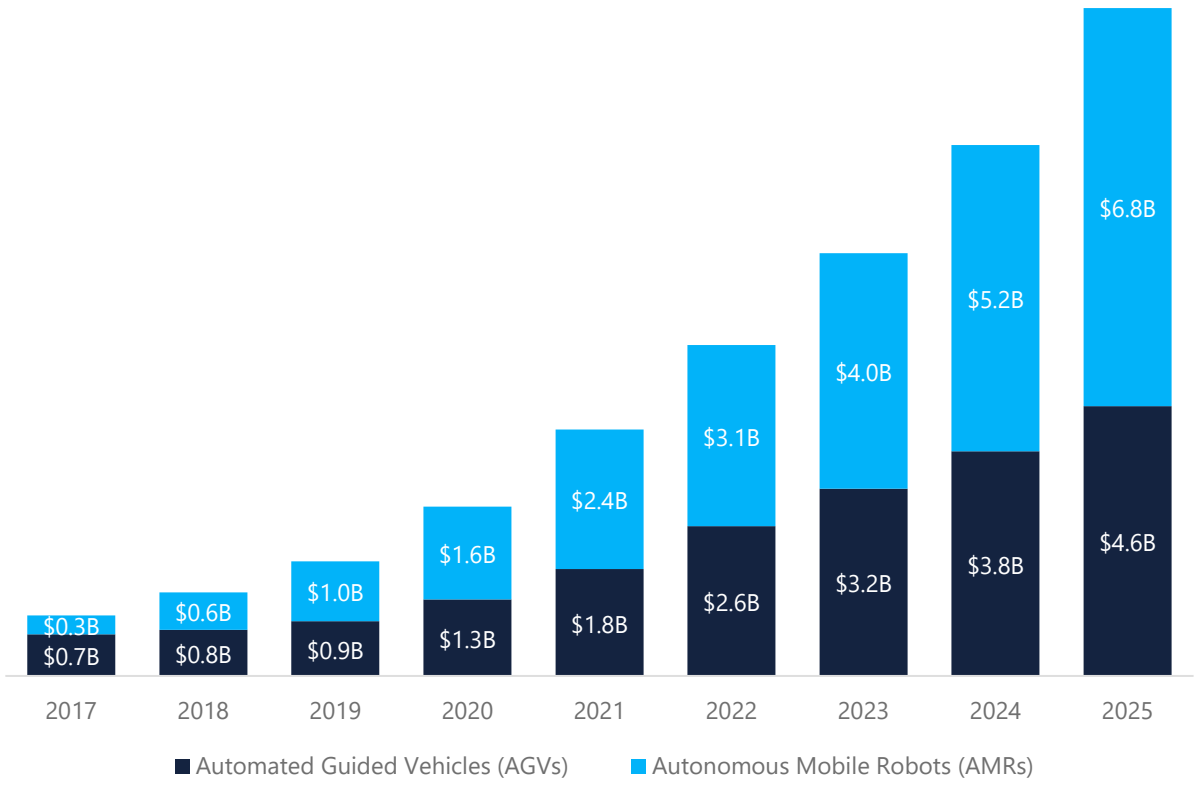
2.1 Robotics & Automation remain a key element for eCommerce success

Robotics & automation is rapidly becoming a key success factor in ecommerce and is about to make a very large impact on the world of logistics. From AMRs and AS/RS to track & trace technologies and advanced supply chain software, it is a game changer enabling increasingly speedy, safe and error-free distribution, shorter time to market and ultimately lower costs to businesses and consumers.

Amazon Robotics automates the company's fulfilment centers using more than 80,000 autonomous mobile robots, up more than 200% from 30,000 at the end of 2015. Amazon continues to aggressively ramp up its patent applications in supply chain & logistics. The company filed at least 78 logistics patents applications in 2016[2], according to tech research firm CB Insights. This was an all-time high and more than double the 33 filed in 2012, the year it acquired Kiva.

[2] https://www.cbinsights.com/blog/amazon-warehouse-patent/

EXHIBIT 3: Opportunity for Autonomous Mobile Robots will grow 10x



Sources:,LogisticsIQ

EXHIBIT 4: Warehouse Automation Robot Players in Picking Solutions

Company	Country	Solution	Function
Amazon	U.S.	Kiva	AGV
Rethink Robotics	U.S.	Baxter/Sawyer	Packaging/ Assembling
IAM Robotics	U.S.	Swift	Picking / AGV
Swisslog	Germany	AutoStore	AS/RS
Locus Robotics	U.S.	LocusBot	AGV
Fetch Robotics	U.S.	HMIShelf	AGV
FIEGE Logistik	Germany	TORU	Picking/AGV
6 River Systems	U.S.	Chuck	AGV

Sources: LogisticsIQ

Many startups have come up to develop robotic solutions for warehousing and retail industries and we are now observing a huge explosion of different mobile robotic systems with various degrees of autonomy. The industry is still in its infancy, with competitors ranging from established players such as Swisslog, a subsidiary of KUKA, Adept, also recently acquired by Omron of Japan, to a multitude of startups such as Fetch Robotics in the US, Mobile Industrial Robots (MiR) in Denmark, which was started by a co-founder of Universal Robotics, Singapore based GreyOrange, with operations and customers based out of India, as well as Hikrobot Technologies, a subsidiary of Hikvision in China.

EXHIBIT 5: Autonomous Picking Robots from Fetch

Sources: Fetch Robotics, LogisticsIQ

EXHIBIT 6: AGVs from Amazon Robotics (formerly KIVA)

Sources: Amazon Robotics, LogisticsIQ

2.2 Small-Scale Automation Solutions Exist but fall short on delivering efficiencies

Current picking robots exist in a variety of forms, but are all designed so that they may be operated in existing warehouses or with dark-store concepts (as well as in in-store picking). LocusBots' claims that its picking robots can deliver 3-5x more productivity through reductions in labour costs relating to "task interleaving", travel time, overtime and training costs. It also minimises the impact of increases in wages and/or related costs. These robots collaborate with workers, making them more efficient and effective in their already established workspaces.

An advantage of using picking robots over a fully automated warehouse solution is that they come with minimal disruption to existing operations. The solution is also scalable, to a point, allowing more efficient management of staffing with regards to growth, swings in demand and location. These also have a smaller spatial footprint than AS/RS solutions that makes it more easily accessible to smaller retailers and at a lower capital expense.

However, the economics of autonomous picking robots are currently challenging, with robot cost versus obtainable picking speed being the main issue. Current robot technology seems to be either too slow or too costly to replace human picking speeds in efficiently designed picking areas. We see their potential use as being limited to picking from warehouses or dark stores.

On the other hand, as costs come down and speeds pick up, variations of picking robots are increasingly seen as the way forward to fully automated order-picking systems. The last generation of picking robots and AGVs provides an opportunity for other areas within e-commerce. Specifically, they seem to be suited for fulfilment operations involving high quantities of small orders for large SKU ranges spread across large warehouse areas. Using autonomous robots to perform the horizontal travelling can increase order fulfilment efficiency. A solution that is not tied to the physical infrastructure of the warehouse is interesting for operations with low visibility of future sales volumes and/or high levels of peak seasonality.

2.3 Cost efficiency

Store Distribution, Picking Costs, and Last-Mile Delivery are the three largest drivers of cost in online grocery retailing. Of these, the largest variable component, and also the easiest to address, relates to order picking and the issue of overcoming the increase in labour costs that follows from having own employees do the picking, rather than the customers themselves. Order picking is also the area in which the industry is really concentrating its efforts with regards to automated and robotic solutions.

In addition to labour costs, the other key cost components in online grocery retailing are property, energy and waste. Use of automated equipment and robotics can reduce all three of these as processes are streamlined with spatial and energy efficiency in mind.

Robots can work in "harsher" conditions than humans, requiring less light and heating, and they also require less energy than traditional trucks. Equipment put in place to handle waste and the recycling of pallets will normally be included in an automated system, requiring less effort and manpower to handle it effectively. In the following segment, however, we will focus on labour costs as this is where the most substantial gains in operational efficiency are made.

Although there are cost savings to be had from enhancing the effective use of assets, the main cost issue evolves around labour costs, which in online grocery amounts to something of a paradox. Lower labour costs are beneficial to online grocery operations as it minimises the additional costs incurred from order picking and delivery. However, higher labour costs might be the incentive needed to switch to automated large-scale solutions, ultimately leading to a point where lower variable costs establish a cost advantage over legacy players.

2.4 Order Picking Remains a Challenge, however the pace of Innovation is increasing to meet the challenges

There have been launches of robots that enable automated order picking. Most of the robot vendors, as well as some of the warehouse automation players themselves, produce some variety of order picking robots that 'pick' the parcels off the pallet and place them into cartons or boxes and onto the conveyor system for further processing.

However, picking robots are being produced that are capable of picking objects off the shelf (a more complex process), such as IAM Robotics which uses an autonomous mobile picking robot called Swift which has a Fanuc arm, RightHand Robotics that also uses a similar technology and Magazino. These robots are often classified as collaborative robots (cobots), and the shelf-picking function often comes on top of being an automated guided vehicle, which transports objects from the shelf to the packaging and shipping corner of the warehouse.

Furthermore, Ocado has recently been evaluating the feasibility of the 'SoMa project,' which explores the robotic picking and packing of shopping orders in conjunction with its highly automated warehouses. Short for 'Soft Manipulation', the project is a European Union-funded program that aims to be fully implemented by 2020 and in collaboration with various research institutions across Europe. Essentially what the project aims to develop is a gripper compatible with the existent industrial robot arm that is able to handle more fragile objects such as fruits and vegetables.

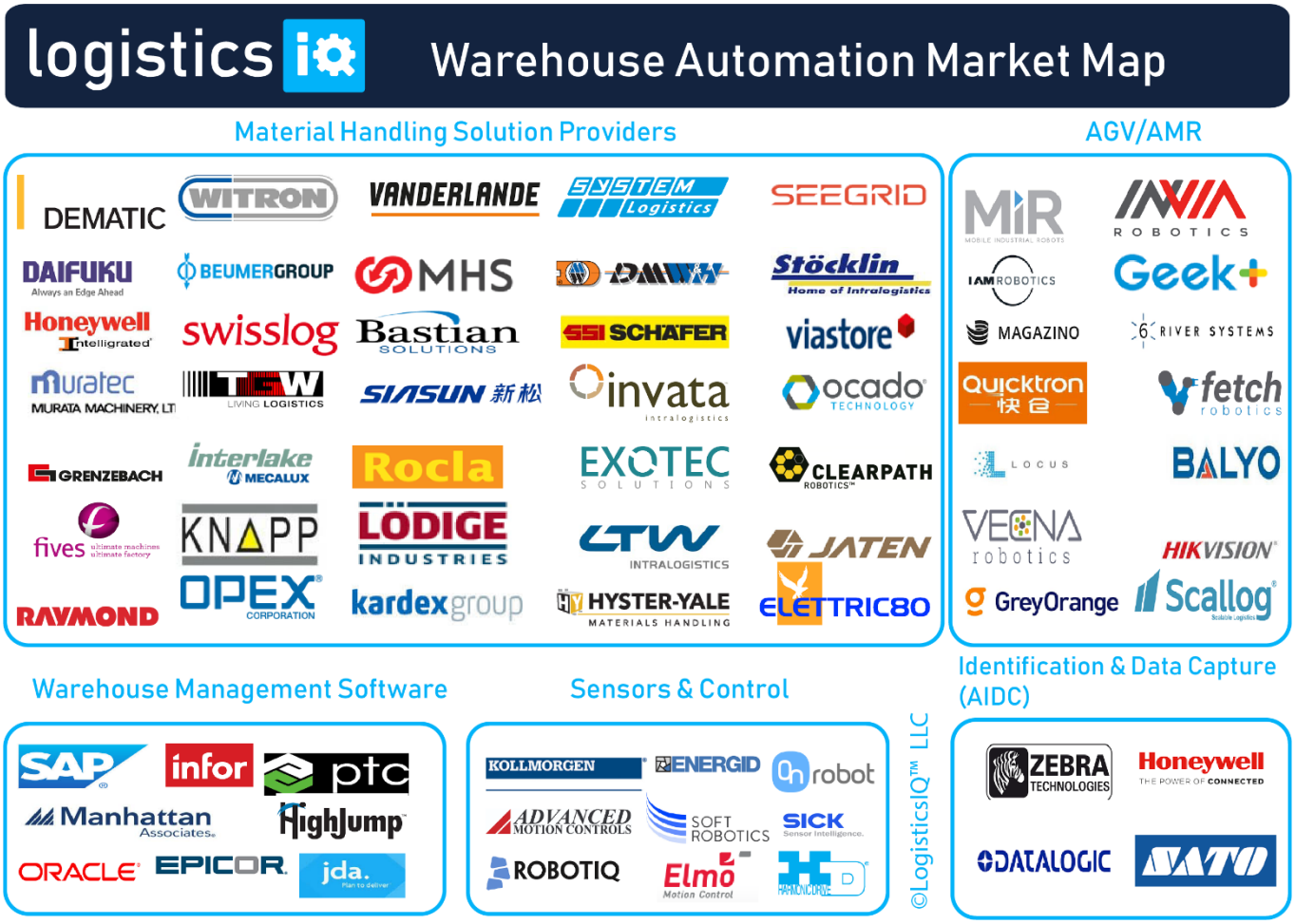
2.5 Conclusions

- **Much of the technology disruption is yet to come:** While e-Commerce is growing at double-digit annual rates, automation penetration remains quite low in many cases. Technology is not yet either capable or cost effective in all cases of order fulfillment, meaning that labor shortages are, for now, still a major pinch point. Technological progress in sensors, data, and software are as important as that in robots and drones to enable this automation. Some of this technology is only just now reaching commercial potential (and some is still on the drawing board), meaning that the full impact of technology has yet to be felt. Even the demand-driver of e-Commerce itself will increase with broadband and mobile device penetration.
- **Growth in e-Commerce is the main driver of warehouse automation:** This driver itself will increase with broadband and mobile device penetration. The driver of e-Commerce growth will always be the "pull" from the consumer. In this report we look at the online penetration of retail by category and geography to understand why there are different levels of development and then look at what has driven the growth of e-Commerce. We then look at the implications for the retail sector, how retailers are adapting to cope with e-Commerce, and ultimately what impact further automation may have on the retail landscape.
- **Cross-border e-Commerce looks set to stay, further driving warehouse demand:** Warehouse options range from one central hub globally to fully localized fulfillment. DHL estimates that 15% of e-Commerce is cross-border, and is set to increase to 25%, as the cost of carrying inventory has to be balanced against the cost of shipping cross-border. There is also a broader debate on the location of manufacturing when factories (and not just fulfillment and delivery) are fully automated.
- **Real estate will be impacted in two ways:** First, is the already-visible decline of high street and mall footprints (or the need for them to fill with other experiential offerings), but second is in how the need for warehouses near or in dense

urban areas is changing how planners look at zoning land. We examine some emerging innovations and concepts that have the potential to significantly impact real estate markets, from the integration of industrial and residential land uses in significantly land-constrained markets, to the development of vertical warehouse solutions and even towards flexible warehouse solutions along the lines of AirBnB.

3 Warehouse Automation Global Value chain and Key players

EXHIBIT 7: Warehouse Automation Market Map – Top 50 players



Sources: LogisticsIQ

4 Emerging Technologies

4.1 Warehouse Drones

Amazon is not the only one focusing on developing drones for automation purposes. Walmart introduced a system in June 2016 where drones would be used to check warehouse inventories. The drones would fly over the warehouse and photograph the aisles to check if the products were misplaced on the shelves or if they ran out, effectively reducing the labor intensive process of checking stocks around the warehouse. They also are looking to deploy drones in their stores, where the drone would retrieve a product from a non-public stock room and fly it over to a delivery area where the staff can retrieve the item, so as to assist store assistants and remove the burden of searching and carrying a product across the store. Figure below summarizes how the specifications of e-Commerce buildings differ across the three broad industrial asset classes.

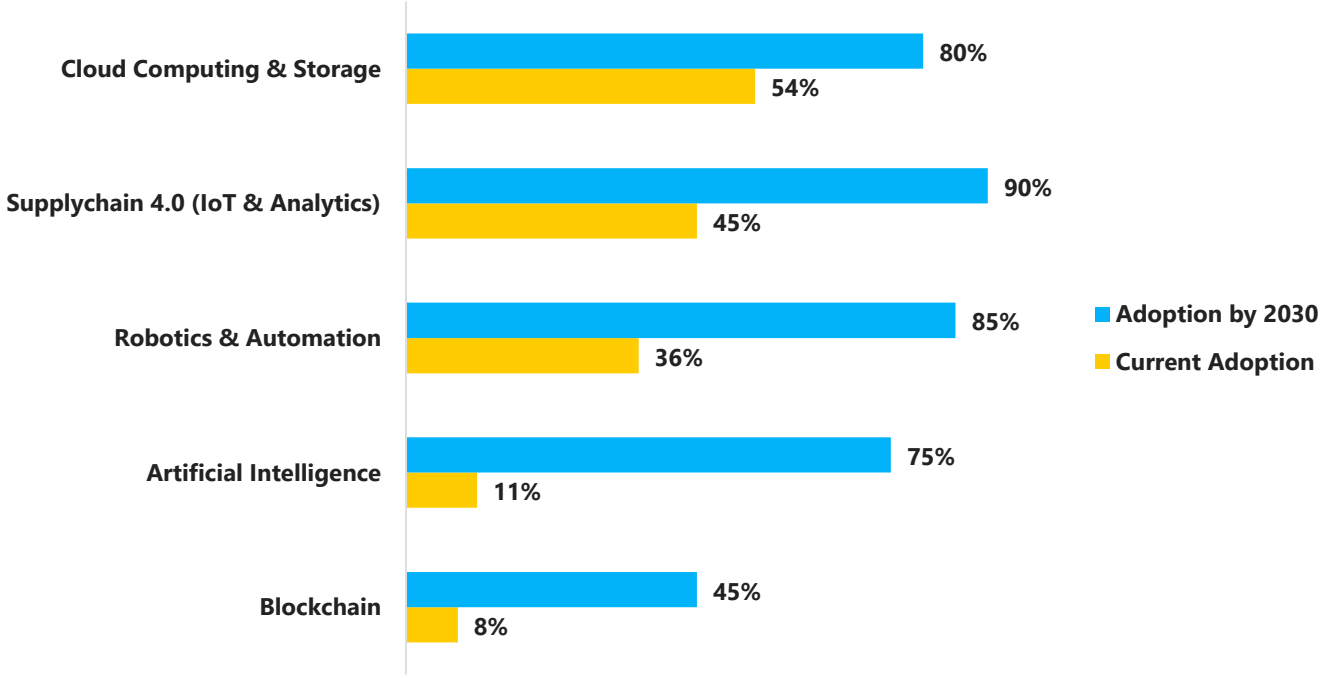
The increased use of robotics has the potential to drive a 25%–30% reduction in average manufacturing costs, predominantly through the potential for savings in labor costs, which are currently estimated to account for 15%–30% of total supply chain costs. However, robotics will not lead to totally automated factories, albeit the labor provision will become increasingly upskilled as highly trained employees will be required to maintain the robots and to make higher-level and strategic decisions.

4.2 Artificial Intelligence and Blockchain

Industry 4.0 is a major disruption in current scenario and is forcing the companies to revalidate the way they are operating their supply chain. Technologies such as **IoT, Augmented Reality, Robotics and Cloud Computing** are changing the traditional business models. Additionally, omni-channel retail has different expectations from supply chain, increasing complexity. Big Data and Analytics are helpful to make supply chains more efficient and effective but to reach the next level of Digital Supply Chain, Artificial Intelligence and Blockchain are the new technologies that will be leveraged for transformation of supply chain and warehouses.

Organizations lack transparency in supply chain processes and visibility needed to forecast better and prevent inventory management concerns. This largely stems from an inability to hold and make sense of an overwhelming amount of data scattered across different processes, sources, and systems. Organizations struggle to keep pace with change, both technological advances and changes that the digital age is bringing to industries and markets. However, by using technologies such as machine learning, artificial intelligence (AI), and IoT Analytics to improve supply chain transparency, organizations can drive product excellence and operational efficiency through quick decision without any human intervention.

EXHIBIT 8: Adoption of AI and blockchain in warehouse automation is on the rise



Sources: LogisticsIQ

Supply chain operations do generate huge volumes of data from various ever-changing sources. AI can use the historical data and analyzes trends that can help in streamlining the supply chain process. The awareness and ability to make fact-based decisions that AI solutions make possible is slowly making inroads into chain management. This technology is expected to create a sentient supply chain for future that would able to feel, perceive, and react to situations at a granular level.

Blockchain technology has also a huge potential to improve supply chain transparency and monitor provenance. In the consumer goods and retail industry, many of the biggest players have undertaken initiatives to amass data about how goods are made, where they come from, and how they are managed. If this information is stored in a blockchain-based system, the data becomes permanent and easy to share, improving that way the comprehensive track-and-trace capabilities

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