HOW TO SUPPORT YOUR RETAIL MICRO FULFILLMENT CENTER

ABiresearch THE TECH INTELLIGENCE EXPERTS **RICOH**

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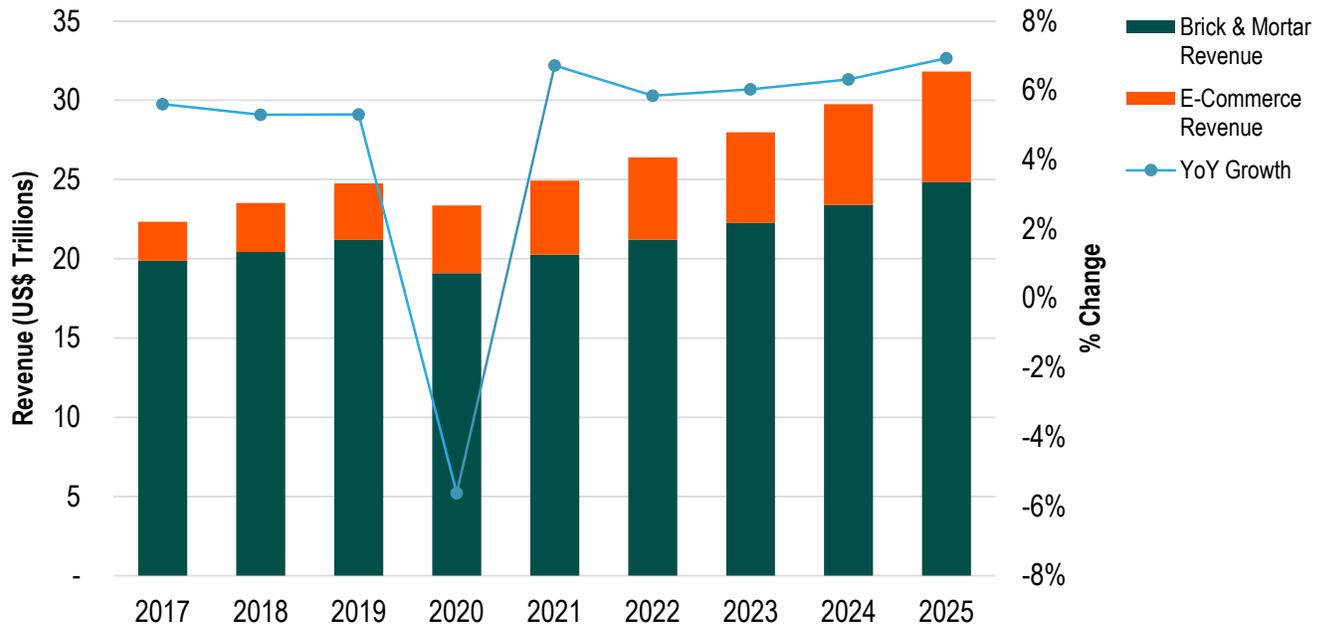Lian Jye Su, *Content Manager*

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1. GROWING NEED FOR AUTOMATION IN RETAIL

While the focus in automation has been on production with industrial robots for decades, the greatest opportunity for automation is increasingly found further down the supply chain at the level of storage, distribution, fulfillment, and retail. This trend is unsurprising, given the high rate of revenue growth in the global retail market. Based on Figure 1, from 2017 to 2025, global retail revenue is projected to grow from US$22.3 trillion to US$31 trillion, with a compound average growth rate (CAGR) of 5.3% over 8 years. An increasing percentage of this revenue is focused on e-commerce, growing from 11% of total worldwide retail revenue to 22%. This growth is attributable to several reasons, including competitive pricing, shopping experience, price comparisons, product ratings, customer reviews, and changing consumer habits accelerated by the restrictions of COVID-19.

Fueled by a massive increase in demand, this growth places high pressure on the current supply chain infrastructure. This pressure is further exacerbated by declining labor participation and tight labor markets in the North America, European, and East Asia markets.

Figure 1: Retail Revenues: Online versus Brick and Mortar Year on Year World Markets 2017 to 2025

(Source: ABI Research)

Running concurrently with demand for more capacity, consumer expectations about product availability and delivery time continue to soar. As a result, all supply chain participants have to deliver more, faster, and maintain a wider variety of stock-keeping units (SKUs) while maximizing throughput and expanding variety calls for more distributed supply chains. Hence older infrastructure is being supplemented and replaced with smaller fulfillment centers placed strategically closer to the customer base.

A further driver is competition. Pure etailers like Amazon have reshaped global retail, and through their expansion of highly automated greenfield sites, take up an ever-larger portion of global retail. As a result, traditional brick and mortar retailers, grocers, couriers, and third-party logistics (3PLs) have to adapt and improve efficiency.

Between increased demand, customer demands, and internal competition, the key players in global retail are investing ever more in automation technologies. Importantly, these technologies are being deployed in retail and further up the supply chain for warehousing, distribution, and fulfillment.

2. MICRO FULFILLMENT GROWTH

The supply chain is incredibly complex but can be broken down roughly into five components;

- **Production Logistics:** Internal warehouses and logistics operations within manufacturing centers, factories, foundries, and workshops. The process often involves Automated Guided Vehicles (AGVs) or Autonomous Mobile Robots (AMRs) carrying pallets and larger goods from the local storage zone to and from the production line.
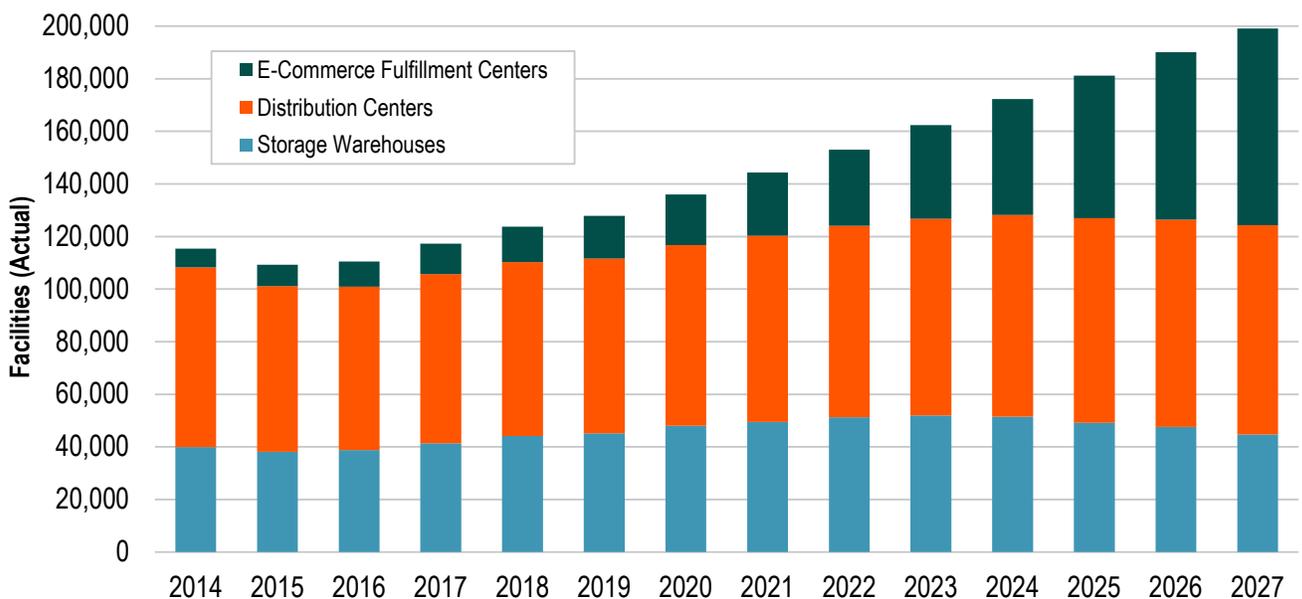
- **Storage Warehouses:** Public or private warehouses for mid-to-long-term storage rather than immediate distribution. Also includes production warehouses used for the storage of fully or partly manufactured goods. Robots and automation systems might be used for unloading, loading, material handling, and inventory tracking.

- **Distribution Centers:** Regional facilities used for the reception, dispatch, or consolidation of goods en-masse or wholesale and non-consumer distribution. Conveyance remains common in this section.

- **E-commerce Fulfilment Centers:** Warehouses used for processing individual customer orders for onward dispatch to the final destination. Amazon's fulfilment centers, for example, are heavily automated and are home to over 350,000 AGVs.

- **Last-Mile Delivery:** The use of vehicles to transport the consumer goods to or near their residence. Mobile robotic systems like those of Starship Technologies and Nuro are becoming more popular in this space. Vendors like Amazon are also seeking other channels of delivery via drone delivery pilots.

While the traditional supply chain has focused on storage warehouses and distribution centers selling directly to retailers, there is an undeniable shift to fulfillment centers.

As shown in Figure 2, the proportion of fulfillment centers relative to traditional storage and distribution will increase markedly, from 13% of all facilities in 2019 to 38% in 2027. This translates to an increase from 19,251 facilities to 74,849 globally. The rapid growth highlights the urgency to create a more flexible supply chain.

Figure 2: Commercial Warehouses by Type
World Markets 2014 to 2027

(Source: ABI Research)

Fulfillment centers can come in various sizes, but increasingly they are being developed with space and location in mind, which lead to the popularization of Micro Fulfillment Centers (MFC). Typically considered a subcategory of fulfillment centers, MFC represents the next stage of the modern adaptive supply chain. They are generally located much closer to urban areas and can even be placed adjacent to stores for walk-in collection. Smaller in footprint than traditional fulfillment operations, these MFCs rely on verticality and Automated Storage and Retrieval Systems (ASRS) for maximum throughput and density.
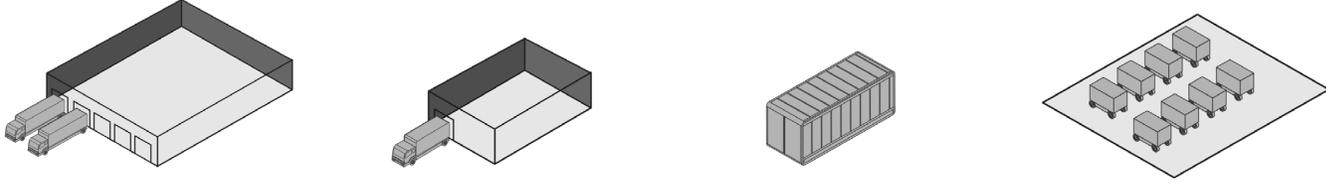
The upcoming growth of MFC Fulfillment should be seen as an extension of broader trends in the supply chain industry:

- A shortage of skills, space, and speed in the retail landscape. There is a lack of available and dependable labor to populate brick and mortar stores, and there is a need to improve speed within the current supply chain.

- The growing availability of cuboid automation solutions focused on fitting in a small space. Players like Autostore, Attabotics, and Alert Innovation are examples of companies that are already generating revenue and establishing themselves in the market.

- Percent of sales through the e-commerce channel increasing. MFC is an evolution of the strategic shift towards online orders. To keep up with this trend, the supply chain has to evolve.

- Long-tail customers want a more comprehensive range of SKUs to choose from as they need to move different types of goods within fulfillment centers. This challenge is exacerbated by the tightening of labor markets but can be solved through robotic picking stations, cuboid ASRS, and mobile manipulation.

- Retailers seek to move closer to metro markets for faster response times to compete against Amazon (the Amazon purchase of Whole Foods acquisition) and defend market share. Driven by demand for hourly delivery of groceries and next-day delivery of retail goods, MFCs help grocery retailers to achieve profitable same-day service for a large assortment of SKUs.

As etailers close larger rural distribution centers and increase their use of fulfillment centers, many decide to build Micro-Fulfillment Centers (MFCs) closer to population centers to expedite shipping. However, these MFCs rely heavily on vertical storage due to their smaller footprint and need to optimize space in expensive urban facilities. This leads to the significant use of fixed automation (AS/RS). A breakdown of major distribution and fulfillment options can be seen in Image 1.

Distribution Center	**Fulfilment Center**	**MFC (Independent Dark Store)**	**MFC (Retail Store)**
Hub Fully automated Pallet or case to stores Long-term	Hub Model Highly Automated Sent to wide consumer base Long-term	Third party locations Services dense urban areas Automation and picking Batched orders for next day delivery	Located in-store Small footprint One-hour fulfilment Fast implementation
$$$$$	$$$$	$$	$

3. DIFFERENCE BETWEEN MFC AND CENTRALIZED FULFILLMENT

How might an MFC-based automated solution be differentiated from standard fulfillment centers? MFC solutions are understood to be goods-to-person picking systems that occupy under 3,000 square meters. MFC can either be located in a store, a distribution center, or as a standalone facility. While MFC solutions and standard fulfillment solutions utilize many of the same automation technologies, larger centralized solutions like those of online grocer Ocado are considerably larger and require dedicated facilities.

While Amazon runs on a system of centralized fulfillment, they have experimented with MFCs. They recently opened a pilot for a dark store in Brooklyn, New York. While traditional large fulfillment centers are larger and less numerous for the same delivery radius, MFCs are expected to proliferate at a high rate to meet customers' demands. The benefits of MFC over traditional fulfillment includes:

- **Delivery time:** It is generally best to pick orders as close to the customer as possible. This can be better achieved through MFC.

- **Radius:** Traditional fulfillment can work reasonably well in densely populated areas, but MFC is becoming critical for meeting the demands of more diffused populations.

- **Capital Intensity:** A MFC model has the benefit of being a less capital-intensive approach than centralized fulfillment. While a centralized fulfillment center like Ocado can take up to 24 months to build a 300,000 square foot facility, it can take up as little as 20 weeks and 1/10th of the cost to install an MFC.

There are, however, drawbacks to MFC solutions. They require many more facilities and a much more distributed network, expanding the area for potential efficiencies, and creating a demand for support for third parties.

MFCs are generally automated through ASRS. These solutions are highly intricate forms of fixed automation and represent the complete opposite of many solutions being touted by the robotics community. But while autonomous mobile robots have achieved some level of popularity, they are far behind ASRS in terms of adoption. While the flexibility afforded by autonomous systems is a bonus, the critical need for high-throughput high-density solutions has made ASRS very popular in modern-day retail.

Of course, going forward there will be a high degree of experimentation, and many MFC providers could utilize AMRs, picking stations, and mobile manipulation systems to supplement their ASRS solutions. Based on ABI Research's findings, the future roadmap for MFC technology will progress as described in Table 1.

Table 1: MFC Technology Evolution

Type	Unautomated Fulfillment	Automated Fulfillment	Cuboid-centric Automation	Adaptive Fulfillment
Technology	Manual pickers Limited conveyance	ASRs Conveyance Manual pickers at stations	Cuboid ASRS Manual pickers at stations AGVs	Cuboid ASRS Fixed robotics AMRs Mobile Manipulation for picking Automated loading and unloading
Timeline	1950-	2000-	2010-	2020-

4. THE CURRENT AUTOMATED MFC MARKET

There is a range of technologies associated with MFCs. Generally, the technologies are similar to the solutions offered for goods-to-person logistics in all fulfillment operations, as seen below in Table 2.

Table 2: Different Automation Technologies for Fulfillment

Automation Category for Goods 2 Person Material Handling	Description	Example of Technology Deployment	Pros	Cons
AGV	Automated Guided Vehicles utilize QR-Codes, teach & repeat methods, and magnetic tape to navigate structured environments. Used for pallet stacking, tugging, and towing.	Amazon: 350,000 AGVs deployed in the Eetailer's fulfillment operations.	Trusted Technology Developed Eecosystem	Need for auxiliary infrastructure, magnets, and/or markers
AMR	Autonomous Mobile Robots are advanced robotic systems that can sense and navigate through their environment with minimal assistance, instead of relying on sensor fusion and simultaneous localization & mapping.	Fetch Robotics was recently acquired by Zebra Technologies for US$305 million and has partnered with couriers like DHL.	Flexibility Dynamic rerouting	Nascent market Lack of technical redundancy Hard to scale
Mobile Manipulation AMR	These are mobile manipulation devices that can pick items. However, they are very challenging to deploy due to motion control, perception, and expense challenges	IAM Robotics is a Pittsburgh-based vendor that is targeting MFC with mobile platforms fitted with articulated arms.	Ability to do much of a worker's tasks, particularly picking	Motion control challenges High cost Underdeveloped market and norms
Automated Storage and Retrieval Systems	Heavy fixed infrastructure that uses a mixture of conveyance, cranes, shuttles, and picking stations to store and retrieve goods. The solution often depends on storing pallets, heavy goods, cartons, bins, trays, or small items.	Knapp, Dematic, and Honeywell Intelligrated are some of the key vendors in this space.	Very high throughput Mature market with many vendors in an established market	High cost Inflexible Takes up a lot of space Cannot be easily redeployed for micro-fulfillment

Automation Category for Goods 2 Person Material Handling	Description	Example of Technology Deployment	Pros	Cons
Cuboid Automated Storage and Retrieval	More compact 3D-centric shuttle systems. Provide verticality and storage density, offering a smaller footprint than traditional ASRS.	Autostore has 500 installations in 30 countries. The company recently received US$1 billion in funding from Softbank.	High speed and throughput High density – can be fitted into an MFC Many new players growing very quickly	Limited market for lifecycle management Cost remains high Not fully automated, still requires pickers

4.1. SHUTTLE-BASED ASRS - SPEED

Established ASRS vendors like Dematic, Swisslog, KNAPP, Vanderlande, and Honeywell Intelligrated rely on a mixture of the shuttle, crane, and picking systems. While their technology is well established, their solutions are difficult to apply to small form factors required for an MFC strategy. Among the main problems are high levels of complexity and maintenance costs, as well as many single points of failure. These systems are also generally too vast and complex to deploy near or adjacent to urban areas or stores. Due to the high price of land in urban areas, these solutions, already a significant investment, become unfeasible beyond centralized fulfillment. For this reason, there has been massive interest in denser ASRS solutions that can achieve similar throughput with a much smaller form factor.

4.2. AGV-BASED ASRS—FLEXIBILITY

ASRS solutions can also run through the mass deployment of AGVs that navigate using external infrastructures like quick-response codes and magnetic tape. Amazon's Kiva systems are the most well-known example, but there are many other vendors, including Grey Orange, Geek+, 6 River Systems, and Locus Robotics. Such systems utilize mobile robots alongside shuttle systems and lifting robots, and the picking and placing is still largely done via human operators at the end of the line. Among these vendors, some offer end users either their own private MFC networks, while others let end users rent or lease a pre-built network through a service option. AGV-based MFC vendors have deployed hundreds of robots in dozens of MFC facilities, and increasingly utilize third-party installation services to help assure consistent services throughout their network.

These vendors have chosen AGV-based solutions because they allow for redeployability, individual robot fault tolerance, and cost reduction based on lowering or increasing the size of a robotic fleet.

4.3. AMRS AND AMMRS

AMRs are largely focused on production logistics with a greater focus on flexible material handling, but there will be a use for these systems in conjunction with ASRS in the future MFC. For example, the emergence of mobile manipulation solutions can reduce the labor demands for individual MFC sites.

Previously, such a solution was largely out of reach. Still, through thorough research and increasing funding in the robotics space, the first commercially viable deployments of Autonomous Mobile Manipulation Robots (AMMRs) have begun in e-commerce fulfillment.

These systems combine articulated arms with mobile platforms. Thus, they require a mixture of advanced perception through sensors and AI algorithms and improved end of arm tooling (EOAT) to handle a variety of products effectively. The motion control and navigation required to achieve this level of automation have only just begun their commercial life.

Much like AMRs, AMMRs can be easily deployed to facilities with small footprints and legacy infrastructure without incurring expensive installation and deployment costs. But while AMRs are great for material handling and are increasingly replacing AGVs due to their lower infrastructure costs, they offer no manipulation capability and are thus not suited to small-volume, high-mix orders of a wide variety of SKUs.
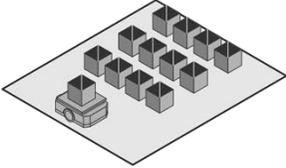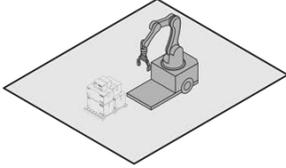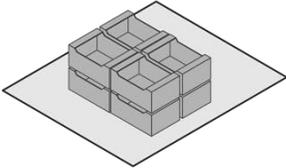
4.4. CUBOID ASRS—DENSITY

Cuboid ASRS systems are highly compact automation solutions running on 3D shuttle installations. AutoStore, the Norwegian pioneer of this technology, was founded in 1996 and is a proven company with 500 installations in 30 countries. The company recently attained more fame by receiving an enormous US$2.8 billion investment from Softbank, giving them a valuation of US$7.7 billion.

Beyond Autostore, the emerging 3D technology players like Attabotics, Alert Innovation, and Exotec. Cuboid systems are also used in centralized fulfillment contexts, with Ocado being the prime example. Below in Image 2 is a list of some key technologies.

Image 2: Examples of Key MFC Technologies

(Source: ABI Research)

Shuttle	AGV/AMR	Automated Picking	Cuboid
Takeoff Technologies, Knapp & Dematic	Fabric, Kiva	Magazino, IAM Robotics	Autostore, Attabotics, Ocado
Mature	Expanding	Nascent	Expanding
High throughput High efficiency and speed at scale	Flexible pricing, Redeployability, Can integrate with shuttle systems	Necessary due to shortage of pickers	Volume Density Critical for MFC
Low volume density Very high expense	Expensive to rollout	Motion control and vision challenges	Challenge to maintain over multiple installations

5. THE NEED FOR SERVICE LIFECYCLE MANAGEMENT

5.1. BASICS OF SLM

The value of automated MFCs is clear. However, increased demand also challenges the supply chain, as difficulties related to scaling automation threaten to hamper the market's true potential. These difficulties are part of the post-sale lifecycle of automation systems, best described as Service Lifecycle Management (SLM). This term entails pre-sale consulting, installation, employee training, operations, customer service, and reconfiguration.

Challenges abound throughout the lifecycle of automation solutions, such as design and evaluation, installation, ongoing maintenance, training, and customer service. Automation vendors will find it challenging to conduct SLM independently, so there is a growing demand for third-party service providers that can assist in scaling. Only via this collaboration can automation vendors meet their potential.

"Third parties are a big part of our scaling plans. The partners we are working with are competent in the technical skills required to service our system and in many cases are local to our customers' sites– so they can get there quickly."

– Fergal Glynn, VP of Marketing at 6 River Systems

To summarize, an increase in demand for automation presents a capacity challenge for automation vendors, which struggle to scale effectively on their own and execute effective SLM. To cope with these demands, collaboration with a growing market of third-party service providers is vital for automation vendors. These third parties, often system integrators that have taken on new responsibilities, are becoming a more important part of the automation value chain and its entire ecosystem.

As outlined in a previous whitepaper (Trends in Supporting & Scaling Modern Automation), the challenges associated with SLM include:

- **Installation:** The installation costs of an MFC solution can vary massively, with some companies suggesting that complete installation would take up to three months. Meanwhile, others proclaim that they offer "MFC-in-a-box" solutions that require as little as twelve weeks to deploy. Because of the nascent nature of the market, there is a high degree of uncertainty. Installation costs also include evaluation and simulation expenses, which tend to involve competency with auxiliary software. Installations are not a strong source of revenue for vendors and expend considerable time required for traveling, site mapping, equipment setups, testing, and administrative scheduling. All of this effort could be redirected toward more profitable parts of the lifecycle, like product development and sales.

- **Maintenance and Repair:** Automation providers can receive revenue from maintaining and repairing their equipment over a five-to-ten-year life cycle. Organizations may deploy considerable resources for repairing and maintaining robotic equipment, and this total lifecycle support cost may impact the productivity improvements afforded by the initial investment. Therefore, maintenance functions require effective management to control or decrease repair costs over the equipment's lifecycle.

A carefully considered maintenance and repair management program is essential to shortening the path to Return on Investment (ROI) and convincing potential users to make new investments in equipment. Furthermore, the purpose of aligning with strategic partners to perform critical components like customer service, support, and maintenance reduces those additional costs quite significantly, thus shortening ROI by years. One example is delegating Level One and Two incidents to third-party 24/7 hotlines so that the vendor can focus on mission-critical incidents.

- **ROI Oversight and Understanding Value**: When manufacturers or logistics companies commit to deploying automation, they know they are making a strategic investment in the future. But without some high degree of visibility about the actual productivity gains, many remain skeptical and hesitant. Therefore, it is critical to have actionable data on hand that provides key metrics. As an example, it is imperative to measure equipment downtime. Ultimately, what gets measured gets managed, and therefore the need for an effective data analytics regime is paramount.

  Clearly, this is an area where third parties can help. There is a burgeoning ecosystem of data specialists that offer predictive and even prescriptive analytics through historical data. They can also assist by educating vendors on best practices for data collection, processing, and feature extraction.

- **Customer Centricity:** To succeed at scaling their operations, those offering automation solutions cannot merely think like roboticists. They have to be customer-oriented. Vendors also need to have world-class customer service that facilitates buy-in not just from executives but from site managers and laborers. The entire customer workforce should be looked at holistically and included in the technology adoption. It is not enough to rely on a select few gurus or automation advocates planted in the customer base, as automation stands to impact the entire workforce. Providing this level of customer service and attention while focusing on optimizing and innovating is one of the chief challenges of automation companies as they exit the engineering lab and startup phases.

- **Workforce Training:** For many automation vendors, thinking about training beyond the initial implementation phase is an opportunity cost that can be difficult to justify. Given the immense pressure to meet demand, most automation vendors will face significant resource limitations if they try to take on training responsibilities. Consequently, those with an established number of deployed MFC solutions are increasingly looking for partners that can be trusted to provide and take responsibility for critical services like ongoing employee training, materials development, and support.

5.2. LIMITED SUPPLY OF SLM FOR MFCS

Currently, there are no or very few significant offerings from third-party service providers. Third parties are primarily limited to pre-sales consulting and system integration.

Typically, the MFCs are staffed with employees of the Original Equipment Manufacturer (OEM) solution provider (KNAPP, Takeoff, Ocado, Swisslog, etc.) to provide the construction, install and technology service and support. The end-user (the retailer) provides the pickers and delivery fulfillment to the consumer.

6. RICOH SERVICE ADVANTAGE

6.1. THE CHALLENGE

Given the breakneck pace of change in the automated logistics industry, there is a minimal self-supporting infrastructure to provide the requisite Service Lifecycle Management. Ricoh Service Advantage is one of the few vendors providing a comprehensive SLM program to the various MFC solution providers.

6.2. WHAT IS SERVICE ADVANTAGE?

The Ricoh Service Advantage program offers MFC automation solution providers and their customers a comprehensive suite of support services, including their newly introduced Advanced Technical Services (ATS) program. Ricoh's deployed managed service offering enables the MFC end-user customers to staff their micro-fulfillment centers 24/7 with dedicated technical service support personnel. Having dedicated onsite (resident) technical staff ensures the fulfillment center operates at peak efficiency with minimal downtime of the equipment and order fulfillment capabilities.

6.3. WHAT IS THE COMPETITIVE ADVANTAGE OF RICOH'S OFFERING?

OEM providers of the Micro-Fulfillment Centers have a challenge with scaling their MFC's to many brands with national and international retail sites and deployment centers. While these automation providers are adept at developing and implementing the various MFC technologies, including shuttle, conveyance, sortation, and operating software, they may not excel at the day-to-day staffing and operations required to support their technology at scale. Ricoh Service Advantage provides a uniquely beneficial partnership to automation partners, allowing them to leverage Ricoh's global service and support infrastructure, including onsite managed services like the Advanced Technical Service offering.

Ricoh has an established service operation that delivers a complete portfolio of Technology Lifecycle Services through Service Advantage. See the Ricoh Technology Lifecycle Services in Image 3.

Image 3: Ricoh Service Advantage Portfolio

(Source: ABI Research & Ricoh)

7. CONCLUSION

As this whitepaper has demonstrated, the demands of modern retail are creating enormous opportunities for automation solutions. While many of these have been around for a long time, the unique challenges of shorter delivery times, greater SKU variety, and more volume require a more distributed network of fulfillment centers. These have to be smaller than the previous generation and also highly automated. While a growing body of MFC providers can take advantage of this opportunity, scaling up is an enormous challenge. So far, there is limited third-party assistance to help these automation vendors and end-users with support solutions for their fulfillment technologies. Ricoh Service Advantage has proved the exception, as the company is one of the few service providers that can offer a full complement of support services. Over time, the need for these third-party lifecycle support services will become self-evident to vendors who must balance expansion with the maintenance of a first-class service. Already, as companies like Alert Innovation deal with more interest from retailers adopting the MFC model, they are building partnerships with the likes of Ricoh to make sure their capacity can keep up with demand.

To learn more about how Ricoh can help you support your automated Micro Fulfillment Center for future business growth, please visit our website.

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