LOADING / UNLOADING 2025

ATLS | TRAILER + CONTAINER LOADING/UNLOADING | PALLETS + CARTONS | FEB 2025

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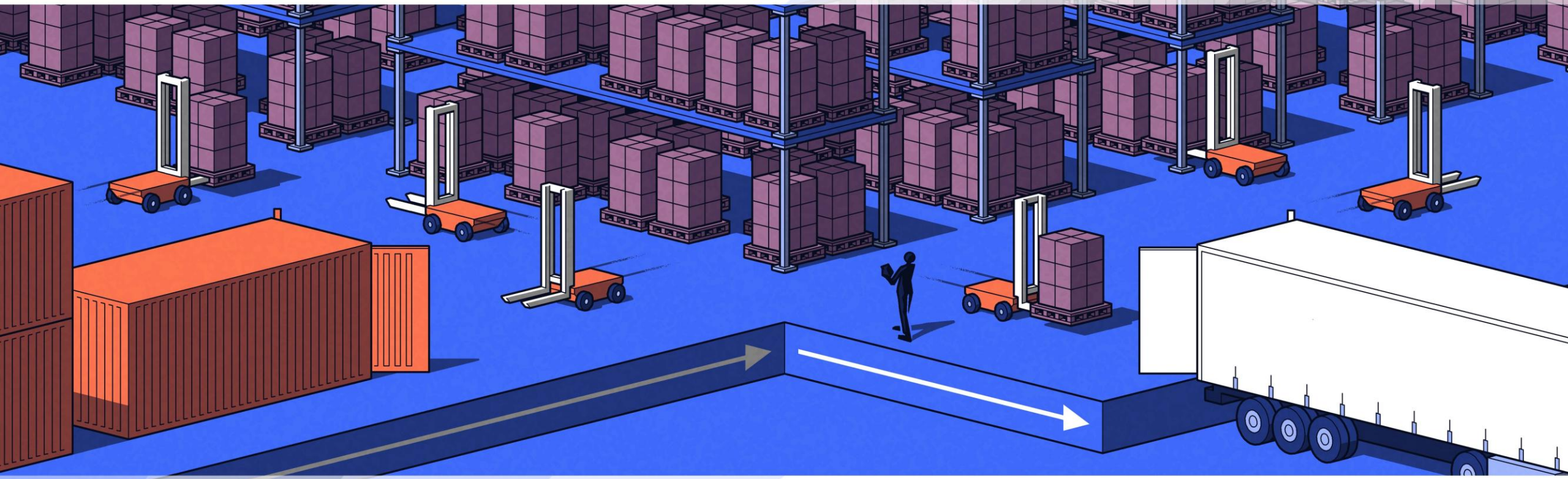

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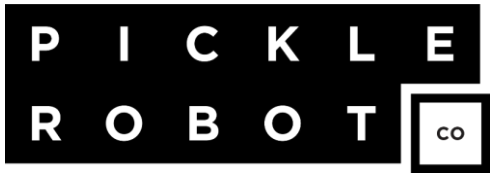

EXEC SUMMARY: A MARKET ON THE CUSP OF DEFINING ITSELF, WITH ATTRACTIVE TAM POTENTIAL. INHIBITED BY >2-SHIFT BUSINESS CASE ALTHOUGH THIS WAS IMPROVING

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DEFINITIONS & SCOPE

- This report focuses on Pallet and Loose Carton Loading & Unloading Automation Equipment
- There are two primary segments: ATLS (Pallet automation to/from trailers) and Case Pick (Loose Carton automation to/from containers)

MARKET DYNAMICS

- Primary market drivers were labor availability, increasing regulations and automations throughout the facility creating congestion at the docks
- Inhibitors varied on the technology, broadly, cost of solutions and the associated civic-works to successfully deploy had major impact on ROI
- Typically, ROIs favored operations with 2 shift, although there was a trend towards increased cost-control throughout the sector

GRAYSCALE OF AUTOMATION

- ATLS a binary between fully manual and fully automated, with little in the way of semi-automatic solutions.
- Case Pick had more variety with solutions ranging from fully-manual, semi-auto (telescopics etc), and (supervised) fully-automated solutions

MATURITY BY SEGMENT

- Case Pick & Multi-Shot ATLS automation were still early stage, with many companies emerging in the last c3 years. Progress ranged from POC to early-stages of commercialization.
- Relatively, Single-Shot ATLS was more mature (Modified more so than Unmodified), with several decades of commercialization although concentrated at the upper-end of the market
- EOL manufacturing to 1st touch warehousing in CPG the main segment for ATLS
- Export Manufacturing and Import-heavy industries like CPG, CEP and 3PL were early adopters of Case Pick
- While technology was maturing, the market was still nascent and largely undefined

DOWNSTREAM COMING INTO FOCUS

- Downstream processes (particularly case unloading) becoming an opportunity space for new entrants
- Inbound Palletizing was singled out as an area that would require much more focus especially as the Case Pick technology matures and potentially increase in their throughputs
- Heterogenous (Multi-SKU) palletizing of loose cartons the biggest challenge for Inbound Palletizing as there was currently a trade-off between speed and space

LONG-TERM GROWTH

- 2024 saw some cool-off in demand as the pandemic was firmly in the rear-view mirror, with global instability thought to be a contributor
- There was a lot of optimism for 2025, with early indicators of capital being acquired/allotted to loading/unloading projects
- For early-stage companies, 2025 would mark the 1st year of major commercialization efforts as POCs completed, with a sense of 'make-or-break'
- Long-term, the market felt largely untapped, with room for much more participation

FOR BUYERS OF LOADING/UNLOADING EQUIPMENT:
STIQ offers a free 30min debrief/Q&A session for this report as part of the sponsorship. Contact us to arrange a confidential "ask us anything" session

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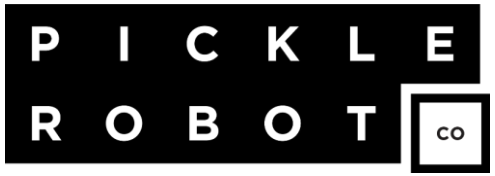

PALLETIZED GOODS AND LOOSE CARTONS ARE SEPARATE APPLICATIONS WITH DIFFERENT OPTIMIZATION DRIVERS AND TECHNOLOGIES

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THE TWO PRIMARY PAYLOADS HAVE DIFFERENT OPTIMIZATION DRIVERS (MANUAL OPERATIONS IMAGED)

	Pallets	**Loose Cartons**
Primary Vessel	Trailers	Containers
Optimization	Handling Speed	Cube Density
Typical Handling	Manual Forklifts/Pallet Jacks	Human Pick/Place, usually with a conveyance system
Positioning	• EOL Manufacturing to Warehousing • Warehousing to End-Users/Retail	• Import/Export DC • Overseas Manufacturing to DC
Main Technologies (incl. emerging technologies)	• Modified Single-Shot • Unmodified Single-Shot • Unmodified Multi-Shot (AGVs, and AMRs)	• Robotic Arm Case Picking • Conveyor with Case Picking Head • Semi-Automatic/Manual+

Source: STIQ Research & Analysis
Image sources: Pallet Loading, Loose Carton Unloading

THE LOADING & UNLOADING AUTOMATION SECTOR IS SPLIT INTO PALLET AND LOOSE CARTON SOLUTIONS, TRANSPORTED IN TRAILERS AND CONTAINERS

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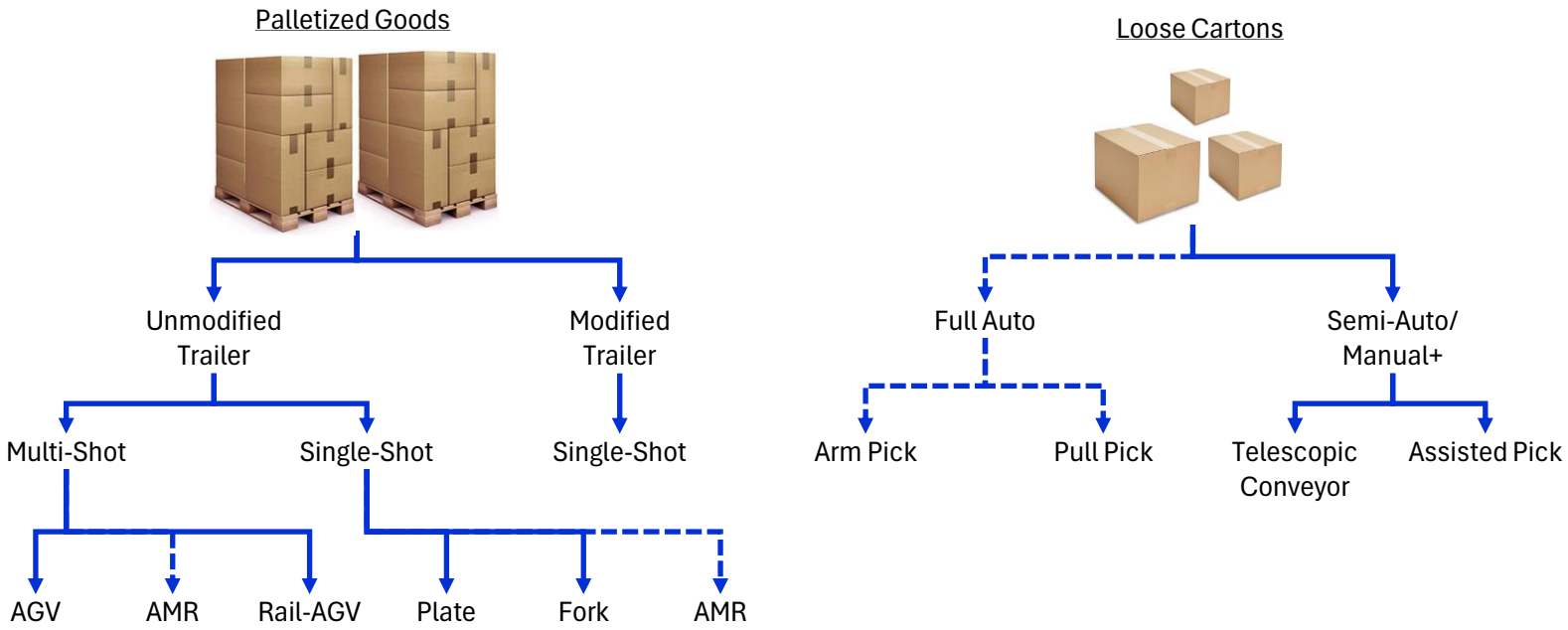
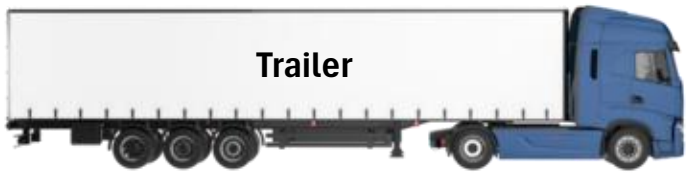
HIGH LEVEL TECHNOLOGY TREE OF LOADING & UNLOADING AUTOMATION SOLUTIONS



Primary Mode of Transportation of Palletized Goods



Primary Mode of Transportation of Loose Cartons

Key: → *Mature Automation Equipment* ⇢ *Emerging Automation Equipment*

Source: STIQ Research & Analysis. Simplified sector overview. Image source: trailer + truck, carton, pallet

LOADING & UNLOADING AUTOMATION

- This report focuses on palletized and loose carton loading & unloading automation equipment
- These payloads are typically transported in trailers or containers which may be used interchangeably throughout this report
- Mature technologies in the sector include pallet single-shot systems for loading trailers in a single mechanical movement and loose carton semi-auto solutions, such as telescopic conveyors, etc.

RECENT TECHNOLOGY INFLUX

- The Loading & Unloading sector has recently experienced an influx of new technologies, such as autonomous pallet/forklift robots and various loose carton pick/put robots
- Newer technologies attempt to disrupt the market but as they are relatively nascent can often be slower than existing technologies or manual (incl. manual+) handling
- However, with an increasing number of ongoing trials and pilots many of these technologies are learning, maturing and getting closer to a potential inflection where they may disrupt parts of the market
- This report provides readers with an overview of the current dynamics in the Loading & Unloading Equipment sector

CONTAINERS AND TRAILERS CAN EITHER BE LIVE OR DROP WITH DIFFERENT IMPLICATIONS FOR LOADING/UNLOADING AUTOMATION

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DROP & LIVE CONTAINERS/TRAILERS

Source: STIQ Ltd Research & Analysis. Live & Drop Trailer

DROP VS LIVE CONTAINERS/TRAILERS

- Containers and trailers can be split into Drop and Live
- Drops are where the driver leaves the container and goes on to to other tasks, allowing 2-3 days to unload
- Lives are where the tractor remains attached, and the driver waits while the load/unload is performed, with between 2-4 hours to complete

"Drop containers are where the driver drops it off and leaves, they're usually 2-3 days of time to unload, while live containers are 3-4 hours for unloading." [Contoro]

"All our customers have both live and drop loads...with lives the window is usually 2 hours... 3PLs tend to have more live loads." [Fox Robotics]

REGIONAL DIFFERENCES

- Interviews suggested that live containers were less common in NA, whilst in EU they were more prevalent

"I almost never see live containers in the US, but in Europe it's a lot more common." [Pickle Robot]

- In particular, live containers were more common close to ports where they may be prioritizing quick turnaround

"In Europe... maybe this is specific to the sites we saw close to the ports, but there were more live loads... that they were turning around the same day." [Pickle Robot]

- Other geographies had a distinct trucking industry where the tractor and the container were fused together

"We have coupled trucks here so there are no drop trailers, they are completely fixed together." [THINK BLUE]

UNLOADING + LOADING AUTOMATION EQUIPMENT INSTALLED AT LOADING BAYS, IN THE INTERSECTION BETWEEN WAREHOUSE AND YARD

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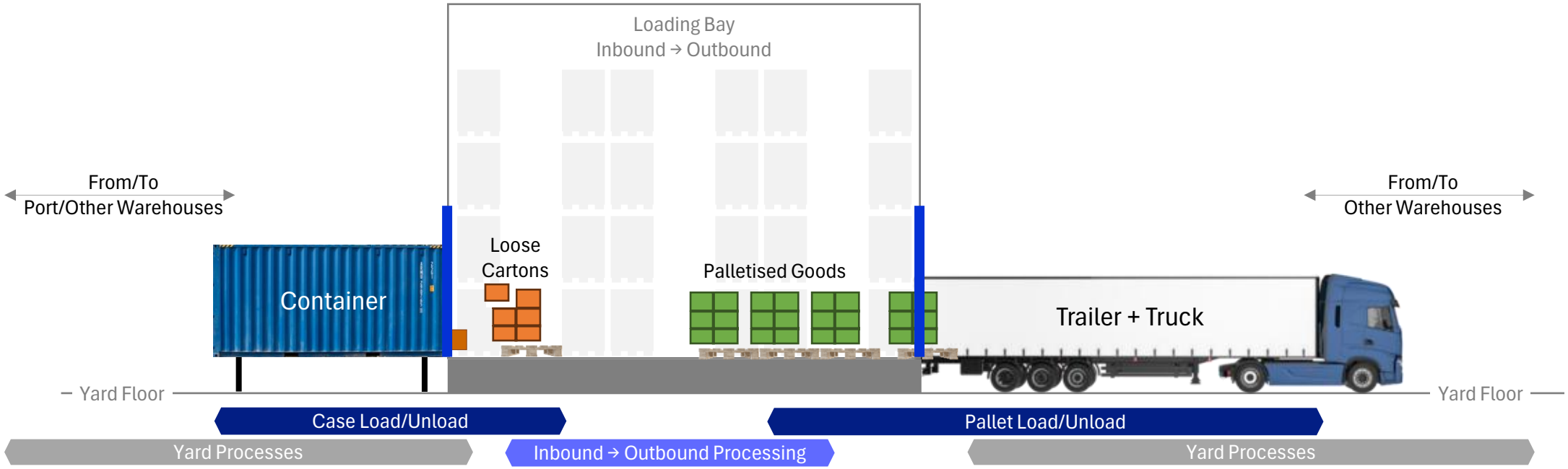
LOADING / UNLOADING OF CONTAINERS AND TRAILERS OCCURS AT WAREHOUSE LOADING BAYS (SIMPLIFIED)



Source: STIQ Research & Analysis. Container, Trailer + Truck

FROM LOGISTICS TO INTRALOGISTICS

- Loading/Unloading often sits at the interfaces between production to warehousing, and from warehousing to distribution, i.e. the intersection of Intralogistics and Logistics

- **Intralogistics** involves the processing and handling of material within the same facility, campus, or increasingly, facilities that are geographically dispersed but part of the same operation

- **Logistics** involves the processing and handling of material to any facility that is external to the operation
- Readers should note that these definitions are not concrete and depend heavily on org structures

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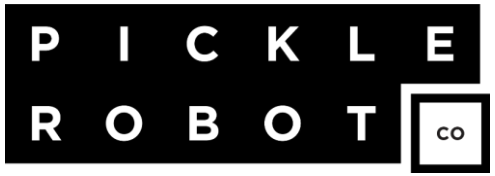

PALLET AUTOMATION BROADLY SPLIT INTO TWO MAIN CONCEPTS: SINGLE VS MULTI-SHOT

PALLET AUTOMATION ARCHITECTURES

	SINGLE-SHOT	MULTI-SHOT
Trailer Type	• Modified • Unmodified	• Unmodified only
Form Factor	• Conveyor • Load Plate • Telescopic Forks	• Lateral-AGV • AGV • AMRs
Trailers/Hour[1]	• 3-5	• 1-2
Description	• Full trailer load of pallets formed onto a plate/conveyor at the docks • All loaded into trailer with a single action	• Pallets are fed into the system in batches • Pallets are sequentially loaded into the trailer in multiple actions

Source: STIQ Research & Analysis. Joloda Single-Shot, Navflex AGV
[1]Trailer/Hour depends on the upstream

SINGLE-SHOTS SPLIT BETWEEN TWO MAIN CONCEPTS: MODIFIED TRAILER AND UNMODIFIED TRAILER SOLUTIONS

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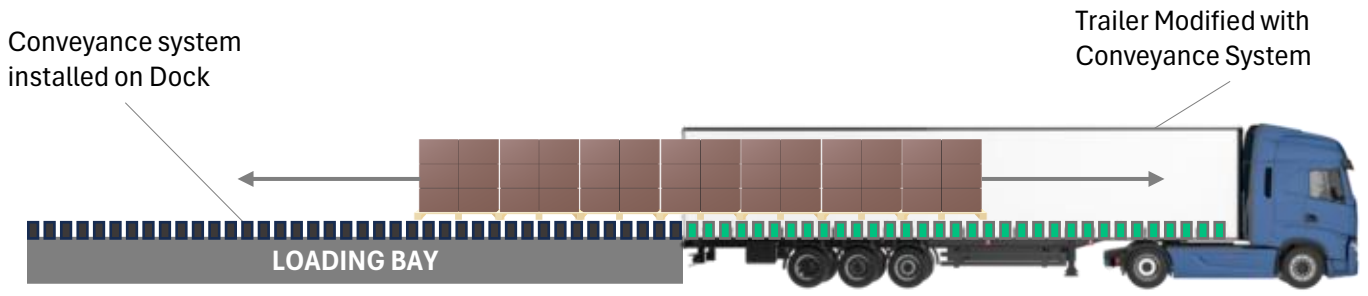
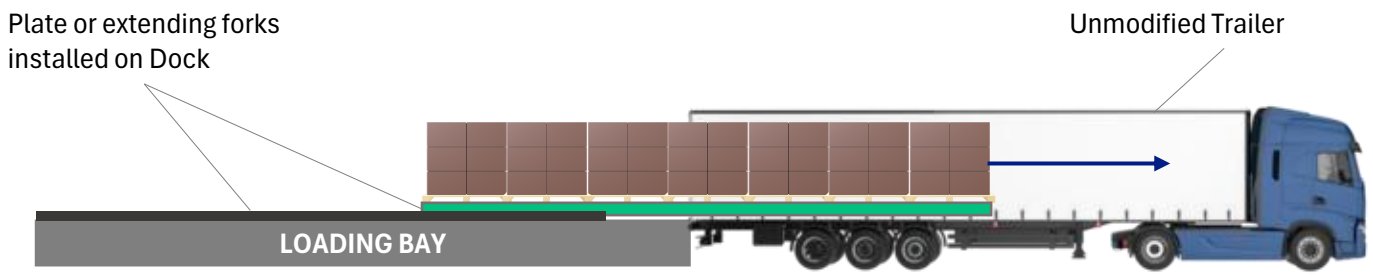
MODIFIED & UNMODIFIED TRAILER SINGLE-SHOT SYSTEMS





Source: STIQ Ltd Research & Analysis

Modified Trailer ATLS

Installed at	Source and Destination
Modification	Dock and Trailers
Travel Distance	<100km
Primary Use	EOL Manufacturing to Warehousing
Process	Loading, Unloading
Conveyance	Slip-chain, Skate, Moving Floor, etc.
Buffering	Yes, can also operate without
Fleet	Dedicated Fleet

Unmodified Trailer ATLS

Installed at	Source
Modification	Dock
Travel Distance	>100km
Primary Use	Distribution to end-users
Process	Loading (can unload if forks used)
Conveyance	Plate or Extending Forks
Buffering	Yes
Fleet	General purpose and/or 3rd party

MODIFIED ATLS POSITIONED BETWEEN EOL PRODUCTION & FIRST-TOUCH DISTRIBUTION. UNMODIFIED IDEAL FOR OPEN-LOOPS AT DISTRIBUTION

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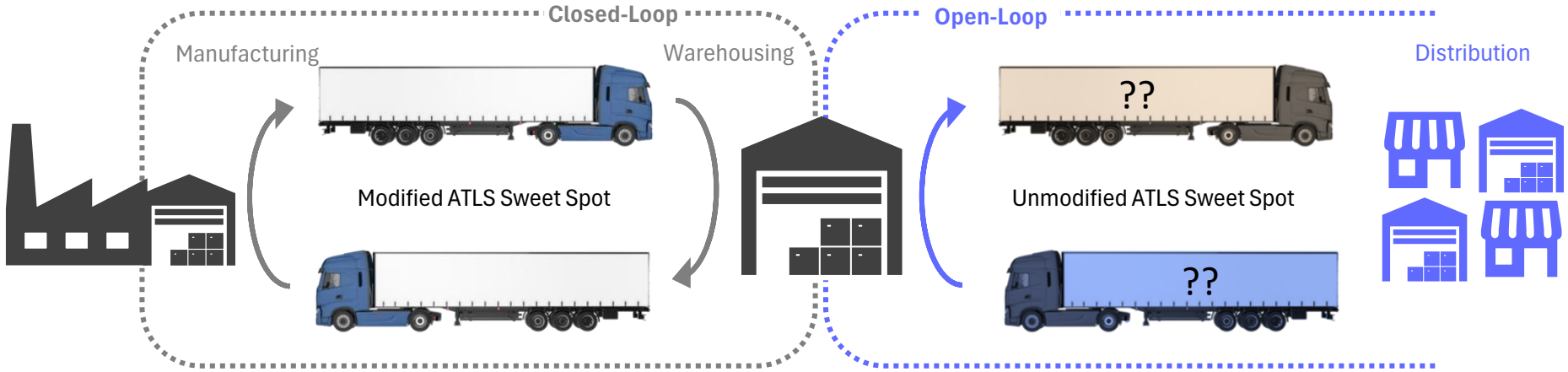
MODIFIED TRAILER ATLS BEST IN CLOSED-LOOP WHERE TRAILERS ARE OWNED/IN CONTROL



Source: STIQ Ltd Research & Analysis

MODIFIED ATLS IDEAL IN CLOSED-LOOPS

- Modified ATLS 2-3x cheaper than Unmodified ATLS with the same/higher throughputs

"The modified systems are much cheaper, something like 3x cheaper than unmodified, because they're basically conveyors, so they're not mechanically complex. The price difference is really important to the customers and that's why it takes longer to sell unmodified solutions." [WDX]

- Modified ATLS was ideal for closed-loops, typically as a shuttle between manufacturing and warehousing

"Modified trailer needs to stay in a closed loop, so that's ideal between a CPG plant to CPG mixing center for example." [Miebach]

- Modified ATLS may also have fewer requirements on the up/downstream, whereas Unmodified faces end-users and so careful planning/sequencing is more necessary

"When it's a modified system, the truck is dedicated, the volume is known between the factory and the warehouse, the distance is usually within 30 minutes... so you don't need to be so careful about how you put things onto the truck, and which order... but when you deal with an end-customer order, then you have to handle that requirement, the sequence of pallets, whether your upstream ASRS can retrieve at the required volume." [Actiw]

- Outside of that closed-circuit, modified becomes hard to justify, and in some cases impossible as the fleet isn't in the end-user's control

"At my previous 3PL we didn't like the idea of modifying trailers because after we're done with the 3-year contract with a customer, what do we do with the trailer, sell it at a loss? And we want to be able to use standard trailers to go somewhere that isn't the factory or the warehouse, that's why we needed to have unmodified." [UC Group]

UNMODIFIED IDEAL FOR DISTRIBUTION BUT STILL IN DEVELOPMENT. CAN BE DIVIDED INTO SINGLE AND MULTI-SHOT SOLUTIONS

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VARIOUS FORM-FACTORS FOR UNMODIFIED SOLUTIONS

Single-Shot Unmodified ATLS

Multi-Shot Lateral-AGV

Multi-Shot AGV/AMR

Source: STIQ Ltd Research & Analysis

SINGLE-SHOT UNMODIFIED ATLS

- Loads the entire trailer in a single action
- Dock is converted with an extending platform which the pallets are buffered onto, requiring extensive civic-works
- Load-Plates are more flexible but only work for loading

"If the customer has different pallets, say Euro and Industrial pallets, or they load in different orientations, then we have a chain solution where the entire platform enters the trailer, but this one can only handle loading." [WDX]

- For very standard loads, extending forks can be used which can work in loading and unloading

"If the customer is using EuroPallets and they load them on the short side, 3 pallets side-by-side, we can load and unload that with the Fork-based solution." [WDX]

MULTI-SHOT UNMODIFIED LATERAL-AGV

- Loads a trailer in multiple actions
- A middle-ground between AGV/AMR and Single-Shot
- Can cover multiple docks via installed rails or wheels
- Doesn't need full-trailer to be buffered, and can be fed directly with a conveyor
- Requires some civic-works if rails are installed

MULTI-SHOT UNMODIFIED AGV/AMRs

- Loads a trailer in multiple actions
- Very flexible solutions with little-to-no modifications required
- Buffering not needed but can help to reduce load times
- ERP/WMS software required for optimal loading

REAR-LOADING MORE FLEXIBLE AND COMPACT COMPARED TO SIDE-LOADING ALTHOUGH THE SPEED OF SIDE-LOADING FAVORED BY SOME INDUSTRIES

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REAR VS SIDE-LOADED TRAILER

Side-Loading

- Allows access to cargo from both sides of the trailer and along the full length
- Useful if dock space is limited, typically done out in the yard
- Can potentially be unloaded faster than rear-loaded
- Requires at minimum 3 aisles worth of space to load/unload
- Most common in the F&B and parts industries
- Fewer automation technologies available

Rear-Loading

- Access to cargo occurs layer by layer which can make it slower than side-loading
- More space efficient for loading a single truck, requiring only 1 aisle width to load/unload
- Common across most industries
- Large number of automation technologies available

Source: STIQ Ltd Research & Analysis. Loading Robots SideBot, Joloda Rear-Load Modified ATLS

REAR MORE FLEXIBLE, SIDE FAVORED BY SOME

- Rear-loading was more common than side-loading in general, with industries like F&B favoring side load

"For the most part, our clients are typical rear-loaded, but there are some markets, for example automotive, or beverages, where the side loading application is very interesting for them." [Loading Robots]

"In Japan, standard trucks are 10-ton which holds 33 pallets, and for the F&B industry they are side loaded trailers." [Ground Inc]

- There were also regional preferences, with China as an example, favoring side over rear-loading, whilst NA and Europe favored rear-loading

"We have 1 project that's rear-loaded, but most in China I would say are side loading... US and Europe are mostly rear-loaded" [VisionNav]

- In general, rear-loaded was seen as the most flexible loading method, and therefore the default

"Anything that can be side-loaded, can be rear-loaded, but the inverse isn't true." [THINK BLUE]

- The space required for side-loading was seen as an issue as automation becomes more prevalent closing the gap on process times between rear and side-load

"You have loading from one-side, and then another machine comes from the other side, so already you're talking about 2 aisles used to load one truck... I think it would be fine if there were single-shot side loads, then that would be interesting." [THINK BLUE]

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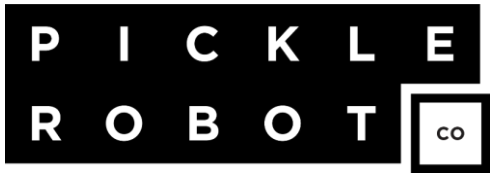
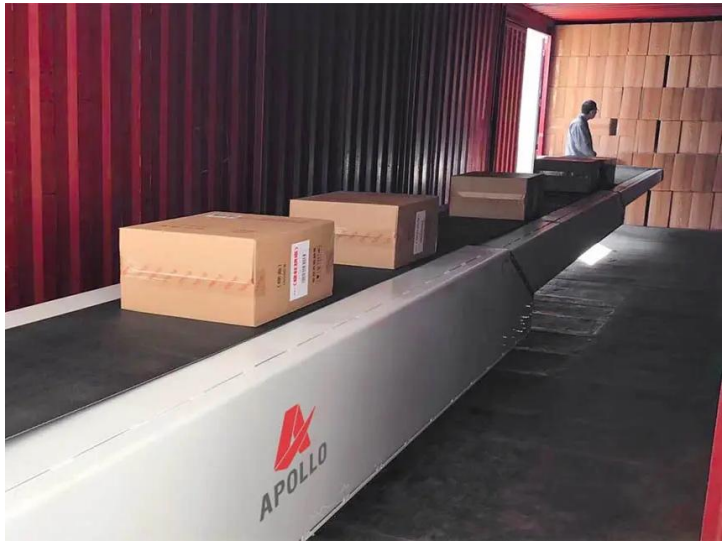


CASE LOADING/UNLOADING TECHNOLOGIES RANGE FROM SEMI-AUTOMATIC, TO FULLY-AUTOMATIC CARTON PICK AND CARTON PULL SOLUTIONS

CASE LOADING/UNLOADING TECHNOLOGIES



Source: STIQ Ltd Research & Analysis.

ROBOTIC PICK & PLACE CARTON AUTOMATION

- A robotic arm (co-bot or industrial), with an end-effector, typically a vacuum gripper
- Carton(s) are picked by the arm, which then articulates to place it onto another platform, usually a conveyor

ROBOTIC PULL & PUSH CARTON AUTOMATION

- A telescopic conveyor with an end-effector, typically a vacuum gripper, attached at the end of the platform
- Cartons are pulled onto the attached conveyor without a rotation, and taken for processing

SEMI-AUTOMATIC CARTON AUTOMATION

- Usually, a telescopic conveyor that can extend into the trailer
- Conveyors can be manually positioned, or electrically via a control panel
- Cartons are manually picked and placed onto the conveyor, and taken for processing

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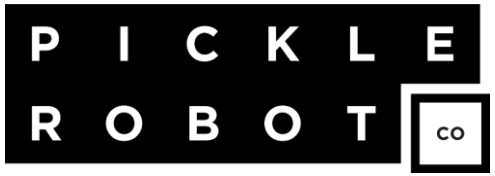

THERE APPEARS TO BE A LEVEL OF BIFURCATION OF NORTH AMERICAN AND EUROPEAN FORTUNES FROM AROUND 1Q23. HIGHER APPETITE FOR INVESTMENTS IN NORTH AMERICA?

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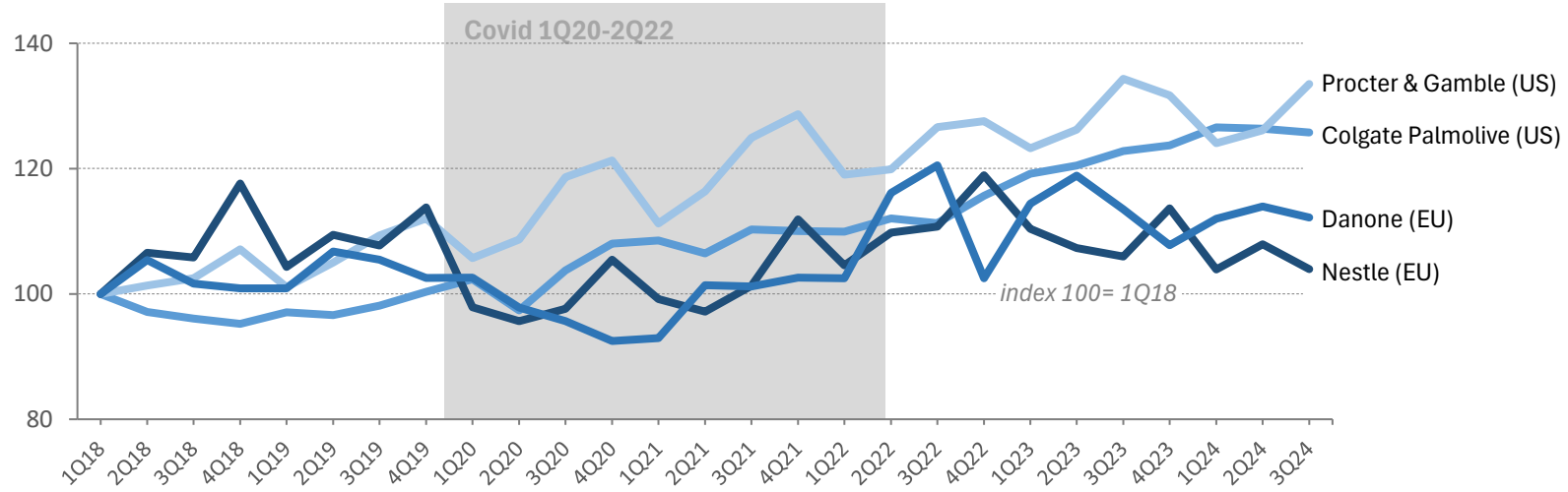
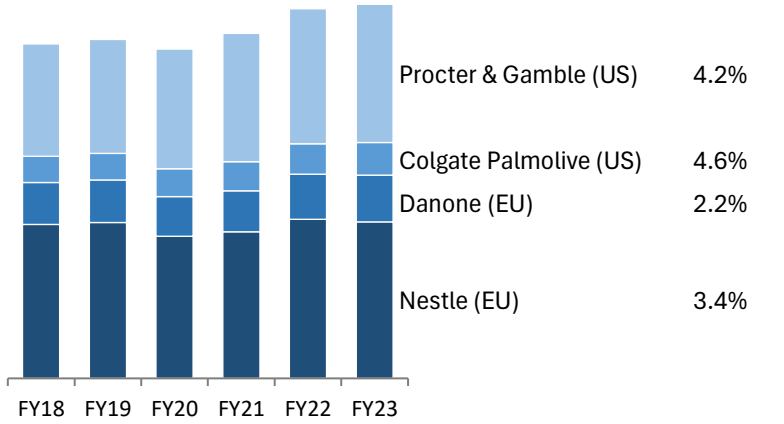
INDEXED CPG + F&B COMPANIES QUARTERLY RESULTS, 1Q18-3Q24 (INDEX 100=1Q18)



Source: Company data

CPG + F&B COMPANIES ANNUAL REVENUE, FY18-FY23 ($M)



Source: Company data

CAVEAT FOR THIS ANALYSIS

- CPG and F&B companies represent an important customer demographic for Loading & Unloading Automation vendors
- The above analysis including four companies (two in North America and two in Europe), while not representing an in-depth analysis is used to highlight wider sector trends, especially the difference between the North American and European markets and potentially the demand for Loading & Unloading Automation
- A presumption is that the companies generate a large proportion of their revenue locally

BIFURCATION OF CONTINENTAL FORTUNES

- The overall quarterly revenue trend 1Q18-3Q24 indicates North American companies may have managed Covid and post-Covid better than their European peers
- Of the two European companies only one breached Index 120 in a single quarter in the full period - 3Q22 – while both North American companies operated at or above 120 from 2Q23 to present
- Growth (or lack of growth) may be indicative of corporate interest in investing in automation equipment

NORTH AMERICAN MARKET HEALTHIER?

- Interviews for many of STIQs open source market research reports throughout 2024 have indicated the relative strength of the North American material handling equipment market and this seems to be reflected in growth figures
- Of the four companies analyzed, the two North American companies recorded 4.2%-4.6% CAGR FY18-FY23 compared to European counterparts at 2.2%-3.5%

2024 A YEAR OF LAUNCHES AND PILOTS FOR YOUNGER COMPANIES. OVERALL A SLOW YEAR WITH LOWER INVESTMENT APPETITE

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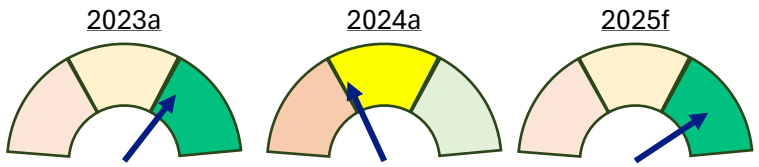
GROWTH SENTIMENT 2023a-2025f



Source: STIQ Ltd Research & Analysis

INTEREST IN NEW TECHNOLOGIES IN 2024

- Younger companies saw 2024 as a very positive year, with products launching/maturing, and completing initial pilots

"I look at ourselves, and our competitors that I think highly of, and I would say none of us are currently a slam dunk... but the fact that we're here, we're a couple of years in, we're all improving, and customers are willing to talk... that's the big difference between 2024 vs 2023." [Pickle Robot]

"Matter of fact we signed 3 customers in the 2.5 months who we started speaking with in 2023, they wanted to try it earlier, but they didn't want to be the first." [Pickle Robot]

"We grew 80% year-over-year in 2024... I think it's because the technologies are maturing so more customers are beginning to notice them... as well as the deep risk with the labor issues we're seeing." [Fox Robotics]

"2022-2023 we were in POC, trial mode. The growth in 2024 was 300 with 2025 seeing exponential growth." [Navflex]

"We're still at the prototype stage for the palletized system, so we don't really have much to report in the matter of sales, so I look forward to 2025, but in general we are a small company, so we still saw fairly large growth, around 50-60% in revenue." [SmartTEH]

A SLOWER YEAR BUT STILL ABOVE THE RED

- Overall, the market grew very slowly in 2024 when compared to other sectors in MHE automation

"Our overall growth was right at 30% this year for everything where trailer loading is probably about 10% of that. It hasn't been retracting, hasn't been flat, but not growing as quick as some of the other areas have." [JBTC]

- Lead times were slower, which lead to potential sales in 2024 rolling into 2025

"For Telescopic Conveyors, I can say that 2024 is quite flat, in general the market is not moving fast enough to finalize all the ongoing projects within the year, but we do have some potentials for the upcoming year." [Lodamaster]

- Project sizes also appeared to have scaled down compared to previous years

"At the beginning of the pandemic, people were really investing in their systems, but after 2022/2023, they stopped. This year was a little better but still fairly low profile, and pretty local." [Sortcon]

- Socio-economic uncertainty was thought to have contributed to hesitancy in the market

"A lot of folks will tell you 24 because of the election, because of the economy, they've seen people pull back on their spending." [ABCO]

2025 VERY POSITIVE WITH INDICATIONS OF MORE INVESTMENT FROM THE MARKET. MANY EARLY-STAGE COMPANIES RAMPING UP FOR COMMERCIALIZATION

EARLY INDICATIONS OF A STRONG 2025

- Sentiment for 2025 was positive with some early indicators that customers were seeking capital for investments

"I have huge expectations for 2025... banks are telling us that companies are starting to ask about credit for investments... and now after the holidays, we are seeing a lot of inquiries from customers for their 2025 budgets...so that's why I have high expectations for 2025." [WDX]

"I think 2025 will be much better because I can see people starting to talk about projects again and I'm send quotes weekly to different companies." [Sortcon]

"There're a lot of good things in the hopper now that the elections settled. We're hearing a lot of folks especially as the budgets for 2025 come in, there's a lot of good projects on the horizon." [ABCO]

- Semi-auto vendors felt that 2025 would be better for companies that handle smaller projects

"2025 there are too many projects... but the point is they are not €10M+ projects, but a lot of smaller projects. Since we're OK with smaller projects, that's great but for companies that only take on big investments, it might be a challenging year for them. " [Sortcon]

- Markets with heavy exports of FMCGs like South America felt that the growth in 2024 would continue into 2025

"I think 2025 is going to be great. The exports will help us, we have so many sales to be okay for the next year. I think it's going to be something like 20% more than this year at least." [CAPO]

EARLY STAGE COMPANIES HAVE HIGH HOPES

- Case Pick vendors saw 2025 as their first major year of growth as they move into commercialization

"Goals for 2025 are, 1st to expand existing and new customers... second, is to set up in Europe." [Pickle Robot]

- Other vendors saw it as an important year for international growth, focusing on beachhead projects

"We don't have 100's of installations in the US which might be a barrier to growth in the US, but once we get in, I think in 2025 we can deploy another 200-300 units in the US, then I think the problem will be resolved." [VisionNav]

- For some vendors, 2025 was the make-or-break year for their new products

"Our goal is to have 6 on the market next year, as always you know it's difficult. However, we still see 2025 as the year that changes everything, and if it doesn't go, then we have to reconsider the market." [Loading Robots]

"In 2025, we're going to produce the system that we sold, then it has to run for at least a year, so at the end of 2025 we will get the decision if they are satisfied or not so would say maybe 2025 it could be 1 or 2 customers, but in 2026, when they're satisfied with the pilots, then it will start to really move forward." [Trapo]

LOADING/UNLOADING PROJECTS GEOGRAPHICALLY DIVERSE WITH MOST CONCENTRATION IN NA, EU & CHINA. EU A CHALLENGE AS DEFINITION OF 'LOCAL' UNCLEAR

THE AMERICAS A MAJOR GROWTH REGION

- Loading/Unloading projects span the globe, with most adoption seen in NA, EU and China

"We have a big client in India that say there's a 25-30% increase in consumption of the beverages, so every 3 years, their volumes are increasing by 80-100%, so they can't plan according to manual operation anymore. We also see automation like ASRS going on there too." [Actiw]

"95% of our customers are from the US, and 5% are in Canada..." [Fox Robotics]

"We're mainly based in Spain and Portugal and have done lots of work in Europe, and in Mexico... In Latin America, we're exporting more now than doing projects here in Spain." [LM Group]

- Vendors preferred to deploy within a certain catchment, either because of cost of shipping heavy machinery, or to be able to support customers

"We're concentrating only on Europe at this moment because of the complexity of the systems we want to be able to give the maximum support. We have some service engineers in America, so that's somewhere that we can deliver... Asia and other parts of the world, we could deliver and find local support, but we don't have a local organization yet." [Copal]

MAP OF DEPLOYMENTS CONFIRMED BY INTERVIEWS

Source: STIQ Ltd Research & Analysis

- Despite lower wages, China was adopting Pallet and Case automation due to the sheer volume from manufacturing

"The Chinese market is huge, and we're only talking about maybe 5-10% of the early adopters who are not that sensitive to ROI calculations, that just want to replace manual labor, and that 5% of the Chinese market is perhaps larger than 100% of other markets. The primary driver for these companies is to just automate." [XYZ]

EUROPE A CHALLENGING GROWTH REGION

- Vendors felt that Europe, despite being geographically small, was a challenging market to spread through because of the number of countries and languages

"Even in Europe, never mind LATAM or Asia, we have a problem in communication... maybe English is the common business language, but still you can't cold call somebody, or try to convince them in a foreign language." [SmartTEH]

"The trouble with Europe is people obviously worry about the after sales process, so let's say I have a branch in Germany... but I have some French company I reach out to... they aren't satisfied by the German office, they want a French office... that's the biggest challenge." [Sortcon]

EUROPE & CHINA SHOWED LESS GROWTH IN PALLET AUTOMATION COMPARED TO OTHER GEOGRAPHIES

Loading/Unloading 2025 (Feb)
Published by STIQ Ltd

CN & EU DOWN, US, SA & AS TRENDING UP

- Chinese vendors saw declining domestic demand for AGV/AMR ATLS, mitigated by increase from export markets

"This year, business in China wasn't great, we didn't sell any truck loading/unloading in China this year, we did sign around 5 projects outside of China including US, Korea, and Japan. If you ask me about next year, I'd say we'll sign 15 projects." [VisionNav]

- Europe declined significantly from 2023-2024 as economic uncertainty created hesitancy in the market

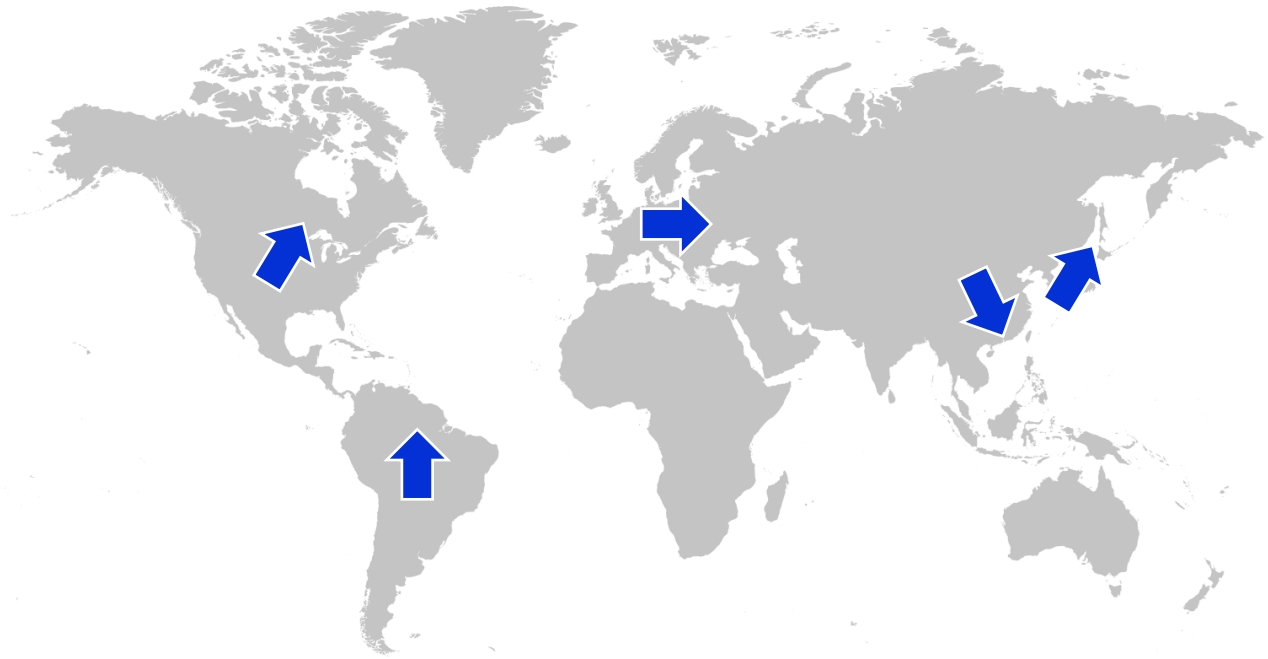
"2023 was flat, I think it was a hard year in terms of investments, they invested less or stopped completely… there was no growth in the German market, so I think 2024 will be the same as 2023 for us." [WDX]

"For 2024, growth appears to be modest, likely in the range of 5–10%. This isn't due to project losses but rather to delays in customer decision-making. This trend is not unique to our industry but seems to be affecting many sectors across Europe." [Actiw]

- Brazil saw a surge in pallet automation despite weak domestic performance, as increased exports resulted in higher pallet volumes shipped out

"Exports have been very helpful for Brazil, the situation isn't great domestically, but export is really helping our business, especially with Argentina, Mexico and Spain. We're almost back to what we were in 2022, which was our best year." [CAPO]

GROWTH SENTIMENT BY REGION, BASED ON INTERVIEWS



Source: STIQ Ltd Research & Analysis

LOADING/UNLOADING STILL A SMALLER SHARE OF OVERALL REVENUE FOR SYSTEM INTEGRATORS

LOAD/UNLOAD PART OF BROADER PROJECTS

- Loading/Unloading projects made up <10% of revenue for System Integrators, but steadily growing

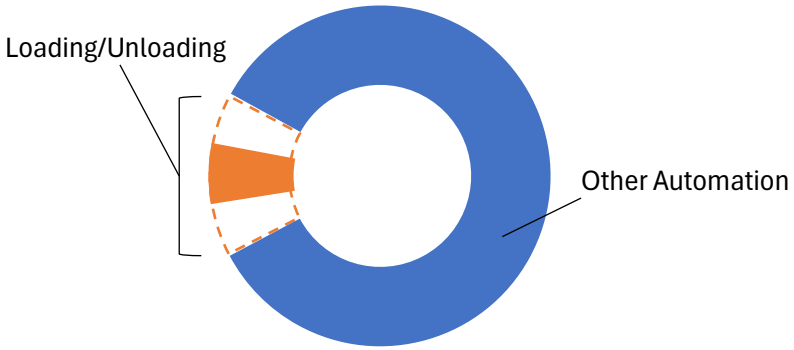
"Loading/Unloading is roughly 3-7% of our total revenue, since our main business is conveyor lines, automatic warehousing and sorting systems." [LM Group]

"It's probably 10% of our revenue; it's not a major part but it's steadily growing... it's often part of a bigger system so it's one of those nice to haves." [JBTC]

- With semi-automatic solutions making up the majority of that Loading/Unloading revenue, as a result of the early stage of full-auto solutions

"It's probably less that 10% from a total dollar volume, since we're a system integrator, we're building out that full solution so that's loading, storage and conveyancing in between. From that 10%, X% is probably the pure gravity conveyors, Y% are the telescopic conveyors and then there's a very small robotic piece in there." [ABCO]

LOADING/UNLOADING AS % OF REVENUE (SIs)



Source: STIQ Ltd Research & Analysis

POSITIVE LONG-TERM OUTLOOK WITH INCREASING END-USER ENGAGEMENT AND A STRONG POTENTIAL MARKET EXPECTED

END-USERS HUNGRY FOR DOCK AUTOMATION

- Vendors across pallet and case solutions believed the demand for load/unload was greater than the supply of solutions

"I think the demand from the clients is increasing faster than the technology is able to move." [LM Group]

- Vendors were beginning to shift their development towards the SME sector that is more sensitive to cost and ROI calculations

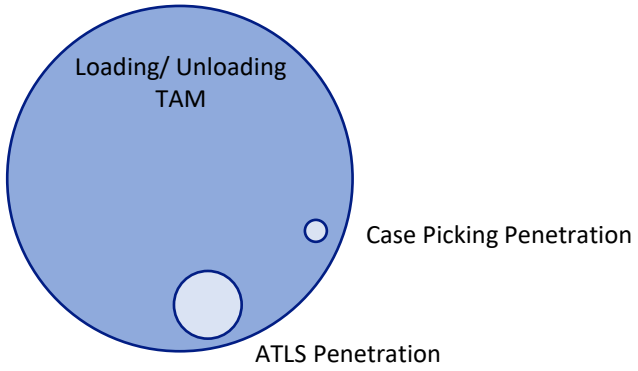
"We see a lot of customer potential; we've met with most of the high-volume players in the market and we're aware that there are reasons that our system can't be pitched to most SME customers just yet. It's mostly a function of cost, the customer really wants the system but they can't adopt them, that's why we're doing a lot of R&D now." [Actiw]

- Interviews suggested that this wasn't a case of if customers would adopt, but rather when the technology was ready to be adopted by them

"Every retailer and CPG would love to do it. Are we seeing successes in pilot programs? Yes. Are we seeing it to the degree that it has a provable business case, not yet, but I don't think we're far off, we're much closer than if you asked me that question 2 years ago." [Miebach]

"I have several clients that are on both palletized and loose loads exploring this with a number of vendors because this is kind of the last frontier in warehouse automation. He who cracks the code, great wealth will come to them." [Miebach]

LOADING/UNLOADING MARKET PENETRATION REMAINS LOW



Source: STIQ Ltd Research & Analysis

"The market is thirsty for such solutions... We cannot put a number on it, but in the next couple of years, I imagine all the solutions will have matured enough and we should see good numbers... I believe something like 3-5 units a year as a start." [Technica]

"I think it's most critical at distribution, but in the end everyone has docks that need to be automated...even small customers will need it and want it at some point." [Navflex]

"Customer demand is still very strong, and the market itself is big, which although you probably see all the other robotics companies, if we include ours and our competitors market shares, it's probably less than 1%, not even close, so the future is bright." [Contoro]

- In the longer term, the market was seen as inevitable as cost and regulatory pressures increase

"Find me a company that's fine for the next 50 years with unoptimized loads. It's one thing if it's a milk-run from my plant to my warehouse that's down the road, that driver is sitting there all day anyway. Whether they make 8 or 16 moves, it's a full-time job, I'm not paying half a driver, and there's where you're seeing a lot of pallet automation these days. If we start talking about the Fortune 100 CPG manufacturers that's shipping to all the big-name retailers, they're not settling for suboptimal freight...I mean there's meticulous routing, load management to optimize transportation...they're going to wait for that solution to where they don't need to take such a big hit on outbound freight." [Miebach]

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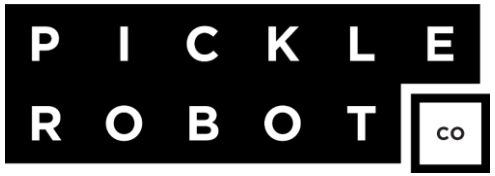
GOLD SPONSORS



MARKET DRIVERS IN THE LOADING & UNLOADING AUTOMATION SECTOR. ACCESS TO LABOR AND IMPROVING H&S TOP DRIVERS

Loading/Unloading 2025 (Feb)
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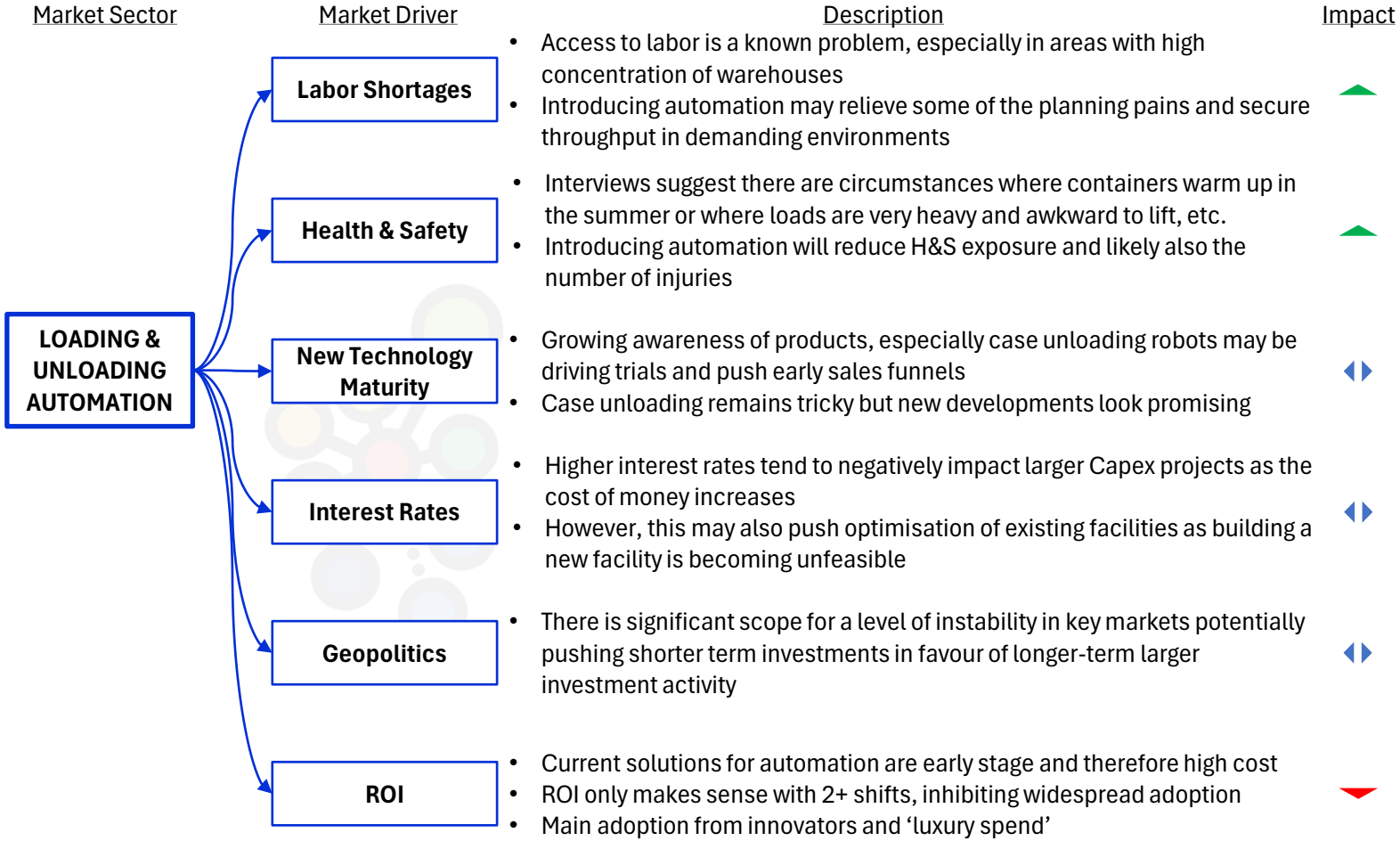
TOP LOADING & UNLOADING AUTOMATION EQUIPMENT MARKET DRIVERS



LOADING & UNLOADING MARKET DRIVERS

- There are a few common market drivers and inhibitors for both container and trailer Loading & Unloading such as access to labor or labor shortages
- While higher interest rates may limit the potential for larger projects, it may also drive smaller projects in existing facilities, such as optimization of loading & unloading
- Inhibitors often center on throughput, i.e. where an automation solution may provide a lower throughput compared to current operations
- Loose carton picking market drivers also include health & safety as cartons can be heavy and include work in demanding environments which may limit the effective working time for labor

GEOPOLITICS, AN UNKNOWN FACTOR

- We may be entering a new geopolitical era with an elevated level of instability, conflicts and tit-for-tat activity focused on protecting perceived national interests
- While some of this is already known, there are significant unknowns which may cause some companies to focus on shorter term investments in existing operations instead of larger longer-term projects
- There may be many unexpected consequences of any actions on the overall market, both potentially positive and/or negative
- One example is an increased demand for automation equipment in conflict areas as labor may be drawn into military service

Source: STIQ Ltd Research & Analysis

INCREASED LABOR COSTS AT THE DOCK RELATIVE TO THE VALUE ADD AN OPPORTUNITY FOR INCREASED AUTOMATION AT THE DOCKS

Loading/Unloading 2025 (Feb)
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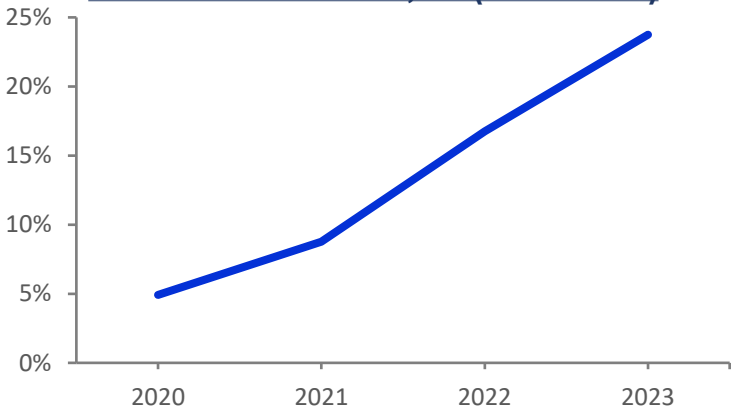
% CHANGE IN MEAN ANNUAL WAGES, WAREHOUSE ROLES, US (2020-2023)



Source: U.S. Bureau of Labor Statistics, OCC Code 53-7062

COST OF LABOR CONTINUES TO RISE

- Various socio-economic factors had contributed to an increase in labor rates

"One of the big challenges you see here lately in North America are the strikes at the import side of the country here on the docks, so not only is the cost of labor going up, but also the availability of labor is not as reliable as it used to be… I think that's one of the biggest challenges." [Mujin]

"Wage inflation is real and it's starting to make warehousing more of a cost issue, and that's what's driving the demand. Everyone is thinking, how do we remove FTEs from the P&L, that's the real questions they're asking even if they frame it in terms of efficiency or all that fancy stuff." [Buyer]

- Developing countries also saw an increase in labor costs, increasing demand for automation

"They don't want people working there, because actually the labor cost in China is increasing, it's not crazy like in the United States, but it's increasing." [VisionNav]

"Mexico saw a 40% increase in labor costs of the last 2 years, so there's a lot more demand from LATAM. We also attended LogiMAT in Thailand and we're also seeing a lot of demand from there too where previously low labor costs would make it hard to justify ATLS." [Joloda]

- In comparison to warehousing, manufacturing facilities were impacted more significantly due to their higher labor rates

"The SLAs for factory employees are higher than in the warehouse… it's not much at about 8-10%, depending who you're talking about… it's not much, but it has an effect." [UC Group]

A BETTER USE OF CAPITAL

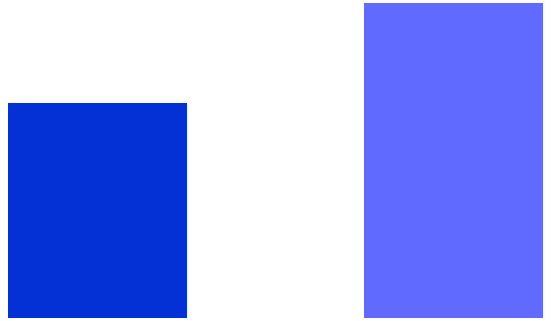
- Load/Unload was considered one of the most FTE intensive processes in a warehouse

"Trailer load/unload is one of the biggest labor consuming processes in all 13 processes of the warehouse." [Buyer]

- Dock employees were typically higher paid than other warehouse roles to incentivize workers to fill the roles

"Last week I was at a client that paid people in the container 150% of the pay of other warehouse employees because it's hard work that nobody wants to do. There's always people that will do it if you pay enough, right? If you need to pay more, then of course the business case for automation is getting more interesting." [RoboWorks]

WAREHOUSE WORKER VS LOADING/UNLOADING LABOR, DIFFERENCE IN PAY



Source: STIQ Ltd Research & Analysis

- Even where labor demands are met, companies preferred to allocate FTEs to higher value roles

"If you start talking about value add, what're you doing at the docks? You're pulling something out to then have another vehicle move it somewhere else, it's 100% the definition of non-value-added work." [Miebach]

"The other fact is that even if they have workers, they want to use them… not only on the forklift to load and unload pallets, since there's no added value in that kind of job… they want to reorganize and use these people for really valuable work." [Forankra]

WHILE AN INDUSTRY WIDE TREND, LABOR AVAILABILITY AT DOCKS FURTHER EXACERBATED BY CHALLENGING WORKING CONDITIONS

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LOW LABOR CONSISTENCY AT DOCKS

- Three major issues are cost of, availability and consistency of labor, particularly where warehouses are concentrated

"One is direct labor costs that they're trying to take out of the business, another is labor consistency where a person just doesn't show up and then there's labor availability. Take port cities...they turnover quite often, and it's not like you don't have labor, but say it's a 7,000-person town, you burn through everyone that wants to do this job, so what do we do now? It can be a challenge." [Anyware Robotics]

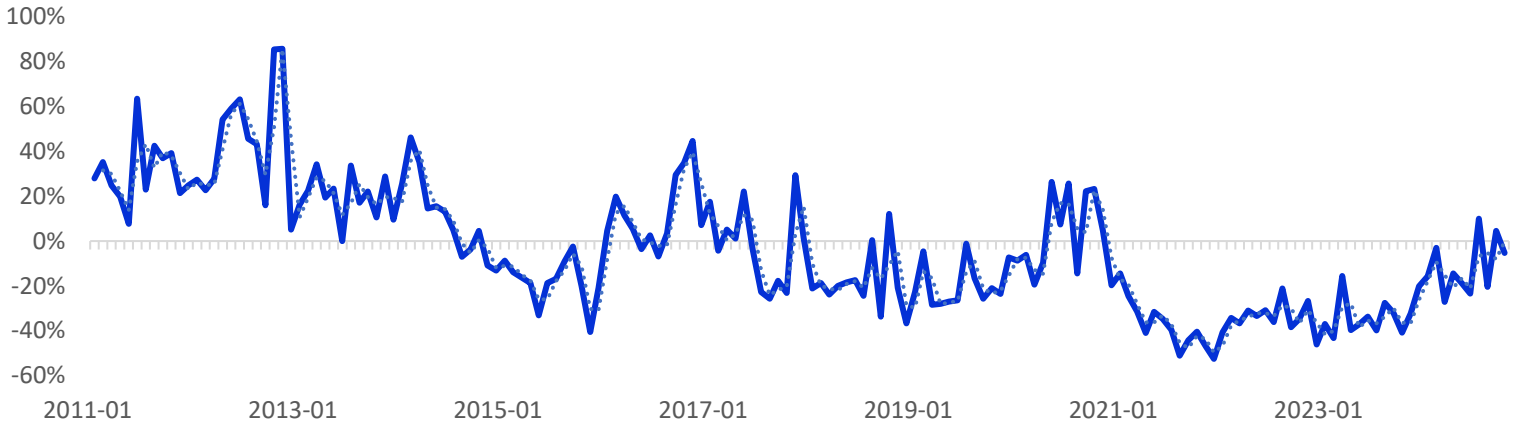
"Following Covid, there was a high demand for operators, but the availability was low and at a higher cost and with many more regulations. This expanded the gap that automation needs to fill." [Technica]

- It was said that dock work was the least desirable in the warehouse and therefore hard to hire for and retain

"First and always it's labor. This is the most miserable job on a forklift... it's hot, it's cold, it's bumpy and it's very mundane, you aren't talking to anyone, so it always starts with labor, the hiring, retaining and the daily management of labor." [Navflex]

"If you look at the interview with head of technology at a major CEP, what they point to is that this is the most painful job in the warehouse and that their team is consistently asking the technology group for a solution to this problem. Everybody hates the trailer loading job, it's high turnover... it's low worker satisfaction, and high injury rate" [Dexterity]

HIRES TO JOB OPENINGS IN TRANSPORTATION, WAREHOUSING, AND UTILITIES. US (2011-2023)



Source: STIQ Ltd Research & Analysis. U.S. Bureau of Labor Statistics - JOLTS

- Typically, companies fill roles through temporary labor, which may result in highly volatile productivity

"Typically, businesses rely on temporary/contract employees to do this work and so that workforce can be unstable because of call-ins or when staff realizes the physicality of the job, they won't or can't finish it... so the bottleneck just continues." [Contoro]

- The licenses required for operating forklifts also further limits the available labor pool for pallet handling

"It's tighter than normal labor constraints because a forklift driver needs a special license... so it's tighter than the already very tight labor pool." [Rapyuta]

"One of the projects we're reviewing right now in Canada, they built 1/2 the factory... soon, the 3rd and 4th hall will be available, but already, with half the halls, they can't get enough forklift drivers." [UC Group]

RISK TO BOTH HEALTH AND TO CAPITAL

- Docks were seen as a high-risk environment for damage to stock and infrastructure and for harm to employees

"On average about 31% of global forklift jobs are empty, the average forklift operator turnover is 4 times a year, 25% of all accidents occur at the dock and the majority of fatalities and serious accidents occur at the dock." [Navflex]

"The dock area tends to be more hectic where there are accidents, whether it's accidents that involve injuries or damage to the doors, conveyors, other equipment or also to the product. It's a tough time to damage the product because you've made the product and sunk all your costs into it and then to have it damaged is very costly." [JBTC]

LOADING & UNLOADING OF LOOSE CARTONS IN CONTAINERS CAN BE HEAVY WORK OFTEN INVOLVING HIGH TEMPERATURES. HEALTH & SAFETY A MAJOR DRIVER

Loading/Unloading 2025 (Feb)
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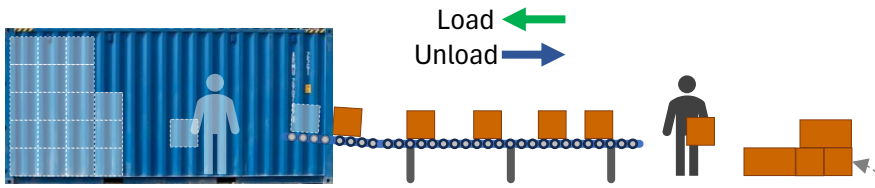
HAZARDS IN MANUAL AND AUTOMATED CARTON LOAD/UNLOAD

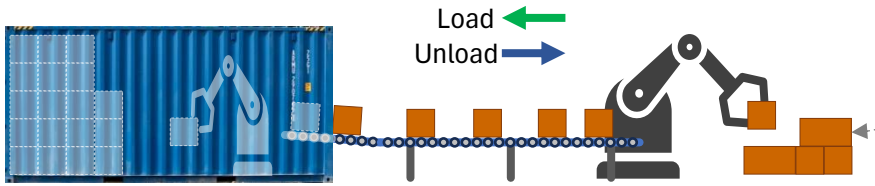
Potential Hazards

Fully Manual Carton Loading/ Unloading



- Fully manual operated loading/ unloading of cartons
- There may be 1-2 workers inside the container to speed up operations
- There is also likely to be 1-2 people palletizing/ depalletizing cartons as they are unloaded/ loaded from/ into the container

Fully Automated Carton Loading/ Unloading



- Fully automated loading/ unloading of cartons
- There may be 1-2 robots inside the container (depends on vendor)
- While focus for many vendors remains on the picking/loading, there is likely also a future where cartons have to be palletized/ depalletized
- Most current solutions operate the 2nd station manually

Pallet Storage

LOOSE CARTON LOADING/ UNLOADING

- Conversations with operators highlighted potential hazards to people in manual loading & unloading of loose cases
- This includes, containers heating up in summer, potential slips if there has been leaks, heavy loads, etc.

"In August here in Toledo, it reaches 42ºC outside, which means inside the container is 50-55ºC, it's crazy to have one person inside there… nobody from the company wants to work in that position so they hire temporary people who spend like 2-3 days and then they say 'okay, I quit because I cannot work here'. This is a real problem." [LM Group]

- Furthermore, as containers have to be unloaded within 2-3 hours (or penalties apply) this can also be stressful work with issues of access to capable labor
- There are currently a number of semi-manual or manual+ solutions for this process including various conveyor concepts such as telescopic conveyors with or without platforms for manual staff

PLENTY OF TRIALS, THROUGHPUT INCREASING

- Interviews suggest there are plenty of ongoing trials with some production site roll outs of loading/unloading picking robots

"We are currently trialing a solution from a vendor in one of our other warehouses." [Anonymous Retailer]

- Full-auto hovering around lower-to-similar throughputs to manual processes remains an issue for the segment to replace injury prone work

Source: STIQ Ltd Research & Analysis

INCREASED WORKER PROTECTIONS AND ESG TARGETS PUSHING UP DEMAND FOR LOADING/UNLOADING AUTOMATION

SMALL IMPROVEMENTS BIG SAVINGS

- With higher volumes, even small improvements in cube-density can impact ESG and overall cost-savings

"A big thing that we can solve is that we're able to increase trailer utilization by up to 10% with the current algorithm... 10% might not sound like a lot, but if you're able to consistently load at 5% to 10% greater trailer utilization rate, that means you can take 1/20 to 1/10 of the trucks off the road. There's the head-haul cost, the back-haul cost, the carbon credits, fuel, insurance, all these different things roll up into pretty significant cost savings." [Dexterity]

- End-users are increasingly exploring novel solutions to prepare for further legislation that may interrupt business continuity

"There's now a lot of focus on truck unloading not only due to labor shortages and rising wages but also, ESGs... Companies are afraid that manual container unloading at large volumes will be impossible within the next couple of years. As soon as the solutions are there to automatically unload these heavy boxes from the container, for high volume operations, it becomes prohibitive to continue doing it manually. I believe that a lot of business leaders, understand the need to automate and that they need time to make this change... and then in the next couple of years... automate the inbound process. Then in a couple of years, when the legislation gets strict, you're ready to keep the process going, it's the continuity." [RoboWorks]

HEALTH & SAFETY DRIVING DEMAND

- H&S legislation around the world that dictates maximum hours for drivers is ratifying, adding further complexity

"In Japan we have the '2024 Problem' which regulates the number of hours and the maximum distance a driver can travel, including the waiting time of the truck driver. When the loading and unloading takes time, that reduces the number of hours on the road for a driver." [Ground Inc]

- Regulations are also dictating resource planning in loose loading/unloading

"More governments are giving attention to the way people are treated inside warehouses, in the Scandinavian countries, there're controls on how many kgs people are allowed to carry in a day, so we are seeing a lot of demand, especially from the northern part of Europe." [Copal]

"In Spain, we have a regulation, maybe it's all over Europe, but if you open a container, you have 2-3 hours, and if you go over that time, you pay for each minute that you go over, so right now it's better for companies to just unload as fast as possible with an operator, rather than to have a fully automatic system that removes the operator." [LM Group]

HIGHER COST OF MONEY MAY INHIBIT MARKET GROWTH IN THE SHORTER TERM, BUT SIGNIFICANT LONGER-TERM DEMAND REMAINS A TREND

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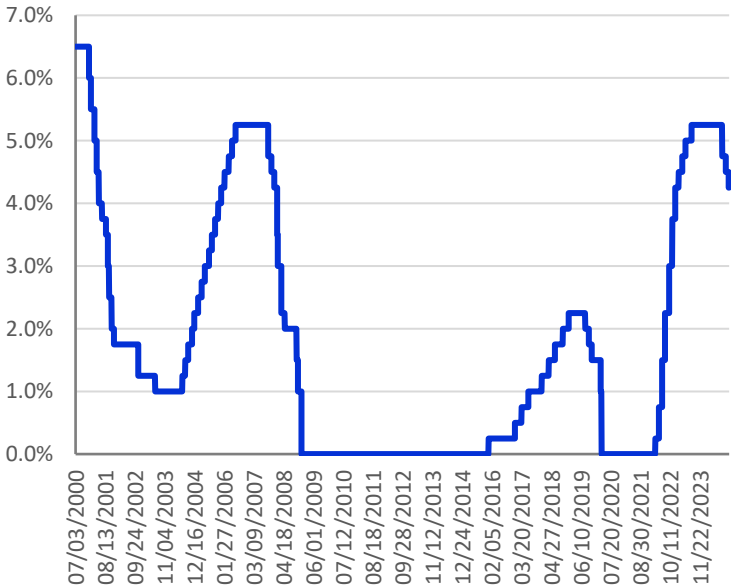
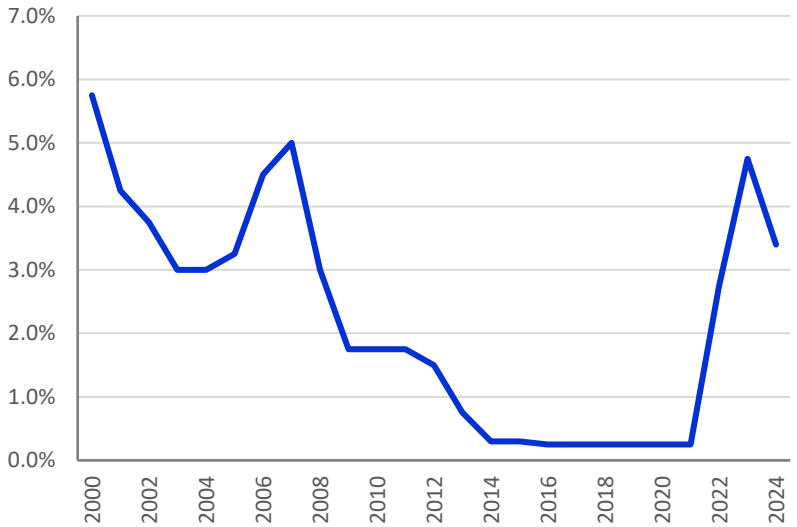
FEDERAL RESERVE BANK INTEREST RATE (EFFR), 2000-2024 (%) (DAILY)



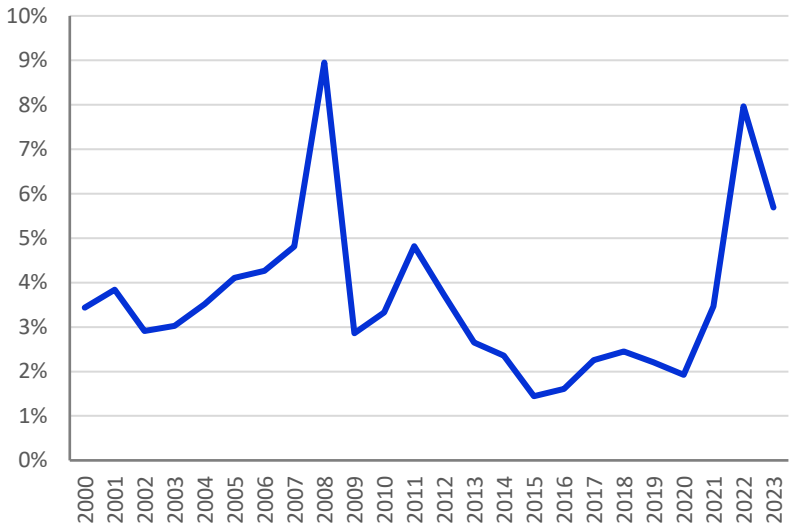
Source: Federal Reserve

ECB MARGINAL LENDING FACILITY INTEREST RATE, 2000-2024 (%) (END OF YEAR RATE)



Source: ECB. Interest rates used as proxy/estimate for the cost of debt funding of warehouse automation projects

WORLD BANK GLOBAL INFLATION RATES, 2000-2023 (%) (END OF YEAR RATE)



Source: World Bank via IMF

HIGHER INTEREST RATES, LOWER DEMAND

- While higher interest rates have a significant impact on demand for larger projects, it may drive up demand for other projects
- For example, companies with factories may delay construction of a new factory which is a major capital expense in favor of upgrading and optimizing operations at existing facilities
- This primarily focuses on brownfield sites and any solutions which have relatively significant impact on output

INFLATION A DOUBLE-EDGED SWORD

- While trending down, inflation was still higher than normal, potentially increasing labor rates
- Higher wages is typically a driver for automation to reallocate FTEs to higher value tasks in an operation
- Although higher cost of goods and services may also impact ROIs negatively

INCREASING ATTENTION FROM INVESTORS, BUYERS AND TRADITIONAL MHEs ENABLING MORE R&D INTO LOADING/UNLOADING SOLUTIONS

ATTENTION SHIFTING TO THE DOCKS

- Interviews suggested that the focus on Loading/Unloading was a relatively new phenomena

"It's a brand-new era, especially when you get into the automation of both the palletized and loose loads, and there are things happening in both areas." [UC Group]

"The market is only just opening the doors, there are plenty of opportunities for everybody, it's just that we need to show the market that these solutions are effective and provide added value, whilst being financially viable." [SmartTEH]

- Given the complexities of loading/unloading, attention typically went to more controlled areas like ASRS, shuttles etc., but is now shifting towards the dock

"Most companies that have a little bit of automation started at shoe-sorters, cross-belts, tilt-trays, you had a lot more capabilities and ROIs that made sense 20 years ago... it took us 10 years to really focus on automating inbound because it was so much more complex..." [Fidus Global]

"We're seeing that inquiries are increasing, initially we had some from an exhibition, then the next year it doubled, and now it's tripled, so the need is increasing from the customer side." [Trapo]

"The customer wants to solve one problem at a time like getting the boxes on pallets, and that problem has many companies solving it now, and prices are coming down, so that'll eventually be a common technology, and then they'll start to focus on truck loading at the docks." [CAPO]

- While current solutions could solve dock automation for specific end-user types, there were more to be served

"If the current solutions were sufficient, they would have exploded already. There's a reason that they haven't and it's because the business case is hard, especially if you look at the TCO. I've seen many of the solutions for both loose load, and for pallets and they're getting there." [Miebach]

"You cannot size the ATLS market, it's difficult to predict because the solutions aren't even there yet... Each vendor is limited to selling their 1 or 2 solutions." [THINK BLUE]

- There was an increase in investment and R&D from both vendors and end-users, as well as some M&A activity

"It's clear that many business segments are not yet in a position to adopt these systems. However, following our recent acquisition, we have launched an intensive R&D programme aimed at addressing these challenges and expanding the applicability of our solutions across a broader range of industries." [Actiw]

"It's going to be interesting how quickly people get gobbled up when they get close to figuring it out though. We've also seen a company running a competition a couple of years back with all the big MHE vendors to try to get them to solve this...it's just a matter of time... You see a lot of startups in this space, and a lot of traditional MHEs partnering with startups to try to crack this." [Miebach]

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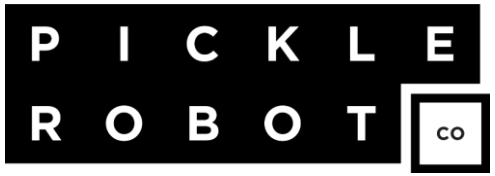

CAPEX STILL COMMON WITH LARGER SYSTEMS. RAAS BECOMING MORE COMMON RANGING FROM LEASE-TYPE TO FULL AS-A-SERVICE OFFERINGS

LARGE SCALE SYSTEMS STILL LEAN TO CAPEX

- For larger-scale solutions, Capex was still the main business model, with Opex covering typical after-sales services and upgrades

"It's mostly Capex. We have services, on-going monitoring, remote support, root-cause analysis, software upgrades over time, all those kinds of things. So there's a small Opex element for the service side, but the hardware and software, the overall system that we deploy isn't something we charge as a service, it's mostly done as Capex." [Mujin]

- For some vendors, the early focus on product hardening rather than scalability meant they opted for the Capex model with plans to explore alternate models in the future

"It's Capex, they sign for the contract and pay it directly, no leasing. This is something that I have in mind for the long term, but first we need to get this product on the market and running properly with no problems 24-7…then we can think of all kinds of ways to scale faster and make the solutions more appealing to a wider range of customers. The main-focus now though is to get the machine on the market and running properly." [RoboWorks]

- This naturally favored larger companies adopting these new technologies

"For now, it's Capex so you can imagine… it's going to be fairly big companies that are initially going to be buying this… mainly retailers and companies with production facilities overseas." [Technica]

RAAS MORE COMMON WITH ROBOTICS

- Some vendors have opted for a Hybrid-RaaS that includes both upfront fees and a recurring rate, either based on no. of robots or some performance-based unit

"We have both Capex and RaaS and we've done some tinkering to make sure that… it works for the big customers with 10-12 containers per machine daily, and companies that do 1-2 containers a day… We landed on a hybrid-RaaS model with an upfront fee, and a base monthly fee that includes a quantity of containers… with a small per-container fee after that… It's volume based which makes it easy to use with all our customers." [Pickle Robot]

"There are 2 go-to-market motions: RaaS and Capex…There's an implementation charge with the RaaS but it's inconsequential… 75% are Capex, 25% are on RaaS." [Fox Robotics]

- Other vendors opted for Capex for the hardware, with the software that supports it sold under a SaaS model

"The robot is sold as Capex, and then we license our AI platform and the specific truck loading application as a separate annual subscription fee. Some customers prefer Capex, others Opex, so we figured out a solution that is more inline with the way finance teams operate." [Dexterity]

- While some offer a full RaaS, incorporating all costs into a recurring fee

"We use a RaaS model, but… we don't charge anything upfront; the installation is covered by us… The idea is that we try to eliminate the idea of ROI, this is a service, like a photocopier in your office." [Loading Robots]

LIKELIHOOD OF BUSINESS MODEL FOR GIVEN TECHNOLOGY

	Capex	RaaS
Single-Shot	High	Low
Multi-Shot	Med	Med
Case Pick	Low	High

Source: STIQ Ltd Research & Analysis

- The RaaS model was seen as particularly favorable for customers that lack long-term stability like 3PLs

"If you take the 3PL that's contracted with their customer, that contract may be 3-5 years… even if they've been working with that customer for 10, 20 years, the contract itself is still short. That's why the RaaS model is important, especially for new technologies, where the customer may have apprehensions to dropping significant Capex… The barrier to entry is relatively low, so we're getting a lot of affirmation on that model." [Contoro]

CHANNEL PARTNERS AN IMPORTANT PART OF THE VALUE CHAIN. CASE PICK VENDORS STILL MOSTLY DIRECT BUT PREPARING TO SHIFT IN THE NEXT FEW YEARS

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ATLS A MIX OF DIRECT & CHANNEL SALES

- Mature technologies like single-shot ATLS were more flexible, with both direct sales and channels like SIs especially for more complex projects

"It's mostly the SIs that organize everything... we do have customers coming direct to us, but in general, there can be three parties involved, there's the production company, the warehousing company and sometimes a separate transport company, so a project can have between 1-3 customers." [Forankra]

- Some vendors preferred to work with SIs for any project with up/downstream elements to not compete with their partners

"We focus on ATLS. We don't provide projects with pallet conveyors or sorters; it's just not our business. We want our integrator partners to understand that we don't want to compete with them." [CAPO]

- Channel partners were also seen as an important way for end-users to explore the market and prepare for tendering

"If you're a Fortune 100, pushing from a global group and pushing 50+ projects, you can go direct... on the other-hand if you're a local beverage company, you may have less experience with projects, in that case, go to a consultant and then tender-out." [Joloda]

CASE LOAD MOSTLY DIRECT WITH AIM TO FLIP

- Case Pick vendors were predominantly selling direct to end-users because of the nascence of their technologies although this was beginning to change

"The market in general, everything is direct... no SI has selected a partner that they're working with... but that will change in the next 1-2 years." [Anyware Robotics]

- Direct sales was seen as beneficial in the early stage for product development, with the aim to shift away from direct

"We're a technology company, not an integrator, eventually we want it to shift to 100% partners." [Anonymous]

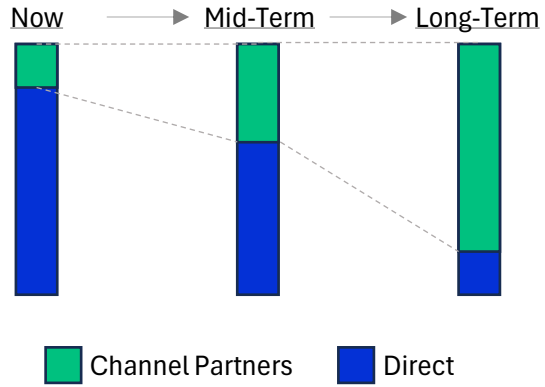
- Channel partners were seen as a key route-to-market with access to more customers, and potentially higher value projects

"We're ramping up in 2025 to add channel partners... For the next 2 years we expect to be more direct than we are channel... but the channel has access to customers, and relationships that we just don't have... I don't know what that would get to, maybe 50:50 but we'll build that up." [Pickle Robot]

- Some vendors preferred to maintain direct sales and installation, with local partners for aftersales support

"We do all the sales directly, our local partners are our service partners." [Copal]

ROUTE TO MARKET EVOLUTION OVER TIME



Source: STIQ Ltd Research & Analysis

CPG, F&B THE MAIN VERTICALS IN PALLET AUTOMATION WITH EMPHASIS ON EOL MANUFACTURING AND 1ST TOUCH AT DISTRIBUTION

Loading/Unloading 2025 (Feb)
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CPG, F&B MAIN INDUSTRIES FOR ATLS

- Main adoption for pallet automation came from CPGs, F&B and apparel as well as 3PLs

"Food & beverage are most eager for palletized loading and unloading... there's a ton of labor tied up at the plant with loading... a ton at the DC with unloading and then loading that back out... within other CPG companies like personal beauty, home care, health care, its also of interest. Not so much the electronic companies, its more your fast-moving consumer goods." [Miebach]

"We've done a lot of work with apparel, cosmetics, health and beauty, and a lot of 3PLs." [ABCO]

"We have many companies in East Spain that are manufacturing companies, which is perfect since they are just-in-time, so the process is very tight, and they know the number of trucks going out... then we have F&B... they're more seasonal with unstable processes." [LM Group]

"We have 115 robots deployed across 12 different customers...From 3PLs, CPG and F&B, which is probably what you hear from the others since they're high volume." [Fox Robotics]"

"We group our customers into 4 categories: Group 1 are the producers – automotive, petrochemicals, FMCGs with lots of bulky pallets. Group 2 are the SIs that do complete solutions. Group 3 are the 3PLs that are becoming more organized and using automation to extend their contracts. Finally Group 4 are the transport companies or trailer builders." [Joloda]

- End-users tended to deploy ATLS at EOL production and 1st touch distirbution

"It's normally after production, they need to take it to some temporary storage for a certain time... in China we do a lot of petro/gas industries, in Korea we have a project with an electronics company... and in the US we're doing a POC with a F&B company." [VisionNav]

"It's mostly industrial customers, between production and distribution or taking smaller steel components to facilities where they may produce other goods." [SmartTEH]

- 3PL appeared to adopt pallet automation with existing contracts to leverage for longer contracts, and competitiveness, at renewal

"For 3PLs usually it's the one that already has a contract... they've been with them for 5 years, and they're comfortable investing to make sure they don't lose the contract to competitors." [WDX]

10+ TRUCKS/DOCK STARTING POINT FOR ATLS

- >40 trucks/day was the rule-of-thumb for Single-Shot ATLS

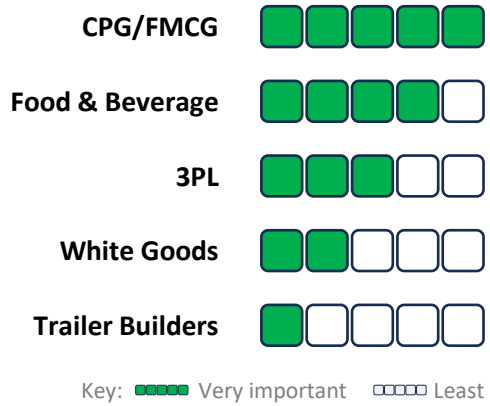
"If a customer has at least 50 transports per day they can be a good candidate for our solution, less than that and the ROI hits 3-4 years which can be too long for customers." [WDX]

"I'd say something like 40-50 trucks per day on inbound or outbound." [ABCO]

- For multi-shot ATLS, <15 trucks/dock could be handled assuming a 30-min process time

"If you have 10-15 trucks per dock per day, then it's a good system to have since you can easily get them done if you're assuming 2 trucks per hour." [Trapo]

PALLET LOAD/UNLOAD KEY VERTICALS



Source: STIQ Ltd Research & Analysis

LONG LEAD TIMES FOR PALLET AUTOMATION

- Lead times were generally >12 months for pallet projects

"From the start of a discussion, it can take something like 12 months till you get the PO, it's a long-term decision for a customer." [Forankra]

"Every time you quote, it can feel like that start of a 10-year journey here in Brazil." [CAPO]

- Newer technologies had more challenges around education and reluctance to be early adopters

"It takes a long time to get the internal approval because it's a new system, there is still some hesitance to install something like this." [Trapo]

HIGHER VOLUMES CONCENTRATED AT PRODUCTION FACILITIES MOTIVATING ADOPTION OF LOADING AUTOMATION AS A FIRST STEP

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HIGHEST VOLUME LOADING AT PRODUCTION

- Vendors suggested that most customers want to automate both load/unload. However, loading was the current priority

"Most of them want to do both loading and unloading, but typically they start with loading... I'd say it's 70% loading, 30% unloading at the moment." [Trapo]

- Loading projects may be prioritized due to the volume of goods at production facilities that concentrates at the outbound dock

"In the past 12 months we did more loading than unloading...It's hard to find DCs that need to unload all the time, but most factories have very little storage, so they're easily loading like 3 containers, so it's very high volume from the manufacturing customers, especially in the FMCG sector." [XYZ]

"Loading is more important because loading at the factory is where the most volumes concentrates. The containers then spread across the world so there are very few companies receiving 1000s of containers a month." [Joloda]

- Countries with a high concentration of manufacturing also implemented more loading solutions to manage volumes

"In international markets, unloading inquiries are way higher than loading, whilst in the Chinese market, loading is much higher and that's kind of expected." [XYZ]

- Regional differences, like pallets used, also had an impact with Europe being more equal in distribution of projects

"It's 50:50... In Europe the fork solution makes sense, but in countries like the US where they have many different pallets, then the chain solution is more popular." [WDX]

- End-user vertical and level of supply-chain integration were also factors in whether end-users automate load or unload, i.e. owners of production and DC may automate both

"We have 1 F&B customer that is loading at production and unloading at distribution... we have another producer that only loads materials and sends them to DCs." [WDX]

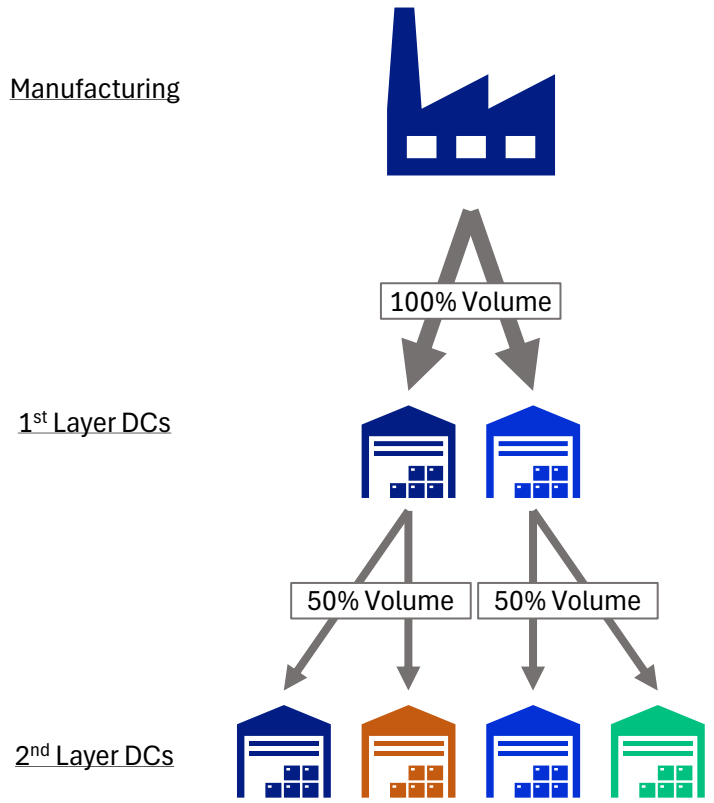
"It's 50:50, we started with loading, but then we had to unload them too... production is more loading, but DCs are 50-50." [Navflex]

- Unloading was also considered more complex due to variability in pallet types, movement during travel, condition of trailer and pallets etc., potentially limiting adoption

"We've done more loading than unloading... the challenge is trying to locate the fork pockets and with unloading there's more risk in the pallets moving around during transport... ideally you would also use the same solution on loading as you would on unloading to minimize that variance but that just hasn't really materialized yet." [JBTC]

"Until now we do more loading... because we can control how the pallets are placed, whereas with unloading, sometimes after a long period of transportation, the positions are off by a lot, so it's very hard to control." [VisionNav]

VOLUME OF LOAD/UNLOAD DECREASING DOWN THE CHAIN (ILLUSTRATIVE)



Source: STIQ Ltd Research & Analysis

SINGLESHOT ATLS PROJECTS TYPICALLY >€1M BUT INFREQUENT AT SUB-10 UNITS A YEAR

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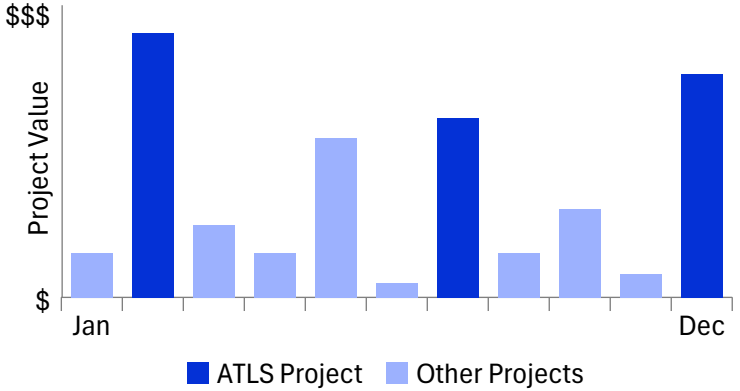
DISTRIBUTION OF PROJECTS IN A YEAR (ILLUSTRATIVE)



Source: STIQ Ltd Research & Analysis

FEW HIGH VALUE PROJECTS IN A YEAR

- Single-shot ATLS projects were typically high value (>€1M), but infrequent (<10 Units/year)

"From 10 or more inquiries per year, we eventually get to 1-2 projects." [Forankra]

"The market remains niche, with no company selling 100 loaders per year. Typically orders range between 1 and 3 units, although we are now discussing projects involving larger orders of up to 8 units in a single contract." [Actiw]

- Starting with fewer systems was recommended to make sure customers can handle edge-cases with manual flows

"If a customer has 10 gates, and they're asking for 8 to be automated, I recommend at the beginning to go with just a few gates to understand the process and how that affects the volumes... it doesn't make sense to block your flexibility." [SmartTEH]

"We don't have customers that immediately buy 4, 5 machines. Most of the time they start with one to check how it works, and then we discuss the next solutions..." [WDX]

- Some vendors found it hard to sell more than 1-2 units to a facility as ATLS reduces the number docks needed to push out the required volume

"A lot of the time, if a factory is using many docks to push out their products, they can move to using 1 or 2 docks because you can now load 50 trucks a day from that single dock... it's hard to find someone pushing out more than 50 trucks a day, so usually one system is enough." [CAPO]

SINGLE-SHOTs OFTEN CONSIDERED IN GREENFIELD PROJECTS, HOWEVER, HIGHER INTEREST RATES MAY LEAD TO INCREASED FOCUS ON BROWNFIELD IMPROVEMENTS

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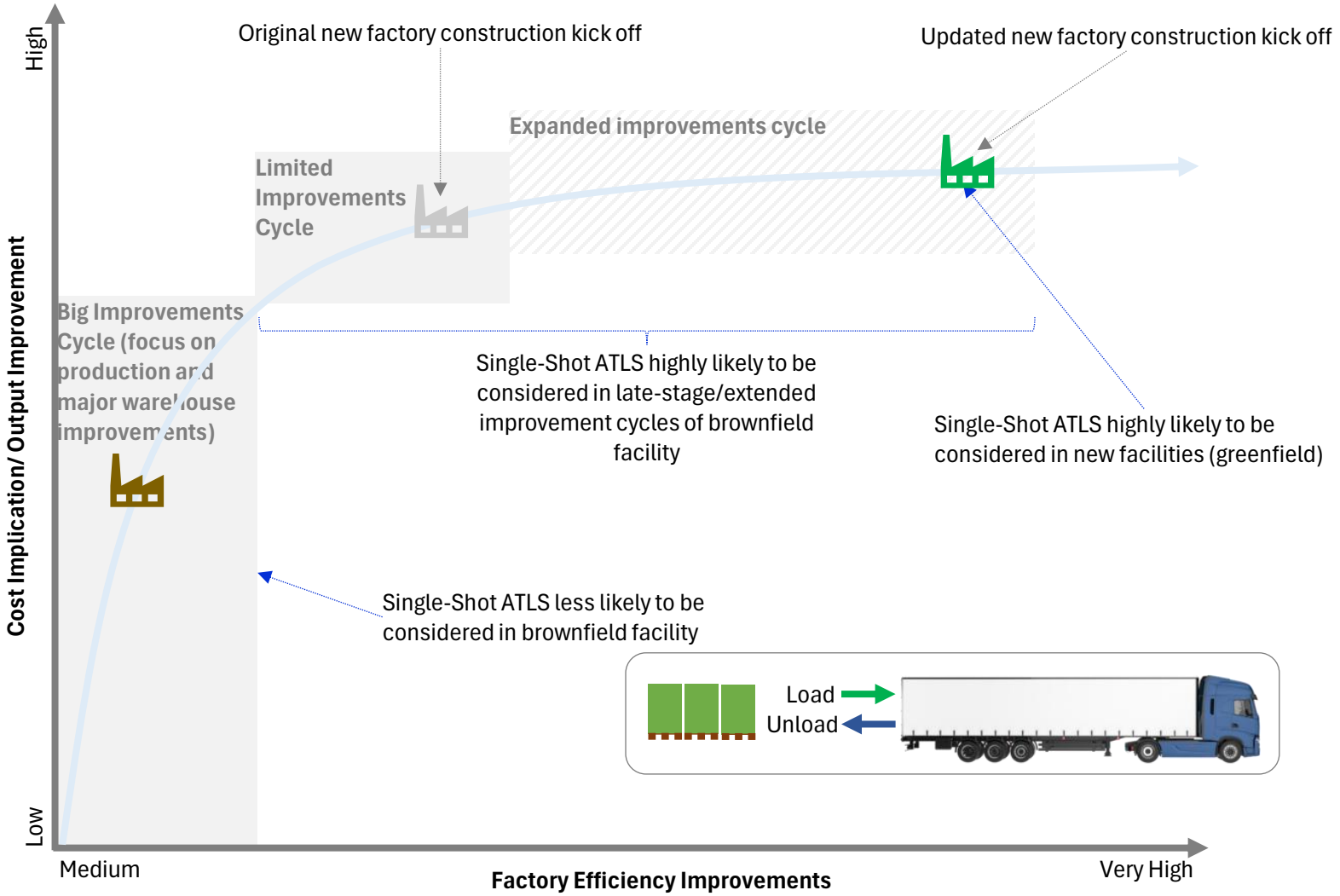
LIFESPAN OF FACTORY OPTIMISATION, IMPROVEMENTS AND NEW FACTORY PLANNING (SIMPLIFIED)



Source: STIQ Ltd Research & Analysis

FACTORY LIFESPAN & IMPROVEMENTS CYCLE

- Brownfield facilities without existing ATLS may suffer from higher costs to install Single-Shot trailer loading & unloading solutions due to significant civil works costs
- Single-shot solutions are an increasingly popular solution in greenfield facilities
- However, higher interest rates may mean companies focus on extending the lifespan of existing facilities rather than constructing new factories and warehouses
- Once a new facility is postponed, it becomes more likely that existing facilities will get budget for incremental improvements including solutions such as ATLS

DIMINISHING RETURNS

- Production & storage facilities will reach a natural level of diminishing returns in continuous improvements and optimization of existing equipment
- This means the cost of improvements may increase as efficiency savings become smaller

PALLET AUTOMATION STILL PRIMARILY IN GREENFIELD PROJECTS TO MAXIMIZE SPACE AND INTEGRATION. MULTISHOT SYSTEMS LIKE AGVS MORE COMMON IN BROWNFIELDS

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GREENFIELDS DOMINATE PALLET HANDLING

- Single-shot ATLS systems were more commonly part of greenfield projects because of the improved business case with tighter upstream integration

"It's 30% brownfields, 70% greenfield currently because the savings are more obvious when you design the warehouse around the automated dock, for example having a fully automated feed from your ASRS, forming the load." [Actiw]

"We do both green and brownfield, but I would say 80% are greenfields." [THINK BLUE]

- Greenfields also allowed the budget for ATLS to be allocated from overall budget, and to separate upstream costs from the system cost

"With greenfield, the budget comes from the overall building budget so it's a no-brainer." [Actiw]

- However, brownfields were still very common, and often brought extra complexity and cost to projects

"Most of our customers already have existing warehouses, with say 100 bays on both sides of the warehouse... The best customer would be a greenfield or just the plot so we can better advise on the number of docks they'd need." [WDX]

"Most of the solutions are brownfield, which is an issue since that usually comes with civic works, which can then be a problem because maybe they cannot do these works because it's rented, so we end up building outside of the facility...which can get expensive...even double the price of the system." [LM Group]

- How to define a customer extending an existing facility was a gray-zone in interviews, although tended towards classification as a greenfield project

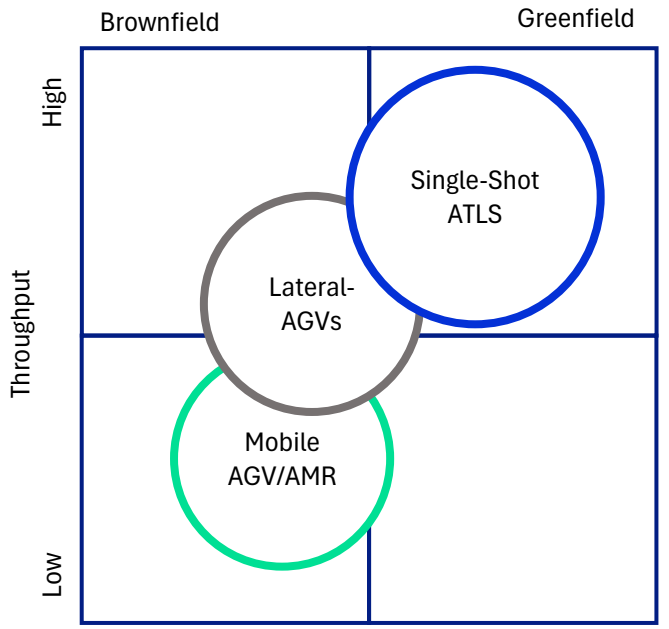
"I'd say it's 60% greenfields, but another point is that...say one of our big customers, we deliver systems to their existing site, but every two years they're adding new buildings to that site, so it's extending." [Forankra]

- Multi-shot ATLS were common in more brownfields as they require less civic-works, integration and space to deploy

"It's probably 50-50... some of them have existing loading halls they want to optimize, others are new installation...that's always nice because then you can really play with the layouts, the loading ramps etc., to make the system run smoothly." [Trapo]

"We have one customer that's heavily automated, and they want the entire system autonomous... Everyone else we're often the 1st automation since there isn't much integration on the unloading side which means you can just drop it in their brownfield and start automating." [Fox Robotics]

LIKELIHOOD OF SINGLE VS MULTI-SHOT ATLS IN GREEN/BROWNFIELD PROJECTS



Source: STIQ Ltd Research & Analysis

ROI TRENDING TOWARDS VIABILITY. MORE VARIETY IN THROUGHPUT/COSTS MAY HELP EASE END-USERS INTO PALLET AUTOMATION

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ATLS ON THE UPPER END OF VIABILITY

- Rule of thumb was an ROI of <3 years is needed for business case to compete with manual flows

"They cannot spend €1m and not see ROI in <3 years, otherwise they'll keep the manual processes, or maybe something like gravity conveyors...but in the end it's a manual process at docks." [Loading Robots]

- End-users considered volume of goods, damage to dock/products/people, and labor rates for ROI

"For each shift we consider the driver cost, the damages in the loading areas, which is important to consider" [Trapo]

"We do a 1st calculation based on volumes, number of forklifts... then there are additional variables like product damage, vehicle damage etc." [WDX]

"The most important factor is the labor rates, so in the US, it's cheaper in Kansas than in Los Angeles." [Navflex]

- Current solutions favored 2+ shifts to hit <3 years ROI

"For 1 shift we see that it's something like 5 years, and for 2 shifts it's down to 2.3." [Trapo]

"There's some interesting players out there, and the technology is continually improving, but the cost still has a long way to go... you're looking at 2-3 shift operations with multiple trucks coming through... or like a cross-dock retailer... but for those small mom and pops, or 3PLs who get a few trucks a week, the ROI just isn't there." [ABCO]

- More options for end-users with a range of costs and capability may help open up the market and enable end-users to start pallet load/unload automatoin

"If you have a little less automation upstream, say a forklift driver is forming the pallets- the current single-shot ATL solutions at €400k+ struggle to provide a good business case. If the machines were less than €200k while still being capable, that could be a game-changer." [Joloda]

"Interestingly, Vendor B is now including unmodified trailers in their portfolio. I spoke to their CEO, who wants to drop the price to €250K. If it's possible, that's a game changer in the whole of logistics." [Buyer]

ROI CALCULATION VARIES WITH INDUSTRY

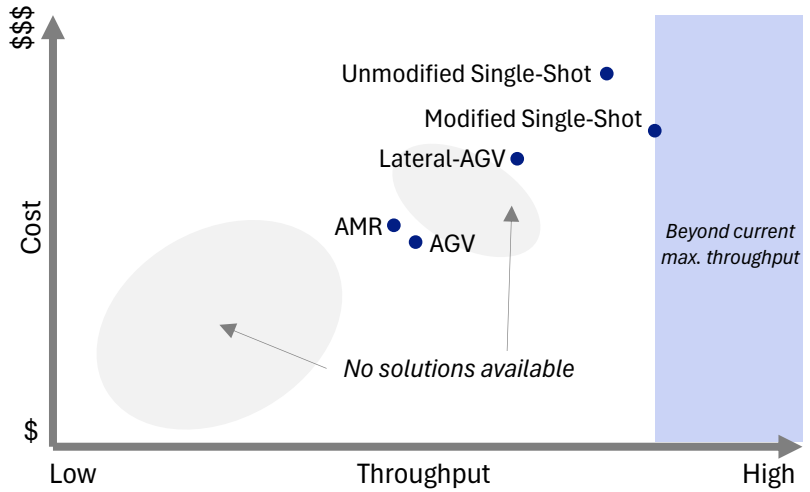
- Certain use-cases/verticals may interpret the value of automation differently depending on their needs

"It's not always high throughput that brings the ROI; the contamination of the product could be critical, reducing accidents at the docks or knowing that a product is in-fact on a trailer because of the automated QC, those are all values as well." [Actiw]

"There was a case of a fertilizer company with a warehouse in the heart of Mumbai. Their problem was they could only let trucks in for 4 hours in the middle of the night, so he had to maximize his throughput in that time window... so his ROI calculation was different to say someone with a warehouse in the hinterlands." [THINK BLUE]

"In a cold-chain trailer, reducing damages is more significant. If you damage a deep-freeze trailer, even slightly, that's a big problem and it's also not a great environment to work in." [Joloda]

DISTRIBUTION OF PALLET SOLUTIONS BY COST/THROUGHPUT (ILLUSTRATIVE)



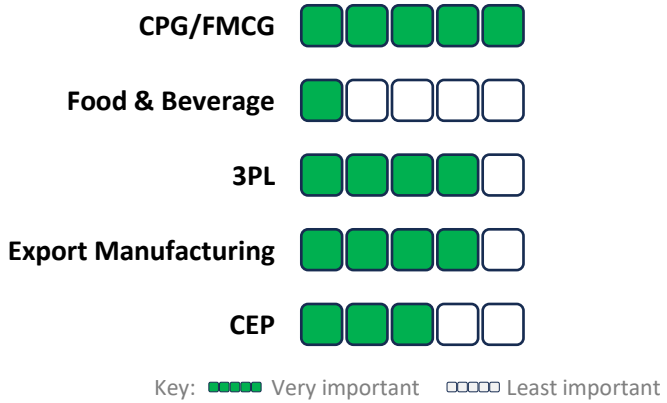
Source: STIQ Ltd Research & Analysis

- Upstream processes also impact ROI as more FTEs can be moved out of the docks with more automated flows

"It depends on how many operators a company uses for their current process, but we have a customer where the ROI is like 10 years... but if that was a complete project where the warehouse directly feeds the system when a trailer is scheduled, then you're taking people out of storage & retrieval, handling and loading/unloading which improves ROI as the whole process is automated." [LM Group]

KEY INDUSTRIES DRIVING CASE PICK GROWTH INCLUDE APPAREL & GENERAL MERCHANDISE PARTICULARLY WITH LARGE IMPORT VOLUMES

CASE LOAD/UNLOAD KEY VERTICALS



Source: STIQ Ltd Research & Analysis

FMCG A MAJOR DRIVER FOR CASE PICK

- Loose carton loading/unloading was most common with customers that frequently handle imported freight

"It's typically import freight coming into import centers or it's freight that's been transloaded to a domestic trailer… usually in apparel, footwear, tools, and general merchandise like toys." [Pickle Robot]

"Our customers are primarily in the import network, and the first touch from manufacturing to the distribution side, where there's some structure inside the container." [Mujin]

- FMCG, especially apparel, and general merchandising saw the highest adoption of Case Pick technologies

"For loose loads, the opportunity is with anybody that's heavy import. so that's fashion, apparel, footwear and toys." [Miebach]

"We see a lot of demand from both FMCG and retail…There's a lot of scale with these already so the priority is to get them up to speed and then we will explore other verticals down the line." [Dexterity]

- Semi-automatic solutions were frequently seen in CEP and FMCGs

"The biggest share of our customers are from courier express parcel companies since they generally don't palletize." [Lodamaster]

"95% of our customers come from FMCG, CEP and Ecommerce, and 5% from other industries like ceramics. 80% are in Turkey, and the rest in Europe." [Sortcon]

CASE PICK AUTOMATION IS MORE COMMON WITH BROWNFIELD BECAUSE OF THEIR SMALLER FOOTPRINTS AND LOWER INTEGRATION REQUIREMENTS

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CASE PICK CONDUCIVE TO BROWNFIELDS

- Case Pick automation was more common in brownfield installations because of the lower integration requirements

"So far it's all been existing location, since we're able to setup and use a dock door with little-to-no retooling... we just need 15 minutes to setup at the door." [Contoro]

- Many vendors positioned themselves as brownfield solutions as this opened them to both ends of the market

"In general, if there's nothing stopping you from being a brownfield solution, that's where you want to end up... We're primarily doing a lot of brownfield stuff because a lot of customers have already built out large distribution networks. We definitely have plans to get more involved with greenfields." [Mujin]

- Although targeting brownfields, vendors still saw the benefits of greenfield projects as a blank canvas to design an optimal solution

"The goal is brownfield, we've had some conversations about greenfields which is exciting since they have less pre-installed infrastructure bolted down, but the brownfield story is what really gets people excited." [Dexterity]

- Larger, more integrated systems are more likely to be part of greenfield projects because of the required space

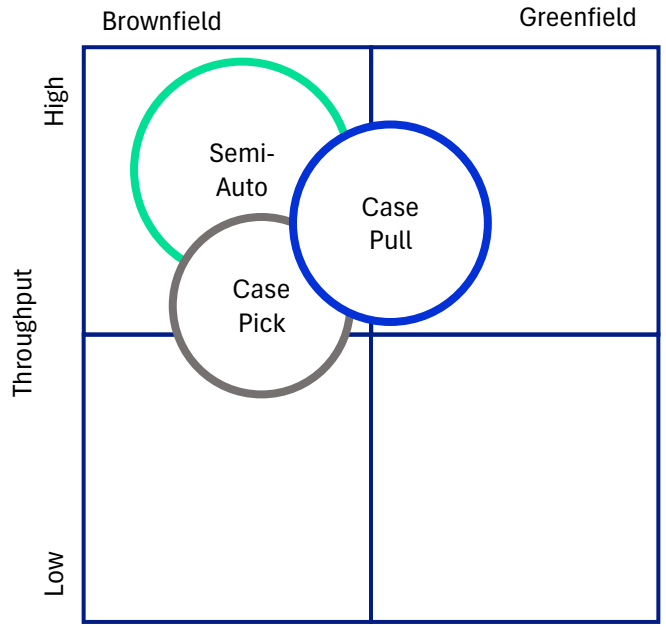
"Around 75% are greenfields, because brownfields just don't have enough space for this automation, usually because the high bay racks are too close to the docks...although it also saves space because you don't need to be storing the pallets at the docks." [Copal]

CASE PICK A SMALL PORTION OF SPEND

- Whether a project is greenfield or brownfield also has an influence on the % contribution of loading/unloading, with case automation typically >10% of total spend

"If it's a greenfield project, case loading and unloading... would be under 10% of the total project. When it comes to brownfields, for example we were in a warehouse last week looking to improve their loading, that would be 100% of the project because that's the focus, but if you then look at the total spend of the building it's actually like 2% because that was a heavily automated, and very large facility." [ABCO]

LIKELIHOOD OF CASE PICK TECHNOLOGIES IN GREEN/BROWNFIELD PROJECTS



Source: STIQ Ltd Research & Analysis

SEMI-AUTOMATIC AUTOMATION FOR CASE LOAD/UNLOAD STILL POPULAR DUE TO THE LOW COST-TO-PERFORMANCE RATIO. SOME CONCERNS AROUND LABOR & ERGONOMICS

Loading/Unloading 2025 (Feb)
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TELESCOPIC CONVEYORS STILL POPULAR

- Telescopic conveyors provide a flexible way to support manual unload processes by reducing the distance operators travel with the cartons

"Here in Spain, because there is a lot of textile industries, they're purchasing everything from Asia, so they receive the goods on containers...they're mostly using semi-automatic, flexible conveyors to unload the containers." [LM Group]

- The simplicity and low cost of installation and maintenance makes the business case strong for semi-auto systems

"Semi-automatic is very popular because compared to a robotic system, it's less expensive, it's flexible and easy to repair, you don't need to wait for a technical team...and it's already 5x faster than a fully manual process." [Sortcon]

- Semi-automatics while able to speed up unload, still exposed end-users to labor risk

"Semi-automatic solutions satisfy 1 or 2 of the 3 factors... so they solve the time to unload, but they don't solve the cost of labor or the regulatory issues." [Technica]

- Flexible conveyor projects could easily reach 10's of units, often requiring complex merge and sorts downstream

"One of the bigger projects we did required 48 telescopic conveyors that converged into a sort system." [Lodamaster]

- Flexible conveyors often contribute a small amount to the overall project cost, typically <50%, even if the number of conveyors is high

"We had a project where the conveyor was <2% of the value. It depends, if the project is simple, then it could be 20-50% of the project value." [Sortcon]

MORE ERGONOMIC PICKING TECHNOLOGY

- More advanced conveyors that raise the operator to the pick level and exosuits might help to alleviate the physical strain of manual unload

"Back when I worked at a major retailer, we used to get boxes with 12 pairs of jeans that weight 50 lbs...that's where things like exosuits and ergonomic tools can help... one of them is a conveyor that moves up and down with the trailer... so that you're not putting as much wear and tear on the back as you typically would." [ABCO]

"There are telescopics that have a big platform so the operator can lift the machine up to be level with the current layer of the wall to improve the ergonomics." [Sortcon]

- However, there were still concerns as these tools may not help with the extreme high/low temps in some containers

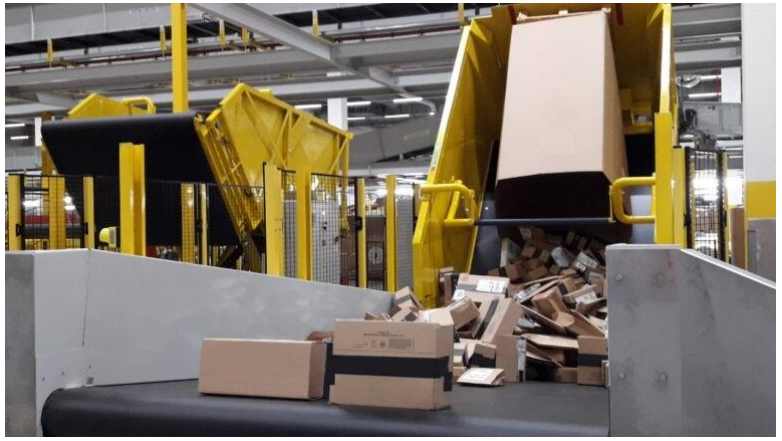
"We've seen things like exoskeletons, but we don't usually see them in use, because ok, it solves the problem of back pain, but the container is still going to be 50 degree inside." [LM Group]

CAN CASE UNLOAD BE SINGLE-SHOT?

- Tippers, typically used within warehouses when items are transported in bulk with roll-cages/buckets, are being considered at the docks
- Cartons are tipped onto a conveyor system that shakes and singulates the cartons for downstream processing

"We have a new solution for boxes where you just tip the boxes onto an aligner, the system shakes the cartons, and a matrix of bands and fishbone rollers run at different speeds to form a single line." [Sortcon]

TIPPER + CONVEYOR SYSTEM



Source: STIQ Ltd Research & Analysis, Alfi Tipper

"There are systems that basically tip a bucket or roll-cage of products onto the system... it's used inside warehouses, but there's nothing stopping it's use here." [Lodamaster]

AVAILABILITY OF LOWER-COST SEMI-AUTOMATIC SOLUTIONS FOR CASE HANDLING ENABLING MORE CASE PROJECTS

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CASE PROJECTS MORE COMMON

- Case projects were seen as more prevalent due to the availability of semi-auto solutions that are significantly cheaper than pallet automation

"Right now, it's more cases than pallets because boxes are cheaper than pallets.. and telescopics are lower cost compared to a pallet system that cost 20x more without civic works, and easily 50x with works and that's not considering conveyors and upstream." [LM Group]

- High-volume pallet warehouses may also have areas of greater ROI when considering current costs of pallet systems inhibiting pallet projects

"It's probably 80% cases, 20% pallets because when I think about finding customers that're moving pallets in mass, they've got opportunities elsewhere where the ROI's are there... you're talking about the ASRS, or pallet shuttles... that would get the bang for buck, and they're focusing there... so if they have to pay a forklift driver to take it off the trailer and drop it on a bit of conveyance that's going to automatically induct that into my storage, and retrieve it when I need it...that's a larger focus." [ABCO]

GREATER CHOICE IN SOLUTIONS FOR SEMI-AUTOMATIC/MANUAL+ CASE UNLOAD/LOAD TECHNOLOGIES (NON-EXHAUSTIVE)

Exosuit

Crane Picker

Vacuum Assisted Pick + Conveyor

Powered Telescopic Conveyor Platform

Source: STIQ Ltd Research & Analysis. German Bionic Exosuit, CargoPicker, TAWI Assisted Pick, Gorbel Powered Platform

CASE PICK PRICING MORE TOLERABLE FOR 2+ SHIFT OPERATIONS. WIDER MARKET NEEDS TO SEE COST COME DOWN BEFORE THEY CAN JUSTIFY AUTOMATION

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CASE PICK STILL PRICED AS A LUXURY

- Majority of adoption for Case Pick appeared to come from less cost sensitive companies

"Of course, there is an economic concern there, but they just want to automate, just don't quote an astronomical number. They're not carefully calculating that a robot can replace 1.75-2 FTEs, then consider the electricity, downtime for maintenance etc, they're not doing that." [Anonymous]

"There are some people who value the benefits of automation in general, they already have quite automated facilities and just want to extend that to the docks, that's more the luxury spending." [Anyware Robotics]

- The price of the current solutions was the main barrier to wide-spread adoption of Case Pick with some ROIs as far as 5-10 years

"Some of the solutions that you saw at MODEX, they're like $1.5m-$2m... if you put three people at the door earning $50k, that's $150k for a 24 hour operation, so that's a 10 year payback... even if it's twice as productive, that's still a 5 year payback. I think there's still time to work on this, there are companies doing a pay-per-carton service, but still the solutions are quite expensive." [ABCO]

- Current ROIs only begin to make sense with 2+ shift operations

"The business case for one-shift warehouses can be challenging... the logistics space is historically quite low margin so teams are focused on every penny they can squeeze out... we feel 2025 it's really going to step up in terms of investment going into the space."[Anyware Robotics]

"The calculation is you're replacing two guys, which is $30k/year per shift, and many of the large Chinese factories with good business are running 2-3 shifts, so that's $60k-$90k saved, so for 2 shifts, you're getting ROI in 4-5 years in China." [XYZ]

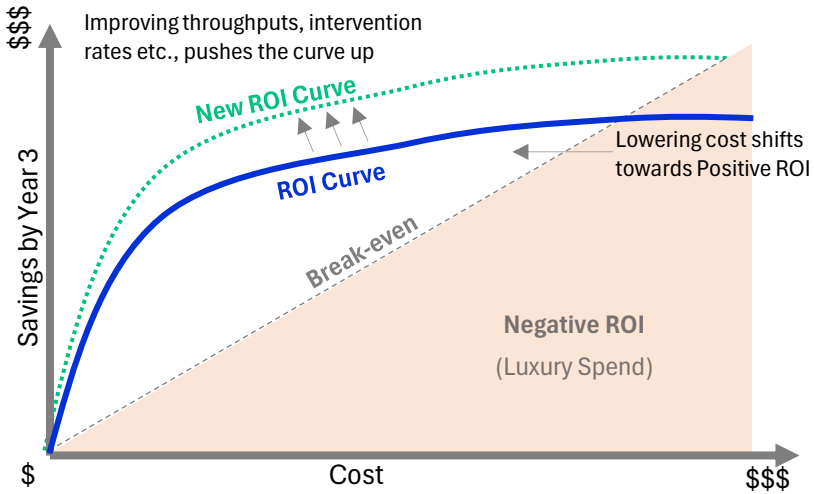
- There was some sense that pressure from the labor market would make more companies tolerate longer ROI, but for now most companies were still sensitive to cost

"There are two buckets of companies, you have one where they've made the strategic decision that they're too dependent on labor and moving forward... they have to minimize that risk even though it's got a little bit of sub-par ROI. The other group is the classic, I want this in under 3 years before you even present it to me, and I'm going to compare it to everything else to see where the best ROI is... there is a shift that we're seeing now of companies moving from the 2nd to the 1st bucket, especially as labor continues to increase at this rate... finance still needs to have a vote." [Miebach]

- Automation budgets may therefore be allocated elsewhere in the facility where the business case was more immediate

"If you're deciding where to spend money... you want to look at the distribution of labor across the warehouse. If you're in a cross-dock facility, 100% it's at the docks, but if you're in an ecommerce warehouse, most of it is within the pick and pack areas." [ABCO]

ROI VS COST CURVE (ILLUSTRATIVE)



Source: STIQ Ltd Research & Analysis

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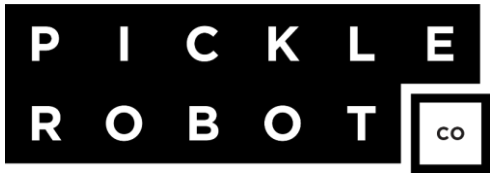

PALLET ADOPTION INHIBITED BY SPACE REQUIREMENTS AND OVERALL TCO FOR MOST SOLUTIONS. SOME TECHNICAL CHALLENGES YET TO OVERCOME

COST AND SPACE THE MAIN HURDLE FOR ATLS

- For Single-Shot ATLS, the required space, and civic-works needed to modify the docks made them a challenging proposition for brownfields

"The reason they don't buy isn't because they don't like the concept, they usually love the concept... typically in brownfields, the main issue is the sheer space that a single-shot system occupies, and the 2nd issue is the cost of installing and buying these systems." [THINK BLUE]

- AGV/AMR also had some issues when considering the dynamic loads entering the trailer, potentially needing alignment systems installed at the docks

"You're talking about dynamic loads of >2-tons moving from a concrete floor onto the truck, which will sink downwards and that's a problem for the AGV, so you need to install structures around the dock that make sure the trailer is straight and 100% aligned and those structures cost money." [UC Group]

- Costs were also a barrier when considering mass adoption, hence the need for cheaper alternatives

"A big-label retailer with 120 doors will never install 100 because they only need say 20-25 systems to reach their volumes, but 20 x $500k will never fly, and that's assuming no other works. If you can make it cheaper, than there may be a good case." [Joloda]

"Today the technologies are priced in such a way that they require a 2-shift operation to get that quick ROI, but as the technology becomes more commoditized, I think the mid-sized market will adopt it at a more furious pace." [Fox Robotics]

SOME CHALLENGES TO OVERCOME

- There were also technical challenges, especially with AGV/AMRs with things like pallet detection

"I think first, is the maturity of the technology... Some industries can't adopt these technologies, since you need to standardize pallets, their placement, etc., like in the automotive industry." [VisionNav]

- Floor condition in the facility and on the trailer was also a concern when considering automation

"There are a lot of parameters when you load a trailer. The unit size, overhang, how stable the units are, the orientation, the truck condition and even the floors can be an issue." [Actiw]

"We're looking at whether we can put AGVs instead of manual forklifts... but we haven't come 100% confident that we can actually use the AGV to do the loading/unloading because it's in the factory where the floor isn't in good condition." [UC Group]

AGV/AMRS BEING APPLIED TO LOADING/UNLOADING DRIVEN BY REDUCED SPACE AND CIVIC-WORKS. MORE COMPANIES WORKING ON SOLVING THIS SEGMENT

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LOWER SPACE & INFRASTRUCTURE WITH AGVs

- AGV/AMR ATLS have been around for more than a decade, however the application of them in distribution is a more recent trend

"We've been doing AGV based trailer loading for 15 years and we're on our 3rd generation vehicle now that's optimized for trailer loading... our first applications were all end-of-line manufacturing facilities that lacked warehousing space that needed to get their product out ASAP... More recently we're getting more into the DCs, the pure warehousing." [JBTC]

- AGV/AMR ATLS required low-to-no civic-works and less space compared to a Single-Shot ATLS

"It's the space and investment required, you need to modify your dock to install those, and most of the time, production is already set up so there's no space to fit them in. AGVs and AMRs don't need big infrastructure changes, AGVs need some, since the process needs to be controlled, but AMRs are capable of dealing with an uncontrolled and dynamic environment." [Navflex]

- Minimizing civic-works also allowed projects to quickly deploy and automate the dock

"If it's a loading project, we'd need 3 weeks to set up for the 1st door, and then each additional door would need another week." [VisionNav]

"They're looking for someone that can perform better than a human and just show up all the time... you don't need to tear up concrete." [Navflex]

- Large buffers/staging-areas are recommended for performance, but are optional/unnecessary in some cases

"There's no load forming area needed which saves a lot of space." [JBTC]

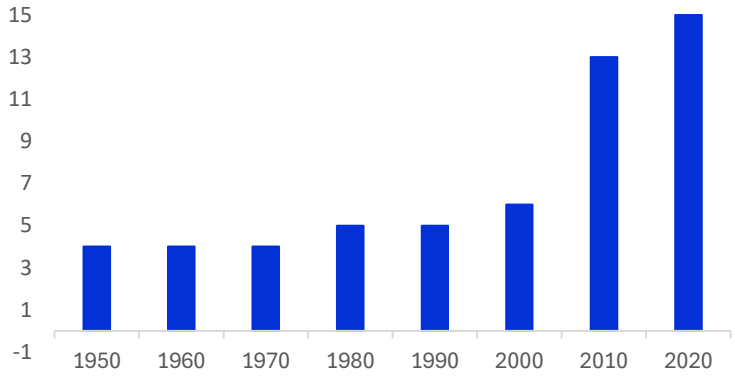
"It depends on whether the organization owns their own fleet of trailers so the customer can just load directly onto the trailer without the buffer... and there are cases like cross-docking that don't require any buffer, you just move from one trailer directly onto another trailer." [Navflex]

- While sometimes pitched as a drop-in solution, some software infrastructure was necessary to get the most out of AGV/AMR deployments

"We offer solutions with or without WMS integration, but most customers require a WMS, and it needs to be able to assign the transport orders to the vehicles... for demo's we can just drop a system and let it run, but in production you really need that software to be able to optimize that process... and there's a lot of time and energy spent on that integration so that it can fit in seamlessly with the customers operations." [Navflex]

"We typically integrate into the customers ERP so can integrate into the receiving process... and for loading we'll know the SKUs they're loading, their loading patterns which they may have multiple of depending on what's being loaded." [JBTC]

TRAILER AGV/AMR VENDORS BY DECADE



Source: STIQ Ltd Research & Analysis

INCREASED PARTICIPATION IN AGV/AMR ATLS

- Although growth was slow for the past decade, there was an increased focus and participation in AGV/AMR ATLS

"It's been a much slower, controlled growth since it's a more challenging automation, so there are less suppliers solving it, and customers had lower hanging fruit to automate first... it's attractive enough that we stayed in it for 15+ years while others exited or got bought... now there are more companies entering the space." [JBTC]

- There was also increased participation from China, particularly in the AMR segment

"We're starting to see them more often in RFQs, we don't know if they're winning the loading or unloading projects, but we are seeing them in general material handling applications." [JBTC]

AGV/AMR ATLS CURRENTLY MORE SUITED TO CERTAIN APPLICATIONS BECAUSE OF CURRENT THROUGHPUT-TO-COST RATIO. FLEXIBILITY A MAJOR APPEAL TO END-USERS

FLEXIBILITY A MAJOR APPEAL OF AGV/AMRs

- Interviews suggested that the lower throughput of Mobile Forklifts made them more viable in specific applications for example with Drop-trailers

"AGVs still take a long time so you can't get a quick turnaround. There are cases that will go to AGVs, say you have space at your docks, you drop the trailer so it can stay there for 2-hours, half-a-day even." [Joloda]

- Industries with more uniform pallets with little overhang/lean were also better for AGVs/AMRs

"There are some verticals that lend themselves better to AGV loading... certainly the heavier uniform loads without a lot of overhang or lean on their pallets, those are better, so like beverages, chemicals like paints, canned pet foot, those are all super uniform and repeatable loads." [JBTC]

- Loading single pallets was seen as limiting the business case, however any form of multi-pallet loading, i.e. loading an entire row in a single pull had benefits vs manual loading

"Any system that is only replacing a person has a limited value, or that's my feeling since people can load single pallets faster... If you're loading 2-4 pallets each time, then you can definitely load faster." [THINK BLUE]

"For a forklift driver, they can be very fast, but they're carrying one pallet at a time, and if you're trying to get a 3rd pallet into the row, then they have to squeeze it in, and that's were damage happens... with an AGV, you're carrying 3-wide and even 2-tall directly into the trailer." [Trapo]

- Vendors suggested that AGV/AMRs could load-form or feed pallets to another ATLS system vs a fixed conveyor

"I believe that AGVs can play a role in forming the pallets on the load-platform." [Joloda]

"We see AGVs and AMRs as a useful way to load our systems, but automatic buffers are key to high throughputs." [Loading Robots]

- Flexibility in placement and shapes of buffers/staging-areas was another benefit of using AGV/AMRs

"With AMRs we're seeing there's a lot of benefit to being able to flexibly redefine the staging areas, so it can move a few meters this way or that way, instead of perfectly perpendicular to the dock... that's something customers really appreciate." [Navflex]

- Consideration of manual intervention procedures has allowed adoption of AGVs/AMRs at an earlier stage of technological development

"If the robot encounters say an airbag in the trailer, which is a common piece of dunnage, it will identify that, stop and call for human assistance." [Fox Robotics]

LATERAL-AGVS A RELATIVELY NEW TECHNOLOGY POSITIONING THEMSELVES BETWEEN MOBILE ROBOTICS AND SINGLE-SHOT ATLS IN TERMS OF PERFORMANCE AND FLEXIBILITY

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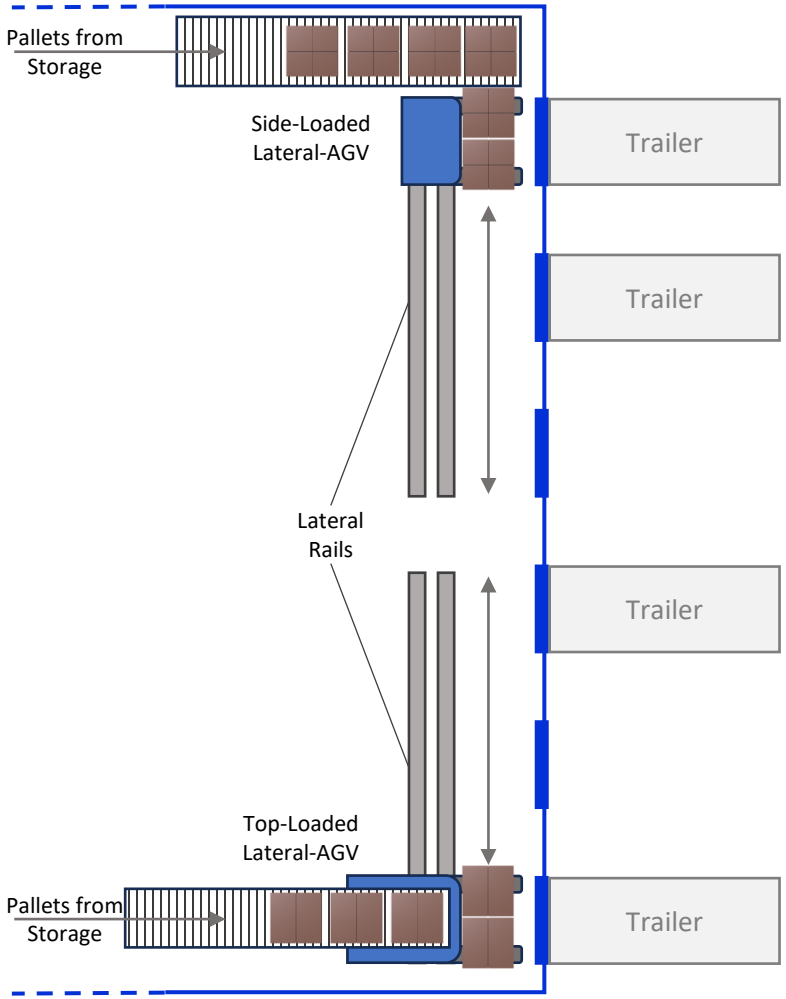
SIDE AND TOP LOADED LATERAL-AGVs



Source: STIQ Ltd Research & Analysis

LATERAL-AGVs A MIDDLEGROUND

- Lateral-AGVs are a middle-ground solution for unmodified loading/unloading of pallets

"When a production site ships direct to end-users, or the DC is like 500km+ away from the facility, that's where these solutions are very good… there are also production lines where they have to go to 6 different sites, so instead of converting 5 fleets and 5 different docks to work, they can just use these Lateral-AGVs." [Loading Robots]

- Lateral-AGVs can be configured to serve multiple docks with a single installation

"You can install it fixed for a single loading bay, or you can have it on wheels, or on rails so that it can laterally serve multiple docks, of course that makes it more expensive." [Trapo]

- The flexibility of moving across docks allows them to work in-tandem with manual processes during peak seasons

"With the multi-docks, there is the flexibility of not completely replacing your manual processes… so we have a case where 3 of 4 docks are served by us… during normal business, a Lateral-AGV can be unloading or loading at a constant rate, and then at peak, you can drive that system to full capacity and then complement with a manual process." [Loading Robots]

- In-feed direction is another choice with benefits either way

"There's consideration to how you feed the system… there is the side feeding which makes it more compact in one direction but increases the size laterally, so it might interfere with docks… we opted for top-feeding which makes it longer, but it doesn't take space laterally." [Trapo]

- With performance slightly above mobile robotic loading/unloading

"We're loading trailers for our customer in 25 minutes." [Trapo]

- Some saw the business case to be a challenge as civic-works may be needed impacting the potential ROI

"They still need modifications to the dock; it's a middle ground." [Miebach]

- Others felt the system would not work because of the regional nuances, excluding it as a potential solution

"The challenge with those is that the machine itself weighs 5-tons, the pallet weighs 3-tons, so you're talking about an 8-ton dynamic load on a truck. 98% of Indian trucks will simply collapse." [THINK BLUE]

PALLET LOAD/UNLOAD EXTREMELY COMPLEX WITH UNLOAD BEING ESPECIALLY CHALLENGING DUE TO SHIFTS IN PALLET POSITIONING

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PALLET AUTOMATION FULL OF VARIABLES

- Interviews suggested that both pallet loading and unloading were complex for different reasons, from pallet condition, to how pallets are formed, to the dunnage used in the trailer for stability

"So that's what I mean when I talk vertical integration, right? You got to make sure that how you're packaging the material at the end of the line, right? How you're labeling at the end of the line, what size of overhang is or isn't there, How are you going to be able to take the pallets from the long side to bring them out? Or do they need to be rotated? Those are the problems on the load. On the unload side, it's how stable is the load when it comes in, right? Am I talking about double stacked, right? Two wide? Or am I talking about super high pallets? And then what sort of airbags and other bulkheads do I have that I'm still going to need an operator to pull out? That is the complexity in the palletized more so than loose load." [Miebach]

- Using standard pallets helped to reduce the complexity, but there would still be challenges on unload as the pallets would shift in transportation

"If the pallets are very standardized, we don't see a lot of difficulties... most of the challenge is customers having broken pallets, or wrapping in the trailer which interferes with the unloading, but overall the most challenging part in unloading is knowing where the pallets will be when you open the trailer." [VisionNav]

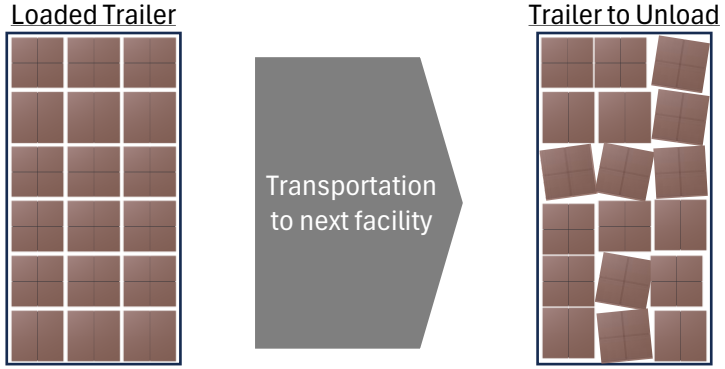
- NA and SA trailers were harder to unload than in EU because of interior doors creating a lip, whereas EU trailers used exterior doors

"Unloading is an easier process in Europe... but can be more difficult in North and South America, since almost all the trailers, have a 1.5 inch lip at the door, which when you're loading two pallets at a time can be a problem since you can catch on that...whereas Europe the doors hinge on the outside, so the width of the trailer is the same all the way." [Navflex]

- For singleshot systems, the need to align everything was crucial as small deviations would magnify across the length of a trailer

"There's all kinds of extras like pallet checks, checking for individual or pairs of pallets, the alignment of the machine, there's the feeding of the pallets, and aligning of the trailer itself. That makes the projects much more complicated and also more expensive." [Joloda]

TOP DOWN VIEW OF PALLET SHIFTING IN TRAILER DURING TRANSPORTATION



Source: STIQ Ltd Research & Analysis

PALLET AUTOMATION A BLEND OF HW & SW TO IMPROVE PERFORMANCE ALTHOUGH HW CHANGES BECOMING MORE INCREMENTAL

R&D FOCUS FOR PALLET AUTOMATION BY SEGMENT

Source: STIQ Ltd Research & Analysis

PALLET IMPROVEMENTS A MIX OF HW & SW

- Improvements to pallet automation technologies were somewhat balanced between software and hardware

"It's primarily software, but it's a combination of both...like building a custom side-shifter or adding 3D LiDAR... so it's a combination for that reason." [Fox Robotics]

- Although the changes in hardware were seen to be more incremental rather than requiring full redesigns

"I still think it's both, there are smaller incremental changes, for example, the lighter we can make our vehicles, the better since trailers are mostly very rough...detecting fork pockets and damaged loads with better sensors... so there are benefits to improving both hardware and software. Technology in general is improving independent of our exact application, sensors are getting better, and the prices are coming down yet delivering more value and applications." [JBTC]

We have some clients that are field testing, many with a startup and are doing 1 trailerbut longer than 40 minutes. They're not there yet because there are too many errors , so more human intervention is needed and the business case plummets. Then this gets into the compute power, access to things like NVIDIA chips so you can drive your vision system to make better determinations... it becomes a full spectrum to solve, you need to marry both the physical with the compute to unlock this." [Miebach]

FOCUSING ON COST-CONTROL

- Single-shots were focusing on cost-control, and reducing overall complexity of their systems for easier production, installation and maintenance

"We feel we finally have a ready product that we've been developing over the past few years... as an example the 1st version had 320 parts, the version that we have now has 100 parts, which makes it easier to transport, to assemble and to service. We're now ready in terms of product to start selling on a bigger scale. We calculated that of version 1 we could produce 12 a year, but now we have this latest version and better standardization, we can do much more than that. It doesn't matter if people want the chain or fork version, 70% of the assembly is the same, so we can begin to stock those. We feel as a product, it's 90-95% complete and now it's just about receiving and fulfilling orders." [WDX]

SINGLESHOTS HOVERING AT 3-4 TRAILERS PER HOUR WHILE AGV/AMR TARGETING <30 MIN PER TRAILER. THROUGHPUT SENSITIVE TO UP/DOWNSTREAM AND BUFFER DESIGN

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HIGH THROUGHPUT FROM SINGLE-SHOTS

- Single-Shot ATLS quoted maximum throughput of 5 trailers per hour, however in practice, including processes like alignment, parking of trailers etc., were hitting 3-4 trailers per hour

"The fastest system we have running is pushing 5 trailers per hour since the load forming was very well designed in that system." [Actiw]

"Realistically, for modified you could get 5 trailers per hour, and for unmodified where you need more alignment and levelling, and more precise feeding, you could get 3 per hour." [Joloda]

"The maximum is 5 trailers per hour... that assumes 3 buffers, 2 on either side, and the main loader...the bottleneck is the load-forming process." [WDX]

- Single-Shot ATLS throughputs required the upstream to be well designed and mostly autonomous for max returns

"Total throughput starts with the ASRS capabilities, then you have the yard management and making sure trailers aren't congested, even the software you're using impacts efficiency." [Actiw]

"Ideally a pallet comes from production, then a conveyor takes it, the pallet is measured, weighed and the quality is also checked, since that's crucial for a successful load. If the customer has a buffer zone, we can form all the pallets and send them to our platform which can then load onto the trailer... if they're manually preparing loads, they're still spending the time to load 33 pallets onto the plate before it goes into the trailer " [WDX]

- Double-buffering allowed throughputs to be pushed even further although consuming significant space

"Usually, they're quite clear with what they want, and would ask for 1 door, but usually it's better to have 2 in parallel because you can triple the effectiveness... because if you have 2, one can buffer while the other is loading, so you can constantly keep loading." [LM Group]

AGV/AMR REACHING >1 TRAILER PER HOUR

- For AGV/AMR based loading, the target time to load/unload trailer was sub-30 minutes

"The industry standard now is to aim for sub-30 minute to load 15 rows or 30 pallets in the US, and 11 rows or 33 pallets in Europe." [Navflex]

- Side-loaders were able to load a trailer in less than 15-minutes with a well designed upstream

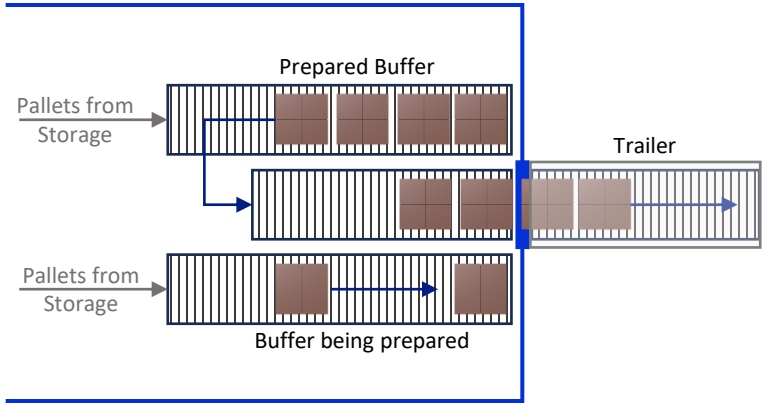
"For side-loading, we're at around 8-minutes per trailer, plus you account for opening the trailers etc, we're looking at 15-minutes per trailer. So you could get 4 per hour if the upstream is perfectly feeding the system." [Loading Robots]

- AMRs were currently at around 45 minutes per trailer

"We're currently at 45-60 minutes to load a trailer...for some that might be a problem... the ones that have very high throughput, they would have concerns with it taking more than 30 minutes." [VisionNav]

"Across the fleet, the top 25% are doing 30 pulls per hour, and if that's double stacked, that would be 60 pallets, so that's 45 minutes for a full trailer... the mid-pack are doing 25 pulls, and the lower-end, typically at cold-storage sites are doing 22.5 pulls an hour." [Fox Robotics]

DOUBLE BUFFERING TO INCREASE THROUGHPUT



Source: STIQ Ltd Research & Analysis

"We load out a 53-foot trailer in around 45 minutes, and that's usually 13 trips...in some cases that can be stacked so we're taking in 4 pallets, particularly for lighter loads where they're trying to cube out...regardless that would still be 13 trips." [JBTC]

UNLOAD LIMITED BY ABILITY TO INDUCT

- For unload, the throughput was limited by the ability for the warehouse to induct the pallets after they've unloaded

"We find that whiFle throughput is important, the utilization is also important... meaning we're typically unloading faster than they can put-away." [Fox Robotics]

- In some cases, the end-user wants to unload the trailer ASAP without worrying about the processing until later

UNMODIFIED ATLS CONSIDERED THE HOLY-GRAIL FOR PALLET AUTOMATION WITH WIDE APPEAL IN LOGISTICS

UNMODIFIED THE ULTIMA THULE

- Unmodified Single-Shot Loading while technically solved, has many tradeoffs that limit its wider appeal

"Unmodified single-shot gets complicated when you're double-stacking the pallet load , because if you're automating only single stack, then you're paying a ton more for freight. Sure, automated loading and unloading has been accomplished, but there are currently heavy caveats of either, capital in my trailer, capital for special equipment, or loss of flexibility at my dock." [Miebach]

- Unmodified Load/Unload was seen as the golden goose of logistics if fully solved

"The holy grail is unmodified trailer and docks, open the door, whatever is inside that treasure trove you're taking it out." [Miebach]

- Modified ATLS vendors also saw much higher potential in the Unmodified market

"Automated loading still has huge potential... and we think unmodified is 5-7x bigger than the modified market." [Joloda]

- AGV/AMRs were thought to have the potential to handle Unmodified Load/Unload without all the caveats from Single-Shot Unmodified

"There's also another set of technologies that do something similar, although not as fast, but also take up less space like the AGVs/AMRs that are being applied to trailer loading/unloading." [ABCO]

- It was suggested that it was a matter of years before there is wider commercialization of these technologies

"I think we're probably a a little over a year away from somebody being able to prove it out with unmodified with an AMR. It's a math equation that needs solving... it's vision systems, and computing power... and history has shown us for millennia that with math problems, we figure it out." [Miebach]

CASE PICK ROBOTS STILL AT VERY EARLY STAGE OF ADOPTION. MANY VENDORS AT THE TAIL-END OF PILOTS WITH SOME ALREADY COMMERCIALIZING

Loading/Unloading 2025 (Feb)
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CASE PICK STILL AT EARLY STAGE OF ADOPTION

- Loose Carton automation was still at a very early stage of development, with most participation in the last few years

"We're still in the cutting-edge phase... if you go back 5 years, there was no-one doing this kind of thing, there may have been some with a video from a tradeshow, but no one had actually deployed them. Now you're starting to get traction with early adopters...and they're quick to test, but very slow to adopt it at scale." [Mujin]

"For bags and other products, we've been doing it for 10 years... but for boxes we released it last year." [Copal]

- High variability of carton, trailer and container conditions makes it hard to test rapidly in-the-lab, requiring live trials

"If any of us were 100% proven, people would be banging down their doors, but there're still edge cases and production issues, and just typical productization challenges that you only figure out once you're in the field, and we're in that process right now, just like everybody else." [Dexterity]

"We've got thousands of hours in a lab, but it's nothing like being in the real-world. You learn about moisture in containers and the cardboard on the floor to absorb that...or the container coming on a flatbed rather than a chassis...or ones that are packed super-tight." [Pickle Robot]

"It's really hard to test these types of technologies quickly." [Mujin]

- Most vendors seemed to be at the end of the early trials, with the plan to productize in the next 2 years

"We're targeting to be fully hardened by Q1 2025, that's ongoing... We've spent the last year improving the product, building out the team, seeking investments and adding more customers, and also bringing on partners, typically integrators, and component vendors." [Pickle Robot]

"The goal is to not launch until we prove it in production, and then it's just a matter of turning the crank. It's going to take some time to prove that out. " [Dexterity]

- Some vendors were already commercializing with new clients, however the product was still iterating

"All our new customers are signed onto a 1-year RaaS, so you could call that 1-year pilot but they're commercial deals... and 2 of our expansions are commercials." [Pickle Robot]

"We have 3 customers that have the full layout installed, and now we're constantly improving as every container you open is a surprise." [Copal]

EDUCATION NECESSARY PRE & POST SALES

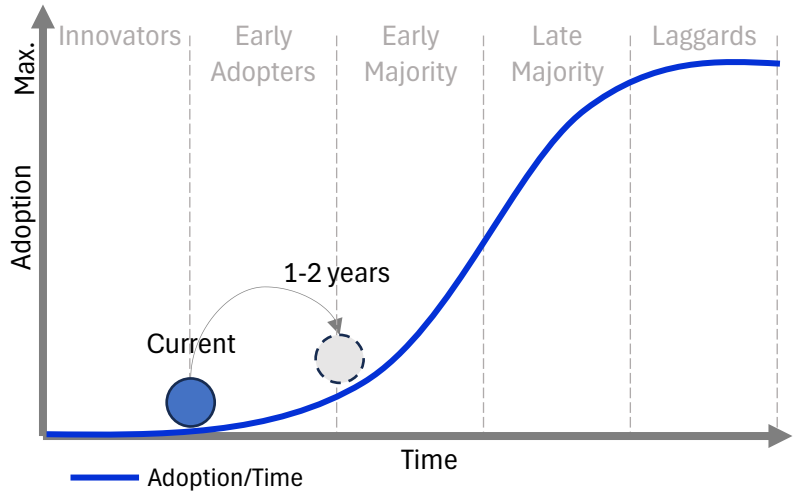
- The nascence of case-pick technologies may necessitate end-user education of the available solutions

"We realize the client doesn't know the kinds of solutions, since they're fairly new... especially loose cartons, I've only been aware of those for 1 year or so." [LM Group]

- Ideally, large numbers of reference sites would allow end-users to see these technologies in-context

"A lot of people are just waiting for when you'll be able to go to a customer site to see... if the SKU or case coverage matches their business and then... understanding the business case... I think it's on the cusp." [Anyware Robotics]

CASE PICK STAGE OF END-USER ADOPTION



Source: STIQ Ltd Research & Analysis

- Education also applies to projects, with vendors having to support early deployments heavily to ensure success

"When we deploy, we know the technology is new and edgy, it's not like dropping off another piece of conveyor and wishing the customer well... we also send a team of field engineers to... be on-site working with the local team... teaching them how to set up the robot, to charge and discharge it, how to move and transport it within the warehouse. They'll stay for some weeks and then will gradually phase out and move to then next deployment." [Contoro]

CASE UNLOAD COMPLEXITY DERIVED FROM 3 MAIN FACTORS – THE CARTON, THE CONTAINER AND THE THROUGHPUT NEEDED TO ACHIEVE ROI

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CASE UNLOAD MORE COMPLEX THAN LOADING

- The complexity of carton automation comes from needing the container condition, the carton condition and the required throughput to align

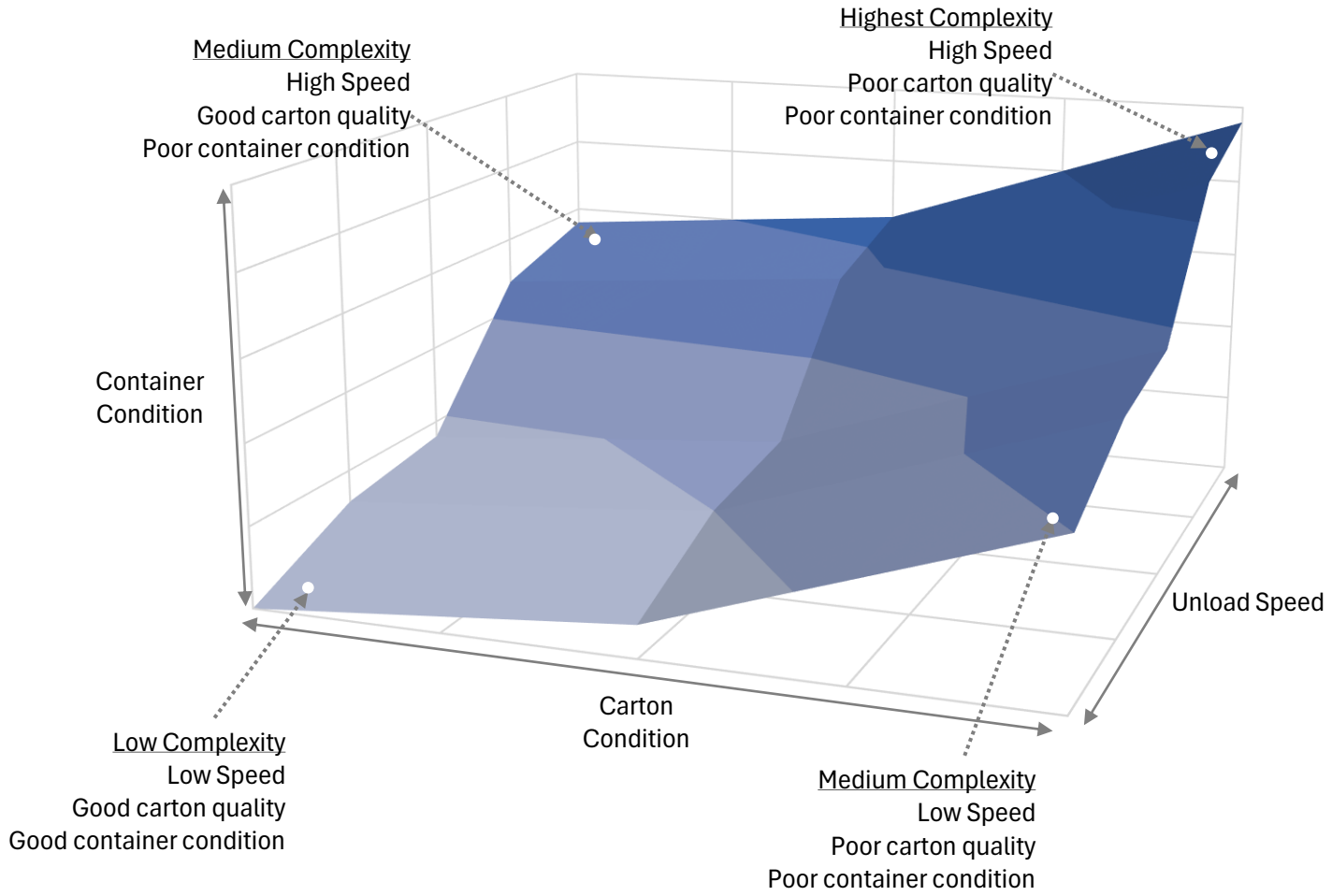
"If you decompose the task complexity, there are three axis. Speed is certainly one of the most important factors, particularly if you're in a live load environment where you pay a fine beyond the contracted 2-3 hours… the 2nd axis is the state of the objects inside the container, how are they mixed, are they section-wise homogenous, or are they completely mixed up… the 3rd dimension is the weight, dimension, and condition of each carton." [XYZ]

- Unloading complexity comes from the transportation of the container, typically at sea introducing moisture and movement to the cartons

"Realistically speaking, not all containers or trailers will come perfectly loaded. You might have a few boxes that have shifted during transportation, or damp boxes due to humidity, and that's where you will need manual intervention…this isn't the normal case and typically it's the first 1-2 rows of a container." [Technica]

"Loading is easier than unloading. Loading is predictable. You know the load is stable, you know what you're going to load in. It's when we open the truck up to unload where the challenge is going to be." [Miebach]

THREE AXIS OF COMPLEXITY FOR CONTAINER UNLOADING AUTOMATION (ILLUSTRATIVE)



Source: STIQ Ltd Research & Analysis

VACUUM GRIPPING STILL THE MAIN END-EFFECTOR FOR CASE PICKING WITH IMPROVEMENTS BEING MADE TO IMPROVE ELIGIBILITY AND SAFETY

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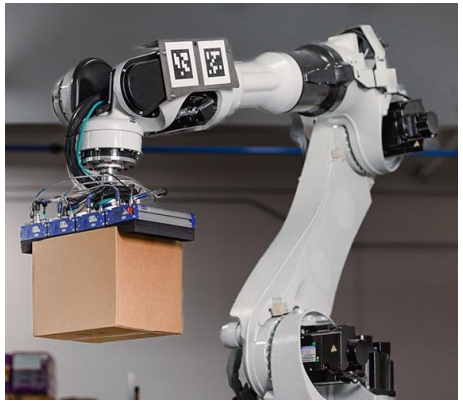
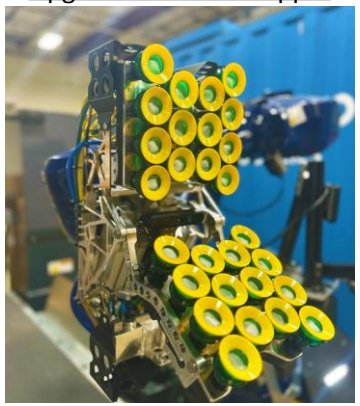
EXAMPLES OF GRIPPER AND ROBOTIC ARM UPGRADES

Custom Robot Arm



Upgraded Suction Gripper



Source: STIQ Ltd Research & Analysis. Robotic Arm (Dexterity), DuoGrasp Gripper (Contoro)

VACUUM GRIPPING DOMINANT IN CASE PICK

- While suction grippers are common in picking automation, suction gripping from a single-side has limitations for case picking, particularly with long aspect cartons

"Long aspect ratio boxes... vacuum grabbing those from the side is very challenging... from our data, we're seeing like 10-15% of volume from our customers are these pizza box size." [Anyware Robotics]

- With longer cartons, the increased force at the end of the carton caused the box to fall away or to tear

"I thought using a suction gripper solved the problem, but it's not solved because if you grasp from the front face, the box drops due to the rotational force, so it's a big problem. Even if you used super-glue it wouldn't solve it." [Contoro]

- This resulted in many vendors redesigning grippers to mitigate this issue, with some opting for multi-face picking

"We designed a gripper with two grasping surfaces." [Contoro]

"Our gripper supports from the front, and the bottom." [Technica]

- Some have opted for single-face, but with software optimizations to pick heavier cartons from the top, and lighter cartons from the side

"We have a single suction-gripper, but it can either pick from the top or the side, so that we can load into the hard-to-reach corners...and since we prioritize lighter cartons towards the top of a wall, we can do the side placement with low of tearing the cardboard." [Dexterity]

MORE INNOVATIONS FROM THE FIELD

- Some vendors have innovated on the gripper in other ways to improve safety and operational continuity

"We've added industrial breakaway capability since you're so constrained in the container... sometimes the gripper can get into a place like stuck against a wall... and rather than the damaging gripper, it breaks-away on purpose." [Pickle Robot]

- Others had designed customer arms for their specific approach to case-pick

"We created a custom reference design that our OEMs partners are building at scale... we wanted an arm that has 8 DoF and can work with another arm so it can reach the 4 corners of a trailer and build multiple walls simultaneously without having to move the base or swivel." [Dexterity]

HARDWARE STABILIZING FOR CARTON PICK SHIFTING THE FOCUS INTO THE SOFTWARE DOMAIN TO FURTHER OPTIMIZE

CASE PICK A SOFTWARE PROBLEM

- There was a consensus amongst vendors that Case Pick had entered the software-domain with only minor hardware iterations

"We're stable on the hardware platform, and we're now in the software domain to get the faster cycle-times, better path-planning, so how you rotate the arm has a lot of impact on getting the box picked without flinging it off, all these split-second decisions of all the potential options the arm can take, and ultimately to get more eligibility with freight, different box sizes, weights, etc. It's mostly software." [Pickle Robot]

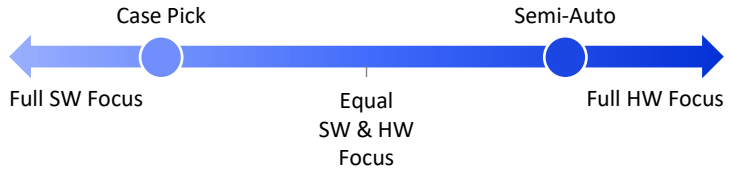
"It's mostly software now, we have the team in place, but to be honest it's never enough engineers especially with the pace of change in AI and ML... even a 1/2 second saved per carton could mean another 1/2 container per day, so we're constantly improving the software." [Copal]

"We're fairly confident on the hardware, of course there will be iterations done, but that's the case with all hardware products. Right now, the goal is to take the existing software stack from our previous generation of robots and port it over to the new design and unlock the additional degrees of freedom...so it's now primarily a software problem." [Dexterity]

- As the hardware form-factors crystallize, this may lead to software driving the differentiation between vendors

"The whole thing is a software domain problem, the guys that aren't doing well right now are those that don't have the software capabilities." [Anyware Robotics]

R&D FOCUS FOR LOOSE CARTON AUTOMATION BY SEGMENT



Source: STIQ Ltd Research & Analysis

- Some believed that software customization would be inevitable as customer requirements vary like other MHE projects

"You might need to make minor tweaks, usually in the software so grabbing from a different position because of the type of box. We're an integrator, so we always cater to requirements, we don't just drop the product and say that's it." [Technica]

SOFTWARE BEYOND DISCRETE USE-CASES LIKE COMPUTER VISION AND KINEMATICS EMERGING IN THE SPACE

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SOFTWARE BEYOND VISION AND MOTION

- Carton loading required additional algorithms to ensure dense, stable loading of cartons

"For loading the priorities are first speed, density or cube utilization, that's number two, and wall stability, meaning that as the truck is in transit, the wall won't collapse, and finally package integrity, making sure the package doesn't get damaged. A function of the last two is making sure you're not putting heavy boxes on top of light boxes... but how do you solve that when you have an unsequenced flow of boxes coming to the robot? A human might put it to the side, but that takes up room in the trailer...We've solved it by having the arm build multiple walls simultaneously, so if you're building a wall, it's 4ft high, then suddenly a heavy package comes, you can just place that on a second wall in front of the lighter, smaller boxes." [Dexterity]

- Software companies outside of the Loading/Unloading space have also applied cartonization algorithms for better cube-utilization in containers and trailers

"Our cartonization engine is fairly flexible, so we have people use it for pallets... we haven't really gone to market with that just yet since we've found more counterintuitive value at the parcel level so that's where we've focused, but to give a sense of the flexibility, a private space company used it to plan astronaut cargo for a mission to the ISS earlier this year." [Paccurate]

COULD ADJACENT SOFTWARE IMPROVE OUTCOMES FOR LOADING/UNLOADING?

Source: STIQ Ltd Research & Analysis, Paccurate

- Interviews also suggested end-users paying more attention to specific metrics for loading and unloading, however there was uncertainty on how they could utilize the data

"Our customers measure things like number of cartons or pallets per container, time spent, and the number of people...but it's not for prediction, as it's very difficult to predict the productivity of a single person so they look at averages. It's being captured for now as the process is ongoing but it's for reviews and not prediction." [Ground Inc]

MOST SOLUTIONS PITCHED AS SUPERVISED AUTOMATION. INTERVENTION RATES <10% AND IMPROVING WITH TIME SPENT AT CUSTOMER SITES

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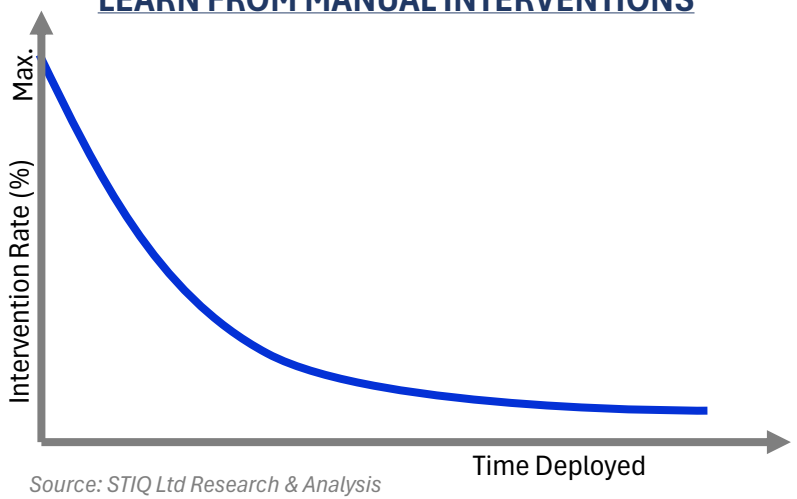
INTERVENTION RATES IMPROVES AS ROBOTS LEARN FROM MANUAL INTERVENTIONS



Source: STIQ Ltd Research & Analysis

SUPERVISED AUTOMATION

- Interviews suggested case-picking was being pitched as a supervised-automation, with ratios of >4 machines per supervisor targeted

"We imagine something where an associate is managing multiple robots simultaneously." [Dexterity]

"If you combine our pallet automation as well, I imagine 2-3 systems can be managed by 1 supervisor... it's the only way to be profitable with containers." [Copal]

"The ratio is about 4:1, we're confident we can get it 7:1 but that's really freight dependent." [Pickle Robot]

- Most vendors quoted intervention rates at <10%, with autonomy improving over time for a given deployment

"Week 1 of a project, it's like a 3-4% human intervention rate, but the AI learns from the human teleoperation so after 4 weeks, it's typically less than 0.5% human intervention. " [Contoro]

"There's maybe 4-5% intervention, but that mostly has to do with if a row of boxes has tape on it, and a box is glued to another, that gives a lot of trouble... but that needs better communication with your supplier."

- Below a certain intervention threshold, the business case for case pick becomes prohibitive for many customers

"Once you get past 2%, the customer doesn't want to use it, that's what we feel in terms of intervention rate otherwise someone has to babysit it all the time." [Anyware Robotics]

"No one expects you to run 100% of the time, but there's a threshold, I'm just picking a number, but say it's 90%, lower than that and it gets really hard." [Pickle Robot]

- Vendors had various ways of intervening, with some using teleoperations as a method of supporting deployments

"We support our customers with teleoperation capabilities, so if the robot meets a challenge that it can't solve with it's algorithms, it pauses and a pilot here in Austin can manually manipulate the arm to fix the issue and then the robot can continue to unload." [Contoro]

HUMAN PARITY THE BASELINE FOR MOST CASE PICK VENDORS

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HUMAN PARITY THE FIRST MILESTONE

- Vendors initially targeting human parity of 300-500 cph with anything above that improving the business case

"Human pick rate is about 300-500 cph uninterrupted and that's our target as well." [Dexterity]

"We think the entry point is human parity... Anything past human parity drives the business case." [Anyware Robotics]

"You can't have a machine that runs slower, because then they'll stay with the manual process... so we have to make sure to surpass that." [Technica]

- Robotic pick had an advantage with heavier boxes, being able to pick multiples in a single pull

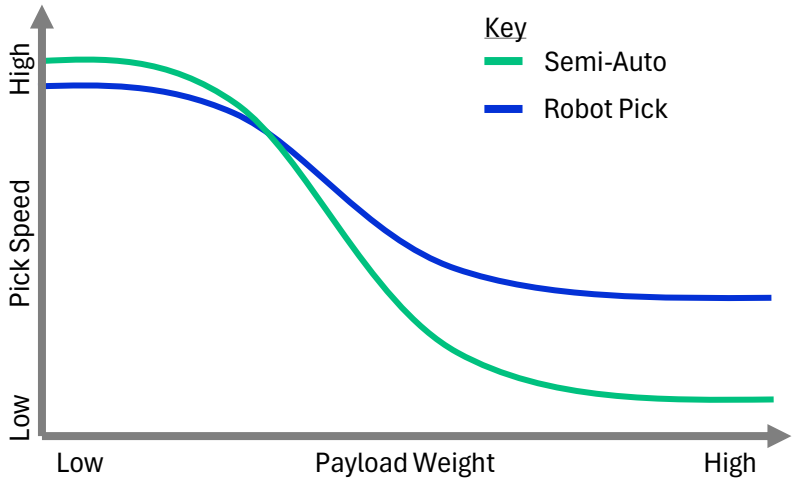
"It depends on the freight... for the heavier, bigger boxes, we're picking at 350-400 cph whereas a human is probably 275-300 cph." [Pickle Robot]

- For smaller, lighter cartons, robotic pick struggled to compete with manual picking, particularly with manual+ systems like telescopic conveyors

"For the smaller and lighter cartons, we're below what people can do since they can just scoop and throw them onto a conveyor." [Pickle Robot]

"If you have a container with 800 boxes that are 600x400x350mm, an operator with a telescopic conveyor can unload that in 90 minutes... which we realized that no automatic system is going to reach that throughput." [LM Group]

CASE PICK SPEED VARIES WITH PAYLOAD



Source: STIQ Ltd Research & Analysis

- Although larger-scale systems that could multi-pick have better than human throughput with smaller boxes

"Our rate is currently at 600-1,200 at a sustained rate, depending on the type of freight, since we can pick 2-3 smaller boxes at a time." [Mujin]

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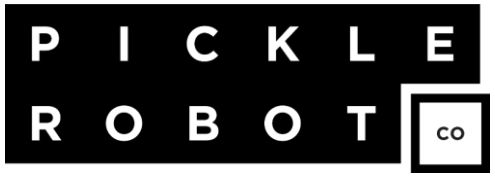


DOWNSTREAM PROCESSES NEED TO BE ABLE TO HANDLE THE THROUGHPUT FROM AUTOMATION AS PICK RATES INCREASE AND MORE SYSTEMS DEPOLOYED AT DOCKS

WHY HUMAN PARITY THOUGH?

- Knowing what pick rate is acceptable is more subtle than just passing an arbitrary target, and depended on multiple factors

"It really depends how fast a container needs to be unloaded... If there are 350 bulky items, you can pick that really slowly and get it done in 90 mins vs you've got 5k small items, even if you're picking at 1k cph that's still going to take 5 hours... so really the question is, how long do you have?" [Pickle Robot]

- This was one of the reasons Case Pick focused more on Drop containers as Live containers couldn't be picked fast enough with current solutions

"Most of our applications have not been with live containers, they're dropping them off because it still takes time, whether it's manual or automatic, even if you're going 1k cph, if there're 3k cases in the container, that's still 3 hours." [Mujin]

- There were also questions as to whether the downstream at end-user sites where Case Pick was being deployed could handle speeds beyond human parity

"There are two things to that thought since, even if the robot speeds up over time, the flow of packages needs to increase which would require additional infrastructure that isn't in place right now, so we're just trying to match manual throughput rates that are in production now." [Dexterity]

"When the trailer unloading companies succeed the next problem will be dealing with the carton flow." [RoboWorks]

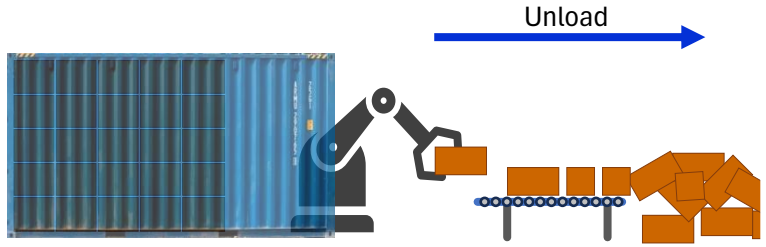
- The steady increase in Case Pick speed, and the ability to run multiple robots in parallel would necessitate major redesign of the downstream to keep utilization high

"I think it's a small but integral part of the process... because whatever you're building down, so let's take unloading, if you're unloading cartons into a sortation system, it's about rate of the cartons, it's about the weight and size of the cartons, all of those things need to be calculated into upstream. If I've got 10 unloaders, unloading 500 cartons an hour, I need a system that's going to be able to catch 5,000 units an hour with some levels of variation because if it's smaller boxes, you're unloading a cosmetics truck, you need to be able to catch more. If you don't size the system properly, you're just going to back up into the truck and you're going to have an unloader standing there unable to move." [ABCO]

- Many semi-automatic inbound flows already handle high volumes beyond current robotic pick rates

"Say you've put 10 telescopic conveyors at the gates, we can merge all of those lines, which then can get sorted out completely autonomously, we can add another sorter to split cartons by size or weight...it's completely up to the customer... we have a customer now asking for 82 different sort destinations which will take around 6k parcels per hour." [Sortcon]

CASE UNLOAD AUTOMATION LIMITED BY DOWNSTREAM CAPACITY



Source: STIQ Ltd Research & Analysis

DOWNSTREAM PALLETIZING SEEN AS THE NEXT LOGICAL FOCUS AREA FOR AUTOMATION AS PALLETIZING AT THE INBOUND A CRITICAL PROCESS IN WAREHOUSING

Loading/Unloading 2025 (Feb)
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INBOUND PALLETIZING THE NEXT CHALLENGE

- Interviews suggested inbound palletizing would be the next frontier of automation after case unload

"I think that a larger growth area than the unloading of the trucks is what to do once it's off the truck... there's many areas you need to get it on a pallet for put-away or for transporting through the building... or some type of cross-docking... there's a huge need there." [Mujin]

"There are a lot of companies working on the unloading systems, but there aren't many working on compact palletization solutions." [RoboWorks]

- Palletizing was an important process at the inbound

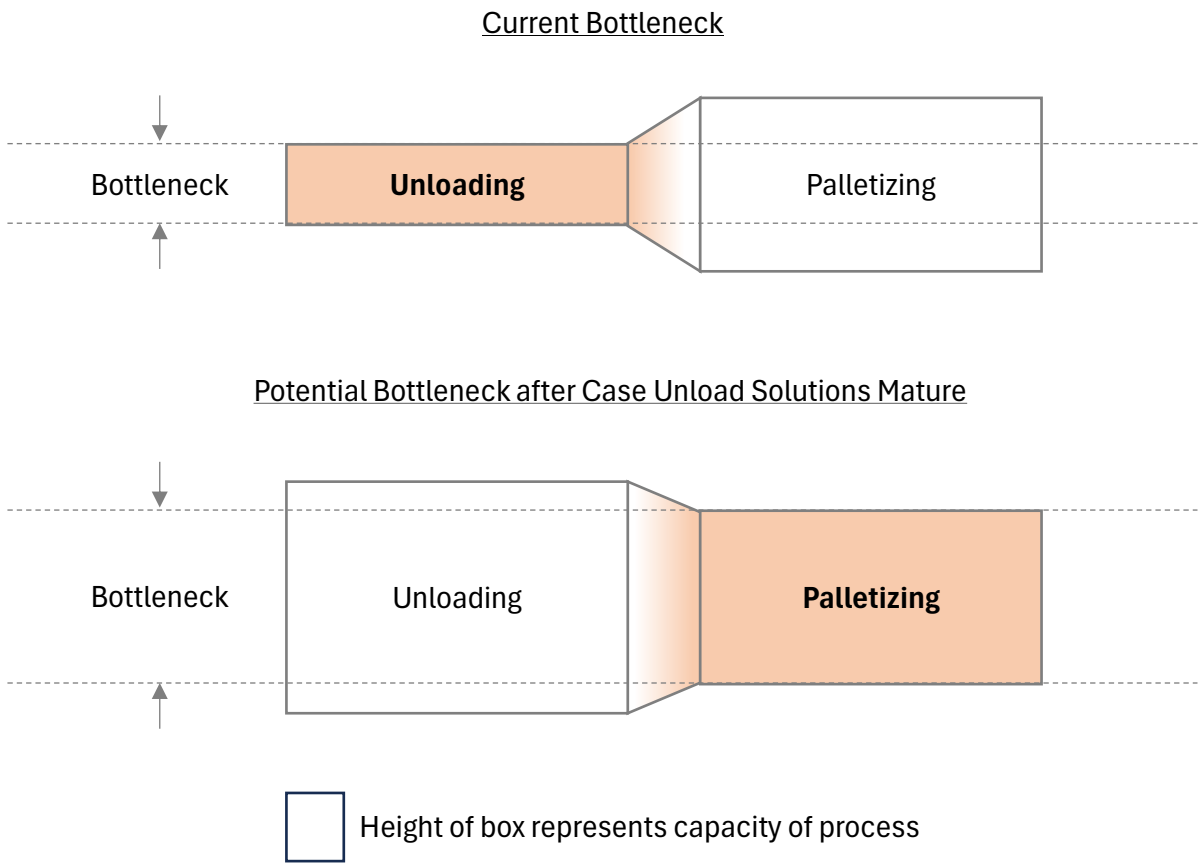
"Not all processes need palletization, sometimes they're unloaded and fed into some sortation system that will take it to some G2P or ASRS system, but most of the time goods need to be palletized." [RoboWorks]

- While robotic palletizers have been developed for many years now, the focus had been on outbound palletizing, which can be less complex than inbound

"Most companies that handle palletizing are concentrated on the outbound, while we're focusing on the inbound... the unload has a lot of companies working, but the process after unloading, verifying products, scanning barcodes, and identifying not just the product but even the batch." [Copal]

"We're introducing a palletizer with a customer soon. We don't want to develop so we partnered with another company. There're lots of requirements for inbound palletizing like scanning the barcode, orienting to make sure the labels face outside, etc." [Contoro]

BOTTLENECK MAY SHIFT FROM UNLOADING TO DOWNSTREAMS LIKE PALLETIZING (ILLUSTRATIVE)



Source: STIQ Ltd Research & Analysis

PALLETIZING FROM HETEROGENOUS CONTAINERS A PARTICULAR CHALLENGE WITH A TRADEOFF BETWEEN SPEED AND SPACE

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HETEROGENEITY A HEADACHE

- Heterogenous (Multiple SKUs) containers were especially challenging as there was a tradeoff between speed and space to effectively palletize them

"If you're above 20 SKUs with 2 pallets worth of product for each, then you need to have say 40 pallets, split over 20 SKUs. You need to sort those out, and then palletize them which would need a lot of space, there's no other way then to just have 20 pallet locations...that's killing the automation... You're just moving the queue from the trailer to somewhere else in the process." [UC Group]

"Single-SKU pallets are interesting; from our perspective it's about how you build the locations so that you serve all all the different pallet locations instead of being limited to 1-2." [Anyware Robotics]

- Buffering the cartons was a tried and tested solution, however buffer size is proportional to the number of SKUs

"We work with 1 pallet at a time, so we build pre-sort lines, and once a pallet is complete for a SKU, the next SKU can be sent to the palletizer... the SKUs handled depend on how many pre-sort lanes you want... we can do infinite lanes, you just need the space for them." [Copal]

"Traditional systems will place a palletizer with a massive buffer deck that can absorb all the SKUs and then release them one-by-one to that single palletizer, it works, and it's a proven technology but requires a massive footprint and budget." [RoboWorks]

- Robotic arms were also being tested, but current solutions were either too slow, or still too large

"The challenge is at the pace you need to go, it's difficult to reach all the different pallets that you need if you're building single-SKU pallets, you could put the robot on a rail for sure but then your rate is going to be slower...you could have multiple arms with a pre-sort to give each arm the right SKU... but that needs space." [Mujin]

"I saw a solution that used cobots with a central sort line with branches to the left and right, and at each branch they placed a cobot palletizer, which say had 10 branches, which meant 20 splits. It's quite expensive since you needed 10 cobots and still needed a fairly large footprint so I'm not sure about that." [RoboWorks]

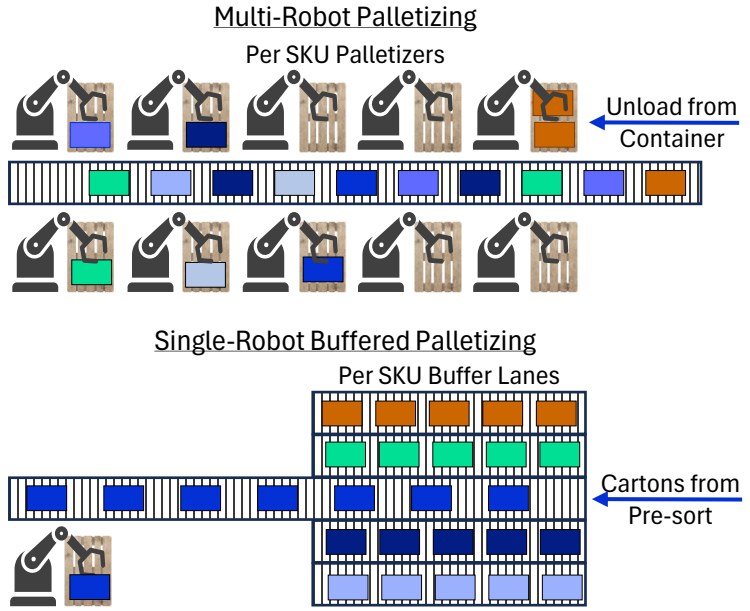
- Mixing manual and automated processes was a typical solution for companies that handled both heterogeneous and homogenous containers

"Some companies will have a policy to send single or low SKU containers to their automated dock, and then do the very complex containers manually, because nobody has 100% robotic container unloading." [Copal]

- Certain industries may have too much heterogeneity to support automation

"I worked for a retailer, they carried food, clothing, housewares, electronic, everything. I was in the back of a store watching truck unloads for store replenishment, so there's a little bit of everything and it all comes in cases. It was way beyond multi-SKU, it was like onesie-twosie... so they had to go manual." [ABCO]

HIGH SPEED HETEROGENOUS PALLETIZING REQUIRES SPACE & CAPITAL



Source: STIQ Ltd Research & Analysis

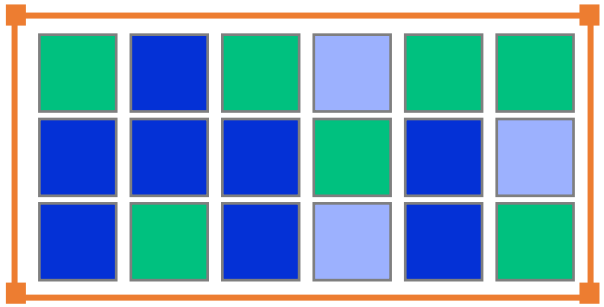
- Vendors focusing purely on compact inbound palletizing were emerging

"We're talking to a customer that receives 20-30 containers per day and with an average of 10-20 SKUs, so how do you sort those SKUs to pallets on a very small footprint? We're developing a layer palletizer that can sort in 8 directions in around 35 sqm by redesigning the standard layer palletizer." [RoboWorks]

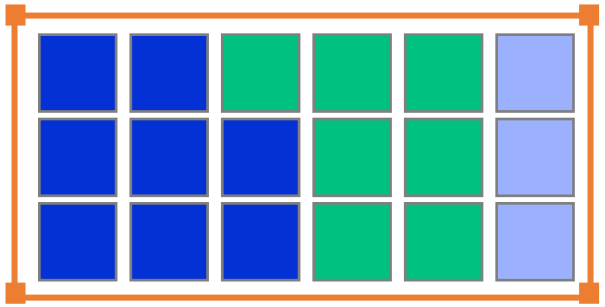
SOME VENDORS SAW SUPPLY-SIDE CONTROL AS A NECESSARY STEP FOR ROBUST AUTOMATION AND SIMPLIFYING THE DOWNSTREAM

IMPLEMENTATION OF PROCESSES WITH SUPPLIERS CAN SIMPLIFY UNLOADING OF CONTAINERS

Randomly Loaded Container



Snake-Loaded Container



Source: STIQ Ltd Research & Analysis

GARBAGE-IN, GARBAGE-OUT

- Many vendors saw communication with the supplier as an integral part of the automation process, and achieving higher ROI

"There are two sides, loading and unloading....but it all begins with the loading...there needs to be decisions about how containers are loaded, or the type of packaging that you're going to use... if one party doesn't listen to the other, say the sending party doesn't care how it's loaded, then how are you going to automate the unload? It's never going to get solved." [SmartTEH]

"There are companies that buy-in containers which are already on the ships and don't even know who the supplier is...but for more than 90% of all containers streaming from Asia to Europe, there is a known supplier, and a known customer, and between them there is communication about what should be in the container, what type of cartons to use, what should the barcode contain, and by improving that process, you can achieve good ROI in automatic container unloading." [Copal]

- Improved communication with supply-side would not only improve things like structure and carton-quality, but can have impacts on the upstream, such as palletization

"Customers that are communicating with their suppliers are able to create containers with a protocol of how they're loaded. If you tell your supplier in China to not put everything together but to snake load it, they will do it because they want to supply to you... what we see is if you improve you loading process in Asia, you can improve your full automation container unloading to a greater degree... garbage in, garbage out." [Copal]

CARTONS PROVIDE GREATER CUBE DENSITY THAN PALLETS HOWEVER TIME & COST OF HANDLING MAY OFFSET TRANSPORT SAVINGS FOR THE NEAR FUTURE

KEEPING THE STATUS QUO FOR THE MOMENT

- Floor Loading/Dead-Stock Loading is the process of loading cartons/product directly onto the trailer floor without pallets to improve cube-density

"Dead Stock Loading is where you load into the trailer without a pallet to increase the fill. For drinks, obviously it weights-out before it cubes-out so taking out the pallet doesn't change much... with snacks, because it's so light, you want to fill that thing up to the brim, so they might remove the pallet and replace with a slip-sheet" [Buyer]

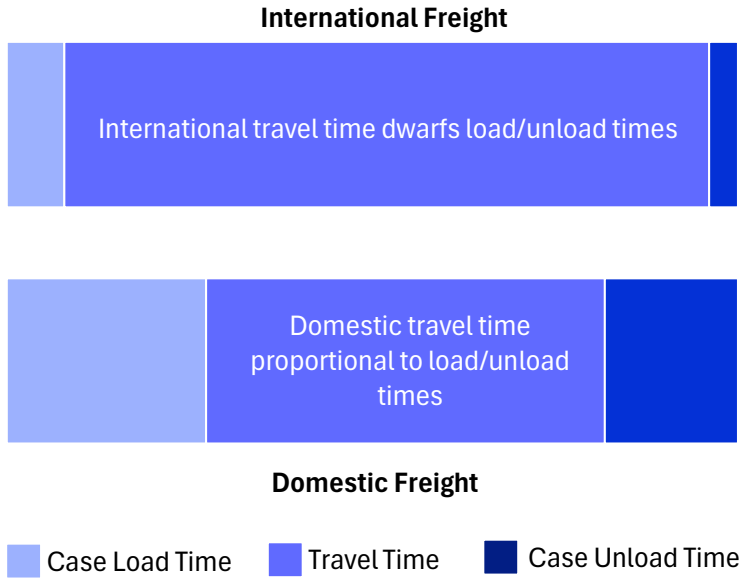
- Interviews suggested that switching from pallets to loose cartons could increase cube density, reducing the costs of transportation

"Pallets are something like 15% of the volume of a container, so by palletizing, every 6-10 loads, you're adding another container... so that can reduce your costs just there, that's pretty significant... you could make the argument for store fulfillment." [Anyware Robotics]

- However, with the current costs for unloading cartons, that saving was seen by some as 'kicking-the-can

"If you floor load your trailers to increase the number of cartons per trailer, that's great, but then you have to spend more money getting them off the trailer, so the money saved upfront is now spent on the backend... whilst pallets you ship more air, so you spend more to get it there, but it's quicker to unload. That's why you see containers with cases coming from abroad, you want to make sure you put as much product since it's taking weeks to get there by sea and the container itself costs money." [ABCO]

RATIO OF TIME SPENT BY PROCESS, DOMESTIC VS INTERNATIONAL (ILLUSTRATIVE)



Source: STIQ Ltd Research & Analysis

UPSTREAM PROCESSES CAN HAVE SIGNIFICANT IMPACT ON TRAILER DENSITY AFFECTING THROUGHPUT AND ROI OF TRAILER LOADING/UNLOADING

Loading/Unloading 2025 (Feb)
Published by STIQ Ltd

STRUCTURED PALLETS = BETTER ROI

- Loading more pallets per trailer results in higher overall throughput and ROI
- Overhang and lean can have a severe impact on density, e.g., >6cm deviation removing an entire pallet from a row

"Our first question to customers is if there are overhangs. A lorry is 2.46m wide, so that means if you want 3 pallets, that's already 2.4m, so there's only 6cm for the pallets to fit." [WDX]

"Since we're loading 3 pallets in a row, that's already 2.4m... so it's important that pallets are very straight with no overhang." [Trapo]

- Density can be improved with different load-patterns like pinwheeling, however this was still sub-optimal

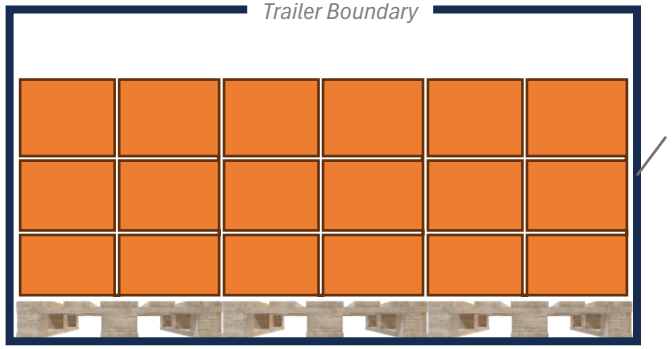
"If there's a little bit of lean or overhang on those pallets, that's going to a very tight squeeze inside the trailer, and you need to do all kinds of things like pinwheeling the pallets... the answer is to start palletizing better." [Joloda]

- AGV/AMR ATLS was particularly sensitive to overhang/lean as their load-times can be improved by loading more pallets in a single trip

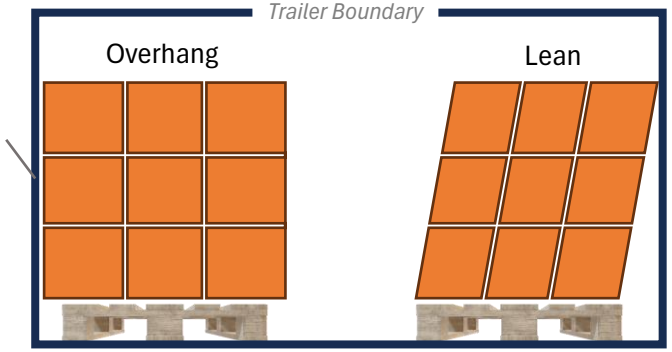
"We move 2 pallets-wide which has it's challenges... the pallets need to fit through the door with less than 1cm clearance... so it's in their best interest to have as precise of pallet stacks as possible with no overhang, because then we're able to really achieve that huge time advantage to manual forklifts." [Navflex]

OVERHANG & LEAN IMPACT ON LOADING DENSITY

Structured Pallets in Trailer



Unstructured Pallets in Trailer



Source: STIQ Ltd Research & Analysis

- Various techniques were employed to try to identify pallets with lean/overhang if there is risk of them interrupting the flow, or causing damage to products, the dock or the trailer

"We have installed pallet detection systems to check them, so that we can reject pallets from the system before we load." [Trapo]

WHILST MOBILE SORTERS ARE WELL ESTABLISHED IN UNIT/PARCEL SORTATION A CASE FOR MOBILE HANDLING OF PALLETS FROM/TO THE DOCKS IS BEING MADE

Loading/Unloading 2025 (Feb)
Published by STIQ Ltd

FIXED VS ROBOTIC PALLET TRANSPORTATION

Fixed Pallet Transport

Robotic Pallet Transport

Source: STIQ Ltd Research & Analysis. Pallet Conveyor, Robotic Pallet Jack

MOBILE ROBOTS CAN GO THE DISTANCE

- AGVs/AMRs are finding a place as flexible conveyance for pallet sortation, removing the need for fixed conveyors from storage to the docks

"Fixed automation are things like conveyors, I'm drilling into the ground, whereas flexible is introducing AGVs or AMRS... If you're an outbound DC, you may have 10 downlines for your carriers, and a handful of inputs at the front... so with AMRs, say they have 40 pack stations on the induct, instead of a spaghetti of conveyors, they're using AMRs to sort to the different diverts...so there's that potential for the docks to use a fleet of robots sorting pallets, and they can just turn on or off the different sections, so you're able to expand your business." [ABCO]

"We're not using AGV inside the trucks, but as an intermediate system to remove the need for a conventional pallet-conveyor." [LM Group]

- The same AGV/AMRs that load/unload could also be applied to multiple roles in the up/downstream to maximize asset utilization and simplify facility design

"Our projects are usually 10-20 forklifts which is kind of big, but the thing is, these forklifts aren't only being used for the docks... the same forklifts might be transporting pallets in the factory, picking up finished goods to put them into racks, or taking from the racks to then load the trailer." [Anonymous]

ALTHOUGH NOT YET A FOCUS, YARD PROCESSES CRUCIAL TO LOADING/UNLOADING AUTOMATION

Loading/Unloading 2025 (Feb)
Published by STIQ Ltd

CAN YOU MEASURE A DOCK IN YARDS?

- Current yard processes sit on a gray-scale ranging from fully analog and manual, to highly digitized and ready for automation

"There are some very small sites still using pen and paper and that's very far from automation... then there are those using Excel still, and that can work, but you still need a manual dispatch from control tower, then you have, usually the larger ones that have an IT system, like a YMS, which if you want to automate, or track metrics, for sure you need to be more integrated." [Ex9]

- Yard Management Systems were critical for companies that want to improve the efficiency in the yard

"Anyone doing ATLS definitely needs an ERP with yard management built into it... the whole idea is the truck doesn't stay more than it's allotted time, YMS is an absolute must and definitely we see it in most cases, otherwise it's a mess." [THINK BLUE]

- Interviews suggested the size and throughput requirements of a company influenced yard process design

"Some companies require the lorry driver to park, step out, enter the dock and press some button to start the process, while others don't see the value since for them the load is only 5-minutes since they want a higher throughput, so they don't want the driver to waste time." [WDX]

"Usually the bigger the site, the more automation we see, as well as things like Drop & Hook... there are some that have very bad IT and discipline but more or less the bigger they are the more disciplined." [Ex9]

- The yard was seen as a complex area to predict because of external factors, such as traffic, weather conditions, etc

"You also have issues that are difficult to handle, for example traffic jams on public roads, so there are a lot of unpredictable factors." [Ex9]

- There are also challenges in aligning stakeholders in some markets where the yard can be managed by a 3rd party to the warehouse

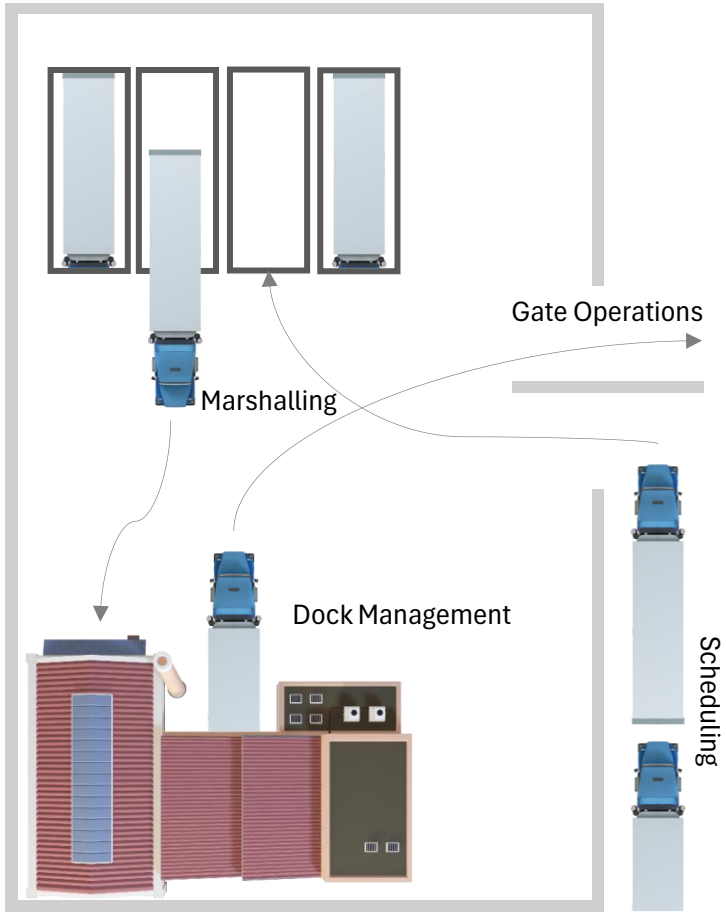
"In the UK, there are some companies that have the warehouse as a black-box run by one company, and then a 3PL managing the yard, the incoming and outgoing transport, and that's hard since you need to align a lot of people to automate that." [Ex9]

- Aside from labor constraints, ESG was another driver for Yard automation, however, this would only be effective with significant investment into electrification of fleets

"If we do automation on diesel, you still emit diesel and CO2. Automation has been a catalyst for electrification because otherwise it's very expensive... but you spend less on damages, with less human errors and less accidents, employees can also be reassigned to more valuable tasks. That means that your investment is redistributed. That's why it can be worth it to make the effort to electrify." [Ex9]

- For more on the interdependence of Yard and Dock performance, consider reading STIQ's 2024 Future of Warehouse Automation Report

INTERDEPENDENT PROCESSES IN YARD (ILLUSTRATIVE)



Source: STIQ Ltd Research & Analysis

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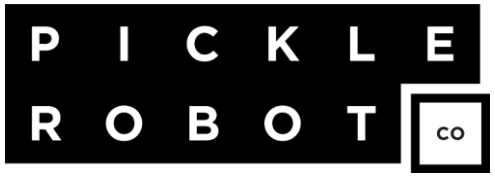
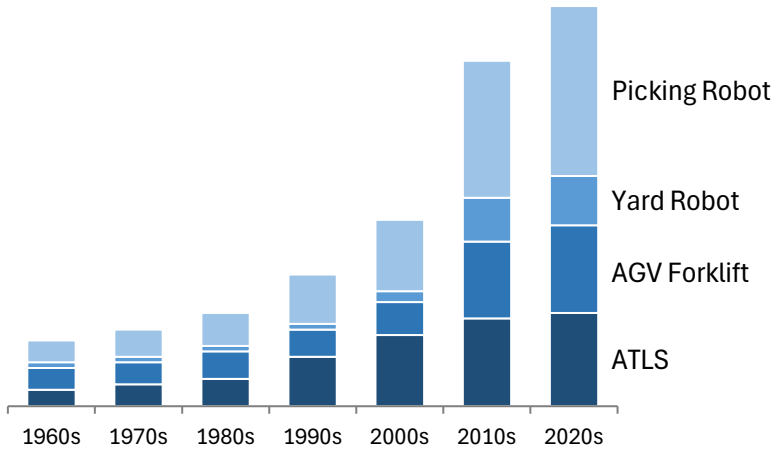
GOLD SPONSORS



ACCELERATED SECTOR STARTUP ACTIVITY IN THE 2010's and 2020's WITH AN APPARENT FOCUS ON ROBOTICS AND AUTONOMOUS SOLUTIONS

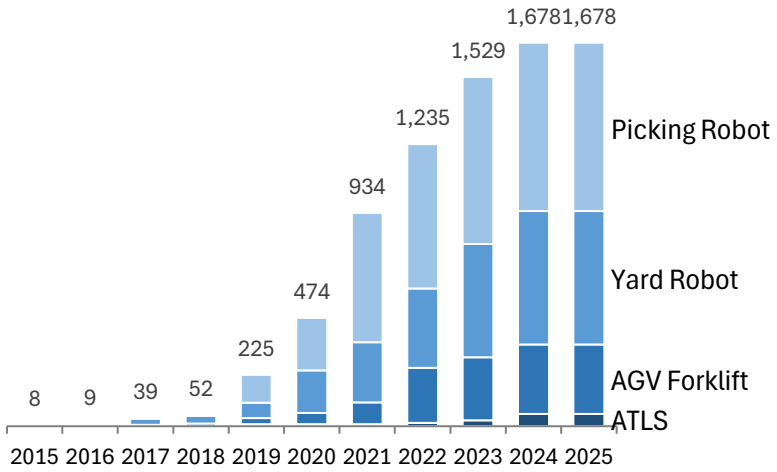
Loading/Unloading 2025 (Feb)
Published by STIQ Ltd

LOADING & UNLOADING AUTOMATION VENDORS BY YEAR FOUNDED, 1960'S-2020'S (#)



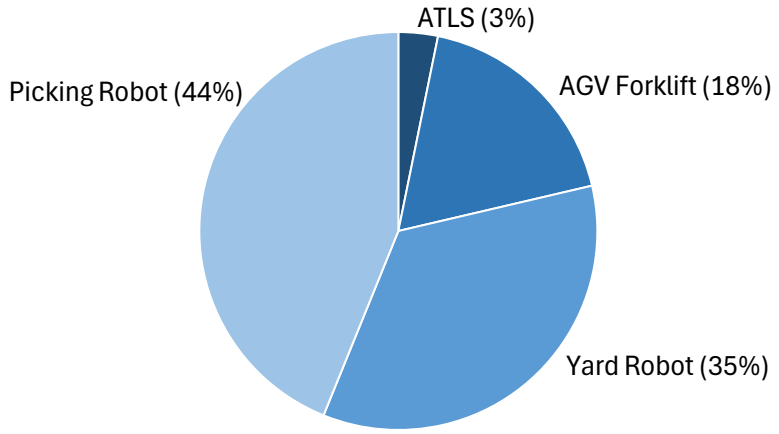
Source: STIQ Ltd Research & Analysis. Note company foundation year rather than year added specific technology/ies

FUNDING IN THE LOADING & UNLOADING AUTOMATION SECTOR, 2015-2025 ($M)



Source: STIQ Ltd Research & Analysis. Funding includes publicly announced figures

LOADING & UNLOADING AUTOMATION SECTOR FUNDING BY SEGMENT SHARE (%)



Source: STIQ Ltd Research & Analysis. Funding includes publicly announced figures

ACCELERATION OF STARTUP ACTIVITY IN 2010s

- Analysis of the primary product segments in the Loading & Unloading sector indicates there was a sharp uptick in new entrants in the 2010's
- The main segments that expanded were those with robot related solutions, AGV Forklifts (loading/unloading pallets), Yard Robots (moving trailers in yards) and Picking Robots (loading/unloading cases)

- There are many drivers for the increased activity including Amazon acquiring Kiva Systems in 2012, the release of open source robotics software such as ROS, increased VC interest in the space, etc.

DECLINING INVESTOR APPETITE?

- Publicly available figures for investments in Loading & Unloading companies indicate a strong interest from VCs from 2019 to 2023

- However, increasing interest rates and some degree of saturation in the sector may have deterred investors from 2023

ATTRACTIVE SEGMENTS FOR INVESTORS

- The Picking Robots segment represents 44% of all publicly known funds raised in the Loading & Unloading sector followed by Yard Robots (35%), AGV Forklifts (18%) and ATLS vendors (3%)

LIMITED M&A ACTIVITY IN THE LOADING & UNLOADING SECTOR. FORECAST TO REMAIN RELATIVELY MUTED/ STABLE. ALTERNATIVE DEALS MAY INCREASE IN THE SHORT TERM

Loading/Unloading 2025 (Feb)
Published by STIQ Ltd
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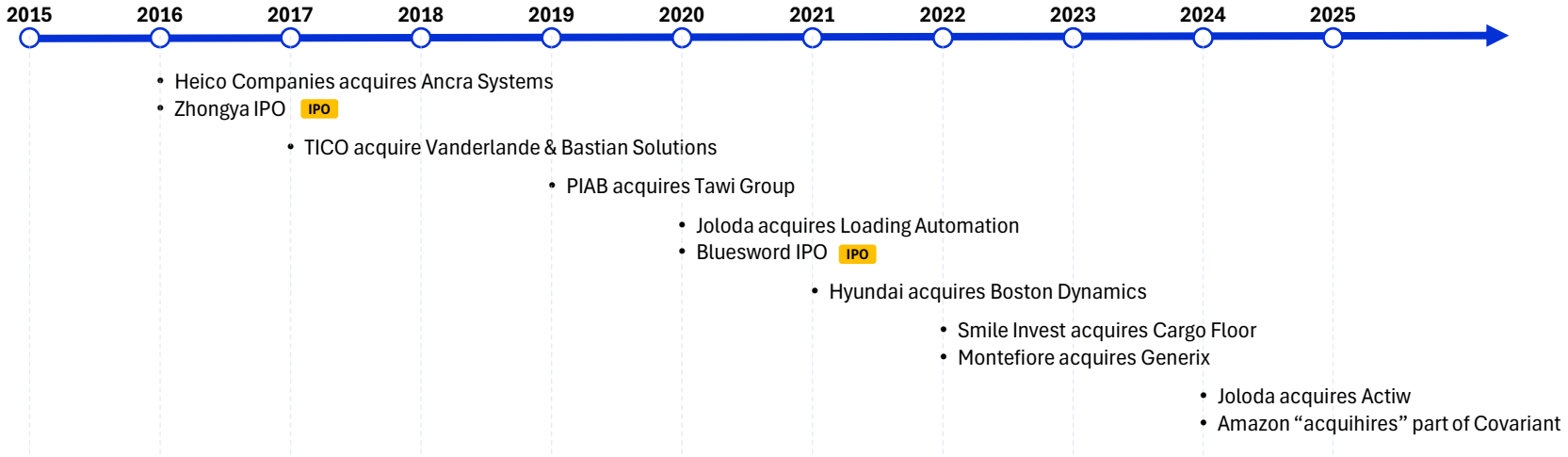
SELECTED LOADING & UNLOADING AUTOMATION SECTOR TRANSACTIONS, 2015-2025



Source: STIQ Ltd Research & Analysis

LIMITED SECTOR M&A ACTIVITY

- STIQ tracks M&A activity up to a month prior to publication, in this case to end Dec 2024
- Overall, M&A activity in the Loading & Unloading Automation sector has been limited to an average of about one transaction per year in the last decade
- This is relatively low when compared to other Material Handling Equipment and/or Warehouse Automation sectors
- The lack of transactions volume could be indicative of:
  - Incumbents leading the sector, in particular in more mature segments such as ATLS
  - A lack of attractive (or palatable) exit opportunities for the many VCs with stakes in the sector
  - A lack of sector traction and/or maturity of some of the technologies
  - Lack of sharp growth or growth prospects in the sector

FORECAST ACTIVITY, LIKELY SIMILAR

- STIQs view is transactional volume will remain at historical levels with about one transaction per year
- However, in the short to medium term there may be some level of heightened activity as later stage investors may attempt to exit and return money to their limited partners
- Note time to exit can vary depending on who the investor is
- For example, corporate VCs may have less pressure to return cash to their owners or partners compared to independent VCs where there are often many different limited partners

ALTERNATIVE DEALS ON THE INCREASE?

- There is also potential for alternative or unconventional transactions, such as Amazon's acquihire of parts of Covariant's team and technology licensing in 2024 (source)
- These deals may be driven by timing and/or may simply be opportunistic but appear to occur when companies are out fundraising again, some having already raised $100m's, and where there is less appetite from investors
- For example, Covariant had raised >$200m with its most recent fundraise announced in 2023 and it is reasonable to presume the company may have started the process of raising money again when the deal was struck

CONTENTS

LOADING/UNLOADING DIRECTORY: A - C

ABCO
US | 2003

- System Integrator

Actiw
FI | 2007

- ATLS

Agilox
AT | 2017

- Autonomous Forklift

Ant Machines
DE | 2021

- Yard Automation

Anyware Robotics
US | 2023

- Carton Automation

Ari Global Solutions
IN | 2001

- ATLS

A-Service
NL | 2000

- ATLS Integrator

ASI
US | 2000

- Yard Automation

Astro
US | 2021

- Carton Automation

Balyo
FR | 2005

- AGV & AMR vendor

Bastian Solutions
US | 1952

- Carton Automation
- Acquired by Toyota Material Handling in 2017

Beumer
DE | 1935

- Aggregate Load/Unload

BlueSword
CN | 1993

- Carton Automation

Boston Dynamics
US | 1992

- Carton Automation
- Acquired by Hyundai Motors in 2021 for $1.1bn

Caljan
DK | 1963

- Telescopic Conveyors

CAPO Tecnologia
BR | 2016

- ATLS

Carton Mover Logisch
NL | 2010

- Carton Automation

CleverTech
IT | 1987

- System Integrator

CLSI Logispeed
DE | 2006

- ATLS

Cognosos
US | 2014

- Yard Management System

LOADING/UNLOADING DIRECTORY: C - G

ConveyX
US | 2018
- Telescopic Conveyors

Copal Handling Systems
NL | 2006
- Carton Automation

Dedem Mekatronik
TR | 1995
- Carton Automation

Dexterity
US | 2017
- Carton Automation

Dorabot
CN | 2015
- Carton Automation

Duro Felguera
ES | 1858
- ATLS

E80 Group
IT | 1980
- AGV Forklift

EasyMile
FR | 2014
- Yard Automation

Easy Systems
NL | 2007
- Telescopic Conveyors

EFAFLEX
DE | 1974
- Dock Doors

Embotech
CH | 2013
- Yard Automation

Ergate Technology
CN | 2021
- Telescopic Conveyors

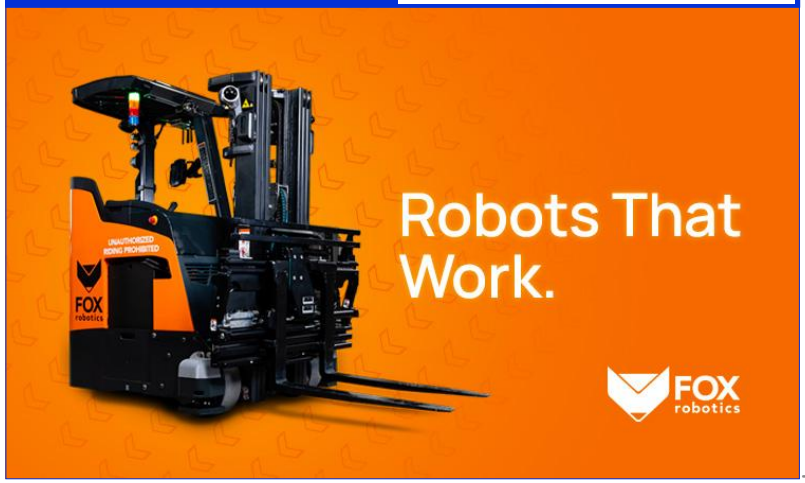
Europa System
PL | 1994
- ATLS

ex9
FR | 2021
- Yard Automation

Filics
DE | 2019
- AMR Forklift

Fidus Global
US | 2020
- WCS, WES vendor

Fox Robotics
US | 2017



Forankra Group
SE | 1984
- System Integrator

Generix Group
FR | 1996
- AGV Forklift

GIDEON
HR | 2017
- AMR Forklift

Ground Inc
JP | 2015
- Warehouse Intelligence System

LOADING/UNLOADING DIRECTORY: G - N

Gorbel
US | 1977

- Telescopic Conveyors

Hanwha
KR | 1952

- Carton Automation

Honeywell
US | 1906

- Carton Automation

ISEE
US | 2017

- Yard Automation

Joloda Hydraroll
UK | 1962

The Joloda Hydraroll Group is a one-stop-shop provider of loading solutions. We help businesses make loading and unloading processes more efficient and effective with manual, semi-automated, and fully automated solutions.

Our story has unfolded over 60 years and we are now regarded as the global leader in loading solutions.

JBT Corp
US | 1894

- AGV & AMR vendor

Kaleris
US | 2004

- Yard Management System

KSM Viet Son Mechanical
VN | 2016

- ATLS

Lab0
US | 2021

- Stealth Mode

LM Group
ES | 2013

- System Integrator

Loading Robots by DF
ES | 1858

- Lateral-AGV

Miebach
DE | 1974

Lodamaster
TR | 2011

- Telescopic Conveyors

Maproloc Systems
NL | 2014

- Carton Automation

Mecalux
ES | 1966

- System Integrator

Meikoku
JP | 1955

- Carton Automation

MSK Covertech
DE | 1975

- ATLS

Mujin
JP | 2011

- Carton Automation

LOADING/UNLOADING DIRECTORY: N - T

Navflex Inc
US| 2020

Nido Automation
IN | 2010

- Telescopic Conveyors

Okura Yusoki
JP | 1937

- ATLS

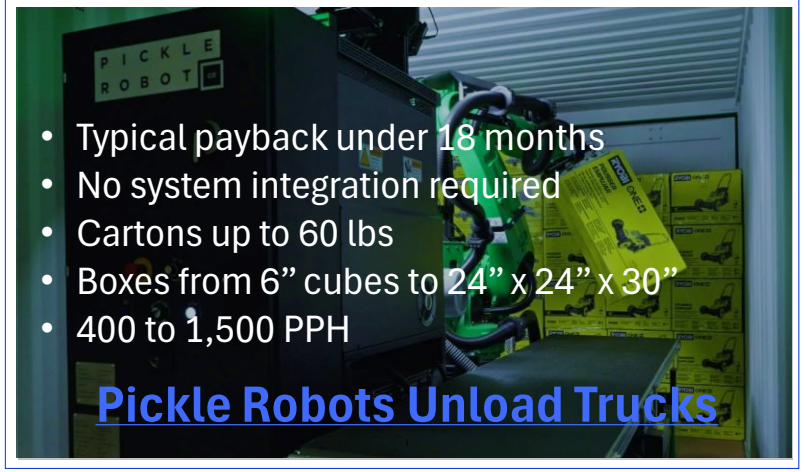
Outrider
US | 2017

- Yard Automation

Paccurate
US | 2013

- Cartonization Software

Pickle Robot
US | 2018



PorTrucks
IN | 2000

- ATLS

Rapyuta Robotics
JP | 2014

- AMR Forklift

RoboWorks
NL | 2021

- Inbound Palletizer

SIMEC Systems
FI | 1841

- ATLS

Skilled Group
IT | 1973

- AMR Forklift

Slip Robotics
US | 2020

- AMR Pallet Lift

SmartTEH
LV | 2016

- ATLS

Sortcon
TR | 2021

- Telescopic Conveyor

Suzhou Wisedock Automation
CN | 2022

- Telescopic Conveyor

Technica
LB | 1982

- Case Automation

THINK BLUE
IN | 2022

- ATLS

Trapo
DE | 1957

- Lateral-AGV

LOADING/UNLOADING DIRECTORY: U - X

Trapo
DE | 1957

- Lateral-AGV

UC Group
NL | 2011

- Consultancy

VisionNav
CN | 2016

- ATLS

WDX
PL | 1995

- ATLS

WSR Solutions
NL | 2014

- Carton Automation

Wynright
US | 1972

- Carton Automation
- Acquired by Daifuku in 2013

CONTENTS

INTERVIEWS, TRADE SHOWS AND GLOSSARY

STIQ INTERVIEWED THESE STAKEHOLDERS

- ABCO (US) — EVP of Product Development
- Actiw (FI) — Director
- Anyware Robotics (US) — Co-founder
- Balyo (FR) — CEO
- CAPO (BR) — Director
- **Contoro (US)** — **Founders**
- Copal Handling Solutions (NL) — Director
- Dexterity (US) — Co-founder
- Ex9 (FR) — Co-founder
- Fidus Global (US) — Co-founder
- Forankra (FR) — Project Manager
- **Fox Robotics (US)** — **VP of Sales**
- Ground Inc (JP) — General Manager, Product Sales
- JBTC (US) — Sr. Strategist
- **Joloda Hydraroll (UK)** — **Director**
- LM Group (ES) — BD Manager
- Loading Robots (ES) — Global BD Manager
- Lodamaster (TR) — Sales Manager
- Miebach (DE) — CRO, US & CA
- Mujin US (US) — VP, Sales & Marketing
- **Navflex (US)** — **Co-founder**
- Paccurate (US) — Co-founder
- **Pickle Robot (US)** — **VP, Product & Marketing**
- Rapyuta (JP) — Product Manager, AMRj
- RoboWorks (NL) — Co-founder
- SmartTEH (LV) — CEO
- Sortcon (TR) — Co-founder
- Technica (LB) — Business Development Eng.
- THINK BLUE (IN) — Director
- Trapo (DE) — Product Manager, TLS
- UC Group (NL) — Partner
- VisionNav (CN) — Director of Sales
- WDX (PL) — Director
- **XYZ Robotics (CN)** — **Founder**

ANONYMOUS CONTRIBUTORS:

- A few stakeholders requested to remain anonymous and STIQ is very grateful for their valuable contributions
- If you wish to participate in a STIQ report but prefer to remain anonymous, please simply let us know; We receive many incoming inquiries from a wide range of stakeholders with comments on our range of reports

TRADE SHOWS & EVENTS VISITED

- IWLEX (Coventry, UK) WEB
- LogiMAT (Stuttgart, DE) WEB
- Logis Tech Tokyo (Tokyo, JP) WEB
- Modex (Atlanta, US) WEB
- MTC Robotics and Automation (Coventry, UK) WEB
- NRF Big Show (New York, US) WEB
- Promat (Chicago, US) WEB
- The Delivery Conference (London, UK) WEB
- Parcel + Post (Amsterdam, NL) WEB
- Logistics & Automation (Madrid, ES) WEB

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Special thanks to our gold sponsors Joloda Hydraroll, Fox Robotics and Pickle Robots for making this report available for free, and to all the companies that sponsored the directory

GLOSSARY

3PL	Third Party Logistics
AI	Artificial Intelligence
ASRS	Automatic Storage & Retrieval System
ATLS	Automatic Trailer Loading System
CAPEX	Capital Expenditure
CEP	Courier Express Parcels
CPH	Cases Per Hour
DC	Distribution Center
ECB	European Central Bank
EOL	End-of-Line
ERP	Enterprise Resource Planning
ESG	Environmental, Social, and Governance
EU	Europe
FTE	Full-Time-Equivalent
G2P	Goods-To-Person
H&S	Health & Safety
HW	Hardware
LATAM	Latin America
LiDAR	Light Detection and Ranging
MHE	Material Handling Equipment
ML	Machine Learning
NA	North America
OEM	Original Equipment Manufacturer
OPEX	Operational Expenditure
PO	Purchase Order
POC	Proof of Concept
QC	Quality Control
R&D	Research & Development
RAAS	Robots-as-a-Service
ROI	Return on Investment
SI	System Integrator
SKU	Stock Keeping Unit
SW	Software
TCO	Total Cost of Ownership
US	United States of America
VC	Venture Capital
WMS	Warehouse Management System
YMS	Yard Management System