AGV & AMR ROBOTICS 2025
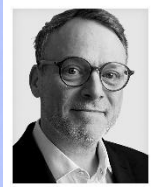
MOBILE ROBOTS IN FACTORY, PRODUCTION & WAREHOUSE ENVIRONMENTS | NOV 2025
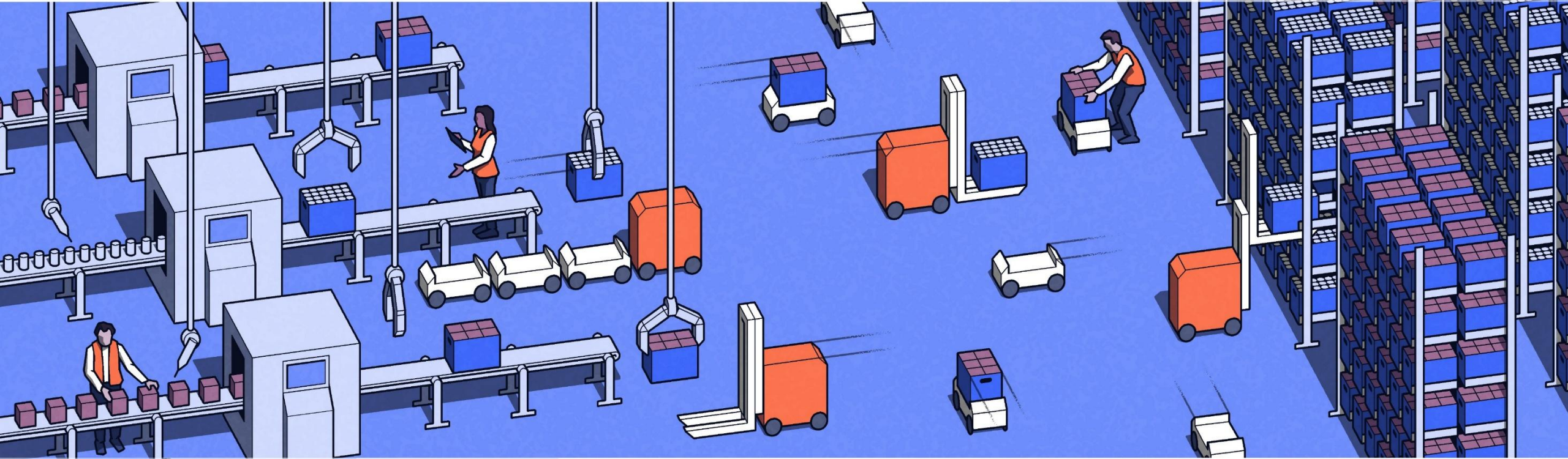
Author:

Tom Andersson
Founder

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EXEC SUMMARY: TARIFFS AND AUTOMOTIVE SECTOR ISSUES CAUSED DECISION PARALYSIS IN 2025. 2026 MORE OPTIMISTIC BUT CLOUDS MAY PERSIST

AGV & AMR MARKET FRAGMENTATION

- The global AGV & AMR market is highly fragmented and STIQ actively tracks >600 vendors globally

- A small number of vendors have (more or less) specialized by industry/ application and frequently compete for most of the larger projects with the vast majority of vendors playing for smaller projects

- Forktruck and Turtle form factors between them represent the majority of TAM, however, penetration remains low

2025 MUTED MARKET SENTIMENT

- Market sentiment suggests that trading for 2024 into 2025 was muted, although some good growth was experienced in pockets such as China and SEA

- The automotive sector, long a mainstay of mobile robotics, has contracted and multiple vendors are looking to other verticals such as F&B

- Uncertainty – particularly tariffs – have been the strongest inhibitor for further growth, causing end users to delay committing and/or slow down their decision making

- However, there is evidence of a normalizing of this factor, as vendors and end users alike adapt their expectations and planning

2026, OPTIMISM RE FUTURE GROWTH

- As a result, there is widespread optimism for growth in 2026, with companies reporting strong pipelines

- Underpinning this is the continued issue of labor availability/cost for end users, pushing them towards automation initiatives, although this has become less of an issue post-Covid

- Vendors will still need to overcome some challenges as safety issues come to the fore, and end user education is increasingly necessary in a fragmented and complicated supply side environment

- Partnerships, and the rise of the agnostic AGV & AMR SI, is one way the market is addressing this complexity, and equally something that is boosting best of breed vendors

SAFETY REMAINS A COMPLEX ISSUE

- The safety aspect of systems and individual machines remains complicated

- As technologies boost robotic autonomy, and AI assisted identification capabilities increase, this is likely to become a differentiator albeit one that will need to carefully balance costs/ROI impact

- Safety standards tend to be stricter in Europe than China or even the US. This may act as a barrier to entry for international players, but also may suppress domestic innovation

THE CHINESE MARKET

- The Chinese market remains strong, but severe production overcapacity and margin pressure has led many vendors to look internationally where they compete very effectively on price

CONSOLIDATION, FINALLY HAPPENING?

- The supplier landscape is potentially consolidating with even some larger vendors in trouble and being snatched up by other players

- STIQ have published an annual report on the AGV & AMR Robotics sector since 2020 – download previous reports to gain more insights on the sector (for free)

FOR BUYERS OF AGVs & AMRs :
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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THREE AGV & AMR ROBOT FORM FACTORS: TAM + ESTIMATED CURRENT PENETRATION

THE GLOBAL AGV & AMR ROBOTICS MARKET, ESTIMATED PENETRATION, VENDOR TIERS AND PROJECT SIZES (HIGHLY SIMPLIFIED)

Tugger   Turtle/ Mouse   Forktruck   AGV & AMR 'Market Tree'   Description

TAM   TAM   TAM

Market penetration

Tugger   **Turtle/ Mouse**   **Forktruck**

- Tier 1: 2% of vendors
- Mid- to large size projects with more and/or larger vehicles, frequently >25 vehicles
- Mix 50/50 between brownfield and greenfield projects with the latter being far larger projects

- Tier 2: 8% of vendors
- Mid-size projects with more and/or larger vehicles, frequently 10-25 vehicles
- Mainly brownfield with some greenfield projects

- Tier 3: 90% of vendors, low hanging fruit projects
- Domestic vendors often preferred due to nature of customers with often limited knowledge of operating mobile robots
- Mostly smaller projects, frequently <5-10 vehicles
- Mainly brownfield projects

Source: STIQ Ltd Research & Analysis

AGV & AMR FORM FACTORS, NAVIGATION TECH

- The AGV & AMR market is divided into three primary form factors: Tuggers, Mouse (aka Turtles, underdrivers, etc.) and Forktrucks
- A multiplicity of different navigation technologies and vendor types often adds a level of confusion to non-professionals

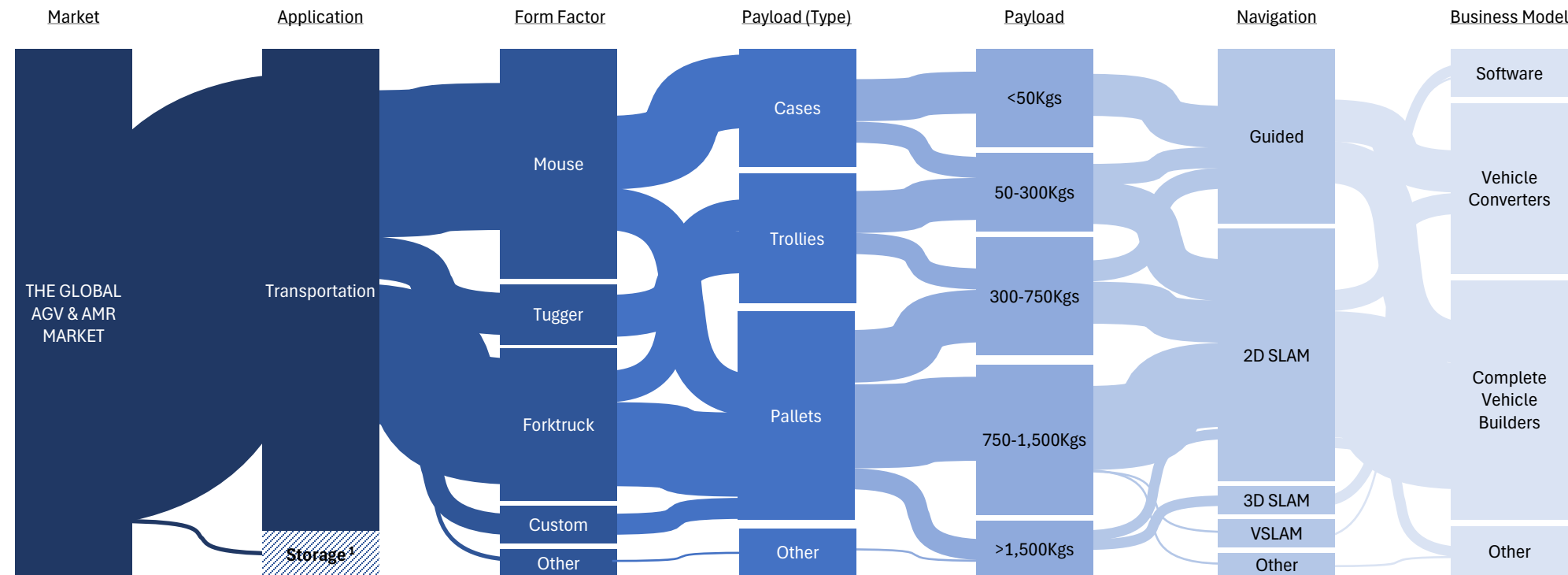## MARKET PENETRATION, CUSTOMER DYNAMICS

- Few potential customers are 'AGV & AMR ready' i.e. they have standardized intralogistics flows and can easily adopt mobile robots in flows
- While the global AGV & AMR Robotics TAM is relatively large, the fact that few potential customers are set up to use mobile robots significantly depresses the serviceable share of the market

THREE VENDOR TIERS, RELATIVE COMPLEXITY

- STIQ splits the market into 3 vendor tiers with Tier 1 players capturing the bulk of market value (frequently greenfield projects) but representing c.2% of vendors by volume
- Tier 2 players represent c.8% of vendors by volume, and operate across mainly brownfield, but also some level of greenfield, projects
- Tier 3 represents the vast majority of vendors by volume and nearly exclusively work on brownfield projects

AGV & AMR ('MOBILE ROBOTICS') MARKET SEGMENTATION CAN BE CONFUSING AS MULTIPLE PERMUTATIONS EXIST. MARKET SIZE FIGURES ONLY RELEVANT WITH DEFINITIONS

AGV & AMR ROBOTICS MARKET 'SPAGHETTI SEGMENTATION' (SIMPLIFIED, ILLUSTRATIVE ONLY, NOT TO SCALE)

Market | Application | Form Factor | Payload (Type) | Payload | Navigation | Business Model

THE GLOBAL AGV & AMR MARKET — Transportation — Mouse / Tugger / Forktruck / Custom / Other — Cases / Trollies / Pallets / Other — <50Kgs / 50-300Kgs / 300-750Kgs / 750-1,500Kgs / >1,500Kgs — Guided / 2D SLAM / 3D SLAM / VSLAM / Other — Software / Vehicle Converters / Complete Vehicle Builders / Other

Storage [1]

Source: STIQ Ltd Research & Analysis. [1] Storage applications are covered in STIQs G2P Solutions reports, download here

THE AGV & AMR MARKET CAN BE CONFUSING

- The global AGV & AMR ('mobile robotics') sector is large and can be difficult to untangle as many vendors operate in focused and/or specialist segments but are often bundled into the overall market

LEGACY COMPANIES MORE FOCUSED

- Legacy players with a decade/s in the sector have often specialized on a limited part of the overall sector
- For example, a vendor may exclusively target pallet handling applications with 2D Lidar navigation while others only make guided mouse vehicles with <300Kgs payload

STARTUPS ADDING FURTHER OPACITY

- To build revenue fast, many startups have added multiple vehicle types, payloads, etc. to reach as wide a target audience and applications as possible, often further obfuscating the market in the process
- *Contact STIQ for more insights into AGV & AMR market segmentation*

AGVs & AMRs ARE RARELY A DIRECT REPLACEMENT FOR HUMAN LABOR. MAY REQUIRE PROCESS CHANGES, STANDARIZED MATERIAL FLOWS, SOFTWARE INTEGRATION, ETC.

AGV & AMR OFTEN PART OF WIDER MATERIAL FLOWS IN FACTORIES & WAREHOUSES
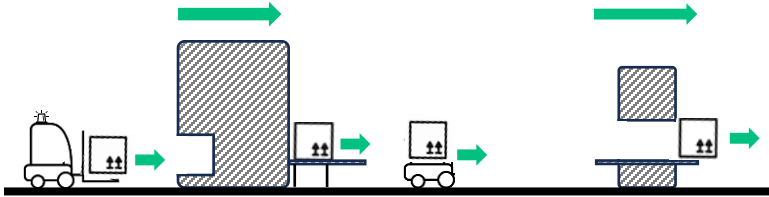
Source: STIQ Ltd Research & Analysis

AGV IS A PROCESS, NOT ONLY VEHICLES

- Implementing AGVs & AMRs is frequently complex as it integrates with other machinery and/or material flows and processes in factories and/or warehouses

"AGVs remain complex because when you have to integrate in an automation process with conveyors, with warehouse management, etc. it easily becomes complex." [Bluebotics]

- Companies lacking experience of AGVs may find that changes required to apply mobile robots can be akin to a surgical intervention

"AGVs are not only a product, it's also a process. We are selling changes in customers material flow processes that's similar to surgery… with companies that never did AGV robotization it can be very hard because we open the gut and we completely lay new lines and new things." [K Hartwall]

- The core value of many vendors is found in their knowledge and how they analyse and interpret customer material flows, and how they adapt AGVs & AMRs to existing flows, especially for larger fleets

"The value of these AGV & AMR companies is not in the product, but the people." [Oppent]

HIGH DEGREE OF CUSTOMIZATION REQUIRED

- Vehicles frequently require some level of customization (or configuration) to fit with existing infrastructure, machinery, processes, etc.

"AGVs are still not an off-the-shelf product. Often, these systems need to interact and communicate with higher-level systems and be perfectly integrated into an automation operation. Such projects are far more advanced." [TUV Sud]

"The reality is that every customer has different specification needs. When they want to automate, they often only automate one section of their facility rather than the whole process. Their vision can sometimes be quite narrow. However, when practical challenges arise, things often turn out differently. Ultimately, every customer seeks some level of customisation." [Expert Technology Group]

EMPLOYEES AND AGV OR AMR?

- Employees are key to AGV & AMR projects as these often need to interact with each other

"Employee acceptance of AGVs is crucial. Without it, the system will never work." [Xscaleo]

- AGVs (line guided) can sometimes be easier for employees to understand the logic behind, as there are often painted lines which robots follow

"AGV or AMR? They differ… AGVs are easier for staff to understand since they follow fixed paths. AMRs are more flexible but reactions less predictable." [Xscaleo]

NEW KINDS OF AGVs BEING DEVELOPED

- The sector is relatively innovative and vendors are continuously developing new vehicle types, form factors and more

- For example, a new class of AGVs developed in recent years only moves between a start and end point where human intervention is required to load/ unload a pallet or payload

- These AGVs may not require any integration with other systems and/or processes

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MARKET SENTIMENT FOR 2025 HIGHER COMPARED TO 2024, DESPITE GEOPOLITICAL EVENTS. A FEW VENDORS REPORT RECORD REVENUE

GLOBAL AGV & AMR ROBOTICS MARKET SENTIMENT (ALL INTERVIEWS)

2025	6%	26%	53%	15%
2024	10%	31%	41%	17%

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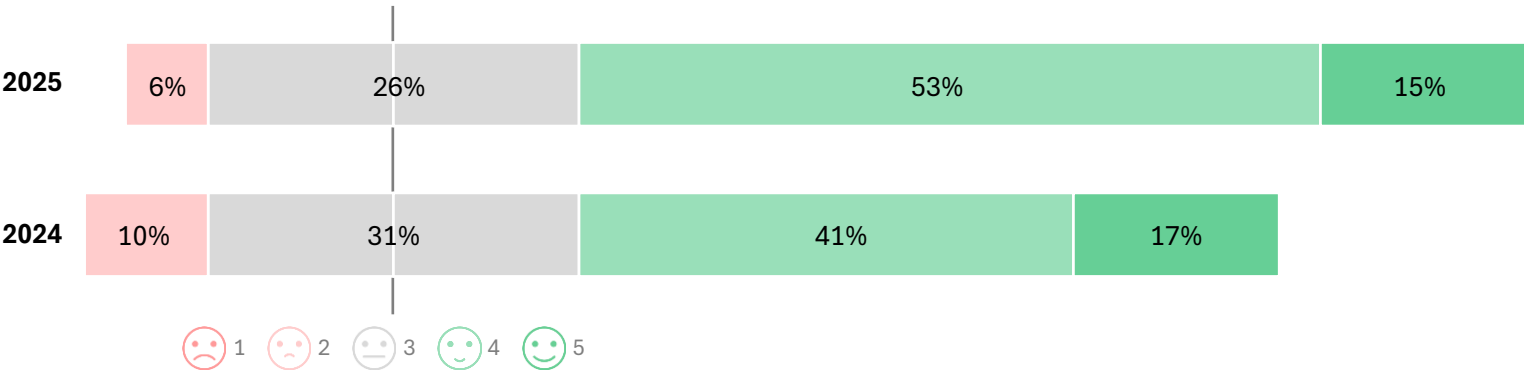
Source: STIQ Ltd Research & Analysis. Interviews

2024, A RECORD YEAR FOR FEW

- A few companies experienced good order intake in 2024
- For others, the year was just another year with some growth, nothing spectacular

"In general, 2024 was good." [Kudan]

"2024 was also a regular year." [Anonymous]

"2024 was pretty much the same. Probably outperforming the market but not as high as we had wished for." [NODE Robotics]

"We're still growing, but we planned more in 2024." [Bluebotics]

"Some things that should have happened in 2024 didn't, and they rolled into 2025 and here we are. It was a good year." [E80 Group]

"In 2024, everything we thought would book booked, but the pipeline wasn't as robust as it is right now." [Mitsubishi HC Capital America]

2025, A VERY STRONG YEAR

- For others, their performance in 2025 is very strong

"We had a fantastic FY25. The order intake was very good last year and this year we have a very strong backlog." [Toyota MH]

"In 2025 we will grow double digits. Compared to previous years, it's a little bit less. But we are satisfied." [Mobotic]

"We have experienced growth in 2025 compared to 2024. Q4 is usually strong and we don't have any reason to believe that it won't be this year." [KOLLMORGEN]

"It's been one of our best years to date. We have managed to expand outside of Vietnam and we have a footprint in Indonesia, India and Turkey." [Techvico]

"2025 will probably be our best year ever. Things were a little bit delayed over the last year and a lot of things broke loose this year. Our customers have continued to pursue automation in a very aggressive way." [E80 Group]

CHINESE VENDORS DOUBLING

- Chinese vendors suggest their growth momentum continues into 2025

"Revenue has already doubled in 2025 compared to 2024… the YOY revenue. 1H25 was going pretty well. Usually, 2H is even better." [Tusk Robotics]

"Probably I have already doubled sales revenue. But my CEO expects me to triple revenue." [VisionNav]

- For some Chinese vendors, expanding overseas has yielded positive results

"I believe 2025 will be very positive, with 4 months to go. Our revenue has kept growing. We started our overseas market from 2021 and now have sales, installations, technology and presence in different countries… Larger accounts are starting to purchase from us." [VisionNav]

A RELATIVELY HIGH LEVEL OF MARKET VOLATILITY IS CONTINUING. HOWEVER, 2025 NOT AN EXTRAORDINARY YEAR. OPEX DEALS MORE ATTRACTIVE

VOLATILITY CONTINUING IN 2025

- A few vendors suggest a degree of caution may have seeped into the market after a great start to the year

"We did record business in 1Q25. Since then, maybe a bit less activity." [Bluebotics]

"1-2Q was strong for us. It was great. But there was some slowing down in 3Q. And also because we need to work on a lot of the engineering now too. But it's been our strongest year so far." [Techvico]

- Others notice early signs of increasing in activity in 2H25

"The overall market for some of our customers wasn't great. This trickles down to us at some point. Growth could be better. But... it's definitely getting better." [Anonymous]

"Things seem to be gaining acceleration at the end of the year in 2025. We're moving into our first expansion with one of our customers, which is a very good sign for 2026." [Third Wave]

- Customers remain active with plenty of projects around

"There are many potential projects out there, but it is not yet a big market." [Anonymous]
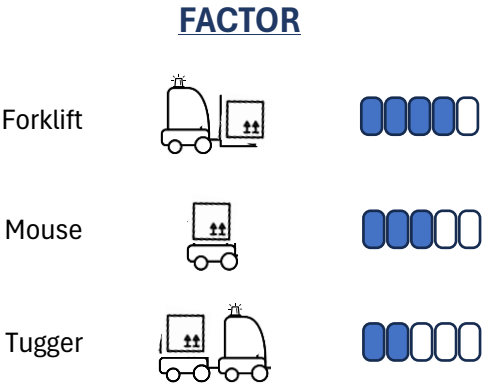
"We are receiving more requests. Demand is still increasing also in Europe. In America, we had a little bit of hesitation. Business is still growing. Growth is steady." [TUV Sud]

2025 NOTHING OUT OF THE ORDINARY

- Several interviews suggest 2025 remains a normal year

"2025 has been regular business, No major changes." [Anonymous]

## 2025 GROWTH SENTIMENT BY AGV & AMR FORM FACTOR

Source: STIQ Ltd Research & Analysis. Interviews

"In my division we are quite happy with the development in 2025. This is a development that continues from 2024, so we see an increase. I think there can be more and I think as soon as the overall global economy gets traction again, we're then in a good position to scale our business." [SICK]

- Demand drivers are often different and depend on the country and potential government incentives

"This year was ok. Customers in Japan are thinking more about truck automation, mainly loading or unloading. But the focus now is software like reservation systems, etc. In Japan, trucks in and out are often complicated and crowded. The Japanese government think this is a priority. So many customers focus on addressing that issue instead of intralogistics." [Rapyuta Robotics]

2025 GROWTH SENTIMENT BY VENDOR HQ CONTINENT
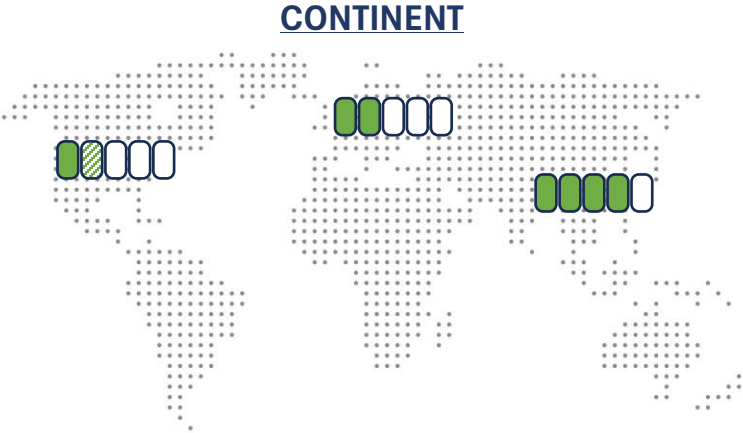
Source: STIQ Ltd Research & Analysis. Interviews

OPEX DEALS INCREASING IN 2025

- Opex deals appear to have flourished in 2025, potentially as a result of increased cost of capital or simply uncertainty

"Companies that are ordering from us in 2025, they are not ordering with Capex. They are ordering with Opex." [AIAutomation]

FOR SOME, 2025 IS A DISAPPOINTING YEAR TO DATE. THERE IS WIDESPREAD OPTIMISM FOR POSITIVE MARKET DEVELOPMENTS IN 2026 BASED ON SALES AND ORDER PIPELINES

2025 DISAPPOINTING TO DATE

- A few vendors expressed some level of disappointment with how 2025 is developing

"I'm very disappointed in how the market picked up in the last 6 months. In China the market is booming. Chinese factories and logistics automate by default, they just go. In Europe the market is much slower." [EP Equipment]

- There appears to be a good level of projects in the market, but with less decision-making initiative

"We see there are a lot of requests out there, that is clear. But decision making is perhaps a little bit lower. That might be due to wider political or macroeconomics." [Anonymous]

"This sector holds strong growth potential, but progress has been slower than expected. A key reason is that some companies remain cautious and are unwilling to take on risk." [Anonymous]

- Local economic pressures also play into mobile robot demand

"Due to the economic slowdown in Korea, we've seen a slight contraction in the near-term automation demand. This is mainly because of the economy here." [Anonymous]

- While others think there is a more widespread problem in the overall industrial automation industry

"I think there's just a large dip in the general industrial automation market right now." [Anonymous]

CURRENTLY WIDESPREAD OPTIMISM FOR 2026

- Plenty of interviewees are very optimistic for the market prospect in 2026

"We're bullish for 2026." [Vecna Robotics]

"We have a good backlog." [ArcBest Vaux]

"I speculate that we start to bounce back in 2026. We talked about it with Covid, the new normal. I think you'll start to see this redistribution and tariff situation becoming the new normal. You'll see investments starting to free up." [Omron]

"I would say 2026 is getting better… but maybe I'm too optimistic." [SICK]

- Sales pipelines look very positive

"Our pipeline is looking much better for 2026." [K Hartwall]

"It's been good and also for 2026 I think we have a great outlook and the order intake has been through the roof." [SAFELOG]

"2026 looks pretty good. We have a good pipeline. We're working on projects now. I'm conservative when I say these things and if we get the same numbers next year as we did this year, we'll be in good shape. That's really a good year of consolidation for us. 10-20% year over year can really be taxing. Just to get the resources ramped up." [E80 Group]

"The pipeline in 2025 is very robust. There's certain projects that we anticipate to book next month, but might be two months. There's certain projects in the pipeline for Nov, Dec, but they could be Feb, Mar. So it just kind of depends." [Mitsubishi HC Capital America]

WIDESPREAD OPTIMISM FOR 2026 BASED ON SALES PIPELINES

2025 ▶ 2026

Source: STIQ Ltd Research & Analysis

PROSPECTS MAY VARY IN COUNTRIES

- Each country may behave differently with government subsidies or local dynamics playing out

"The government implied a subsidy for the next fiscal year with a 48% increase compared to 2025. And that's society helping warehouse to have a robotic solution." [Rapyuta Robotics]

- Parts of Asia remain difficult, for example

"When you speak to people, the general outlook is super pessimistic. Real estate is hit pretty badly. A lot of factories are closed down. A lot of these Chinese AMR companies are selling at a loss. It is really fierce. But there is a certain benchmark in terms of pricing that cannot go lower." [Anonymous]

TARIFFS CAUSED INITIAL HEADACHES BUT APPEAR TO HAVE BECOME PART OF DOING BUSINESS FOR SOME PARTS OF THE MARKET

NO MAJOR IMPACT FROM TARIFFS

- Businesses appear to have been affected differently by tariffs with minimal impact for some

"We do hear about certain regions that we're active in that they are more or less affected." [KOLLMORGEN]

"There's no impact from tariffs for us in EMEA." [EP Equipment]

"For us, the effect of tariffs is very limited because our business is predominantly software-based."[Kudan]

"I would say for the time being, you don't feel any tariffs impact yet. Because I guess we are always a little bit late cyclically. So deliveries that are planned, obviously, they will go forward, whether or not you have to pay the tariff." [Conductix-Wampfler]

TARIFFS, JUST ANOTHER BUSINESS ISSUE

- To some degree, tariffs may have eased into being a part of doing business

"At first the tariffs were a little bit challenging. We had to start looking at our providers who are selling to us and the pass on costs associated with that. That has settled down a bit. From a sales standpoint, it really hasn't impacted us." [Vecna Robotics]

"As far as tariffs are concerned, no one's using that as an excuse not to place orders anymore." [Third Wave]

- It appears customer and vendors have accepted tariffs and are proactively trying to work with the additional costs

"Tariffs are still a question we get from time to time, but we also see folks learning how to work around them." [Omron]

"Tariffs have affected us, but not to any significant extent. You need to adjust accordingly. It's been a little bit of disruption... I think it has been a question mark in decision making processes. What will happen? As of now, no direct impact." [Anonymous]

ADDITIONAL PLANNING WORK REQUIRED

- There's a level of complexity involved in managing exports to the US and country of origin to accurately represent the tariffs impact

"We're still working through how tariffs impact us. It influences our different products differently. That's very complex for us to analyze right now." [E80 Group]

"Tariffs are really a thing which we are worried about. But we prepared ourselves, even at the beginning of this year, that the focus in America is really unpredictable." [K Hartwall]

- There also appears to be a degree of equilibrium as plenty of vendors may be affected similarly

"All the tariff is a problem not only for EU companies, but also for American companies, because the main components come from foreign markets." [Anonymous]

TARIFFS DISRUPTED THE STATUS QUO BUT IS SLOWLY RETURNING TO A NEW 'NORMAL'

Tariff changes

New normal

Previous normal

Source: STIQ Ltd Research & Analysis

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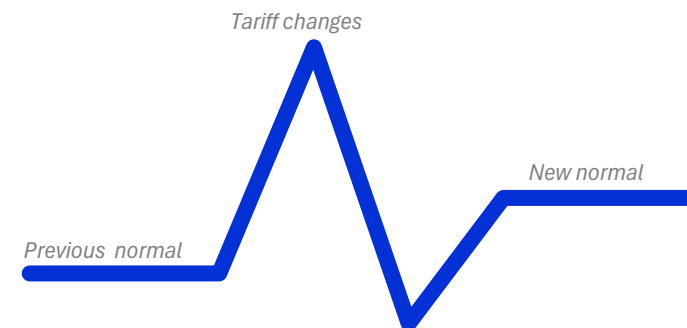
CHINESE VENDORS TAKE A WAIT-AND-SEE APPROACH TO TARIFFS. THE US MARKET IS TOO IMPORTANT TO NOT BE ACTIVE IN

TARIFFS, CHINA-US: LATEST UPDATE

- The issue of tariffs on Chinese goods continues to change, and the latest update known prior to the publication of this report is a 12-month deal (source)

CHINESE VENDORS WAIT AND SEE APPROACH

- While tariffs have affected decision making, some Chinese vendors have taken a wait and see approach to events as there may be further disruption

"My colleague in US has been very relaxed in 1H25 and everyone has been waiting to see what really will be going on. They're just hesitating. They really want to work on this project, etc. But for us in Europe, we didn't see such a big impact. When we are bidding on projects in Europe, we barely see any of the American suppliers, mostly the Europeans and the Chinese." [Tusk Robotics]

"I would say there is definitely some disruption from tariffs, but it's not that bad. We also promised we will not change our price based on the tariffs. Some customers are delaying." [VisionNav]

- Some observers suggest the price delta remains too significant for customers, with or without additional tariffs

"If we compare the price... the products still come into the US market. They still work because the cost gap is very big so tariffs are not going to change that a lot." [China Forklift Blog]

- There are also plans for manufacturing in other countries to keep any major impact from tariffs under control

"Tariff's influence is limited and we also have some backup plans for manufacturing overseas to make sure the tariff impact is under control." [Anonymous]

THE US MARKET IS TOO IMPORTANT

- There is significant potential in the US market and any additional tariffs are simply table stakes

"We're noticing a decrease in our US revenue because of the uncertainty, tariffs and everything. But that doesn't change my perspective that the US is the most important market for us." [Anonymous]

WAITING FOR THE TRADING ENVIRONMENT TO CLEAR UP
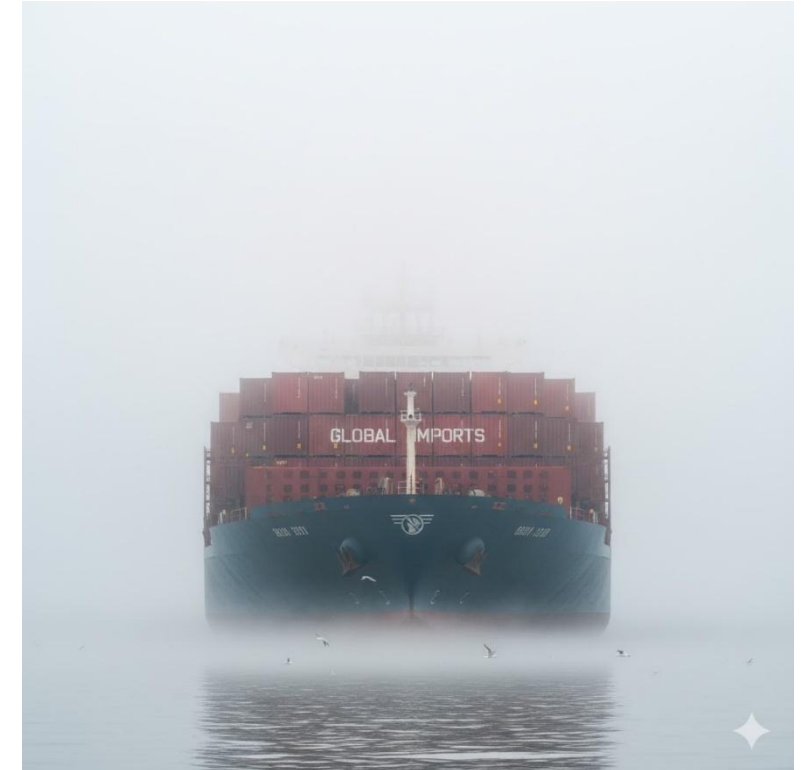
Source: STIQ prompt with Google Gemini

SLOWING DECISION PROCESSES MAY BE A PRE-CURSOR FOR CONTINUED DEPRESSED DEMAND AND SOME SUGGEST THE AGV & AMR MARKET MAY GET TOUGH(ER)

TARIFFS SHIFTING END CUSTOMER PRIORITIES

- Interviews suggest there have been a significant degree of adjustments at end customers with priorities shifting away from automation projects to managing supply chains

"Tariffs impact our customers and they have to be careful and very specific about their supply chains, which means that they're kind of looking at everything with a big magnifying glass." [ArcBest Vaux]

"Tariffs does not affect us so much, but our potential customers. Every time risk goes up, the first thing that is done is to put a pause on automation and investment." [The Mobile Robot Company]

Tariffs caused a lot of pullback of Capex from buyers. We had a big order that was pushed indefinitely. For our supply chain, tariffs were probably a net neutral… it kind of affected everybody." [Anonymous]

SLOWING DECISION MAKING PROCESS

- In general, it seems sales cycles have expanded due to the many different disruptive events, including tariffs

"We had Covid and now tariffs. Sales cycles have become longer. But that's also the nature of the business. There's going to be bumps in the road and you have to be flexible to deal with that. The sales cycle is very slow but it always has been. I don't think that's going to change." [Mitsubishi HC Capital America]

"The main impact from tariffs has been postponed decisions. There are no cancellations." [SAFELOG]

"I think tariffs are really slowing down the world. There is so much uncertainty that projects are not cancelled but delayed. People are waiting, which is logical." [Anonymous]

CONTINUED DEPRESSED DEMAND POTENTIAL

- Some interviews highlight project postponements continue in 2025 albeit with no clear reason, potentially as a result of many different causes

"We hear from OEMs that things are similar to 2024… projects are paused, delayed or postponed. The pipeline looks really good… but it doesn't convert fast enough. This have also put some in financial troubles. I don't know if it's due to uncertainty of tariffs or the overall uncertainty due to the economy or automotive, which of course plays a huge role, especially in Germany. I don't know the exact reasons just that the industry is hesitant… at least in 1H25." [NODE Robotics]

- This appears to be a reflection of the wider industrial automation industry and may not be isolated to the AGV & AMR Robotics sector

"We track other industrial automation trends and see a large decrease in those sales starting in 2024… due to elections perhaps, both in the US and abroad. And that caused a lot of uncertainty. We're still seeing some of that softness or uncertainty in the market due to the tariff conditions. That's just one excuse and there seems to be a lot of other things that play here too." [Anonymous]

SLOWING DECISION MAKING PROCESSES
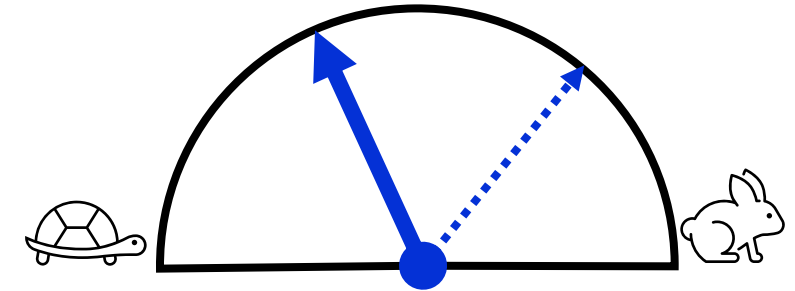
Source: STIQ Ltd Research & Analysis

"Our customers are saying people are holding back because they don't know about the future. For example, the German automotive industry have to transition from IC to EV. In the US we don't know if it's going to be a high tariff or not. Our customers may still able to assemble robots in the EU and ship to the US." [Anonymous]

- There are concerns the AGV & AMR Robotics market may go through something of a revolution in the short-term

"I'm pretty sure that the market is going to get tough in the next couple of years." [Anonymous]

TARIFF IMPACTS IN THE US MARKET MAY BE COMPOUNDED BY AN INVESTIGATION BY THE US DOC INTO ROBOTICS AND INDUSTRIAL MACHINERY (NO OUTCOME AS OF YET)

FURTHER MARKET DISRUPTION

- In the end of Sep 2025, The US government created further uncertainty in the robotics and automation market announcing a national security investigation into imports of robotics and industrial machinery (source)
- STIQ reached out to ask whether this will include mobile robots, but has not received any clarification to date

US, A LEADING MOBILE ROBOT PRODUCER

- The US is the worlds largest producer of mobile robot, courtesy of Amazon
- However, many of the electronics components are likely to be produced overseas and imported, including chassis and mechanical parts
- Note that Amazon's mobile robots are primarily the Hercules and Titan G2P AGVs (aka 'Shelf to Person') but do also include the more recent Proteus, an AMR type solution (source)
- Amazon have built and deployed >1m of these mobile robots in its own facilities and do not offer these on the open market yet

NATIONAL SECURITY INVESTIGATION OF IMPORTS OF ROBOTICS AND INDUSTRIAL MACHINERY

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DEPARTMENT OF COMMERCE

Bureau of Industry and Security

[Docket No. 250924-0161]

XRIN 0694-XC138

Notice of Request for Public Comments on Section 232 National Security Investigation of Imports of Robotics and Industrial Machinery

AGENCY: Bureau of Industry and Security, Office of Strategic Industries and Economic Security, U.S. Department of Commerce.

ACTION: Notice of request for public comments.

SUMMARY: On September 2, 2025, the Secretary of Commerce initiated an investigation to determine the effects on the national security of imports of robotics and industrial machinery. This investigation has been initiated under section 232 of the Trade Expansion Act of 1962, as amended (Section 232). Interested parties are invited to submit written comments, data, analyses, or other information pertinent to the investigation to the Department of Commerce's (Department) Bureau of Industry and Security (BIS), Office of Strategic Industries and Economic Security. This notice identifies issues on which the Department is especially interested in obtaining the public's views.

DATES: Comments may be submitted at any time but must be received by [INSERT DATE 21 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: Comments on this notice may be submitted to the Federal rulemaking portal at: www.regulations.gov. The regulations.gov ID for this notice is BIS-2025-0257. Please refer to XRIN 0694-XC138 in all comments.

Image source: US Department of Commerce (website)

THE US COMMERCE DEPARTMENT RESPONSE

- STIQ reached out to the US Department of Commerce for comment on whether mobile robots would be included in this investigation
- This is the response we received

"Greetings,

We appreciate your interest regarding the investigation into the national security impact of imports of robotics and industrial machinery, and their parts and components.

For the purpose of this investigation "robotics and industrial machinery" includes, among other things, robots and programmable, computer-controlled mechanical systems. This equipment spans CNC machining centers, turning and milling machines, grinding and deburring equipment, and industrial stamping and pressing machines. It also includes automatic tool changers, jigs and fixtures, and machine tools for cutting, welding, and handling work pieces. Application-specific specialty metalworking equipment used to treat, form, or cut metal, such as autoclaves and industrial ovens, metal finishing and treatment equipment, EDM machinery, and laser and water-cutting tools and machinery is also included. The scope of this investigation does not include unmanned aircraft systems, which are covered by a different section 232 investigation (see 90 FR 31958)." [US Department of Commerce]

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CONTINUED IMPROVEMENT INITIATIVES DRIVING THE LARGEST PROJECTS. SMALLER BROWNFIELD PROJECTS MAY BE DRIVEN BY VENDORS

TOP AGV & AMR ROBOTICS MARKET DRIVERS

Market Sector	Market Driver	Description	Impact
AGV & AMR ROBOTICS MARKET	Continuous Improvement	• Continued improvement initiatives are typically driving efficiencies at companies with more 'intralogistics maturity', and this includes new factory and warehouse construction, often with the largest budgets	▲
	Labor Constraints	• Labor shortages and/or attrition are common issues among employers for specific work	▲
	Improved Robot Technology	• Recent technological advancements (mainly ROS) have driven up the number of manufacturers in the sector - mainly affecting the availability of smaller brownfield and POC type projects, and this contributes to growing fragmentation of the sector	▲
	VC Funding	• The influx of investor monies into the sector has had a net positive effect on the general awareness of mobile robots, but does not appear to have significantly changed sector demand fundamentals	◀▶
	Geopolitical Uncertainty	• Uncertainty from geopolitical tensions, such as tariffs, etc. continue to impact growth prospects in the sector despite a level of 'return to normal'	◀▶
	Economic Climate/ Interest Rates	• Continued pressure on Capex investments from relatively high interest rates and continued post-Covid turbulence	▼
	Potential Customer & Knowledge	• Few potential customers are aware of changes required to implement and operate mobile robots, with a high degree of early sales pipeline churn	▼▼

Source: STIQ Ltd Research & Analysis

MARKET DRIVERS VARY BY SIZE OF PROJECT

- There are a variety of different market drivers depending on which segment of the market vendors operate in and these vary on a grey scale from very large to very small projects
- For example, larger projects tend to be driven by continuous improvement initiatives including efficiency drives, new construction, etc. where customers are highly 'intralogistics mature'
- At the other end of the scale with near exclusively brownfield opportunities, projects may be driven largely by vendors where customers tend to be less aware of intralogistics goods flows and processes, etc.

OTHER MARKET DRIVERS EXIST

- AGVs & AMRs can be deployed in a very wide range of industries and sectors each with individual demand driver profiles, especially with changes to individual economic outlook and facilities, etc.

"The market is very positive. We're talking to customers who dismissed us 2yrs ago because they needed a higher level autonomous solution. Now they come back and say, I think we like a simple solution." [EP Equipment]

- AGVs & AMRs also exist in an ecosystem of other solutions and can form one part of larger projects

"What is really pushing a lot of revenue is that we're selling a great deal of automated reach trucks with these radio shuttles." [Toyota MH]

"We also make a pallet shuttle these days." [Russell Robotics]

LACK OF LABOR IS A WELL-KNOWN MARKET DRIVER FOR AUTOMATION. FOR SOME CUSTOMERS, ON EDGE ROIs CAN SOMETIMES BE TOO RISKY

LACK OF LABOR AND OTHER CONSTRAINTS

- Labor constraints, including the cost of labor, are always important in automation projects

"The first pain point is the labor cost and automation can save some cost for the manufacturer. If we're talking about AGVs in China, the main market is the manufacturing industry. Labor cost is very important and is the first issue in the decision The second is automation. Because Chinese like automation, they like new tech. They have this kind of interest… we need to have automation systems, we need have some robot running in our company." [China Forklift Blog]

"It's clear that in a few countries, employee shortages and working in warehouses moving things, that creates a drive combined with safety for automation." [MAXAGV]

- One of the most commonly quoted drivers for robotics and automation market growth is a lack of available and/or suitable labor

"It's not always the cost of labor, but the shortage of labor. Because employers can't find suitable labor for such jobs. This is the first step. The second is simply the demand. Factories need a lot of labor. In China, for some solar industry or new energy factory or some new energy vehicle factory… each of the projects require maybe 100-300 AGVs for a single project… it may be equivalent to manual forklifts with maybe 200-300 drivers for such a factory. This is very difficult to manage… 200-300 drivers." [China Forklift Blog]

- Staff attrition is also a major issue, often combined with availability of labor

"We found a mix of market drivers. One is the folks that are buying our system don't have enough people in the building. Usually because they're suffering attrition, not because they can't hire them in the first place. Once they get our system installed, they just don't backfill roles as people are leaving." [Third Wave]

LACK OF LABOR MORE PRESSING FOR SOME

- Some countries appear to have a more urgent requirement than others, for example, Japan is already forecasting they will have 20% less available working age labor by 2040

"The main reason from a high level is this customer expect they will suffer from an aging society in Japan. From the public statistics, we estimate a 20% drop in labor by 2040 in Japan. And the customers care strongly about that forecast. And then they are considering having some robotic solutions in the warehouse." [Rapyuta Robotics]

- Immigration may be a partial solution, but this may come with political barriers, even though its often cheaper than robotics and/or other automation

LOWER RISK APPETITE WITH LOW ROI DELTA?

- However, readers should note that even with a lack of labor it can be difficult to calculate a positive ROI

"Small, midsize companies struggle to roll out mobile robots in their factories because it's quite complicated. It needs to become easier, more standardized, and cheaper. Because even though you have labor shortages, if you get a quote for an AGV system, the number may just be too big to risk an investment." [Conductix-Wampfler]

ROI AND LEVELS OF UNCERTAINTY

Key: ▢ On edge ROI ▢ Certain ROI
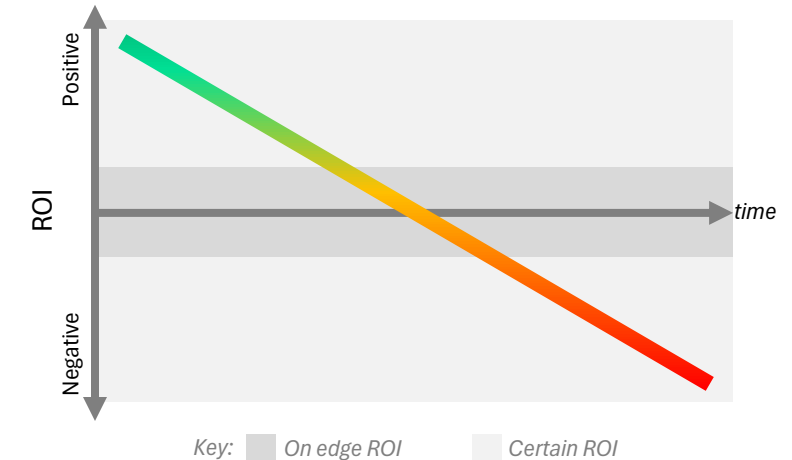
Source: STIQ Ltd Research & Analysis

TELEOPERATION CAN OFFER A SOLUTION

- Another solution can be using teleoperation where a single driver operates multiple vehicles and is often based inside the same building (can also be remote)

"When using our autonomous teleoperation supported system, some customers can do a 2nd or 3rd shift. Finding labor to solve these issues is challenging. And we've seen customers where the cost of labor is so high and they have other locations in their network that they would rather have their labor located at. It's up to the customer how they deploy teleoperation drivers and our vehicles." [ArcBest Vaux]

THE AUTOMOTIVE INDUSTRY IS NORMALLY THE SINGLE LARGEST AGV & AMR CUSTOMER IN NORTH AMERICAN AND EUROPE, CURRENTLY DRIVING ON EMPTY

AUTOMOTIVE SECTOR DEMAND VOLATILITY

- Automotive sector demand is very large and dominant in the European and North American AGV & AMR markets
- However, the sector is currently experiencing issues which is depressing AGV & AMR demand, and is being felt throughout the entire AGV & AMR landscape

"Automotive remains horrible… and automotive is a big user of automation. But Eastern Europe is very adoptive in robots. There's a lot of automotive suppliers in Eastern Europe. Eastern Europe is a market with a lot of potential and where we are doing the most products." [EP Equipment]

"Germany is the economic engine in Europe. We are in a valley, but what I see now is that it's a good way out of the valley. It really takes a lot of efforts, but we are going in the right direction." [Anonymous]

DIVERSIFICATION MAY BE KEY TO SURVIVAL

- A high reliance on the automotive sector may not be great at the moment and having a diversified customer base may be paramount for survival

"A lot of the traditional players may have almost 50% of their business or even more with automotive customers. But that sector is in a small crisis. These players are struggling now, and here and there some are going bankrupt." [Anonymous]

"If you have deep involvement with automotive currently, that's difficult. If you don't have at least a second vertical, which can somehow balance this out... I'm not 100% pessimistic on automotive, but I think it's tough business if you can't really know what's happening in the next 12 months." [NODE Robotics]

SOME VENDORS PROACTIVELY MOVED AWAY

- A few vendors saw automotive problems appearing and took action to diversify into other customer sectors

"We saw it coming, that the business is going to have to switch from automotive to general logistics." [SAFELOG]

"We focused on automotive because this is what we knew when we started. But since end of 2024, we also started to look at other industries. We went into logistics and different production sectors. For example, one of our customers produces cooking oil, another produces tobacco and there's one producing coffee machines and so on." [AIAutomation]

- Automotive sector demand can also be volatile

"Our aim is also to move away from automotive, because it's quite an up and down market. But it is a major market for us, I would say. But yeah, intralogistics is also interesting and the pharma market as well." [Anonymous]

AUTOMOTIVE WILL NO DOUBT RETURN, WHEN?

- While there are problems in automotive there are also vendors that see the sector returning as a key customer in coming years

AUTOMOTIVE SECTOR DEMAND SUFFERING IN EUROPE AND NORTH AMERICA

Automotive

Source: STIQ Ltd Research & Analysis

"The whole automotive business is struggling, and right now they're by far not the biggest cluster that we are serving, but I'm pretty sure they will be back soon." [SAFELOG]

FOR SOME AUTOMOTIVE REMAINS GOOD

- A few interviews suggest automotive remains a relatively ok customer base, but this may vary depending on where in the landscape a vendor operates

"There are a lot more customers in the industries which are all doing better, definitely not consumer oriented, but semiconductor, electronics, and automotive." [Techvico]

"We're deployed across a variety of verticals from automotive to CPG to manufacturing. And every one of them has said the same thing. We tried a variety of automation before, but it was always the last 5-10% that always killed the ROI. Somebody always had to go and chase these vehicles because they just needed intervention." [ArcBest Vaux]

AS AUTOMOTIVE STUTTERS, FOOD & BEVERAGE IS EMERGING AS A KEY MARKET SECTOR FOR VENDORS. DATA CENTERS: A POTENTIAL NEW OPPORTUNITY?

F&B, INCREASINGLY ATTRACTIVE

- STIQ analysis of the AGV & AMR market since 2020 has highlighted F&B customers as a growing sector for vendors (download previous AGV & AMR reports here) and this is a trend that continues in 2025

"We are now moving very quickly into grocery and food and beverage." [Vecna Robotics]

"Food and commodities in particular experienced a lot of interest in mobile robots. Their biggest entry point was forklifts because they have a lot of pallets to move." [Omron]

"Food and beverages are strong, and healthcare is doing well. Automotive is weak right now." [Anonymous]

FORKTRUCK VENDORS

- Forktruck vendors tend to focus more on pallet handling and may not be as exposed to the automotive sector with retail and general logistics as key customer sectors

"In 2024 there was a lot of demand from durable manufacturing… for transportation close to production lines either for buffering of goods or storage of unfinished raw material and bringing it then to the next process. Most of our projects are in the manufacturing area, perhaps 3PL sometimes, because when they automate, they like to automate with flexible mobile solutions." [Jungheinrich]

"We are more successful in, let's say, retail and logistics. We do a fair amount in manufacturing, but not typically in the automotive sector. We support our own automotive business." [Toyota MH]

HOSPITALS, A DIFFERENT DEMOGRAPHIC

- Hospitals can be good customers, but appear potentially more complex to manage compared to industrial projects
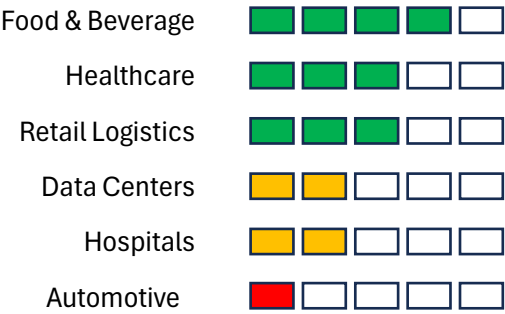
"Demand in the hospitals space can be volatile but I think that sometimes projects are more complicated in healthcare, compared to industry. There are a lot of cultural differences. Healthcare customers are also mostly government owned companies. There is some risk aversion." [Anonymous]

DATA CENTERS, THE NEXT FRONTIER?

- While there has been sporadic demand from data centers highlighted in previous STIQ reports, the recent demand for AI data centers has pushed demand from this niche

"I visited a data center site where they had >7,000 server racks . They expressed their frustration when it comes to moving these devices for servicing. They have a central area where they have all their tools, everything. They have a team disconnecting servers and another team that comes over and moves them. This team is overworked… and they need guys who are careful, because they're kind of banging into things and potentially damaging stuff. We see a real opportunity in data centers." [Thoro]

NON-AUTOMOTIVE AGV & AMR SECTOR DEMAND DRIVERS (NOT EXHAUSTIVE)

Sector	Rating
Food & Beverage	🟩🟩🟩🟩⬜
Healthcare	🟩🟩🟩⬜⬜
Retail Logistics	🟩🟩🟩⬜⬜
Data Centers	🟨🟨⬜⬜⬜
Hospitals	🟨🟨⬜⬜⬜
Automotive	🟥⬜⬜⬜⬜

Source: STIQ Ltd Research & Analysis

VENDORS WITH DIVERSIFIED CUSTOMER BASE

- Vendors supplying software tend to be relatively diversified with no major exposure to demand from a specific industry

"My take on this is we have different business models. Some of the companies you're talking to, they also do the installations. We have a positive outlook because we have a broad partner network. I would say that that kind of evens out the highs and lows." [KOLLMORGEN]

EUROPEAN MARKET DYNAMICS CHANGING. SOME RETURN TO NORMAL IN NORTH AMERICA. LARGE POTENTIAL IN SOUTH EAST ASIA BUT LOW SALARIES ARE A KEY BARRIER

EUROPEAN MARKET DYNAMICS CHANGING

- Germany has been a traditionally strong market for AGV & AMR vendors, but this appears to be suffering, partially due to problems in the automotive sector

"The current situation can potentially be tricky if your company does installations at customers in Germany. If that's your niche, that could be tricky." [Anonymous]

"If you roll back the tape a couple of years, it was always Sweden, UK, Germany… the traditional large countries. But now we see almost the opposite. [Anonymous]

- Some of the demand may be moving to Eastern Europe

"We have great success in countries like Poland, Denmark, Belgium, Czech Republic even Hungary. I think it's the fact that the whole network is now contributing. It's not just a few large countries, it's the whole network that is generating sales." [Toyota MH]

VOLTILITY IN THE US MARKET

- US elections in combination with tariffs put some projects on ice, but this appears to be thawing

"Going into the election some things were just on hold last year and people weren't pulling the trigger. This year a lot of those projects are a go." [Mitsubishi HC Capital America]

- But some level of concern remains with plenty of projects on hold

"When we speak to customers in the US, everything is on hold now. There's no activity at all." [Anonymous]

SOUTH EAST ASIA, PROMISING

- South East Asia is a large potential market with huge promise, but low salaries remain a key barrier to wider adoption

"For customers in Southeast Asia, in Vietnam or Malaysia, it really depends on the industry. If they're doing well, the tariffs don't really affect them. They just don't really care too much. But if it's consumer goods, FMCG, then they're definitely a lot more cautious." [Techvico]

"I think that's a lot is happening in Asia Pacific, South East Asia. It's not our biggest market, but I think that there's good potential." [KOLLMORGEN]

- Some vendors offer different business models to potential customers

"In places like Vietnam, the ROI still does not really justify it because wages are $6-7/hr. ROI is crazy at 5-8yrs. Customer are a bit hesitant and often start with a small batch pilot to evaluate the performance first." [Techvico]

DEMAND VARIES DRAMATICALLY BETWEEN COUNTRIES (SIMPLIFIED)
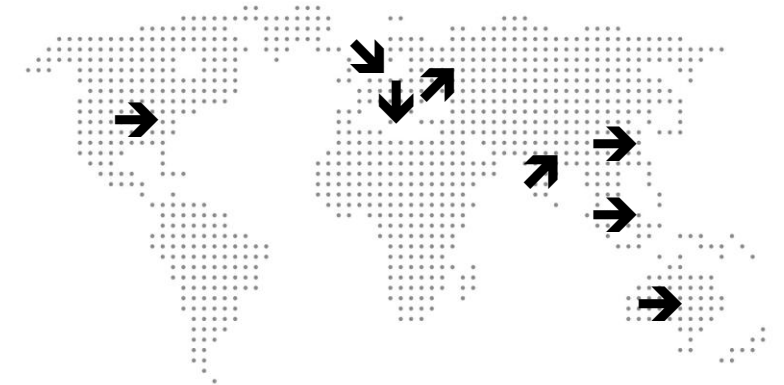
Source: STIQ Ltd Research & Analysis

DEMAND CAN BE VOLATILE IN A LARGELY PROJECT BASED BUSINESS. MANAGING CASHFLOW AND RISK IS TRICKY WHEN DEMAND IS SUBDUED

AGV & AMR PRIMARILY PROJECTS BUSINESS

- Vendor interviews suggest AGV & AMR is primarily project business with maintenance and service the only recurring revenue source

"This business is project based." [Anonymous]

- With any projects business, planning the use of resources, cashflows, etc. is a challenge

"The market is pretty cyclical. Also given the resources that we have for implementation - it's project business - if you sell something it then takes a part of your resources for some time and if you sell a bigger project then your lead times for a new project get longer because you have a backlog on a project that has to be implemented, and that has a negative effect on how much new projects you can do at the same time. It's still a little bit binary sometimes." [Anonymous]

"You have to be very careful about the projects you take, because it can be enough with one bad project." [Anonymous]
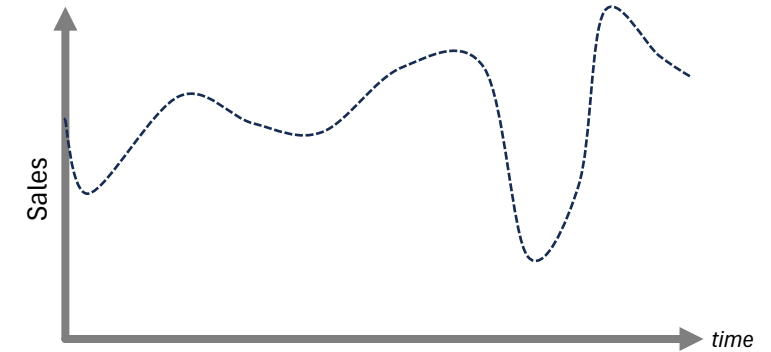
VENDOR BUSINESS RISK MANAGEMENT

- Managing business risks is often key to continuity and longevity for vendors

"It's extremely important to work with risk management. You need to have that as the CEO of the company and it needs to be in the DNA of the business." [Anonymous]

- Not overstretching capabilities and resources is tempting for any company, but turning down projects is part and parcel of risk management

"Every vendor would like to implement a lot of robots but maybe some projects are too big." [Anonymous]

POTENTIALLY HIGH DEGREE OF VOLATILITY IN A PROJECT BUSINESSES

Source: STIQ Ltd Research & Analysis

CONTENTS

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CHINESE COMPETITION IS RESPECTED AND ANTICIPATED TO INCREASE OVERSEAS WITH UNSUSTAINABLE PRICE PRESSURES IN THE CHINESE DOMESTIC MARKET

CHINESE COMPETITION LIKELY TO SHARPEN

- The feeling among some interviewees is that Chinese competition is likely to intensify

"In the future, there will be a fight, a very hard fight with Chinese vendors." [Anonymous]

- Others highlight Chinese competition is already relatively established, often through local partners

"We're only bidding against Chinese companies. As there's nobody else left. And it's not Chinese companies, it's integrators with Chinese products." [Anonymous]

- Chinese competition is increasingly present at trade shows and has already had a huge impact in certain market segments

"We also see, in the mobile robots business, that Chinese competitions come to the European market via the trade shows, you always saw them, but the success has not been there for material transport that much. In order fulfillment, it's a little bit different." [Anonymous]

RISING PRICE COMPETITION IN REST OF ASIA

- Asian markets have been more affected by price competition courtesy of logistical proximity

"Historically speaking, Chinese companies have influenced a lot of pricing discussions in the areas surrounding China. There's a lot of price pressure in Asia Pacific, Australia, Singapore, Malaysia, Thailand, South Korea." [Anonymous]

- In parts of Asia, some Chinese vendors are aggressively entering new markets by offering 1+1 (pay for 1 vehicle, get a second free, aka 'BOGO' or 'BOGOF')

"Chinese companies are trying to enter our market. Their strategy appears to be to supply their products 1+1 for the first order. After the initial sale, it's often back to normal pricing but then the customer is locked in. After that, the price is not very different to ours." [Anonymous]

- Southeast Asia already mimics Chinese domestic pricing pressures with some vendors electing to stay away and focus on countries with higher margin potential

"I think a lot of the really good, solid Chinese AMR companies with very strong technology background don't really care about the Southeast Asian market. There's not much margin here. For example, vendor A are heavily focusing on Japan and other overseas markets, but we don't see them here." [Anonymous]

OVERCAPACITY = SHARPER COMPETITION?

- The overcapacity in the Chinese market is a potential threat and some vendors are strategically preparing for potentially increased competition

"In China there are some company with the capacity of production of 1,000's of vehicles. Our approach is not to wait until a critical moment when they arrive." [Anonymous]

"They have high production capacity in China. It's really impressive. But the big question is how much is utilized? There's a lot of overcapacity in the market. There's a lot of intransparency on the market." [Anonymous]

"In Asia, you have a hyper competitive market driven by China. Nobody's making money." [Anonymous]

BARRIERS INCLUDE SCALING, TARIFFS

- However, scaling overseas often relies on partnering with resellers + integrators and can be difficult

"Chinese vendors also compete in Europe and take market share. I don't know how much market share they take, but they can be successful when they work closely with local integrators with close end customer relationships. That's scary for us in a way, but it's really hard to scale that way. They would have to find 100's of small integrators and that's going to take time and effort." [Anonymous]

- Some think tariffs may remove some of the competition, especially in the US market

"I picture Chinese competition almost dropping off completely." [Anonymous]

A FOOTHOLD IN THE TOUGH CHINESE MARKET

- A few vendors have managed to gain a foothold in the tough Chinese market

"I think that internally it is seen as a success that we got a foot in the Chinese market at the time that we did. We had our first partner in China in the 90s, and then some in the beginning of the 21st century, and then it's continued in that way. The feedback we get is that the NDC brand is something that stands for quality and it stands for many good things." [KOLLMORGEN]

THE CHINESE MARKET REMAINS RELATIVELY STRONG BUT SUFFERS FROM EXCESS CAPACITY AND LOW PRICES. OVERSEAS MARKETS VIEWED POSITIVELY FOR MARGINS

IN GENERAL ON THE CHINESE MARKET

- In STIQs experience, the Chinese market is moving very fast with input and influences from several industries and sectors
- For example, Chinese WMS vendors often also offer MES software (or vice versa) combined with an agnostic fleet manager (often referred to as Robot Control System or RCS) to manage robots including AGV & AMR
- There are often confusing relationships in the sector and AGV & AMR vendors may also be OEM/ODM suppliers, and system integrators frequently also operate components production, such as sensors
- While the innovation genesis in the wider AGV & AMR sector has largely shifted to Chinese vendors, softer IP protection means that if a new form factor or other aspect gains market traction, it is often widely copied fast

AGV & AMR PART OF THE FABRIC IN CHINA

- Interviews suggest AGV & AMR robots are part of the package (alongside other robot types) when building a new factory in China and are no longer an optional extra to squeeze out additional efficiencies

"European customers tend to be more conservative, and it takes them longer time to take decisions. But in China, the clients are much faster… I think it's also part of policy, because the Chinese government has been pushing all of the industries to embracing the new technologies and trying to get involved in this robotic trend now in China." [Tusk Robotics]

- This appears also to be pushed by the government and may include various incentives

EXCESS MANUFACTURING CAPACITY & PRICE

- The Chinese market suffers from over capacity and is super competitive on price with few vendors operating profitable businesses

"The production capacity in China is really huge and the market requirement is not so big. Price competition in the Chinese market for every project is very strong. Suppliers thinking about the Chinese market is to get some orders to run their production. But to earn money, more and more Chinese AGV-AMR, logistic robot company, they need to find overseas order to get some margin." [China Forklift Blog]

- The Chinese business culture appears very price focused and sensitive which is also often the first item to suffer in a competitive offering

"Chinese customers they like to reduce the price. Because if one or two competitors meet together, the first thing is to reduce the price. This goes for anything, including manual forklifts… they also have the same conditions." [China Forklift Blog]

CHINA MARKET GROWTH REMAINS STRONG

- The Chinese market continues to grow at a relatively fast rate despite rumours of a slowing economy

"I think the Chinese market for AGV & AMR has increased 20% for each year increase I think is reliable. For 2025 market size in China I think it will be 30% increase." [China Forklift Blog]

THE LURE OF THE US MARKET

- The US market is viewed as a great growth opportunity (not only by Chinese vendors)

"We relocated to the US for expanding our global business. There are several reasons. Firstly, the US is our biggest market now of our international business, i.e. outside China. Secondly, we plan to go public here. Thirdly also for getting more confidence for our users here. I would say those are the three main reasons we relocate to the US." [VisionNav]

GLOBAL PRICE LISTS

- Global enterprises typically set a price list which they work on for all countries which can cause issues if they base it on lower certification countries

"In the Chinese market, the product price is not the same as for other markets. For example, you have the CE and UL certificates, so the price cannot be the same. Customers are reasonable, so they can accept a certain percent of the increasing price, but at the end of the day, still, they compare the price in different regions and question suppliers about that." [Tusk Robotics]

CHINA 2025 IPO PROSPECT ANALYSIS: SHARP RECENT GROWTH BUT LOSSES REMAIN WITH QUESTIONS AROUND FUTURE PROFITABILITY

CHINA IPO PROSPECTS 2025 (COMPANIES WITH IPO FILINGS IN 2025, YET TO GO PUBLIC)
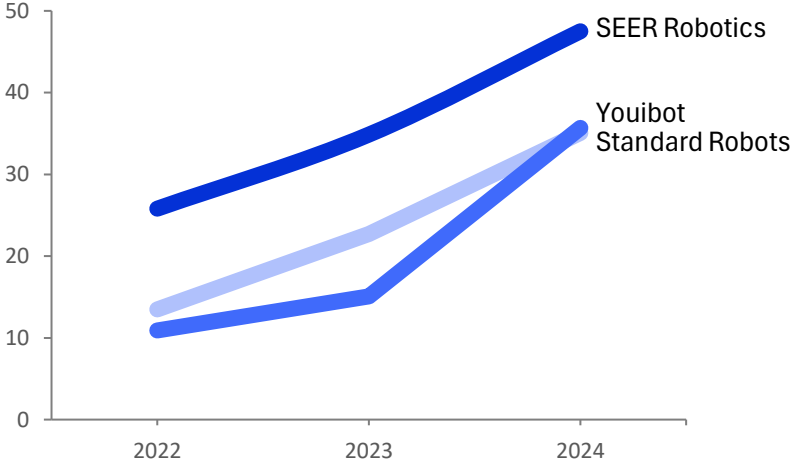
Company	Founded	Business	Revenue	Funding[1]
SEER Robotics	2015	AGV & AMR, OEM, Components	$48m	$36m
Standard Robots	2015	AGV & AMR	$35m	$197m
Youibot	2017	AGV & AMR	$36m	$63m

Source: STIQ Ltd Research & Analysis. Not exhaustive as other companies have also applied for IPOs. [1] Publicly known funding. May differ from actuals

CHINA 2025 IPO PROSPECTS ANNUAL REVENUE, 2022-2024 ($m)

Source: STIQ Ltd Research & Analysis. Companies

CHINA 2025 IPO PROSPECTS ANNUAL PROFIT BEFORE TAX, 2022-2024 ($m)

Source: STIQ Ltd Research & Analysis. Companies

THE CHINESE IPO QUEUE

- STIQ tracks about 100 Chinese vendors of AGV & AMR robotics and many of these are VC funded often with a clearly stated aim of going public
- Following Geek+'s successful HKEX IPO in the summer of 2025, there have been at least three new companies applying for IPOs on the same exchange (there are 4 main exchanges in China)

- There have been previous attempts at IPOs in the AGV & AMR market (by other vendors), but these have largely failed or been postponed
- The three companies, founded in 2015-2017, grew revenue sharply between 2022-2024
  - SEER Robotics: AGV Component + AGV OEM (revenue 36% CAGR 2022-2024)
  - Standard Robots: AGV OEM (revenue 61% CAGR 2022-2024)
  - Youibot: AGV OEM (revenue 81% CAGR 2022-2024)

NEGATIVE PROFIT (LOSS) BEFORE TAX

- Despite soaring revenue between 2022-2024, each of the three companies were loss making in every year
- While two of the companies (Standard Robots and Youibot) have improved losses between 2022 to 2024, they remained in the red in 2024
- STIQ recommends anyone interested in investing in these companies to do their own research

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AGV & AMR END CUSTOMERS ARE ULTIMATELY RESPONSIBLE FOR SAFETY. BUT IT CAN BE CONFUSING TO IDENTIFY WHERE LIABILITY RESIDES

RESPONSIBILITY FOR AGV & AMR SAFETY CAN SOMETIMES BE CONFUSING (SIMPLIFIED)

Key: ☐ Software   ☐ Components   ☐ Hardware   ☐ Services

Source: STIQ Ltd Research & Analysis
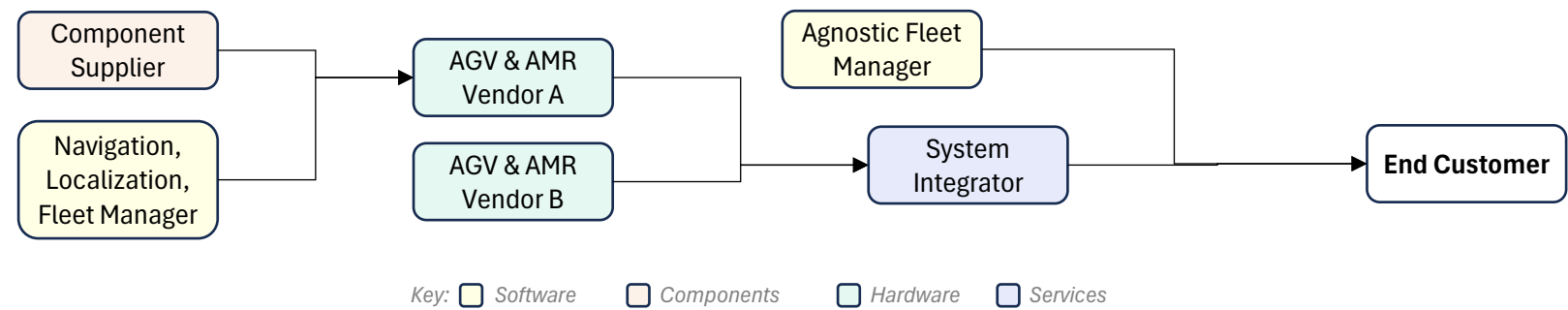
SAFETY RESPONSIBILITY →

☐ **Component Suppliers**
- Do not take responsibility for vehicle or application safety
- May certify products to make it easier for vehicle vendors to certify

☐ **Software Suppliers**
- Do not take responsibility for vehicle or application safety

☐ **Agnostic Fleet Manager**
- Responsible for vehicle and application safety

☐ **Vehicle Vendor**
- Responsible for vehicle safety
- If they install, etc. also responsible for application safety
- Responsibility for application may rest on System Integrator

☐ **System Integrator**
- Responsible for vehicle and application safety

☐ **End Customer**
- May be responsible for vehicle or application safety if no checks made on vendor vehicles or on application (and even if checks have been made)
- For example, by using a non-ISO certified vendor an end customer may shoulder responsibility for safety or when installing an agnostic fleet manager or other software controlling individual mobile robots
- May want to get specialist advice on safety responsibility

END-CUSTOMERS, SAFETY RESPONSIBILITY

- Ultimately, the responsibility for safety resides with end customers

"The manufacturer or the facility using these vehicles, can take over the responsibility for safety." [Anonymous]

"The robot itself is responsible for its own certification, which is linked to its safety level. In certain cases — for example, when robots interact with lifts through handshake scenarios — an overall safety concept and risk assessment are required. We always communicate that the responsibility for this lies with the general integrator. In most of our typical use cases, the end customer acts as the general integrator. However, this is often not clearly understood, so we make sure to highlight it early in the process to avoid confusion." [NAiSE]

- Component suppliers for building AGVs or AMRs are unable to take responsibility as they do not control vehicle form factors, etc.

"We think safety is important but we're not taking responsibility for it, since we're not designing the vehicle." [KOLLMORGEN]

"Our solution provides positioning information using a compatible camera and our software. Responsibility for ensuring AGV safety lies with the AGV vendors themselves." [Canon U.S.A.]

- *NOTE: Buyers may want to get specialist advise to determine where safety responsibility resides*

SPECIFIC SAFETY STANDARDS FOR AGV & AMR RELATIVELY NEW AND PLENTY OF VENDORS PREVIOUSLY APPLIED THEIR OWN INTERPRETATION

ISO 3691-4 RELATIVELY NEW TO THE MARKET

- The international ISO3691-4 safety standard for mobile robots is relatively new with nearly all vendors having interpreted safety in their own ways

"ISO 3691-4 appeared in 2020, and last updated in July 2023. The previous standard, EN 1525, dated back to the 90s. That made that, during many years, OEMs had to follow general safety practices, doing their best and relying on standards that were not specific for AGVs." [Pilz]

- Changing safety mindsets in the sector may be a challenge

"Now we have a standard reflecting the state-of-the-art technology... we need alignment of all OEMs." [Pilz]

MHE AND STANDARDS – THE WILD WEST?

- Knowing which standard to apply may be open to interpretation and perhaps also customer demands to some extent

"Material handling is a little bit of the wild west when it comes to standards... B 56.5 or the ISO standard, whatever the equivalence is... people are just throwing products out there. The surprise is that it's operating in an open environment with the general public."[Anonymous]

- A few vendors consider existing safety standards inadequate and have added their own take on safety concept

"The actual part of the safety is the functional safety that sits on top of the entire system. We build redundancy with multiple sensors, which is the expensive way to do it. Of course, once they're certified, we can reduce our sensor count. I firmly believe that 3D safety is far safer than the B56 standard in North America. It's a nod to safety. It's not real safety in my opinion." [Anonymous]

- Many vendors have applied a very rigorous approach to safety, often fusing different sensor input

"The braking distance is based on the speed, and you need to know the speed and how to achieve a stop. The easiest way is to have safety encoders. However, this can be discussed, for example tires can get damaged. A lot of customers require to have encoders. Most vendors are combining encoders with IMUs, with scanners, and more and they fuse the data to get the safe speed." [Mobotic]

SOME SAFETY CHALLENGES REMAIN

- A few observers suggest there are further safety challenges in the space which are being addressed or considered

"I think there are tons of safety challenges out there and we are solving one after the other. So, the more technology we have, the better the technology gets, the more safety challenges we can solve." [SICK]

- Technology may still develop faster than safety standards

SAFETY STANDARDS PLAYING CATCHUP WITH TECHNOLOGY DEVELOPMENTS (ILLUSTRATIVE)

Technology
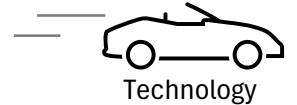
Standards

Source: STIQ Ltd Research & Analysis

"There's no one safety standard that covers all the things that we're doing. Our vehicles can perform like an AGV or like an AMR, depending on how you configure the fleet manager. They also have remote operations. Our approach was to go to a higher level standard that applies to all of the core fundamentals. This is why we've brought in a functional safety expert and we also work with third-party functional safety firms. We are still not in the European market and we're mostly targeting North America. We want to make sure that the technology is where it needs to be, but we leverage a mixture of internal safety experts and external consultants for safety." [ArcBest Vaux]

SELF CERTIFICATION (OR 'SYSTEM SAFETY') IS AN ACCEPTED AGV & AMR SAFETY CONCEPT USED WIDELY OUTSIDE THE EU

THE 'SELF CERTIFICATION' CONCEPT

- Self certification or system safety is when vendors certify their product as compliant with various safety requirements
- This compares to using a 3rd party certification organization to test products for safety compliance against a standard
- The concept of self certification is to use 2 (or more) sensors AND logic and only when they both agree there is no human/ obstacle in the way, the robot can operate

SELF CERTIFICATION/ SYSTEM SAFETY

- The alternative to ISO standards is to use system safety or self certification which is also an acceptable approach in some countries

"In some ways, we're a little bit behind because we've been using this rapidly becoming an antique safety approach where we use safety Lidar and safety fields. The rest of the industry has moved heavily into system safety in the sense of having overlapping Lidar sensors. And that's how you make your safety case." [Anonymous]

- Using two sensors is the typical self certification and may also be used to identify humans, with the ability of vehicles to slow down further when there are humans around versus objects

"We have a safety system and it treats everything as an obstacle, so it just won't hit anything. We have a layer above it both in the camera and in the LiDAR space, where if we see a person, we'll slow down well before we have to stop. The operation around a person is different than it would be around a trash can or something else, if it's just an obstacle." [Anonymous]

- Changing between standards can be a painful experience

"We have been slow to get on that, to kind of adapt our platform to system safety. Our first machine that has a system safety will roll out next year. We're going through that process now. It is a little bit painful. We're behind where others are on that topic." [Anonymous]

SELF CERTIFICATION SCHEMATIC USING SAFETY SENSORS (SIMPLIFIED)

Sensor A

AND logic

If Sensor A+ B, Go

Sensor B
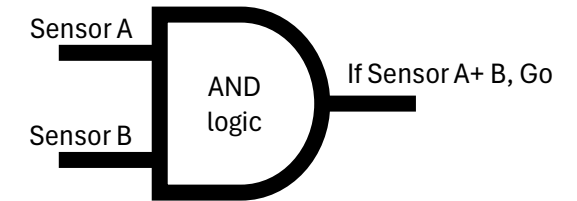
Source: STIQ Ltd Research & Analysis
Note: Self Certification is sometimes also referred to as System Safety

MULTIPLE END CUSTOMERS CONDUCT THEIR OWN TESTS INCLUDING SAFETY BEFORE ALLOWING VENDORS INTO FACILITIES

END CUSTOMERS PERFORMING OWN TESTS

- Many larger end customers frequently perform their own tests before allowing vehicles into their facilities, especially when operating around people

**"System level safety is not good enough for customer A."
[Anonymous]**

"Some customers do extensive safety testing before they allow our vehicles to run in their facility... they run their own safety testing before they allow us in." [Third Wave]

- This may be due to a relatively limited standards environment in the AGV & AMR space

"Ironically, standards in AGV are less prescriptive than standards for cleaning robots, which may explain a lot of the scrutiny that some enterprises are putting on products that come into their shops." [Thoro]

- Larger end customers have spun up their own testing labs where they run vehicles through specific processes to determine safety and, presumably, other performance

"Some end customers have their own lab environment, a closed environment, where they expect you to send a vehicle and set it up so that they can run their own battery of tests. And that's after you're certified and everything else, all the paperwork is done. They still want to have it in their hands without you there." [Third Wave]

## CERTIFICATION IS ONLY ONE PART OF SAFETY

- Certifying the vehicle to standards may only be one part of getting the product accepted by end customers, especially in Europe, North America where end customers may request additional safety features

"Safety is necessary for many reasons. For us, it's okay to do the certification. But more important is the feedback from end customers. We implemented blue spots, a lot of LEDs and more because the robot really needs to be safe, not only on paper, but also in practice. This is why certification itself is just one part of the business." [Anonymous]

- Additional safety features, on top of standards, may be related to cultural aspects where some workers appear to view getting injured by a machine as a chance for an insurance payout

"Some customers have very specific and weird requirements. I'm sorry to say that, because we have just come to realize the working environment is quite different in Europe. For example, because the workers here in China, or the labor cost will be lower, and people try very hard to protect themselves. But in Europe, some people would jeopardize their safety just to get the insurance payment. I was very surprised by that at the beginning. Customers would be asking, OK, we need to add a lot of safety features. Even though, because when people are trying to hurt themselves, we cannot stop that. But the clients were asking, at least, we need to show that we tried to stop them. There would be a lot of features like that." [Anonymous]

SOME CUSTOMERS HAVE THEIR OWN INTERNAL SAFETY AND SECURITY TESTS FOR ROBOTS

Perceived Market safety requirements

Perceived customer internal safety requirement

Low   High
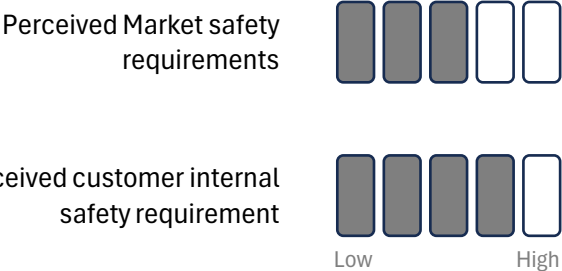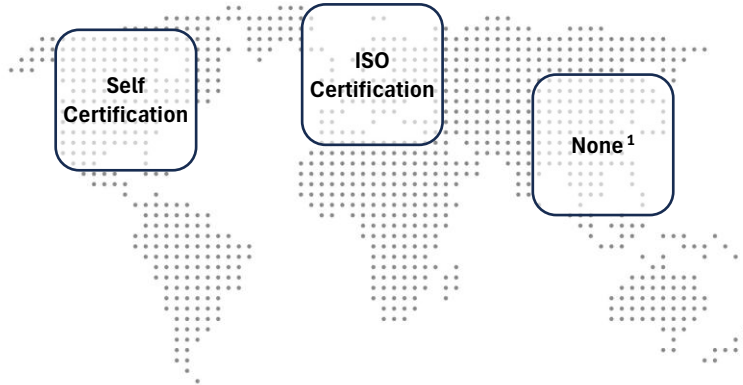
Source: STIQ Ltd Research & Analysis

END CUSTOMERS COMPARING PRICES

- Specialists are sometimes called in to advise on reasons for price differences and in some cases these are related to safety compliance

"The global AGV market is diverse, and suppliers differ in terms of maturity and compliance frameworks. End-users need to understand why pricing varies, whether the more economical options meet the required standards, and how they compare to suppliers operating under European norms." [Aesir]

DIFFERENT AGV & AMR SAFETY ACCEPTANCE INTERNATIONALLY. GERMAN SPEAKING MARKETS PERCEIVED AS MOST DEMANDING

DIFFERENT SAFETY STANDARDS ACROSS CONTINENTS (SIMPLIFIED)

Self Certification

ISO Certification

None [1]

Source: STIQ Ltd Research & Analysis. [1] To STIQs knowledge/ interviews

CAVEAT

- Note for further clarity on safety requirements, standards, etc. please refer to a reputable specialist firm
- This section is based on interviews which may differ from actual and legal requirements, specifications, etc.

DIFFERENT SAFETY REQUIREMENTS

- Interviews suggest there are three different overall safety concept requirements in Asia, Europe and North America
- Asia (excl. Australia) does not appear to have any legal framework, requirements and/or standards for safety related to mobile robots and may largely be determined by individual customer requirements and vendors

- Europe has the most stringent regulations globally and nowadays requires compliance with various ISO standards, such as ISO3691-4, ISO10218, etc.
- North America is largely relying on Self Certification, but do operate standards frameworks under ANSI and UL which includes mobile robot (source) – this may also be referred to as 'system safety'

US VENDORS TARGETING EUROPEAN MARKETS

- Plenty of US vendors have ISO certification on their roadmap, but few have gone through this process partly due to the size of the US opportunity and the higher level of competition in Europe

"On our roadmap to fix, is we haven't yet pulled the trigger on Is the safety standards are a bit different the ISO standards and while we have to go through a third party to get the official regulation done." [Anonymous]

EUROPEAN MARKET

- Some component vendors are targeting German speaking markets first as these are perceived to have the very highest safety requirements and demands, and if you can supply a safe solution there, it will be suitable anywhere

"For us it's been a particular importance to prove that we can deliver safe solutions in the German-speaking countries because this is where the safety requirements and focus is the highest. If you can make it there, you can make it anywhere. But I think the US is also extremely aggressive on robotics, as you know, especially coupled with the software side. We have lots of advanced conversations there, too." [Sonair]

LESS STRINGENT SAFETY REQUIREMENTS IN MANY ASIAN MARKETS. SOME SEE INCREASED SAFETY AS A NATURAL MARKET EVOLUTION, BUT WHEN IS BIG QUESTION

LESS STRINGENT SAFETY DEMANDS IN ASIA

- The Chinese domestic market does not currently appear to value certified safety

"Safety is not so important in China at this moment. Especially when you compare to European considerations, for example." [Anonymous]

- A few other Asian countries also appear less strict (compared to Europe, North America) when it comes to safety requirements

"ISO certification is not a requirement from Japanese customers. Our solution is based on ISO and JIS standards but is not certified. We always explain that to the customer when we sell our product. Customers are satisfied with that." [Rapyuta Robotics]

"China's machinery approval process differs somewhat from that of Europe. Furthermore, risks that would no longer be permitted in Europe may still be accepted in China. Systems placed on the market in Europe must comply with EU safety requirements, such as the Machinery Regulation. There is a clear procedure and process for this, which also mandates physical testing. Certain machines must also undergo evaluation by a notified body." [TUV Sud]

- There is a level of concern among customers, but there does not appear to be any significant regulatory environment requiring end customers to ensure vehicles are safety certified, etc.

"Customers care about safety with automated forklifts. But In my understanding there is no statement or requirement about standards in RFQs. As long as we talk about JIS or ISO, the quantity of sensors hasn't been a topic with customers. If customers require us to deploy in a very crowded area, it could happen that they want us to have a more Lidars to detect surroundings, for example, human or cargo. But it's not always. It depends on individual customer requirements." [Rapyuta Robotics]

## ASIAN VENDORS INCREASINGLY COMPLIANT

- The AGV & AMR sector remains relatively young and Covid prevented many Asian vendors from expanding overseas
- Since Covid restrictions ended these vendors have gained significant insights into EU and NA customer requirements, safety demands, etc. and are now more fluent in incorporating these for overseas customers

"Vendors worldwide have made strong progress in standards and safety compliance, but there is still no unified AGV standard outside the established European frameworks." [Aesir]

- Chinese vendors are very adept at changing manufacturing or incorporating additional safety standards, etc.

"Chinese manufacturers can follow up very quickly to the new product, new technologies or the new standard. If you have the new technology, the time gap for the new technology on the market is about 2-3 months. If you have some new technology, the followers will be very quickly to get the same . For the patents, I think there's no problem for Chinese manufacturers to bypass." [China Forklift Blog]

COMPARATIVE SAFETY REQUIREMENTS ASIA V EUROPE & NORTH AMERICA (PERCIEVED)

Asia / North America / Europe — Low to High
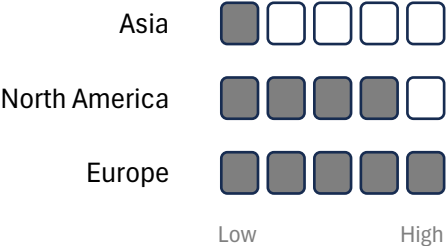
Source: STIQ Ltd Research & Analysis

GROWING SAFETY CONCERNS IN ASIA?

- There have been a few concerns raised about safety in China by the Chinese Mobile Robot Alliance (source)

"Safety is a necessity. We also see that in Asia, that its more and more important. My prediction is they will more or less adapt existing standards in the future. Because they also want to address our markets and they see the benefits of using this also in their local market." [SICK]

- However, it should be noted the Chinese market suffers from intensive price competition and higher levels of safety does not appear to be a priority currently

SAFETY CERTIFICATION INVOLVES THREE DIFFERENT ASPECTS (SIMPLIFIED): VEHICLE COMPONENTS, VEHICLE AND APPLICATION

DIFFERENT SAFETY ASPECTS WITH AGV & AMR ROBOTS (SIMPLIFIED)
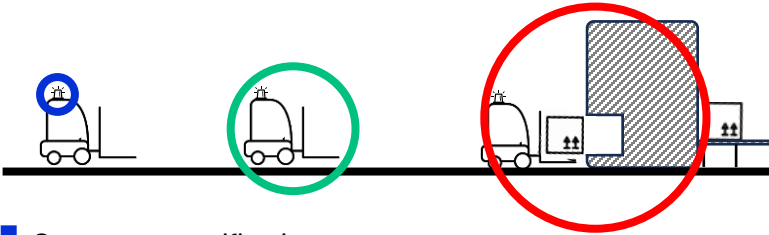
Component certification

- Using safety certified components improves the vehicle certification process experience
- Any components may be certified, such as sensors, controllers, motors, etc.

Vehicle certification

- The vehicle needs to be certified for specific payloads, speeds, etc. and re-certified if any key parameters changes, for example if another customer requires a higher payload or any other customization

Application risk assessment

- If vehicles are working with other machinery, for example loading a machine with a pallet on conveyors, etc. then there are additional factors to consider with the machine or equipment that involved in the process
- If this involves integration, it may require further certification and/or risk assessments

Source: STIQ Ltd Research & Analysis

SAFETY CAN BE CONFUSING

- Safety can often be a confusing topic and not all customers are always aware of the various aspects that need to be included in an assessment

"Safety standards are a challenge. 3691-4 makes things easier, but new interface norms are coming. It's hard for customers to know what to look for." [Xscaleo]

- There are three major safety certification or assessment aspects from components used, to the mobile robot itself, and the task/application it performs in an environment

"You look at the vehicle... safety components, architecture, software which is used, which load it is carrying, how big are the safety fields, stopping distance... this is quite heavily regulated. But then also evaluate the environment, and do a risk assessment as well. The AGV can be safe on its own, but if you implement it in a certain environment it can be unsafe. For example, if you put an AGV in an explosive environment, it's of course not safe. Or, if you put an AGV in a production environment, or if you do a warehouse block stacking where people can get locked in and so on." [Aesir]

CONNECTING AGV & AMR TO MACHINERY

- Connecting mobile robots with existing machinery may pose new risks that may need to be evaluated and managed

"An important safety topic is how AGVs interact with existing machines in a factory. There are many things to consider, like certification and linking safety between machines and AGVs. Connecting an AGV with a machine may pose new unknown risks that need to be evaluated, and this the vehicle, the software, the machine and any related machinery. So not only the AGV itself." [Pilz]

- Customers frequently have people with knowledge of machine safety, but this typically does not extend to mobile robots and how such vehicles interact with machines

"We have a dedicated specialist focused on safety. Customers often ask how much space do AGVs require? Is the AGV CE-compliant? What is its maximum allowed speed to drive? Can it operate in my environment? Customer safety officers usually know stationary machines but rarely mobile robots so they sometimes need support." [Xscaleo]

COMPONENT CERTIFICATION IS A STRENUOUS PROCESS, BUT CAN BE REWARDING AS THERE IS A LIMITED LINEUP OF COMPONENTS WITH SAFETY CERTIFICATION

USING CERTIFIED COMPONENTS

- Certification in its own right is not a guarantee a product is great or inherently safe but is a guarantee that a product performs to a standard

"Certification signals risk mitigation, not that uncertified products are unsafe. We're not just selling safety—we are selling safe, high-performance efficiency." [3Laws]

- For AGV & AMR vendors, using safety certified components can make the vehicle certification process easier (less arduous) as the process avoids going into component level examination

"Offering safety certified components means we take over some part of the safety certification responsibility and make it easier for manufacturers to gain full vehicle certification. We also offer safety services so customers could also come to us for safety consulting." [SICK]

THE COMPONENT CERTIFICATION PROCESS

- The certification process can be extremely detailed and may also limit the R&D process

"Certainly, certifying a component is not because we wanted to go easy on ourselves. It's extremely hard to achieve safety-certification. It also limits you on how you build the product. It's basically a business decision." [Sonair]

- Having experience of the certification process and its potential advantages can be useful

"Some of our founders previously had a company with a certified industrial gas sensor. There's experience in the team on how to do it and the feedback from customers is that when you get this certification, definitely let's talk... we see that as a big foot in the door." [Sonair]

CERTIFICATION AS BUSINESS ENABLER

- Certification may be viewed as a business enabler, especially as the availability of safety certified components remains relatively limited

"We are on track for safety-certification early next year, which means that we are safety-certifying it for a robot to be safe around humans. That will be a first for 3D ultrasonic sensing in air. That is a key business enabler for us, because the moment we are certified, that takes a whole lot of pain out for people building robots." [Sonair]

EFFORT REQUIRED TO CERTIFY VEHICLE WITH AND WITHOUT SAFETY CERTIFIED COMPONENTS

With safety certified component/s
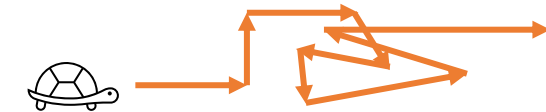
Without safety certified component/s

Source: STIQ Ltd Research & Analysis

ONE VIEW ON THE FUTURE OF SAFETY AND AUTONOMY INTERACTING FOR IMPROVED PRODUCTIVITY

IS TODAYS SAFETY CONCEPT TOO SIMPLE?

- The current safety concept is to get a vehicle come to a stop or slow down as quickly as possible once a safety system is triggered

"Today's safety systems slow or stop robots based on proximity, without understanding autonomy's intent. Our integrated component interprets autonomy signals, so speed reduction is not the only action. With proven safe motion, robots move around people more dynamically and efficiently." [3Laws]

- Mobile robots typically have two separate systems for autonomy navigation and for safety which never interact

"All robots have collision avoidance, but autonomy and safety remain separate. No current safety system embeds collision avoidance, limiting productivity. The solution is not better autonomy—it is smarter safety."

- Robots are safe, but there may be an opportunity to rethink safety and robot behavior by allowing safety and autonomy layers to interact

"We are solving the safety bottleneck that limits robot productivity. An automotive manufacturer bought AMRs that looked fast and fluid in demos but, in practice, it took nearly a minute to move around a person. Avoiding a person is easy—the hard part is doing it safely without risking a collision." [3Laws]

- The way safety is handled has remained static in the past few decades while alternative technological solutions are evolving which may present improved ROIs and grow the market faster while maintaining strict safety protocols

"Safety becomes incredibly important both as the complexity of the systems scale and as more and more AI components are brough in that are very hard to trust due to their non-deterministic nature. Despite how rapidly robotics is evolving, safety has been very static and has stayed mostly the same over the past few decades. There's this concept of just slowing down and stopping with simple laser scanners that detect in a single plane." [3Laws]

- There may be an opening for improving productivity and unlocking more applications by allowing safety and autonomy to interact in meaningful ways
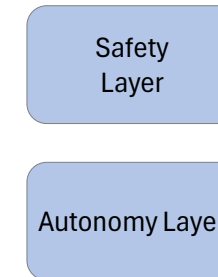
"Our customers are interested in transforming safety to enable better performance and unlocking new, higher throughput use cases." [3Laws]

- Safety, as it stands, may be a bottleneck for performance

"We see today's safety systems as bottlenecks. Our mission is to enable safe autonomy everywhere as robots become more intelligent." [3Laws]

AUTONOMY AND SAFETY SYSTEMS MAY INTERACT IN FUTURE SYSTEMS TO IMPROVE PRODUCTIVITY

Current Status   Future Status

Safety Layer → Safety

Autonomy Layer → Autonomy

Source: STIQ Ltd Research & Analysis

35
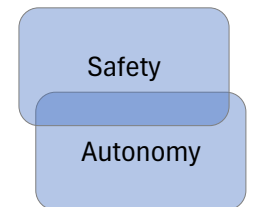
SOME VENDORS TRY TO DESIGN OUT PEOPLE AS FAR AS POSSIBLE TO IMPROVE SAFETY AND REDUCE THE CHANCE OF INJURIES, TYPICALLY IN HIGH VOLUME PALLET HANDLING

HUMAN BEHAVIOR DIFFICULT TO ANTICIPATE

- Human behavior can be difficult to design out of processes and is often impossible to fully anticipate which is why additional safety can be required

"Safety is a core value. We want to push the technology as far as we can from a safety point of view. It allows greater flexibility in the operations and so forth. But the main objective is just to make sure that everybody who wanders around is safe. We can't control human behavior. All we can try to do is safeguard against unsafe behavior. And this is one of the ways that can happen. We've just begun to implement it as a standard on our vehicles this year." [E80 Group]

DESIGNING OUT PEOPLE, SAFER OPERATIONS

- Designing out people from processes may be desirable to remove any accident potential, especially in processes with heavier payloads

"Safety is paramount as we operate in environments with people and machines. The best way is that you work without people in the area or solely with machines. We are focusing on pallet handling and upwards in size and weight and so on. It's typically less people intensive." [Anonymous]

- Where it is not possible to design out humans, there have to be rules of engagement, training for people working in the area, etc.

"There are rules of engagement regarding safety, but sometimes there are manual vehicles and pedestrians in the same space. It depends really on the traffic rules that have been established, but we don't really encourage manual trucks to just drive around randomly. They have to stay in kind of a lane, and they have some rules of engagement when they encounter LGVs." [E80 Group]

- Alternative safety features can also be part of creating very safe environments, occasionally above and beyond standards

"We also have a safety device called the SmartDect®, using UWB. It allows for detection of pedestrians and vehicles when they are circulating in the area of the LGVs. And it's a proprietary, patented safety development that we've done. The vehicles slow down or come to a stop. It allows us to see beyond the field of the safety sensors and we can literally see around corners." [E80 Group]

PEOPLE MAY BE EXCLUDED FROM HIGH VOLUME APPLICATIONS TO IMPROVE SAFETY

Image source: E80 Group

WHILE SAFETY IS PARAMOUNT IT COMES AT A COST DIRECTLY AFFECTING ROI. AN ACCEPTABLE LEVEL OF SAFETY CAN BE A DIFFICULT CHOICE, STANDARDS ASSIST

SAFETY AND COST IMPLICATIONS

- Safety topics can be contentious but there is a cost increase associated with any level of safety

"We get safety questions all the time. The standards define the complete vehicle and it defines braking systems and so on, but not the brake itself or what is inside our unit. A lot of customers, especially smaller ones, they would like to have certified products, certified encoders. It's OK, we can put certified encoders there and the price will be OK for a prototype, but for not for serial production unit. We have some customers who want to have certified encoders and so on, but the majority are not using that level of components." [Anonymous]

CUSTOMERS LOVE SAFETY (THAT'S INCLUDED)

- Interviews suggest additional safety measures are liked by many end customers, but when there are additional costs, interest often dissipates

"Customers love safety until they have to pay a little bit extra money for it. It's amazing how people claim that safety is number one until it costs a little bit more. And then they're like, oh, wow, I think we're good." [Anonymous]

- In general, higher (or very high) safety standards may also limit further market developments

"The barrier here is so high to reach that safety compliance and the actual safety margins that you get for this last 1-2% is... the numbers are rather low in terms of accidents that you're really paying a lot for a really high safety standard. It prohibits cheaper robots on the market. I think that's a disadvantage." [NODE Robotics]

USING SYSTEM SAFETY, A BETTER OPTION?

- Some interviewees suggest using system safety may offer a near equally strong safety level with potential cost savings for vendors

"I think in the mobile robotic space, we would also be better off to more look into alternative paths and achieving at least somehow close to the same level of safety and what is actually important. Having two non-safe scanners and sensors that together give some redundancy and thereby having maybe the same level of safety but with a different approach. This is something where I see a lot of possibilities, a lot of potential. But of course, everybody's a bit hesitant because it's safety." [NODE Robotics]

RELATIONSHIP BETWEEN SAFETY AND COST IMPLICATIONS (SIMPLIFIED)

- ○ Optional safety
- ○ ISO certification
- ○ Self certification
- ○ No standard
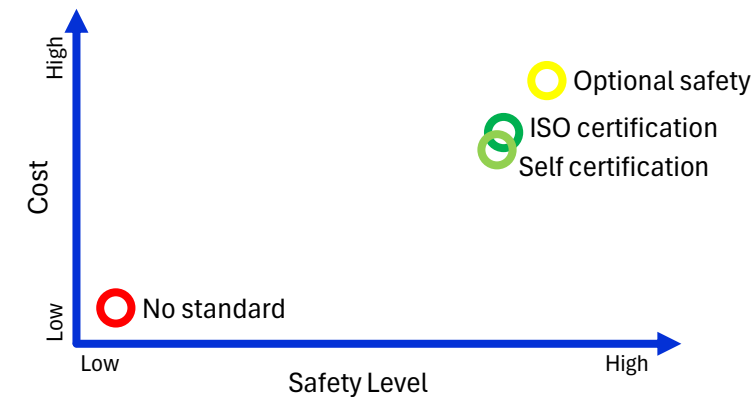
Source: STIQ Ltd Research & Analysis

ARE STRENUOUS SAFETY STANDARDS SET BY EUROPEAN END CUSTOMERS AN IMPEDIMENT TO INNOVATION BY VENDORS IN THE REGION?

SAFETY, NOT AN OPTIONAL EXTRA

- Safety is never an optional extra!

- However, different safety requirements internationally put vendors manufacturing AGV & AMR in higher safety conscious markets at a significant disadvantage

- For example, iterating new vehicle designs in the EU market may require re-certification which adds costs and ties up resources

- Vendors may avoid skipping certification of their first few prototypes used in their own offices, but as soon as they go and test market fit with active customers vehicles have to be certified

"We didn't do safety certification for our first prototype, but for the second version we did the full CE compliance and all the tests, because this is now live at some customers." [Anonymous]

- Such tests and innovation iterations to optimize market fit may be far easier in less safety-conscious countries

"Less safety-conscious countries can be a good playground for innovation, because you have less limitations." [Anonymous]

- Safety standards need to change with further technological developments but it may be important to weigh the wider market impact from such changes

"We need safety and we have good safety in Europe and North America. Those that want more safety standards... we should check if they are not just trying to protect for their own market. That's a danger for innovation, and that's even a danger for the market, because if you start making products that are too expensive, for useless safety reasons, that's not good. The other extreme is China, where the safety expectation is much lower, and they can go to market much faster with things, trying things much faster than here." [Anonymous]

- The difference between 'self certification' and the ISO standard may not be significantly different

"Self certified systems are not so much different to ours, and that's a competitive disadvantage here in Europe since you require all these expensive hardware parts. In the end, it makes the robots more expensive, and it makes it less attractive for the end user ROIs. And I think, that's only for a small margin of actually increased safety." [Anonymous]

RELATIVELY MINOR ISSUE TO UPDATE

- It is relatively quick to update a vehicle developed for the Chinese market to European standards

"We are now upgrading our vehicles to European safety. It takes me six month to update the safety of an existing product and rolling it out in Europe. And it does exactly the same job as it does in China. I agree with extra safety features and there's a lot of good stuff around it. But it does slow down innovation." [Anonymous]

- Chinese vendors have gained significant knowledge of safety requirements and some may start with this in mind when designing new vehicles

ARE INNOVATION ITERATIONS MORE EXPENSIVE IN THE EUROPEAN MARKET?

Source: STIQ Ltd Research & Analysis

"The reason we are more safety conscious is because we have been in the US for 3 years. For the 1st and 2nd year we sold very few robots. But we collected a lot of customer requirements about certifications for safety, cyber and IT or whatever. At this stage, when we design or release a new product in the US or Europe, we can pre-consider about that part." [VisionNav]

EUROPEAN ENGINEERS USED TO STANDARDS

- However, some disagree with the idea that higher European safety standards are limiting innovation and R&D

"I don't think safety requirements is an impediment for European companies. Because European companies are used to that. That's the daily work for us. It's hard for somebody who is entering that market new from outside. For example, American or Asian companies which always had machines in their region and enter Europe. That's very hard. But it's the same for everyone." [K Hartwall]
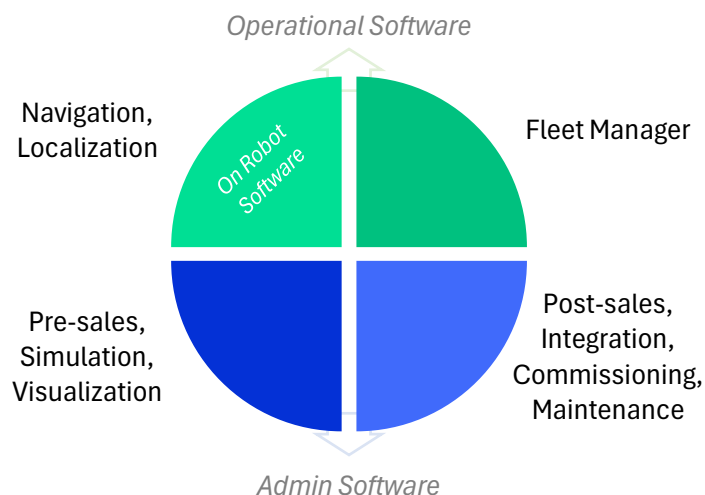
CONTENTS

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THE AGV & AMR SOFTWARE ECOSYSTEM IS GROWING. NEW VENDORS JOINING, OTHERS DIVERSIFY. INCREASING USE OF AI TOOLS

SOFTWARE PACKAGES USED WITH AGV & AMR ROBOTS (SIMPLIFIED)

Operational Software

Navigation, Localization

On Robot Software

Fleet Manager

Pre-sales, Simulation, Visualization

Post-sales, Integration, Commissioning, Maintenance

Admin Software

Source: STIQ Ltd Research & Analysis

AGV & AMR SOFTWARE ECOSYSTEM

- STIQ divides AGV & AMR software into Operational and Admin software
- Operational incudes on-vehicle software for navigation (often a defining issue for whether to call a robot an AGV or an AMR) and localization, and also includes fleet management software
- Admin software includes pre- and post-sales tools from visualization to simulation, to integration and maintenance tools

NEW FOCUSED DEVELOPMENTS

- R&D activities are increasingly focusing on improving AGV & AMR deployment processes including commissioning

"We are seeing commissioning becoming increasingly important, and many companies are struggling with it. To address this, we are developing digital-twin and simulation pipelines that help streamline the commissioning process while reducing costs. Most of the demand for these commissioning tools currently comes from Asia, where customers typically require more competitive pricing and shorter project cycles." [Kudan]

NEW SOFTWARE VENDORS

- Software vendors may enter the AGV & AMR Robotics sector from a variety of directions with different products, for example SLAM is used in a wide variety of applications including robotics and AR/VR

"We developed our Vision-based Navigation Software after that we observed a significant trend towards unmanned operations in manufacturing and logistics environments. We had an idea to leverage our expertise in imaging technologies, and we launched our Vision-based Navigation Software, specially designed for AGVs that operate autonomously." [Canon U.S.A.]

- Government funding can also be an important driver

"We expanded our technology stack for two key reasons. The first is the growing government support in Japan, where new funding programs are accelerating the robotics sector. The second is the shift in customer demand - more clients now require a comprehensive autonomous navigation solution, not just standalone SLAM." [Kudan]

THE PERENNIAL QUESTION – AGV vs AMR (TAUTOLOGY OR ARE THERE DIFFERENCES?)
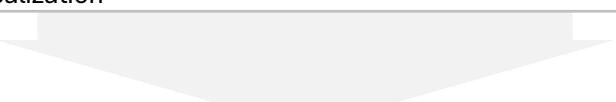
AMR **AGV**
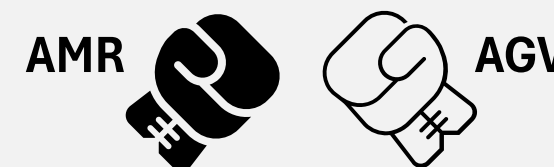
Source: STIQ Ltd Research & Analysis

AGV vs AMR – NOW TAUTOLOGY?

- There are multiple different navigation software for AGV & AMR robots with often confusing definitions of what is an AGV versus an AMR (defined by software functionality)
- Observers draw the line at 'object avoidance', i.e. an ability of the robot to notice an obstruction and navigate around it
- However, this ability is rarely used in applications with contractual performance indicators since allowing robots 'off track' will disrupt strict production flows
- A mobile robot with object avoidance and the ability to change its path dynamically is often referred to as an AMR while those following lines are AGV
- However, this is increasingly a tautology as many advanced navigation robots often navigate using virtual guided lanes and line guided robots are increasingly able to veer off track to avoid obstacles
- STIQ uses the AGV and AMR acronyms interchangeably

AGV & AMR NAVIGATION AND LOCALIZATION TECHNOLOGIES. MORE COMPLEX SOLUTIONS, SUCH AS VSLAM OFFER THE POTENTIAL OF ROBOTS WITH A SEMANTIC WORLDVIEW

AGV & AMR NAVIGATION AND LOCALIZATION TECHNOLOGIES

Navigation Tech	**LINE GUIDED**	**2D SLAM**	**3D SLAM**	**VSLAM**
Primary Sensor				
	Magnetic or painted line sensor	2D Lidar sensor	3D Lidar sensor	Visual camera sensor
Software Used	• Navigation software embedded in sensor • Localization primarily using staging points and/or IMU • May use 2D Lidar for safety	• Navigation & localization software (natural feature and/or reflector based) • Safety lidar may also be used for navigation/ localization	• Navigation & localization software • 3D Lidar used for navigation and localization • May use 2D Lidar for safety	• Navigation & localization software • Visual sensor (camera), stereo camera for distance • May use 2D Lidar for safety

Potential for a semantic worldview of navigation & localization technology

✖	✖	✔✔	✔✔✔
• No semantic worldview possible	• No semantic understanding, simply views the world as a slice or 2D map	• May have some semantic view or inference from 3D point cloud, depending on sensor used, but unlikely full picture	• May be able to have semantic worldview and differentiate between humans and various objects

Source: STIQ Ltd Research & Analysis
Note: Semantic Worldview = here, the ability for a robot to understand what an object is, i.e. a human, a pallet or a forktruck, etc.
Images: RoboteQ, KOLLMORGEN, Robosense, Canon

EMERGENCE OF SEMANTIC WORLDVIEW

- Line Guided and 2D SLAM remain the most widespread used navigation & localization technologies
- However, developments in 3D and Visual SLAM are progressing fast and also offer robots the ability to determine what the objects are in front of them are – 'semantic worldview'
- This may assist with, for example, improved localization and safety aspects

"I think all AGVs & AMRs will have semantic recognition in the future. Especially when you're talking about the standard AMR technology where you want to be able to run more freely and avoid obstacles, which is something we think is really important. But we also see that there is a risk you get lower performance in the system and therefore being able to understand what you're seeing will help with the performance and the efficiency of the system."
[KOLLMORGEN]

MOBILE ROBOTS WITH A SEMANTIC WORLDVIEW MAY IMPROVE THROUGHPUT AS OBJECTS MAY BE UNDERSTOOD AND POSSIBLY MANIPULATED

SEMANTIC ROBOT UNDERSTANDING MAY IMPROVE THROUGHPUT

Image source: ChatGPT.com

SEMANTIC WORLDVIEW AND THROUGHPUT

- Introducing a semantic view of the world may improve performance by knowing if an obstacle is a person or an inanimate object

"To understand the reason why there's an obstacle in the way or what it is will help with performance. One very specific thing is that sometimes when you have a pallet, there can be plastic wrapping hanging down that has been around the pallet. If that plastic is sticking out and if you're not able to understand that it's plastic, then you might stop for it. That would decrease the efficiency. But if you can understand that it's plastic, then you can just run through it. And if you have enabled that technology, then you've also enabled the understanding if it's human or if it's a parcel or something else. Looking into that, I think will be a really crucial in the future to get higher efficiency in systems." [KOLLMORGEN]

SEMANTIC (SAFETY) LEGISLATION PROPOSALS

- There are apparently proposals for updated ISO safety standards that robots should be able to differentiate between a human and an inanimate object

"We reviewed the last update proposal of the Safety Certification for AGVs in Europe and there are suggestions you should have, or must have, a sensor that detects if the object in front of you is a human or an object." [Anonymous]

- Such a proposal will likely require a visual sensor and additional software capabilities and may potentially also require safety certified software components

SEMANTIC SAFETY APPLICATIONS

- However, using software algorithms to recognize a human may require certification, especially if it is deployed as a safety component

"If the safety of a person relies on this, it's like any other safety function. The algorithm that interprets it must be reliable enough because it's protecting a person's life." [Anonymous]

AI INCREASINGLY USED ACROSS SOFTWARE

- AI is not only used to give robots a semantic understanding of their environment, but also to enable human and natural language instructions to robots

- AI is increasingly used in AGV & AMR applications such as fleet managers and simulation, etc.

"We use Gen AI to build digital warehouses. We can build a digital twin from CAD files, but we can also create multiple scenes using Gen AI. For example, if you want to have 100+ different, realistic, and simulation-ready layouts to explore how your robots operate, you can use Gen AI to generate these." [Robotec]

"Users can use natural language to configure, operate the warehouse, production line... And that's our claim - you vibe code your intralogistics processes." [openmaind]

SLAM LOCALIZATION CAN ALSO BE USED FOR RTLS. VSLAM IS PARTICULARLY USEFUL AS IT IS INFRASTRUCTURE FREE AT A REASONABLE COST + ACCURACY

LOCALIZATION AND RTLS

- There is a growing market for improved localization and RTLS and SLAM navigation vendors may develop their own localization module which is essentially RTLS

"We see a growing trend toward the use of RTLS, and we recognize strong potential in infrastructure-free solutions such as VSLAM." [NAiSE]

"We sold RTLS first in 2015 because a company approached us saying, "We see that you do AGVs, etc. but we would like to track manual vehicles". We started to sell that without doing any advertising. Then we had a second and then a third sale, so we thought, maybe we should start advertising that, because if companies are reaching out without any publicity or promotion for it, that means there's a market." [Bluebotics]

"Tracking is RTLS that you can put on manual driven trucks. We have a huge customer in the pipeline that asked us if we can provide this. Since we do localization for AGVs, AMRs, this is actually kind of a byproduct." [NODE Robotics]

- RTLS potentially allows fleets with manual and autonomous vehicles to coexist more harmoniously

"The immediate need for RTLS is that there are deadlocks and even accidents between manual trucks and AGVs & AMRs, so mixed fleets. They need to coexist and not to collide with each other. That's the pain point. And then, of course, there is heat map, fleet optimization, etc." [NODE Robotics]

- One advantage of VSLAM may be faster position/ localization recovery, potentially requiring fewer maintenance staff

"When the AGV is lost, the camera does not know the position. Our solution can help localize the position very quickly. With a 2D Lidar, it is very difficult to localize again once lost. Our solution takes only a few seconds to localize, which allows for a very quick recovery time." [Canon U.S.A.]

"Localization is still underestimated. We're coming back to that basic education, about how important it is to have good localization because every time a vehicle is lost a human has to go in and fix a vehicle." [Bluebotics]

SENSOR FUSION MOST LIKELY FUTURE

- The longer-term trend is likely a fusion of visual and lidar sensors

"In the medium to long term, we see potential for Lidar and VSLAM to complement each other by leveraging their respective strengths." [Canon]

DIFFERENT TYPES OF SLAM (SIMPLIFIED)

Localization Technology	RTLS suitability
2D SLAM	- 2D lidars rely on single horizontal slice of the world, typically navigating around 'natural features' - May require infrastructure, such as reflectors with excellent location accuracy
3D SLAM	- Multiple horizontal slices of the world, may make inference about objects based on point clouds - Improving sensor price points but still more expensive compared to visual sensor, good location accuracy
Visual SLAM	- Visual (semantic) representation of the world, typically using stereo camera (or TOF) for depth perception - Currently best value infrastructure-free RTLS with reasonable location accuracy

Source: STIQ Ltd Research & Analysis

Vision Solutions for Mobile Robots

Vision-based Navigation Software with our Visual SLAM tech, enables mobile robots localization for intelligent navigation.

- Simultaneous Localization & Mapping with compatible stereo cameras

- Maintains tracking despite scene changes

- Fast recovery from sudden loss of localization tracking
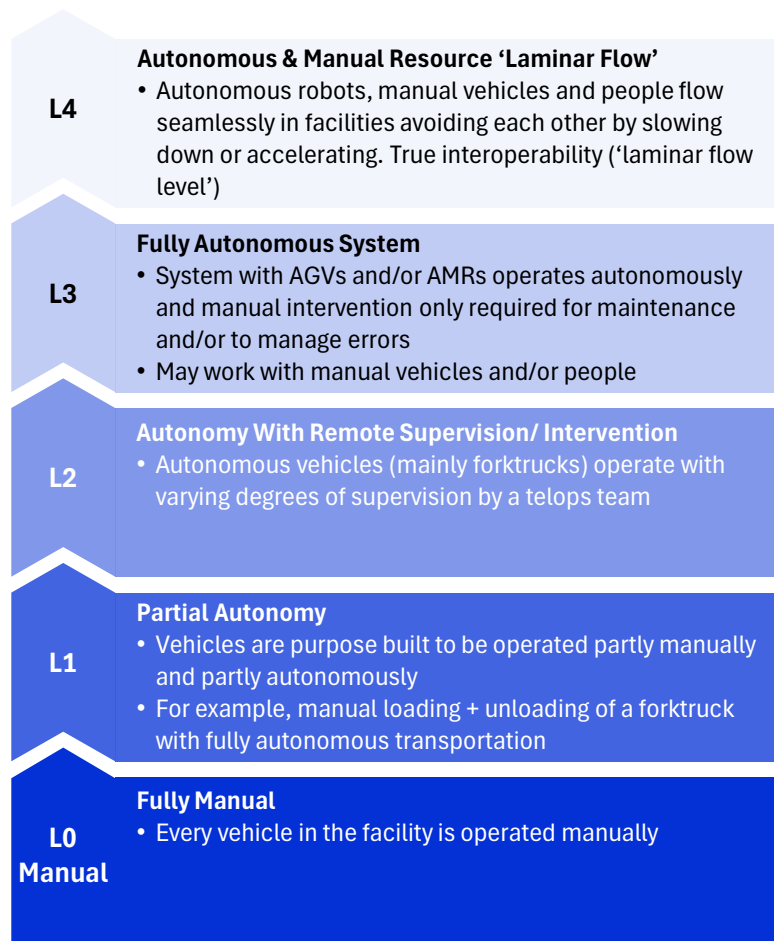
- High performance during start-up and map creation

Contact Us: **vision-solutions@cvi.canon.com**
Learn More: **canon.us/visualslam**

Robot not included. Must be purchased separately.

THE SECTOR IS BIFURCATING INTO 'BITE-SIZE' AUTONOMY SYSTEMS AND 'LAMINAR FLOW' TYPE INTRALOGISTIC SOLUTIONS

DIFFERENT LEVELS OF AUTONOMY EMERGING AS A SOLUTION (SIMPLIFIED)

L4
Autonomous & Manual Resource 'Laminar Flow'
- Autonomous robots, manual vehicles and people flow seamlessly in facilities avoiding each other by slowing down or accelerating. True interoperability ('laminar flow level')

L3
Fully Autonomous System
- System with AGVs and/or AMRs operates autonomously and manual intervention only required for maintenance and/or to manage errors
- May work with manual vehicles and/or people

L2
Autonomy With Remote Supervision/ Intervention
- Autonomous vehicles (mainly forktrucks) operate with varying degrees of supervision by a telops team

L1
Partial Autonomy
- Vehicles are purpose built to be operated partly manually and partly autonomously
- For example, manual loading + unloading of a forktruck with fully autonomous transportation

L0 Manual
Fully Manual
- Every vehicle in the facility is operated manually

Source: STIQ Ltd Research & Analysis

EMERGENCE OF L1 AUTONOMY

- A relatively new development is mobile robots that solve one part of a mission, for example a forktruck is loaded manually and then it moves to a staging post autonomously waiting for manual intervention to unload

"Most SLAM robots today use mapping mode. You drive around and create a map. And then you use that map as foundation for the tasks, laying out paths and so on. That's not how our solution work. You take it out of the box, you turn it on, and then it's ready to go. You need to show it the task one time by driving the forklift around manually. When you get to the destination, you click remember this position. After that it can drive back to that position autonomously. You don't even see the map. We can visualize it, but there's no mapping process." [The Mobile Robot Company]

- These vehicles are viewed as an entry point for customers with limited knowledge of mobile robots as they remove autonomy which frequently add significant costs

"I think that removing all the complexity that comes from time to achieve 100%, the last 5% really creates a lot of cost." [The Mobile Robot Company]

DEVELOPMENT OF L2 AUTONOMY/ TELOPS

- Another development over the past few years has been remote controlled vehicles, typically forktrucks
- This includes a varying degree of autonomy from full remote control to supervised autonomy where manual operators oversee multiple vehicles and only intervene when there is a problem or particular process

"Our customer's environments change day in and day out. You go in now and then 3hrs later, the facility is completely different. Those are the environments that we're operating in and have to develop a solution for. The remote operator in the loop allows us the flexibility to hop in the seat whenever the vehicle needs assistance, but also to handle those hard to move materials, whether that is, different sizes, shapes, colors, all of those properties that make automation hard. And we just balanced that out and we believed that remote operations was a key to addressing these challenges from early on." [ArcBest Vaux]
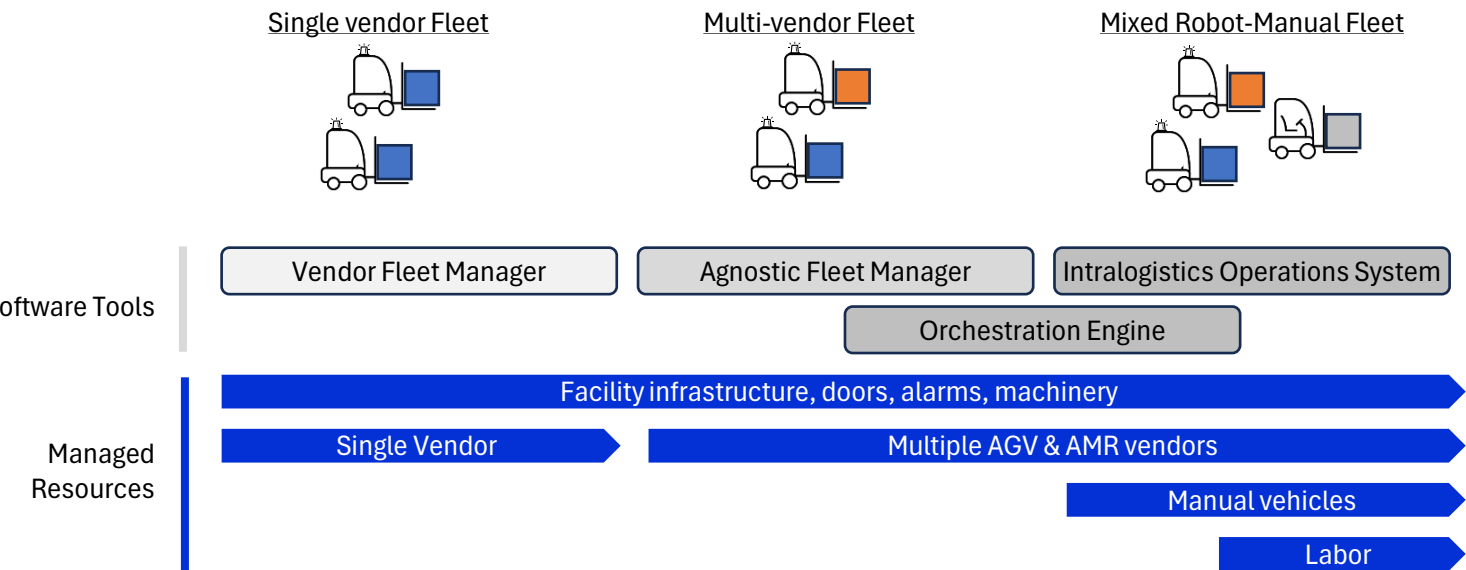
L3 - LEGACY AUTONOMY

- Level 3 autonomy is how legacy AGV or AMR systems ideally operate, without any manual intervention where vehicles stop for objects, other traffic and people

EMERGING L4 AUTONOMY AND RTLS ADOPTION

- Level 4 autonomy is an emerging stage which can best be explained as a 'laminar intralogistics flow' where vehicles rarely stop for objects, traffic, other vehicles
- This is made possible courtesy of agnostic fleet managers and RTLS-enabled manual vehicles and human labor where all resources in the facility can be tracked in real time

THREE PRIMARY TYPES OF FLEET MANAGEMENT PACKAGES WITH AN INCREASING OVERLAP BETWEEN THESE SOFTWARE TYPES

FLEET MANAGEMENT SOFTWARE USED IN SINGLE VENDOR, MULTI VENDOR AND MIXED MANUAL + AUTONOMOUS FLEETS AND RESOURCES MANAGED (SIMPLIFIED)

Single vendor Fleet   Multi-vendor Fleet   Mixed Robot-Manual Fleet

Software Tools

Vendor Fleet Manager | Agnostic Fleet Manager | Intralogistics Operations System

Orchestration Engine

Managed Resources

Facility infrastructure, doors, alarms, machinery

Single Vendor | Multiple AGV & AMR vendors

Manual vehicles

Labor

Source: STIQ Ltd Research & Analysis

MIXED FLEET SOFTWARE MANAGEMENT

- A number of different software packages have evolved and continue to develop for the management of multi-vendor fleets
- Some packages are based on APIs while others use interoperability standards, such as VDA5050 allowing a single fleet software to manage individual mobile robots

"We have a platform where all the robots we work with are able to interact. It's a fleet manager, but not in the traditional sense like managing a VDA5050 fleet. It supports VDA5050 but it's also working with the existing API of each robot, or the fleets. Because in some installations... and I can give you a concrete example, is Vendor A and B. They are working together. At the time, they were not VDA5050 compliant. So, we developed this connector that made them work together." [AIAutomation]

"We call our solution an orchestration platform. We don't consider ourselves to be a fleet manager. Instead, we sit in-between the fleet managers and all the other systems that need to be involved. We act as a centralized hub, bringing all system components together into a holistic solution. We communicate with the AGV & AMR fleets through their APIs to dispatch missions and to monitor missions as they're running." [Flexware]

"We call it fleet orchestration. It sits on top of VDA 5050. What we've seen in the past is that fleet orchestration can be done, but normally it takes a lot of expertise that is necessary to plan projects, to execute them, to set them up, and to change them." [openmaind]

GROWING NUMBER OF MULTI-VENDOR FLEETS

- Interviews suggest there is a growing number of more advanced customers requiring an intralogistics tool with AGV & AMR management and orchestration functionality

"Customers are seeking solutions because they recognize the growing need to automate material flow using AGVs and AMRs. They also understand that this cannot be achieved with a fleet manager from a single supplier. That's why they are looking for an interoperability solution that enables the use of different AGVs available on the market." [NAiSE]

- For some system integrators, nearly half of all projects involve multiple different robot vendors

"Out of 10 of our projects, perhaps 4-5 involves multiple AGV & AMR vendors." [AIAutomation]

- While there are more mixed fleets in existence, they are typically limited to more advanced AGV & AMR users

GROWING USE OF MIDDLEWARE; FLEET MANAGEMENT SOFTWARE AND INTRALOGISTICS OPERATING SYSTEMS WHICH OVERLAPS WITH WES, WMS, MES SYSTEMS

AGV & AMR MIDDLEWARE

- Fleet or orchestration software often integrates with other machinery and equipment and needs to ingest such data and make it relevant to the mobile robots

"Our software is the middleware controlling both fleets, in that case it's controlling the Vendor A fleet and the B fleet. That means the ordering system, the door control systems, the traffic control, deadlock prevention. If we arrive at a deadlock, we also need to fix that deadlock by moving the robots to some other location without losing the jobs, because that's important. All of this, what the traditional fleet manager is doing, we had to put it in all these mechanisms, including integration with the ERP systems. For example, we have equipment that is connected and we pull that data with all the protocols we are compatible with and digest the data and we make it relevant to the robots." [AIAutomation]

- Some of these middleware packages may be likened to MES (manufacturing) or WES (warehouse) software packages

"If you can imagine the convergence of MES and WES, in a manufacturing space, that is what our software is... intralogistics execution management. It kind of sits in-between a WES and an MES." [Flexware]

- Part of the driver for an intralogistics tool is also that this is an organisationally centralized tool

"Another reason is that this kind of request is coming from the plants, but there is also a central demand. Companies want to centralize material-flow automation at the IT level. They see that many things are already automated and will continue to be automated. But we are still talking about isolated solutions that have to be connected separately. You might have a forklift control system connected to SAP, and then an AGV system connected as well. This becomes difficult every time a new solution is added, because the IT team in a large company simply doesn't have the time to support all these integrations. That's why they see a strong need for one central standard to connect everything related to material flow." [NAiSE]

VENDOR-AGNOSTIC TOOLS AND ROI

- Evidencing a classic ROI for vendor agnostic tools can be a tricky task as the software is often an enabler rather than a direct labor saving measure

- However, once installed, savings can be made in the integration part if new vendors are required and there are also additional savings from improved intralogistics flows

"It's not a classic ROI. We are not the company directly automating the material flow. We are the company providing a tool that makes automation possible." [NAiSE]

MOBILE ROBOT INTEROPERABILITY STANDARDS

Standard	Robot View/ Description
VDA5050	• Developed by the influential German VDMA (automobile association) and is the generally current accepted standard for interoperability
ISO21423	• Relatively new attempt, appears to currently have low uptake, low recognition among vendors
Massrobotics	• Largely defunct. Attempt by US Boston-based robotics group/association to develop standard
API [1]	• API remains widespread in use by many of the agnostic fleet managers, etc.

Source: STIQ Ltd Research & Analysis. [1] Not an interoperability standard per se

INTEROPERABILITY STANDARDS

- There are currently a number of competing standards initiative for interoperability of mobile robots

- VDA5050 was released in Jan 2020 and has gone through a few revisions and updates

- ISO21423 is currently in draft form and is planned for first release in 2026

- Massrobotics was first released in 2021

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CUSTOMERS NEW TO AGVs & AMRs OFTEN HAVE INFLATED EXPECTATIONS AND MAY ABANDON PROJECTS ONCE THEY UNDERSTAND THE EXTENT OF CHANGES INVOLVED

NEW CUSTOMERS AND AGVs

- Plenty of STIQ interviews over the years indicate there is significant interest in AGVs & AMRs, however, vendors indicate from 100 incoming inquiries less than 5 have good awareness of the complexities involved

"Many clients have little or no knowledge of AGVs. Larger companies usually have sometimes more experience." [Xscaleo]

- A common misconception is AGVs & AMRs simply replace manual processes without any additional work or changes

"A lot of people think to just replace a forklift driver with an AGV and that's it. They underestimate what a forklift driver actually does. We often also find that hybrid solutions are required. It's very important to have a backup. For example, if an AGV is down, that you're able to intervene manually or to solve the problem at hand." [Aesir]

AGV CUSTOMER PROJECT ABANDONMENT

- Once new customers understand the level of changes required to implement AGVs & AMRs, they frequently drop out from conversations

"If customers understand how much they have to do before automating, then we have a larger dropout rate. We are usually contacted by logistics people eager to change. But as soon as we touch the processes... we need to restructure a lot of processes, including manufacturing, how finished goods are picked up and so on. And then it gets tough. First, it's a change of mindset in the whole company until this change can be implemented." [Automation A]

- There are often significant barriers to new customer adoption which requires a high degree of management buy-in and additional resources

"A lot of people talk about AGVs, but it takes a long time before they can make the 1st step. They start with the idea of an AGV replacing a driver, for example. And when they realise what they can expect from an AGV, they get a bit disappointed and say 'perhaps it's not the best solution'." [Aesir]

AGV & AMR IS NOT SIMPLE (YET)

- Mobile robots frequently interact with many different machines and infrastructure adding complexities beyond just transporting between 2 points

"Customers realize quite quickly that AGV is more complex than a traditional robot... you have to interact with the complete environment. You are driving in the factory mixing with people and other traffic often integrating with WMS or ERP and so on. You need quite a lot of knowledge about a lot of different things, especially around safety." [Aesir]

- One of the first tasks with new customers can be to introduce basic intralogistics processes which can be standardised and automated

"Half of our job is to scan all the material flows and processes... and firstly to introduce basic logistics processes that are then ready to be automated. And yeah, so we covered the full story from the beginning from this logistics fundamentals until the first mobile robots are running there." [Automation A]
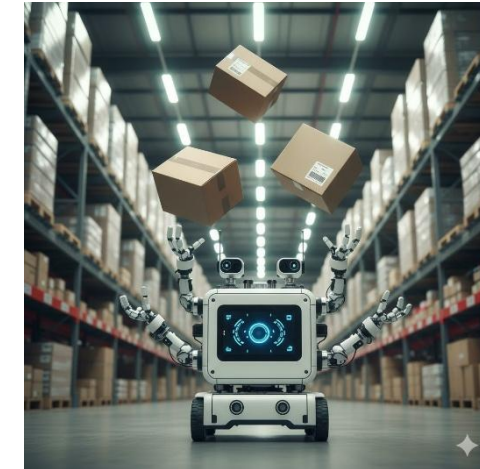
MOBILE ROBOTS THAT JUGGLE CASES?

NEW!
The Fantastic Juggling
Mobile Robot. In a
warehouse near you...
very soon

(SPOOF)

Image source: Google Gemini

- Such projects can take 12 months or more

"The project length depends on the process maturity we find. 12 months from our workshop until the first robot is up and running is normal. If customers need to do homework, then it depends a lot on the willingness to change, but I would add at least another year." [Automation A]

- Part of integrators task is to manage expectations and ensure customers understand operational changes are required to prepare for and implement mobile robot automation

"I try to manage the expectations of the end users and make them understand that operations will be different." [Aesir]

THE EMERGENCE OF AGNOSTIC MOBILE ROBOT SYSTEM INTEGRATORS

MOBILE ROBOT SYSTEM INTEGRATORS AND DIFFERENT CUSTOMER EXPERIENCE PROFILES

Inexperienced Users ←- - - - - - - - - - - - - - - - - - - -→ Experienced Users

- Introducing to mobile robots, process standardization
- Managing customer expectations and internal change management
- Initial software integrations

Source: STIQ Ltd Research & Analysis

- Introducing new/ complimentary vendors, form factors, etc.
- Improving existing operations with new types of mobile robots
- Introducing agnostic fleet management tools

NEW BREED OF SYSTEM INTEGRATORS

- A new breed of agnostic system integrators focusing on mobile robots is slowly emerging, primarily from existing customers with experience of the problem

"I worked in an automotive company and wanted a mix of robots moving goods in the factory. We wanted an integrator to put these systems together but couldn't find one. So, if there's nobody, it's either one of two ways: You are the first or you are better. And that's how we started in 2018." [AIAutomation]

"We were customers looking for a neutral consultancy that could support us in finding the right solutions. But we couldn't find a supplier and set up our own business in 2024. We use the knowledge gained through projects with all the mobile robot suppliers and now, we support other companies so they don't have to get lost in the mobile robots jungle." [Automation A]

"In my previous job, I worked extensively with AGVs and AMRs around the world. Now I founded my own company." [Xscaleo]

"I sold my AGV & AMR robotics company 2 yrs ago and started this company when the non-compete expired. We are a consultancy for AGVs and logistical automation. I noticed there was a big gap between OEMs and end users. Many projects I worked on got hung up or derailed because of miscommunication, what the technology is capable of and what end users can expect." [Aesir]

THE RESELLER INTEGRATOR

- In addition to agnostic integrators, companies with existing solutions, such as packaging for example, may add mobile robots to move payloads to and from their systems

"We saw an opportunity to grow in AGV & AMR. We are on conveyors, but somewhere payloads need to be introduced or removed from conveyors and AMRs can do that very well. We decided to partner with a vendor." [MPAC]

TARGETING NEW/ SMALLER CUSTOMERS

- Some of the new breed of mobile robot integrators target customers with limited knowledge of AGVs & AMRs

"We focus on smaller projects to kickstart automation with mobile robots. These companies usually want to start with smaller projects to get experience. In the first instance they are dependent on our knowledge and we show them how to work with AGVs & AMRs. We remain a back up for follow-on projects or scaling projects. But afterwards they usually manage projects on their own." [Automation A]

- Others aim for larger and more experienced organisations where projects are clearly scalable

"What we are aiming for is standardization and we focus on global companies. Because if we work on one production site and we cover all the needs... for example, moving pallets, then we know we can scale that in every single plant as the IT infrastructure is known and it's more like plug and play to expand." [AIAutomation]

BEST OF BREED IS A REQUIREMENT BY MANY AGNOSTIC AGV & AMR SYSTEM INTEGRATORS AND MAY HERALD A NEW DEVELOPMENT PHASE FOR THE SECTOR

PROJECT LIABILITY = BEST OF BREED CHOICE

- Integrators suggest there is no single AGV & AMR vendor currently supplying products for all different applications in production and warehouse environments

"Our focus is on mobile robot integration and we work with nearly 20 vendors. Why so many? Because we work with customers that either already have robots and we have to overlap and mix types of robots; or customers already have a preferred vendor and then we may have to introduce another vendor. We also try to find technologies that are better or focusing on a niche. Up to now, we haven't found a single company that is able to fulfil all processes from in- to outgoing goods and in the middle." [AIAutomation]

- There are often specific problems, especially in brownfield sites, where certain vehicles and/or navigation technologies are unsuitable and adopting best of breed is also important for support topics

"For example, with autonomous forklifts... a lot of the forklifts are good, but then you have specific site problems, such as layouts with space restrictions. When it comes to the dynamic of the factory, you cannot always use SLAM for example. For every single integration, we choose best of breed technology. In the end, we are responsible to the customer and with projects worldwide, it is also a bit difficult to go and fix something." [AIAutomation]

SYSTEM INTEGRATORS MAY BE ABLE TO MATCH REQUIREMENTS WITH BEST OF BREED VENDOR

Project Requirement

AGV & AMR Suppliers

System Integrator
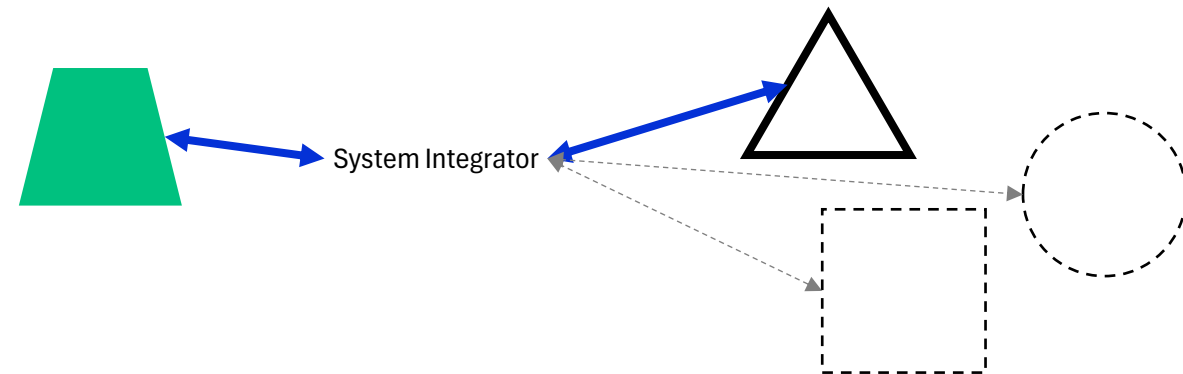
Source: STIQ Ltd Research & Analysis

- Getting the best product for the application matters more to the end customer rather than a specific vendor

"We consult on automation with a focus on mobile robots. We always look on the best possible use case and to match up suitable technologies." [Automation A]

"It doesn't matter if I use vendor A, B, or C, the focus have to be on what the client truly needs. Times are tough for many companies, so we have to help to find correct solutions for their needs." [Xscaleo]

DRIVERS FOR THE EMERGENCE OF AGNOSTIC AGV & AMR ROBOT SYSTEM INTEGRATORS INCLUDE A CONFUSING VENDOR LANDSCAPE AND GROWING CUSTOMER INTEREST

MARKET DRIVERS FOR THE EMERGENCE OF SPECIALIST AGV & AMR SYSTEM INTEGRATORS

Fragmented market

- The global AGV & AMR Robotics market is hugely fragmented and identifying suitable vendors for a specific project can be difficult
- System integrators may offer from a range of known and vetted vendors

Growing Customer Interest

- Interest in mobile robots is growing, but inquiries can be difficult to manage if customers are too immature to adopt robots
- Some system integrators target smaller, less mature customers with handholding type services. This may also drive a larger market

Vendors Appointing Resellers

- Vendors are pushing hard to build market demand by appointing resellers. Some of these are growing into system integrators (others remain 'resellers')

Key: ☐ *Pull driver*   ☐ *Push driver*

Source: STIQ Ltd Research & Analysis

PULL DEMAND FOR INTEGRATORS

- There are many 100's of AGV & AMR vendors globally and for end customers, this can be a daunting list of companies to select for a project

"There's over 500 mobile robot suppliers worldwide, many small ones, and startups. At least 50 of these are interesting and needs to be checked out. How can a customer know which one is the right one based on brochure and exhibition visits? It's just impossible." [Automation A]

- Vendors may also be incentivized to sell their own vehicles whether they are the most suitable or not

"Sometimes customers are already talking to vendors with a lot of offers. But they hear different things about solutions and perhaps contradictions in those solutions. They ask me to help out understand the why's and what's." [Aesir]

PUSH DEMAND FOR INTEGRATORS

- Vendors are also driving up demand for system integrators (and resellers)

"There's a very big pool of potential partners. We speak with many potential distributors every day. Probably 10% or less eventually sign an agreement. And then maybe only half of them can get deals done in the first year." [Tusk Robotics]

- For vendors and resellers, identifying the right partners can be a demanding process (both ways)

"Our partner sales also increased a lot this year. Sometimes partner revenue generation is slower than direct sales. Because you also need to train them and set up the cooperation, build the confidence, demo vehicles, etc. There's a lot of things to discuss up front. Last year was our preparation to working with partners. And this year they start to generate results." [VisionNav]

- This also includes resellers/ integrators with an existing range of products

"We compared a list of around 30 vendors. We defined criteria, what are we looking for, important topics, etc. So we could weigh what is more important to do a comparison. From 30 vendors, many of them had knockout criteria so that we didn't have to look further. In the end, we had 3 vendors left who were pretty close to each other." [MPAC]

EARLY SIGNALS THAT RAAS IS GROWING IN AGV & AMR. BUT IS IT DRIVEN BY A LACK OF CAPEX BUDGETS RATHER THAN SECTOR PARADIGM?

MORE RAAS DEALS IN 2025

- Interviews suggests there were more RaaS deals struck in 2025

"We have done more RaaS deals in 2025, especially for automotive customers." [AIAutomation]

- Some vendors, especially in the US, hint at near exclusive RaaS business and there are several different models in the market such as Movements as a Service (MaaS) and more

"RaaS has continued to gain momentum." [Third Wave]

"While we offer CapEx and RaaS options, we've seen RaaS favored." [Vecna Robotics]

- The backdrop to the increasing attractiveness of RaaS deals appears to be higher than normal market volatility and uncertainty (or a lack of Capex budgets)

"It seems business is very volatile at the moment and it doesn't come as a surprise people are hesitating to take decisions on Capex. What gives me confidence is our rental model. We work with financial solutions to help ouRear customers with decision making. Having a rental model makes it less difficult to close opportunities. I think that's going to help us in the coming 12-18 months." [Toyota MH]

- Some end customer business models may be more amenable to the RaaS business model

"3PLs are very, very happy for RaaS. Especially as their customer base tends to shift over time as well." [Third Wave]

ELIMINATING ANOTHER REASON NOT TO BUY

- Offering a RaaS model may be one way of expanding the market potential by side stepping Capex routes

"RaaS is key to removing barriers and risks. We see it as a way to eliminate one more reason not to buy. If you can borrow or rent the vehicle and give it back, then your commitment and risk is less. But not every customer wants RaaS and we offer both Opex and Capex options." [The Mobile Robot Company]

LEASING AND RESIDUAL VALUE POSITION

- There appears to be more demand for RaaS and some legacy players are working on how to provide financing models that works

- However, RaaS (or leasing) is not always very simple to introduce, especially when there is heavy customization required on vehicles and how to deal with residual value

"RaaS is not always easy. For example, with certain manual forktrucks you may struggle with leasing because they are often customized. We see that is a market requirement and also understand from the customer perspective. We try to bring our portfolio in a more standardised direction so that we don't have so many parameters that can be configured rather than customizing vehicles." [Anonymous]

DIFFERENCES OF RAAS DEALS (OFTEN BUNDLED INTO 'RAAS' DEFINITION)

Financing Deal	Description
Rental	• Monthly payments, typically charged in brackets of performance indicators • Contract lengths typically 1-3 years • Robots remain property of supplier
Leasing	• Monthly payments (exchange for Capex deal) • Contract is duration of payments or as agreed • Robots are property of buyer (at end of contract)
True RaaS (incl. MaaS)	• Payment per performance or per movements (MaaS), etc. • Robots remain property of supplier

Source: STIQ Ltd Research & Analysis

"If it's an ASRS system or something that's sticky, for lack of a better term, large racking systems, customers aren't really asking us for fair market value are operating leases on those assets. They see those as a 15 -20yr asset. They want utilization of it. They want ownership of it at some point. So it's just a cash flow play where they don't want to pay out of pocket until they have." [Mitsubishi HC Capital America]

SHOULD WE WAIT FOR HUMANOIDS? THE GROWING USE OF ARTICULATED ARMS ON MOBILE ROBOT PLATFORMS. EXCELLENT MARKETING JOB

THE MOBILE ROBOT + COBOT COMBO

- The fast innovation pace of mobile robots and Cobots in the 2010s fueled a new robotics segment, the articulated arm mobile robot combination

"... coming back to your humanoid piece. The one thing we do see is a lot of articulation on top of our mobile robots… like a robot arm. And then being able to store something on the robot so it can carry it around and they go interface with the machine doing some sort of machine tending. Sometimes we see two arms on top which seems to be a little futuristic. But definitely the Japanese market has been pushing that solution for quite a while. And we're actually starting to see that gain some traction now." [Omron]

- This has gained accelerated interest in the 2020s with the huge interest and investments in AI and humanoids (for more information on humanoids, download STIQs report on Humanoids)

SHOULD WE WAIT FOR HUMANOIDS?

- System integrators/ consultants are increasingly being asked about humanoids as the marketing of these is quite successful in social media, such as YouTube, LInkedIn, etc.

"Of course, people are asking about humanoids… 'should I even start with mobile robots or should I wait for humanoids?' The marketing of humanoids is really awesome and you have the feeling that there will be a humanoid doing the whole job in a few weeks time. And why should I start with not so fancy AGVs if there will be humanoids soon?" [Automation A]

INCREASING USE OF ARTICULATED ARMS ON MOBILE ROBOT PLATFORMS (NOT TO SCALE)

- AGV/AMR mouse/turtle robot without any top attachment

- AGV/AMR mouse/turtle robot with top articulated robot arm attachment on 'mobile trolley'

- AGV/AMR mouse/turtle robot with top 'humanoid form factor' including 2x articulated robot arms

Image source: SAFELOG , Omron, Kinisi Robotics

PARALLELS WITH AGV VS AMR MARKETING

- There is some precedent and a parallel with marketing of the importance of obstacle avoidance in the AGV (line guided) versus AMR (free navigation) conversation

- This also appears to have further confused potential customers in the market

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MULTIPLE ACQUISITIONS OF DISTRESSED AGV & AMR COMPANIES IN 2025. POTENTIAL FOR AN INCREASE IN OPPORTUNISTIC M&A IN 2025 AND 2026

MARKET MAY TURN BAD FOR SMALLER CO'S

- Interviews suggest there is a likelihood for further problems, especially among smaller vendors

"There's no risk for the top 5 vendors. They have enough demand and they also have cash to support them for further development. For those beyond the top 10, there will be some action needed to emerge or maybe some of them will be bankrupt." [China Forklift Blog]

- VC funding drying up may also exacerbate the impact
- There are early distress signals in the marketplace

MULTIPLE VENDORS IN DISTRESS IN 2025

- News of EK Robotics (Germany) running into problems in 2025 was received with sadness throughout the industry as it may reflect on the current state of business

"That's bad for everyone, because such a good company like EK Robotics having trouble is not good." [Anonymous]

"It's very sad what happened to EK Robotics." [Anonymous]

- There were a few more failures in 2025 including Kivnon in Spain

"We also see there are a lot of companies going bankrupt or have serious troubles." [Anonymous]

- Note both EK Robotics (acquired by Neura Robotics) and Kivnon (acquired by Green Robotics) were acquired/ saved and continue doing business under new ownership

OUTSIZED CAPACITY VS DEMAND IN THE AGV & AMR MARKET (SIMPLIFIED, NOT TO SCALE)

Capacity/ Vendors

Current market demand

Tugger

Turtle/ Mouse

Forktruck
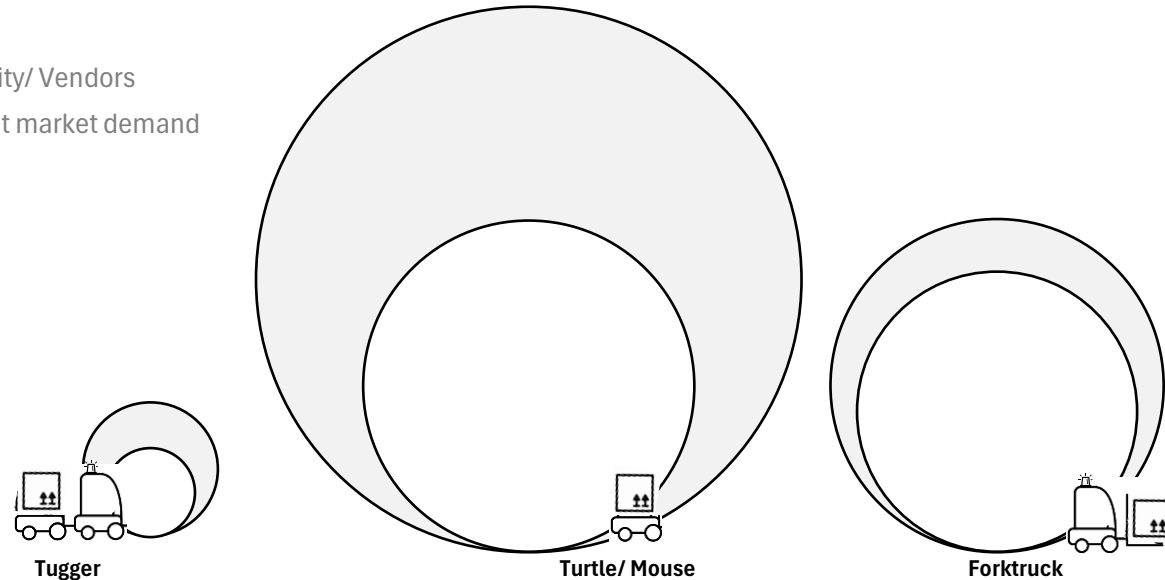
Source: STIQ Ltd Research & Analysis

"It's difficult to raise money now and some of the companies will be dead. Others will be sold to the bigger company. Many of them cannot stay alive themselves, I think." [Anonymous]

CAPACITY FAR OUTWEIGH DEMAND

- STIQ analysis suggest global production capacity in the three segments far outweigh demand or requirements, especially in the highly competitive Chinese market

- The Turtle/Mouse segment is the most competitive with most vendors and excess production capacity as larger projects tend to be in many 100's vehicles and some vendors may have oversized their production facilities

- Other segments appears to match demand more closely, but also include excess capacity

INCREASING NUMBER OF M&A TRANSACTIONS IN THE AGV & AMR SECTOR. GROWING SELECTION OF DISTRESSED COMPANIES MAY TURN INTO BUYERS MARKET

SELECTED AGV & AMR ROBOTICS SECTOR TRANSACTIONS, 2012-2025 (NOT EXHAUSTIVE)

2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026

2012
- Amazon acquire Kiva Systems

2013
- KION Group IPO `IPO`

2014
- KUKA acquire Swisslog
- Daifuku acquire Wynright

2015
- Dematic acquire SDI Group
- Casun IPO `IPO`
- Rofa Group acquire MLR Systems
- Noblelift IPO `IPO`
- JBS acquire Scott Automation

2016
- KION acquire Dematic
- Krones acquire System Logistics

2017
- ST Engineering acquire Aethon
- Asseco Group acquire CEIT
- Flexqube IPO `IPO`
- Matthews acquire Guidance Automation
- Miele acquire Yujin Robot
- Balyo IPO `IPO`

2018
- Teradyne acquire MIR
- Muratec acquire AGVE Group
- Vinci Energies acquire AVT Europe

2019
- Shopify acquire 6 River Systems
- Teradyne acquire AutoGuide
- Promach acquire Quest Industrial

2020
- SwissFactory acquire Ansorix
- Porsche acquire Serva TS

2021
- Regal Beloit and Rexnord merger
- Jungheinrich acquire Arculus
- ABB acquire ASTI Mobile Robots
- Cyngn IPO `IPO`
- Elektroautomation acquire EA Robotics
- Verizon acquire IncubedIT
- Inpixon acquire Intranav
- JASCI Software acquire Nextshift Robotics
- Zebra acquire Fetch Robotics

2022
- Reliance Retail acquire Addverb
- Latour acquire MAXAGV & Soft Design
- Zapi acquire Bluebotics
- Hitachi acquire Flexware
- Movu Robotics acquire iFollow

2023
- Jungheinrich acquire Storage Solutions
- Alstef acquire Solution Net Systems
- SoftBank acquire Balyo
- Agile Robotics acquire BAR Automation
- Continental acquire Kinexon
- Regal Rexnord acquire KOLLMORGEN
- Rockwell acquire Otto Motors

2024
- Enerpac acquire DTA
- Lincoln Electric acquire Redviking
- Camline acquire Romaric
- ABB acquire Sevensense Robotics
- Troax acquire ST&L
- WDX acquire Versabox
- Mpac Group acquire CSi Palletising

2025
- Geek+ IPO `IPO`
- Cap Capital acquire Kivnon
- Neura Robotics acquire EK Robotics
- SICK acquire Accerion
- Fleetglue acquire Freedom Robotics
- Serve Robotics acquire Phantom Auto
- SoftBank acquire ABB Robotics (TBC)

AGV & AMR ROBOTICS SECTOR M&A ACTIVITY
- The AGV & AMR sector experienced a relatively low level of M&A activity up to 2021 when activity accelerated, potentially as a result of Covid infused market dynamics
- M&A activity continues at a relatively elevated level

IPO ACTIVITY SET TO ACCELERATE?
- While there were many 100's of SPAC IPOs in various industries during the height of Covid, only a single IPO registered in 2021 in the AGV & AMR sector
- There are, however, now a number of Chinese vendors queuing up for IPOs following Geek+'s listing in mid-2025

- When this report was produced there were at least 4 Chinese AGV & AMR (and related businesses) with IPO applications
- If these are viewed as successful, this may also spark further IPO activity in Europe & North America

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Mobile Automation Group
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3Laws
US | 2022

Safety does not mean slowing or stopping

90%+ fewer safety zone violations

20%+ higher motion efficiency

Maximize AMR Throughput with 3Laws Dynamic Safety

ABB Mobile Robots
CH | 1988

- AGV & AMR vendor
- Acquired by SoftBank (TBC)

Acieta
US | 2015

- System Integrator

Aesir
BE | 2025

- Consultant

Agilox
AT | 2017

- AGV & AMR vendor

AGV Consult BV
NL | 2017

- Consultant

AGVE Group
SE | 1986

- AGV & AMR vendor

AI Automation
RO | 2018

- AGV & AMR System Integrator

Aitech
SG | 2013

- AGV & AMR vendor

Align Production System
US | 1967

- AGV & AMR vendor

Alstef Group
FR | 1961

- AGV & AMR vendor

Amerden AGVs
US | 1988

- AGV & AMR vendor

Anronaut
CH | 2002

- AGV & AMR vendor

ArcBest Vaux
US | 1923

Intelligence Behind Every Move

Vaux Smart Autonomy™ brings a new level of efficiency and flexibility to warehouse operations. AMR forklifts and reach trucks, powered by intelligent fleet software and remote teleoperation, automate the workflows that keep supply chains moving.

Want smarter material handling? Explore Vaux™

Automation A
DE | 2013

- AGV & AMR System Integrator

Automni
BR | 2014

- AGV & AMR vendor

Balyo
FR | 2005

- AGV & AMR vendor

Big Joe Forklifts
US | 1951

- AGV & AMR vendor

AGV & AMR ROBOTICS DIRECTORY: B-D

BlueBotics
CH | 2001

- ANT navigation & fleet management
- 150+ models of 'ANT driven' AGV/AMR
- 6,000+ vehicles in operation

Automate vehicles: BlueBotics.com
Browse vehicles: ANTdriven.com

Bluepath Robotics
TR | 2019
- AGV & AMR vendor
- Spinout from Ford Otosan

Botsync Robotics
SG | 2017
- AGV & AMR vendor

BlueSky Automation
US | 2018
- System integrator

Brother International Corp
JP | 1934
- Component supplier

Canon U.S.A., Inc.
US | 1955

Vision-Based Navigation Software

Canon's Visual SLAM technology enables quick startup, fast map loading, and seamless adaptation to changing environments with rapid recovery from localization loss.

Contact:
vision-solutions@cvi.canon.com

Learn More:
https://canon.us/visualslam

Brisa
BR | 2018
- AGV & AMR vendor

Casun
CN | 2007
- AGV & AMR vendor

Chaint Corporation
CN | 1996
- AGV & AMR vendor

Conveyco
US | 1979
- System integrator

Conductix-Wampfler
DE | 1959

WirelessCharger 3.0 — Charging Contacts — KontaktCharger — Energy Storage — RadioSafe

Do you need charging and data communication for your Mobile Robots?

Cornerstone Speciality
US | 2003
- Flooring supplier

Crown Equipment Corp
US | 1945
- AGV & AMR vendor

CSi Palletising
NL | 1964
- AGV & AMR system integrator
- Acquired by Mpac Group in 2024

Daifuku
JP | 1937
- AGV & AMR vendor

60

Dematic
US | 1819
- AGV & AMR vendor

DS Automotion
AT | 1984
- AGV & AMR vendor

DTA
ES | 1974
- AGV & AMR vendor

Duality
US | 2019
- Digital Twin software

EP Equipment
CN | 2007

Durable Surfaces
US | 2001
- Flooring supplier

E80 Group
IT | 1980
- AGV & AMR vendor

Encoder Products Company
US | 1969
- Component supplier

EnerSys
US | 2000
- Component supplier

Expert Technology Group
UK | 1972
- AGV & AMR vendor

Filics
DE | 2019
- AGV & AMR vendor

Flowbotic
PT | 2022
- AGV & AMR vendor

Gideon
HR | 2017
- AGV & AMR vendor

Gray AES
US | 1960
- System integrator

Grow Automation
SE | 2023
- Consultant

Guide Robotics
JP | 2020
- AGV & AMR vendor

HAI Robotics
CN | 2016
- AGV & AMR vendor

Hamilton Caster
US | 1907
- Component supplier

Hakuou Robotics
JP | 2022
- AGV & AMR vendor

Hangcha Group
CN | 2004
- AGV & AMR vendor

Hedin Lagan
SE | 1996
- AGV & AMR vendor

Hikrobot
CN | 2014

Transforming Logistics Elevating Production
Wide-Ranging AMRs & AGVs for Every Need
Experience & Scale in Every Industry

100,000+ AMRs Produced
17,000+ Clients
200+ Scenarios Mastered

Huaxiao
CN | 2006

- AGV & AMR vendor

ifm
US | 1969

- Component supplier

MAG Mobile Automation Group

JBT Corp
US | 1894

- AGV & AMR vendor

MAG Mobile Automation Group

Jungheinrich
DE | 1953

- AGV & AMR vendor
- IPO in 1990

KOLLMORGEN
SE | 1972

NDC Solutions by KOLLMORGEN, a Regal Rexnord brand, is an industry leading platform utilized by top AGV & AMR builders to create driverless logistics automation solutions.

- The platform consists of both **software** to manage fleets and route vehicles efficiently, and **hardware** for navigation and control.

- With KOLLMORGEN you have the power to automate any type of vehicle, in any industry, worldwide.

Real Stories, Real Results on LinkedIn

K Hartwall
FI | 1932

- AGV & AMR vendor

KION Group
DE | 1819

- System integrator

MAG Mobile Automation Group

LIFT by Flexware Innovation
US | 1996

LIFT by Flexware Innovation

SOFTWARE FOR ALL THE WAYS YOU MOVE MATERIALS
INTEGRATE
SIMPLIFY
OPTIMIZE
WWW.LIFT.SOFTWARE

Kivnon
ES | 2007

- AGV & AMR vendor
- Acquired by Cap Capital in 2025

MAG Mobile Automation Group

Knapp
AT | 1952

- System integrator

MAG Mobile Automation Group

KPI Solutions
US | 2006

- System integrator

MAG Mobile Automation Group

Kudan
JP | 2011

- Software vendor
- IPO in 2018

LGIM
CN | 2013

- AGV & AMR vendor

MasterMover
UK | 1997

- AGV & AMR vendor

AGV & AMR ROBOTICS DIRECTORY: M-N

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MAXAGV
SE | 1990

Most probably we have done it before

- MAXAGV develops and produces proprietary AGV/AMR systems that automates your intralogistics.
- 35+ years of experience.
- Installations in 25+ countries.

Contact us here

Micropower Group
US | 1984

- Component supplier

Mitsubishi HC Capital America
US | 1971

- Finance provider

Mobile Automation Group
US | 1987

- We are an independent non-profit authority comprised of almost **50** OEMs, component manufacturers, integrators, and consultants.

- Through blogs, podcasts, seminars, videos, and other thought leadership avenues, we inform practitioners, end-users, and suppliers on market trends, technology developments, safety, best practices, and applications.

- Provide education and scholarships to students and young professionals to bolster the industry

Movu Robotics
NL | 2023

- AGV & AMR vendor

Murata Machinery
JP | 1935

- System integrator

Mobotic
DE | 2019

MoboDrive ST
STEERED TRACTION UNITS
for Omni-directional Mobile Robots

ENDLESS STEERING
TRACTION

Plug & Play | Designed for highly maneuverable AMRs & AGVs | Endless rotation | High-torque traction unit | Safe encoder systems | Robust motor control electronics | Compatible with industry standards

www.mobotic.de
info@mobotic.de

NAiSE GmbH
DE | 2017

AUTOMATED INTRALOGISTICS DO IT YOURSELF

MANAGING THE WHOLE MATERIAL FLOW WITH ONE SOFTWARE

NODE Robotics
DE | 2020

NODE Robotics delivers advanced, reliable, and modular software that maximizes the potential and scalability of mobile robots (AGVs/AMRs).

NODE.OS modules provide:
- **Live SLAM Localization delivers continuous map updates for precise positioning and stable performance in dynamic environments.**
- **Autonomous Hybrid Navigation enables flexible path planning and reliable obstacle avoidance in complex industrial settings.**
- **Scalable Task Management utilizes standardized VDA5050 interfaces for efficient pick-up, transport, and drop-off workflows.**
- **Advanced Fleet Management ensures optimized collaboration and coordinated traffic control across mixed AMR and AGV fleets.**

Key Benefits:
☑ Proven Reliability: 1500+ mobile robots successfully deployed
☑ Ease of Use: Quick integration and independent configuration
☑ Modular Architecture: Flexible adaptation to individual needs
☑ Hardware Agnostic: Full independence in hardware selection

AGV & AMR ROBOTICS DIRECTORY: O-S
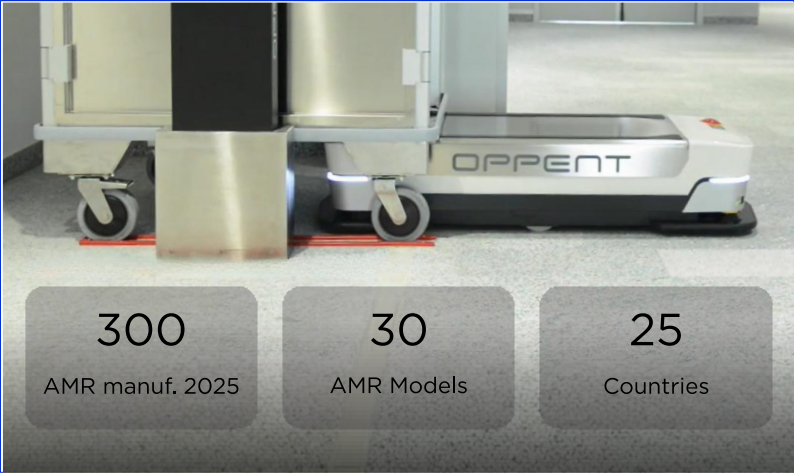
Oceaneering
US | 1964

- AGV & AMR vendor

Omron
JP | 1933

- AGV & AMR vendor

Oppent
IT | 1960

OPPENT

300	30	25
AMR manuf. 2025	AMR Models	Countries

openmaind
AT | 2025

- Software vendor

Performance Networks
UK | 2012

- Wifi specialist

Pepperl+Fuchs
DE | 1958

- Component supplier

Phoenix Contact
US | 1923

- Component supplier

Pilz
DE | 1948

- Component supplier
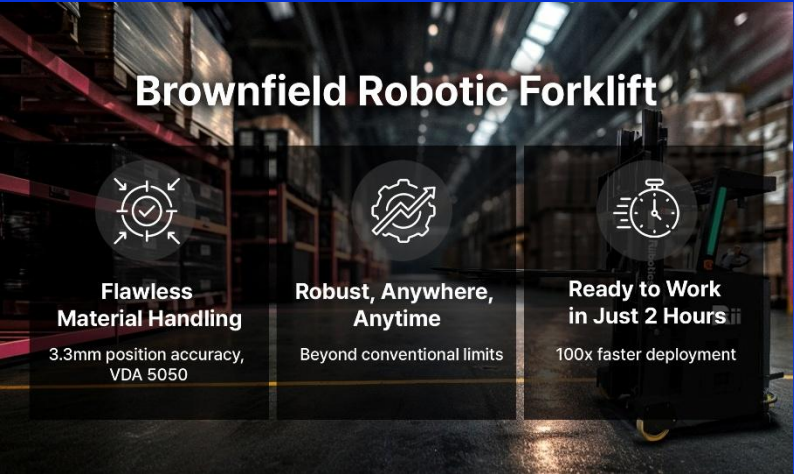
Rapyuta Robotics
JP | 2014

- AGV & AMR vendor

Riibotics
KR | 2024

Riibotics
Robotics for industrial innovation

Brownfield Robotic Forklift

Flawless Material Handling
3.3mm position accuracy, VDA 5050

Robust, Anywhere, Anytime
Beyond conventional limits

Ready to Work in Just 2 Hours
100x faster deployment

Raymond
US | 1922

- AGV & AMR vendor

Robotec
PL | 2019

- Software vendor

Rockwell Automation
US | 1903

- Component supplier

Rocrich AGV Company
US | 2023

- AGV & AMR vendor

Russell Robotics
KR | 2012

- AGV & AMR vendor

SAFELOG
DE | 1996

- AGV & AMR vendor

Seegrid
US | 2003

- AGV & AMR vendor

SEW Eurodrive
DE | 1931

- Component supplier

Sonair
NO | 2022

Are your humans safe around robots?
Introducing **ADAR**, the world's first safe 3D ultrasonic sensor for autonomous robots.
sonair.com

SICK
DE | 1964

- Component supplier

Siemens Industry
DE | 1847

- Component supplier

Techvico
VN | 2019

We provide SLAM AMR Material handling solutions

Why Techvico?
Trusted by Fedex. Cost effective. Reliable & Industry Proven

We don't just build reliable AMRs — we **design intelligent systems** that deliver **end-to-end material handling automation**, helping your business operate more efficiently and reduce costs.

Brownfield or greenfield — we've got you covered.
Contact us today.

Slamcore
UK | 2016

- Software supplier

Slapstack
DE | 2024

- Software vendor

Slip Robotics
US | 2020

- AGV & AMR vendor

Standard Robots
CN | 2015

- AGV & AMR vendor

T-Robotics
KR | 2018

- AGV & AMR vendor

The Mobile Robot Company
DK | 2025

- AGV & AMR vendor

Third Wave
US | 2018

- AGV & AMR vendor

Thoro.ai
US | 2021

- SW vendor

TOYO Automation
TW | 2008

- AGV & AMR vendor

Toyota Material Handling
JP | 2013

- AGV & AMR vendor

TriOrb
JP | 2023

- AGV & AMR vendor

Tusk Robotics
CN | 2021

- AGV & AMR vendor

TUV Sud
DE | 1866

- Service provider

Vecna Robotics
US | 2018

- AGV & AMR vendor

VisionNav
CN | 2016
- AGV & AMR vendor

Wagner Fire Safety
DE | 1976
- Component supplier

Xscaleo
DE | 2024
- Consultancy

Yale Lift Truck Technologies
US | 1875
- AGV & AMR vendor

Zebra Technologies
US | 1969
- AGV & AMR vendor

WHY ARE WE NOT INCLUDED? *(most common question to STIQ)*
HOW IS THIS DIRECTORY PUT TOGETHER?

- STIQ tracks >600 AGV & AMR vendors including hard- and software vendors, integrators, consulting firms, etc. globally
- This directory contains c.100 of these companies
- Sponsors and companies interviewed are always included

STIQ LTD
UK | 2018

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- **Global stakeholder audience** with **>55,000 downloads** since 2020 and a min. 5X viral multiplier (est. >225,000 readers)
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3Laws

MAG Mobile Automation Group
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STIQ INTERVIEWED THESE STAKEHOLDERS

- 3Laws (US) — COO
- Aesir (BE) — CEO & Founder
- AI Automation (RO) — CEO
- ArcBest Vaux (US) — VP Smart Autonomy Engineering
- Automation A (DE) — Managing Partner, Co-founder
- Bluebotics (CH) — CEO
- Canon U.S.A. (US) — Advisor, Business Planning & Development
- China Forklift Blog (CN) — Founder
- Conductix-Wampfler (DE) — Global Market Director Industrial Automation
- CSi Palletising (NL) — System Sales Engineer
- E80 Group (US) — President North America
- EP Equipment (NL) — VP Automation, Europe
- Expert Technology Group (UK) — Business Development Manager
- Filics (DE) — CEO
- Flexware (US) — VP of Products
- Hikrobot (CN) — Sales Executive
- Jungheinrich (DE) — Manager Market Intelligence
- K Hartwall (FI) — Head of Automation
- KOLLMORGEN (SE) — Product Management Director
- Kudan (JP) — COO
- MAXAGV (SE) — CEO
- Mitsubishi HC Capital America (US) — VP Sales
- Mobotic (DE) — CEO & Founder
- NAiSE (DE) — CEO & Co-founder
- NODE Robotics (DE) — CEO & Co-founder
- Omron (US) — Global Product Marketing Manager AMR
- openmaind (AT) — CEO
- Oppent (IT) — CEO
- Pilz (DE) — CC Robotics Manager
- Rapyuta Robotics (JP) — AFL Sales Lead
- Riibotics (KR) — CEO
- Robotec (PL) — CEO
- Russell Robotics (KR) — CTO
- SAFELOG (DE) — Managing Director
- SICK (DE) — Strategic Product Manager
- Slapstack (DE) — CEO
- Sonair (NO) — CMO
- Techvico (VN) — CEO
- The Mobile Robot Company (DK) — CEO & Co-founder
- Third Wave (US) — CEO
- Thoro (US) — CEO
- Toyota Material Handling (SE) — SVP
- Tusk Robot (CN) — Director of Global Development
- TUV Sud (DE) — Head of Machine Safety Dept
- Vecna Robotics (US) — CCO
- VisionNav (CN) — VP Global Sales
- Xscaleo (DE) — CEO & 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

- Automatica — (Munchen, DE) — WEB
- Automate — (Detroit, US) — WEB
- CeMAT Asia — (Shanghai, CN) — WEB
- IMHX — (Birmingham, UK) — WEB
- LogiMAT — (Stuttgart, DE) — WEB
- LogiMAT SEA — (Bangkok, TH) — WEB
- Logis Tech Tokyo — (Tokyo, JP) — WEB
- Manifest — (Las Vegas, US) — WEB
- Modex — (Atlanta, US) — WEB
- NRF Big Show — (New York, US) — WEB
- Promat — (Chicago, US) — WEB
- Robotworld — (Seoul, KR) — WEB
- STIQRobotics — (London, UK) — WEB

AGV & AMR ROBOTICS RELATED GLOSSARY

AMR	Autonomous Mobile Robot
AGV	Automatic Guided Vehicle
AS	Asia
ASRS	Automatic Storage & Retrieval System
BOGO	Buy One Get One Free (aka BOGOF)
CAGR	Compound Annual Growth Rate
CPG/FMCG	Consumer Packaged Goods (US/UK)
DC	Distribution Centre
EU	Europe
FC	Fulfilment Centre
FLV	Forced Liquidation Value
FMV	Fair Market Value
G2P, GTP	Goods to Person
GOH	Garment On Hangers
LLM	Large Language Model (AI)
M&A	Mergers & Acquisitions
MES	Manufacturing Execution System
MHE	Material Handling Equipment
NA	North America
RAAS	Robotics As a Service
ROI	Return On Investment
SI	System Integrator
SMB/SME	Small & Medium Businesses (US / UK)
TBC	To Be Confirmed
TOF	Time of Flight (used for distance measurement)
US	United States of America
WCS	Warehouse Control System
WES	Warehouse Execution System
WMS	Warehouse Management System