AGV & AMR ROBOTICS 2024

MOBILE ROBOTS IN FACTORY, PRODUCTION & WAREHOUSE ENVIRONMENTS | NOV 2024

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EXEC SUMMARY: HIGHLY OPTIMISTIC 2024 WITH LOW VISIBILITY FOR 2025. THE US MARKET AND FORKTRUCKS CONTINUES TO PERFORM. CHINA TURNING TO INNOVATION?

2024 VERY OPTIMISTIC, 2025 OPAQUE

- Nearly 80% of respondents for this report forecast a very healthy 2024 performance; the comparable KPI for 2023 was only 60%

- Whilst there were some positive suggestions for 2025, few were able to provide a clear signal, hinting at an increasingly opaque market outlook

- The US market was widely viewed as outperforming the rest of the world and the recent election outcome may also further accelerate growth

- European and Asian markets are in decline or flattish

- There is significant traction in the forktruck segment which is a continuation of the popularity of F2F vehicles (aka "pump trucks") lifting max 1m

GROWTH INHIBITORS

- While many vendor interviews hinted at a growing awareness of AGVs & AMRs, important barriers to faster market growth remain

- Such barriers are primarily focused on end-customer's knowledge of intralogistics flows, orchestration and SOPs among other things

- There are also innovation barriers with demand from many customers (one such interviewed here) with unsuitable flow characteristics for the current crop of AGVs & AMRs

END CUSTOMER + EXPERT INTERVIEWS

- STIQ interviewed 3x end-customers with a combined revenue of $185bn with a variety of automation experience and stages for this report

- These interviews highlight the many challenges of driving further growth in the AGV & AMR sector

- STIQ also interviewed 3x experts incl. a former CEO and industry veterans with great insights on how to develop and gain market traction

NORTH AMERICA AND THE US

- North America remains the most important market for nearly all vendors interviewed from Europe and Asia looking to establishing a presence in the market

- Tariffs of 25% on Chinese robots were introduced during the first Trump administration and the next 4 years may include more barriers to trade

- A heightened level of politically induced market volatility is to be expected in the short to medium term

CHINA, CRADLE OF INNOVATION?

- China remains the most important market for AGVs & AMRs by volume, however, few vendors operate domestic projects profitably due to ever intensifying price pressures

- Some vendors view overseas markets as the only route to profitability

- Intensifying domestic competition may have pushed many Chinese vendors to innovate with a growing range of unique solutions originating in the market

IPOs COMING IN 2H25?

- A small number of startups indicated profitability with a growing potential for IPOs and/or higher exit multiples in 2025-2026

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- To advertise in STIQs publications and to gain important exposure to end-customer decision makers, vendors, investors, component suppliers and more – request our media pack or contact us

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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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THERE ARE THREE PRIMARY FORM FACTORS IN THE AGV & AMR ROBOTICS SECTOR: FORKTRUCK, MOUSE AND TUGGER

## THREE PRIMARY AGV & AMR FORM FACTORS

- STIQ divides the AGV & AMR Robotics market into three primary form factors – Forktruck, Mouse and Tugger
- **Forktrucks** are vehicles with forks for picking up and depositing pallets, trolleys, etc. and can pick up from the ground or from heights in storage racks, etc.
- Forktrucks are sub-segmented into F2F, Stacker and VNA trucks
- **Mouse** vehicles are the most versatile AGVs & AMRs and can be confusing to newcomers to the sector
- The primary function of a mouse is to travel under a payload and pick up or attach to it for transportation, but can also be something put on top of the vehicle, etc.
- Mouse vehicles often come with a "top attachment" or "end effector", such as a roller top, lifting mechanism, etc. which can also often add significant cost to these vehicles
- Mouse vehicles come in a huge variety of weight capacities, from serialised production vehicles taking <30Kg, to custom built vehicles managing >100t
- **Tuggers** essentially pull a payload, typically a train of trollies and mimic manual tuggers
- Note that due to new innovations in the AGV & AMR sector, these three form factors increasingly overlap with each other and it can be difficult to isolate segments

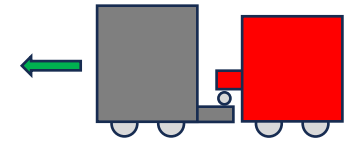## THE THREE PRIMARY AGV & AMR FORM FACTORS: FORKLIFT, MOUSE/TURTLE, AND TUGGER
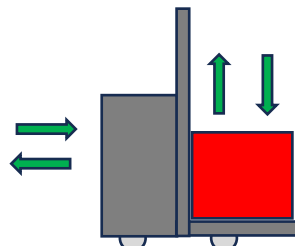
Forktruck
USPs: Autonomous lifting
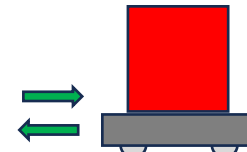
Mouse
USPs: Most versatile form factor. Add-ons available for lifting, moving, etc.

Tugger
USPs: Autonomous tugging

Key: ⬅ Direction of movement (typical) 🟥 Payload ⬛ AGV /AMR Chassis/ body

Source: STIQ Ltd Research & Analysis

A VARIETY OF NAVIGATION TECHNOLOGIES

- There is an evolving range of different navigation technologies that can be used with AGVs & AMRs giving vehicles more or less autonomy
- Some vehicle vendors offer multiple navigation technologies while others specialise in a single technology
- The choice of navigation technology can often depend on a particular application scenario; if the environment is highly dynamic, with a highly repetitive pattern, light conditions, etc.

- For example, a semiconductor environment may not require solutions where humans cross vehicle paths and may use more guided technologies such as datametric
- Other applications may have to work with people and are not possible to fence off
- Some applications such as car manufacturing production lines have to meet specific takt times and robots have to be highly predictable which may demand a specific technology
- Furthermore, in highly dynamic environments that change a lot, perhaps a SLAM type solution may be more suitable

THE PRIMARY MISSION FOR AGVs & AMRs IS A-B TRANSPORTATION. HOWEVER, AN INCREASING OVERLAP WITH STORAGE MISSIONS

AGV AND AMR ROBOTS ARE USED TO MOVE RAW MATERIALS AND/OR FINISHED GOODS

Yard

Factory

Finished Goods

Materials
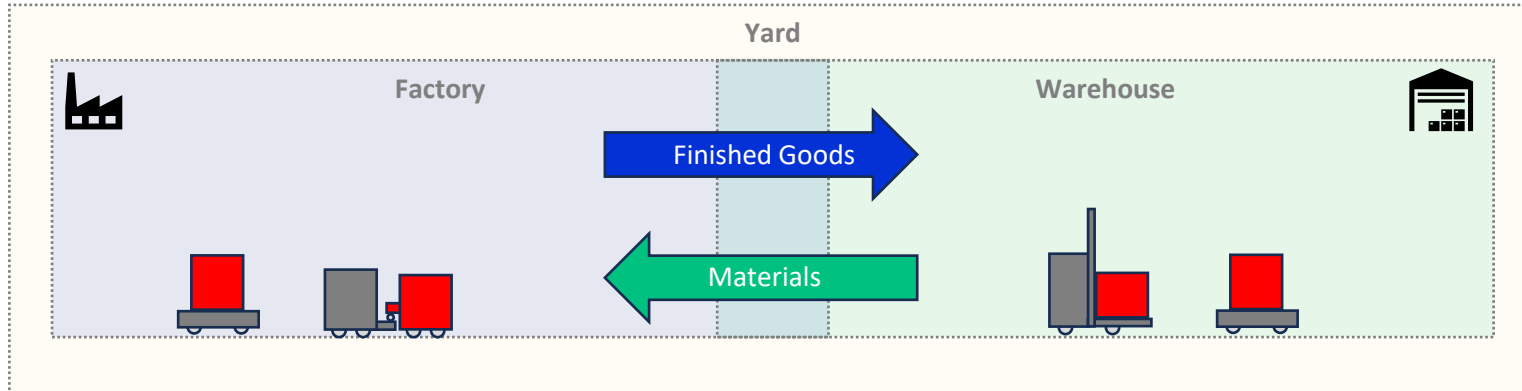
Warehouse

- Typical vehicle form factors in manufacturing environments are Mouse and Tuggers and also Custom Vehicles

- Typical vehicle form factors in warehouse/ storage environments are Mouse and Forktrucks
- Forktrucks may also drive in yards

Source: STIQ Ltd Research & Analysis. Graphic used to highlight typical deployments. Forktrucks are being used in production facilities and factories, and tuggers are also being used in warehouses
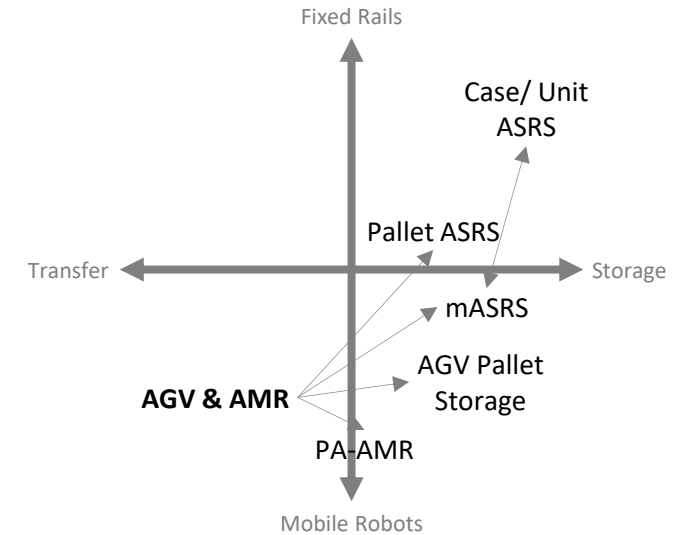
AGV & AMR IN TRANSPORTATION MISSIONS

- AGVs & AMRs are primarily used in transportation missions and typically compete with conveyors or manual transfers
- Relevant transportation missions typically occur in manufacturing, warehouse and/or distribution facilities, and can include metal foundries, semiconductor wafer production, parcel shipping, car manufacturing plants and beyond

STORAGE MISSION OVERLAP

- Note transportation missions may overlap with storage missions and some (solution) vendors include AGVs & AMRs as part of larger solutions, typically entire warehouses where AGVs/AMRs represent a smaller part
- An increasing number of AGV & AMR vendors are moving towards provisioning solutions by combining systems
- These solutions have tended to focus on pallet handling rather than case or unit handling

AGV & AMR INCREASINGLY OVERLAPPING WITH OTHER MHE SECTORS AND SEGMENTS

Fixed Rails

Case/ Unit ASRS

Pallet ASRS

Transfer

Storage

mASRS

AGV & AMR

AGV Pallet Storage

PA-AMR

Mobile Robots

- However, developments in recent years have further blurred distinctions and some AGV & AMR vendors increasingly overlap with Goods to Person Solutions (unit or "eaches" storage and picking focus)
- If you are looking for Storage & Retrieval automation used in ecommerce type warehouses, please refer to STIQs G2P Solution reports here

EXTREMELY WIDE VARIETY OF SIZES, SHAPES AND WEIGHTS OF PAYLOADS, OFTEN SPECIFIC TO CUSTOMER SECTORS, ESPECIALLY WITH THE MOUSE FORM FACTOR

HUGE PAYLOAD VARIETY (WEIGHT, SIZE, SHAPE) IN THE AGV & AMR ROBOTICS SECTOR
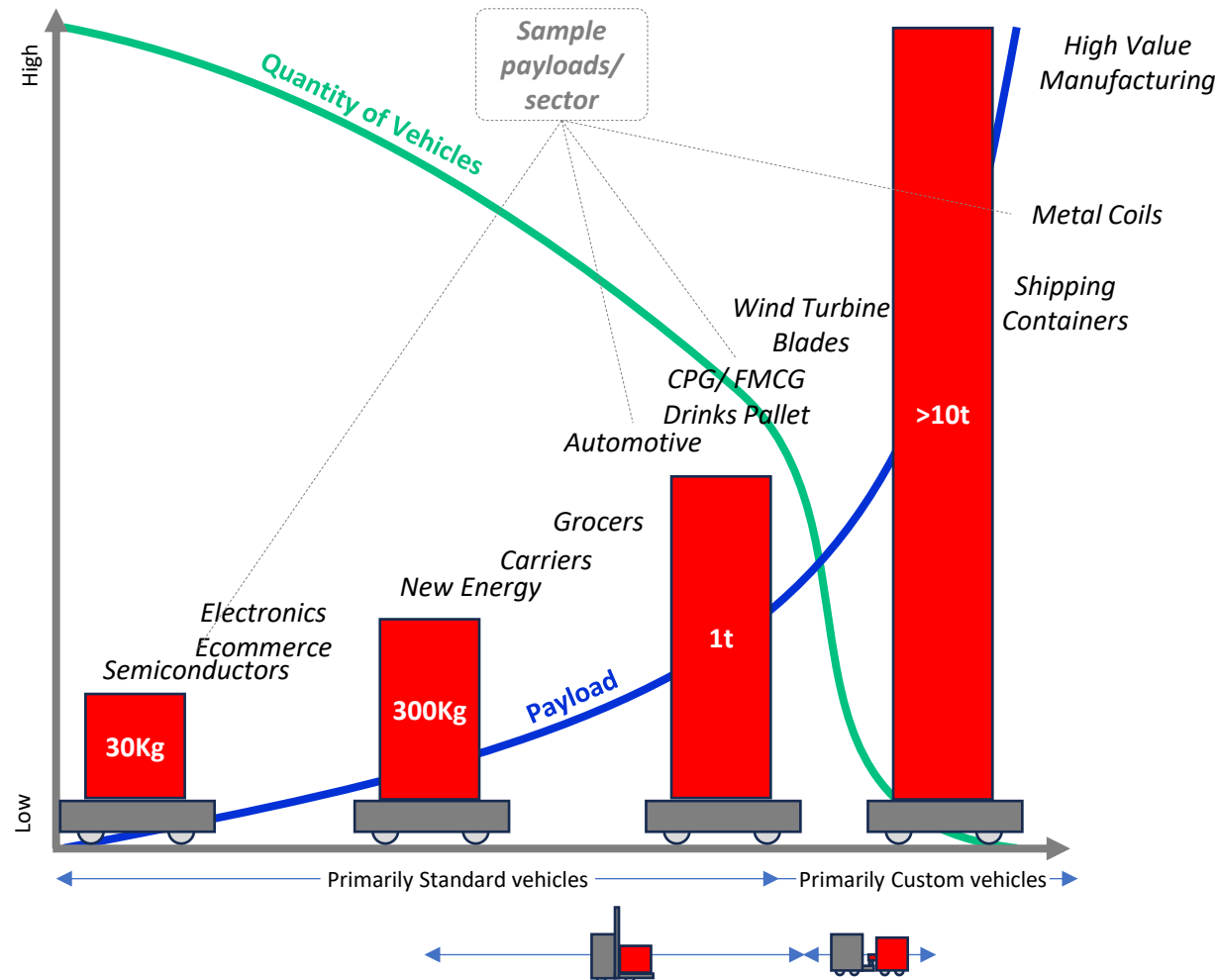
SIGNIFICANT VARIATION IN PAYLOADS

- Payloads for AGVs & AMRs can vary significantly, especially for the mouse form factor whereas forktruck and tugger payloads tend to be relatively static

- Forktruck payloads generally vary between 300-2,000Kgs and tuggers at about 5-10tonnes (note the latter is pulling, rather than lifting, payloads)

- While a majority of mouse AGVs & AMRs (by volume of vehicles) vary in payload between 100-1500Kgs, the form factor can range from as little as 30Kgs and go up to sometimes many 10's of tonnes

CUSTOM HIGH PAYLOAD AGVs & AMRs

- Many incumbents have evolved standardised vehicle options which are highly configurable, especially vendors selling forktrucks

- The difference between highly configurable and customised can sometimes be opaque

- However, customised high payload vehicles tend to be mouse vehicles starting in payload from 2,000Kgs

- Customisation levels may vary and there can also be a high degree of configurability in many incumbent's vehicles with standard payloads

- Payloads which require custom vehicles can include wind turbine blades, tractor chassis, large scale transformers, etc. weighing many tonnes

- As a side note, some custom vehicles with very high payloads can occasionally be entirely controlled by radio/ remote controls, often based on specific circumstances

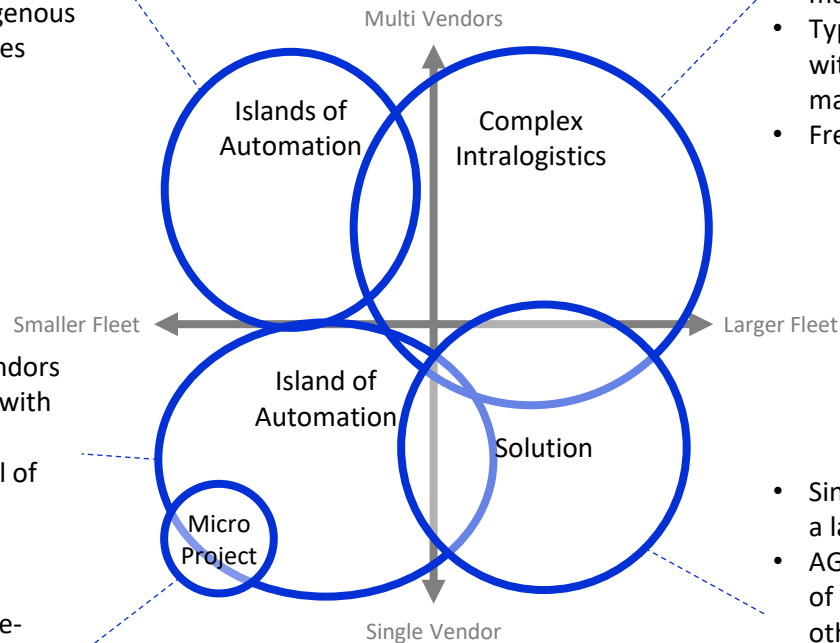*Source: STIQ Ltd Research & Analysis*

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THE LEVEL OF COMPLEXITY IN AGV & AMR DEPLOYMENTS VARIES SIGNIFICANTLY, FROM SIMPLE MANUAL ORDER INPUT TO FULLY AUTONOMOUS FLEETS WITH 100'S OF VEHICLES

WIDE VARIETY OF COMPLEXITY IN AGV & AMR DEPLOYMENTS (SIMPLIFIED)

- Single vendor, possibly mixed form factor fleet with >50 vehicles
- Intersection with manual vehicles
- May be completely homogenous large fleets of single vehicles

- Multiple vendor (heterogenous) fleets and form factors with multiple and complex intersections
- Collaborative environment with manually operated vehicles
- Typically advanced end customers with teams of employees who can manage any failures
- Frequently >100 vehicles

- >5 vehicles from single vendors
- May include intersections with manual vehicles
- From medium to high level of complexity depending on application and industry

- <5 vehicles with simple, pre-programmed tasks
- No Fleet Manager required
- May feature manual orders

- Single vendor fleet, often as part of a larger solution (not always)
- AGV & AMR may account for 50% of entire solution, often including other types of automation
- May include embedded personnel to manage maintenance, support, etc.

Source: STIQ Ltd Research & Analysis

WIDE VARIETY OF FLEET COMPLEXITY

- AGV & AMR projects have varying levels of complexity from very simple deployments with <5 vehicles, which may not require fleet manager software, to many 100's of vehicles from multiple vendors interspersed with manual fleets
- The current state of the AGV & AMR sector is that most vendors have specialised in either Micro Projects, Large Single Vendor Deployments, Solutions, or Complex Intralogistics
- The earlier the vendor (startups), the more likely they focus on micro projects which may also be related to the business model
- Solution vendors typically do not entertain micro projects and use their AGVs & AMRs as a part of the solution sale, i.e. an entire warehouse or a functionality of storing and retrieving pallets, etc.
- Many vendors focus on solving individual transportation needs sometimes also referred to as islands of automation
- This may include micro projects as well as fleet deployments with many 100 vehicles but typically solve a single problem or problems for customers
- Complex intralogistics is predominantly advanced users of AGVs & AMRs with extensive experience of operating separate vendor's fleets, who now seek to combine these into more complex and optimised logistics flows
- Typically these customers are found in the automotive industry but increasingly also in electronics and related sectors
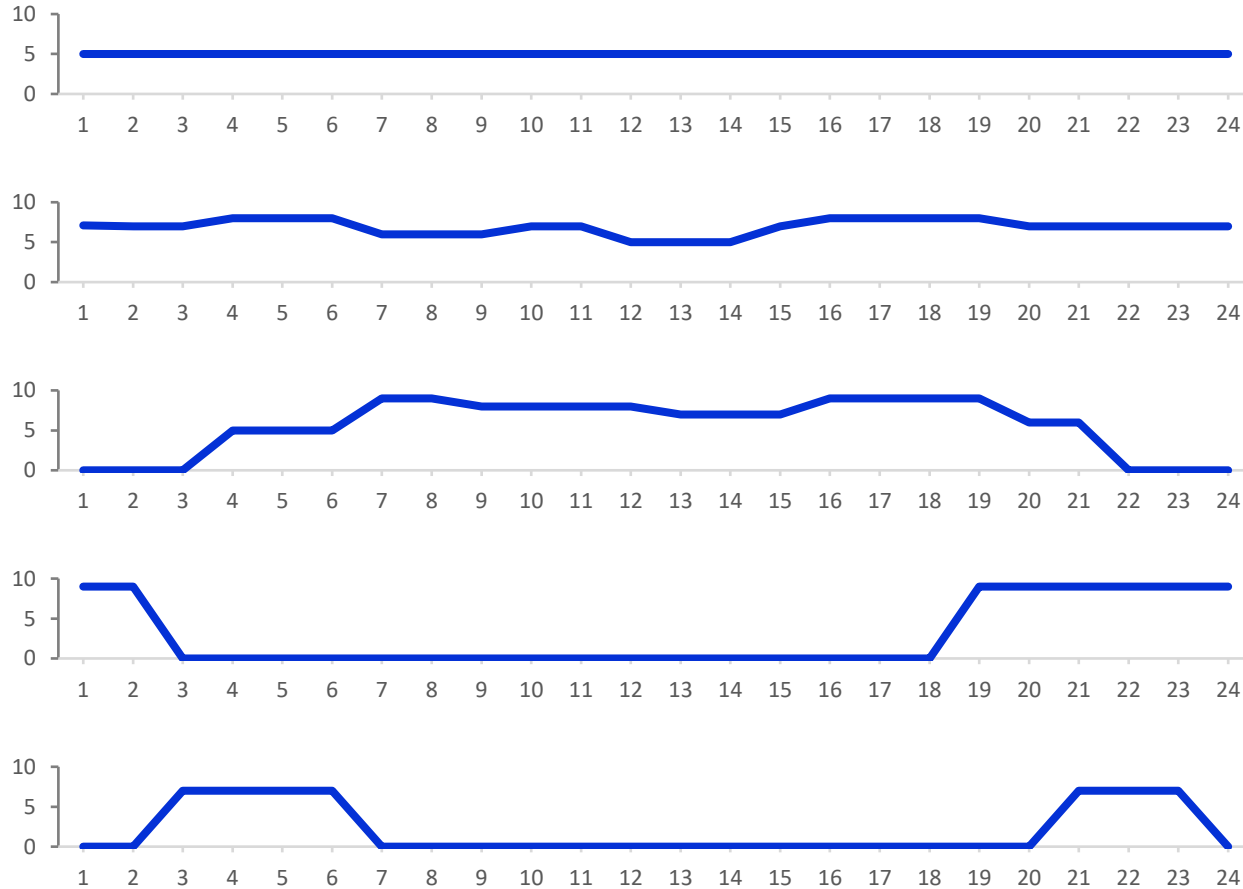
AGVs & AMRs CURRENTLY SUITABLE FOR SOME APPLICATIONS AND/OR INDUSTRIES MORE THAN OTHERS. FURTHER INNOVATION EXPECTED

HUGE VARIATION IN WORKLOAD BETWEEN POTENTIAL CUSTOMERS, INDUSTRIES AND SUITABLE APPLICATIONS FOR AGVs & AMRs (ILLUSTRATIVE EXAMPLE ONLY)

Illustrative Workload over 24hr period

Sample Industry

Car Manufacturer (3 or 4 shift operations)

CPG, F&B (3 or 4 shift operations)

Ecommerce Retailer (2-shift operations)

Courier, Postal Company (single shift)

Grocer (single operation in 3 shift operation)

Source: STIQ Ltd Research & Analysis. Perceived demand and/or requirement for AGVs & AMRs within a particular sector

WORKLOAD VARIABILITY

- Demand for AGVs & AMRs varies by industry and the type of transportation application

- Some applications are steady workloads spread over 24hrs and 3-4 shifts, whereas others are high intensity workloads during very short periods

- For example, car manufacturers typically have very stable output (combined with a highly automated strategy) which is highly conducive to AGVs & AMRs

- Other companies with more stable output and longer shifts where AGVs & AMRs may be suitable includes F&B, CPG, Electronics, etc. sectors

- Potentially large customers, such as Couriers and Grocers tend to have short intensive bursts with very high workload which they are looking to automate, but various limitations of AGV & AMR vehicles are barriers to adoption in some industries

STIQ WELCOMES CONVERSATIONS

- STIQ always welcomes end user contacts to discuss any potential applications for AGV & AMR Robots or material handling equipment covered in any of our reports

"We have researched the sector without finding any suitable vendor and thought you at STIQ might be able to confirm our search and/or give us some ideas. Our use case is very specific. We get fresh produce in the morning which needs to go to the shops as soon as possible. This gives us a 3hr window to... you can call it cross docking, if you will." [Anonymous]

AGV & AMR CUSTOMERS RANGE FROM COMPLETE NOVICES TO EXPERTS OFTEN WITH DIFFERENT LEVELS OF HANDHOLDING REQUIREMENTS
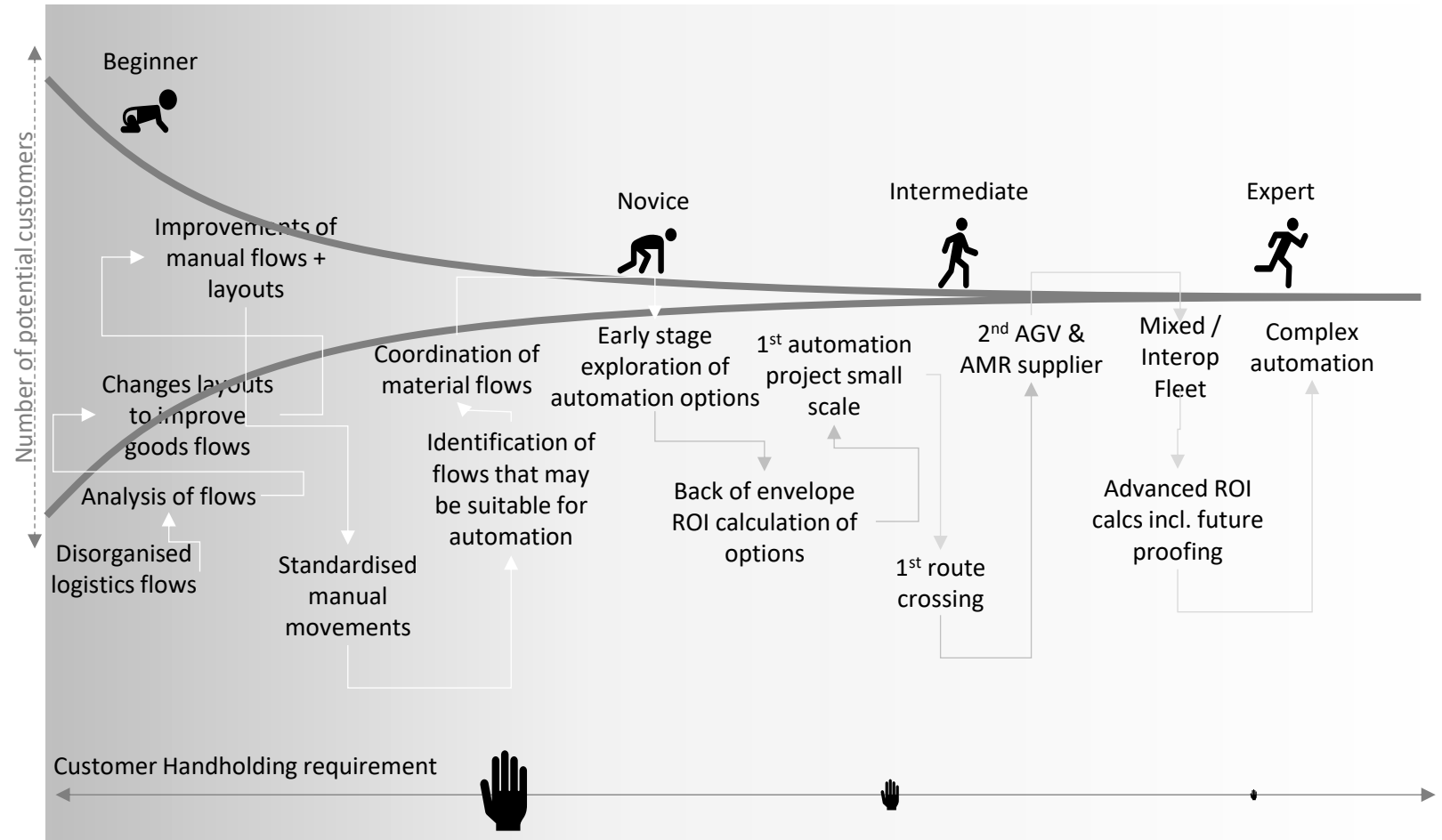
HANDHOLDING REQUIREMENT

- There is a wide range of customer readiness for AGVs & AMRs, often depending on the industry targeted

- **Beginners** can be completely unaware of mobile robots or may have heard about them but never used them or seen them in action

- Sales conversations with beginners can be very rudimentary and can be resource intensive on sales teams, often with low conversion rates, as there may be several manual steps of introducing SOPs, intralogistics thinking, etc. before an AGV/AMR sale can be executed

- **Novices** are at an early stage of thinking about mobile robots and may have done some research and gone to a few trade shows

- These customers may require some level of handholding on what is possible and which processes may be suitable for AGVs & AMRs, and perhaps on what navigation technology is most suitable

- **Intermediate** users have deployed a fleet or multiple mobile robot fleets and have gained important experience, but are yet to master deployments without vendor assistance

- **Experts** currently include car manufacturers and some electronics companies

THE SOLUTION SALE IS DIFFERENT

- Solution sales typically talk about outcomes rather than the particular piece of automation or vehicle type and navigation that is included, and are not overly concerned about the technologies involved

STIQ INTRALOGISTICS FLOW AUTOMATION READINESS SCALE

Source: STIQ Ltd Research & Analysis

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TLDR: THE AGV & AMR ROBOTICS MARKET IS MARKED BY WELL DEVELOPED TECHNOLOGY, A MATURING CUSTOMER BASE AND RELATIVELY LOW TAM PENETRATION

AGV & AMR ROBOTICS MARKET, CURRENT SENTIMENT

Maturity of AGV & AMR Technology

Maturity of potential AGV & AMR Customers

TAM Penetration

Source: STIQ Research & Analysis

PANDEMIC SECTOR AWARENESS BOOST

- Issues experienced during Covid appear to have widened the awareness of AGVs & AMRs

"Awareness of AGVs & AMRs changed from 2019 to 'OK everyone is aware about AGVs and AMRs', so this is the thing you need in the future in your intralogistics if you want to make it more or less autonomous." [NAiSE]

"The overall industry of the mobile robot is now more mature than it was 5 years ago. Then maybe it was a little more fun and games and just to see how it works. Now there is much more demand for these things to work. Reliability and dependability issues are not taken lightly anymore. Ability to have spare parts… and you need to produce at the same quality level every time. Our internal processes for go-to-market with products is also at a different level now." [MIR]

- Testing and POC's still exist but this appears to have moved on to testing for rollouts

"There's certainly some component of testing the technology today, but what you're really doing is testing your ability to integrate the technology into your operation. Can you get your people to accept? Can you get them to adopt? Can you get them to stay with the utilization profile that you need for the investment? Those are the dominant challenges, not the technology." [Seegrid]

AGV & AMR ROBOTICS, A MATURE MARKET?

- The AGV & AMR Robotics market is technologically very mature, yet does not grow as fast as many observers think
- There is still plenty of work to be done on making it easier for customers to adopt the technology

"Technology-wise it's really mature. And still it's not taking off. I have a conclusion why this is happening, why the market is so inefficient and why it's so hard to get into a commodity type business. It's because there's too many hurdles, everything is too small and too complicated and too many bits and pieces. So it can never scale. That means, on the other hand, our first interest and the most important thing we have to accomplish is to make it easier and more universal in order for our business to scale. And that's not a hardware problem." [Anonymous]

- More recent technology developments, such as the AMR, are not disrupting the existing market per se but are rather expanding mobile robotics into new industries and applications for now

"Our solution is not an innovation anymore. It's an automation project. With cost pressure everywhere, we provide a solution. Our order intake from automotive, also for next year, looks strong." [idealworks]

- Overall TAM penetration in the AGV & AMR robotics sector remains relatively low mainly because many potential customers are not yet aware of the advantages of AGVs & AMRs or have clear visibility on a positive ROI

"I think the market is not mature yet. Some of the customers I talk to… and some of them are really big automotive companies. I think the market is not there yet. I think they don't know what they want. Everybody is talking about VDA5050, but hardly anyone has implemented it. And I think they are not sure what they will do." [Flowbotic]

TLDR: INCREASING AWARENESS OF AGVs & AMRs BUT MANY POTENTIAL CUSTOMERS STILL REQUIRE EDUCATION. GROWING PRICE PRESSURES

SOME SECTORS MORE MATURE THAN OTHERS

- The automotive sector and associated supply chain is driving a lot of the developments in the AGV & AMR space

"What we see is if you go to bigger companies like all the automobile industry tier one companies; in these companies, which are focused on automation also in their production, they are prepared rather well." [K.Hartwall]

- Increasingly, a greater awareness and expertise of AGV & AMR robots is spreading through to many other industries with an expectation that there is significant scope for the market to grow further

"… it spreads to the next level which includes tier 2 and mid-sized companies in engineering, pharmacy, etc. They are also aware that they need to automize their material flow. However, it's not easy to persuade a company which is not yet ready for automation." [K.Hartwall]

- However, an element of educational process remains in some customer segments which sometimes makes sales activity a bit more drawn out

"And I think in the AGV market still, especially in the sector we're in, we're typically the first AGV onto their site that they've ever seen. There's a bit of caution, there's a bit of education on the customer side and on our side, there's a lot of learning." [Mastermover]

- Market drivers include the pure financial ROI, but also increasingly the ability to meet SLAs or production targets as some areas have less and less people available for particular types of work

"Customers always struggle to justify these things. I think we have two perspectives there. For one, inflation and things are increasing in terms of wages. And there's a problem especially here in Portugal, which is the availability of people, non-specialized tech engineers and whatnot, to be on the production line. So there's a huge lack of this non-specialized technicians. Even forklift drivers and people like this… it's very difficult to find them in Portugal nowadays. So the ROI is no longer only the financial ROI, but it also includes this absence of people." [Flowbotic]

FULL SERVICE PROVIDERS (DO NOT YET EXIST?)

- Interviews suggest there are no single vendors with a full set of different robots able to fulfil all the requirements of customers, but that the software required to mix such fleets is now a reality (courtesy of VD5050)

"There is no supplier anymore who can have a portfolio of robots which can fulfil all the requirements in the future, so that's why they have to make it independent. So this is like a strategy point and also, they see a lot of costs happening when you're connecting the robots in individually to the third party system in the company." [NAiSE]

- This could potentially also force a long overdue evolution of a system integrator layer in the AGV & AMR Robotics sector

NEW NOTABLE PLAYERS IN THE SPACE

- STIQ conversations and visits at trade shows have highlighted big names entering the SLAM area such as Sony and Intel both with varying business models currently

- Both companies appear to be using their physical camera expertise to launch new, sometimes embedded, software products

- Inquire about STIQs Trade Show Reviews for a free copy of our latest report from Logis-Tech Tokyo 2024 where, for example, Sony showed their SLAM launch alongside other exciting exhibitors (tom@stiq.ltd)

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2023 WAS A REASONABLE YEAR FOR THE SECTOR. STIQs FORECAST FROM 2023 REPORT WAS SOLID

2023 A GOOD YEAR AFTER ALL

- The sentiment for FY2023 (from interviews in 3Q23) was confirmed in interviews for this report (in 3Q24)
- Part of this was due to a level of backlog from 2022

"We had exceptionally good year in 2023." [Navitec]

"I would say that 2023 was a good year for us. Comparing the 2022 and 2023, the overall sales performance would be double for us." [IplusMobot]

"2023 was good because of a large order backlog from Q4 2022. As a result, we were able to increase turnover in 2023, although incoming orders slowed down that year." [SICK]

"2023 was stronger than 2022. We noticed a little bit of an overall weakening in 2023 of the market. This happened during the second half of 2023, when we noticed that decision making times went from 3-6 months and now to 9-12 months. Besides that, there was an increase in RFQs for AMRs." [Knapp]

"2023 was good. We were happy. We now have more than 1,100 robots running in production." [NODE Robotics]

"I think we grew by 90% in 2023." [Synaos]

"I mean, we definitely had growth in 2023. What has been impressive is the progress we have been getting with certain customers in moving the project forward. It takes a real long time. The bigger the company, the longer it takes." [Sevensense]

AGV & AMR ROBOTICS MARKET, 2023 GROWTH SENTIMENT (%)
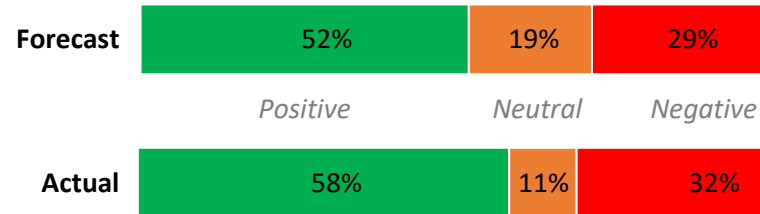
	Positive	Neutral	Negative
Forecast	52%	19%	29%
Actual	58%	11%	32%

Source: STIQ Research & Analysis. Share of interviewees that reported positive v neutral v negative sentiment
Note: Focus on growth % in 2023 v 2022. Forecast = survey responses in 3Q23, Actual = survey responses in 3Q24

- The year started slow, but a good 2H made up for the

"In 2023 we had a slow start but we recovered quite well and we ended strong." [Toyota MH]

- Chinese vendors also experienced good double-digit growth in 2023, but as usual with bookings, revenue may be deferred to a different year

"So last year, 2023 compared to 2022, we at least doubled. From the contract perspective, we multiplied our performance in 2022. But revenue-wise, because revenue is on the measurement of the project go live, only then we start recognizing revenue and that has some delay." [ForwardX]

"I think it was significant growth in 2023. Because we have the goal for sales as maybe mid to low double digit %." [LGIM]

- For some vendors, AGV & AMR is a smaller proportion while the overall business experienced good growth

"It's been pretty consistent the growth. I know the top level numbers, but I think we got up to, we just broke through the 20 million turnover barrier in 2023. We should get up again from that in 2024. And then next year, we've got the biggest order we've ever had going into the new year. So lots of that. And we've got some really interesting projects that we're in RFQs for as well, still for next year." [Mastermover]

RECENT ENTRANTS FINDING MARKET FIT

- Some of the more recent entrants appeared to have found market fit and some early traction in 2023

"We found a product match, I would say 2023 was good and as we scaled our customer interactions, we had a lot of iterations to improve the product and develop new features to fit requirements. We have been witnessing a lot of demand." [Rapyuta Robotics]

2023 WAS OK, BUT MORE DIFFICULT

- For some vendors, the year was flattish with limited growth, partly as the sales process drew out

"The number of robots increased in 2023. But it's not as easy as in the past." [Casun]

"2023 was more of a flat year. We were expecting big growth, like our customers, but in the end it was flat, which was surprising. We saw that some small companies still had some supply chain problems, although not as strong as in the past. On the contrary, some big companies, those that had success, they were struggling to deliver, either because of lack of resources or maybe also some delays from their suppliers." [Bluebotics]

"Our FY24 is calendar year 23 plus a month, and I think that year was kind of flat overall compared to the year before. Maybe a slight revenue growth over the previous year. We did better because we had a strong finish. So maybe we were up 10% perhaps from 22 to 23." [Toyota MH]

"2023 was slightly lower than... slightly below flat." [Seegrid]

"2023 did not move up. It's been a mix." [Scott Automation]

ELONGATED DECISION CYCLES

- Part of the limited growth in the space was elongated decision cycles at customers, which often deferred revenue and bookings to 2024

"I was a bit disappointed with our 2023 performance. What we faced in 2023 was that many projects which needed to be signed off were postponed to 2024. And then we're talking about big projects." [Lowpad]

HIGH EXPOSURE TO SINGLE INDUSTRIES

- Vendors with a higher exposure to individual industries may have faced some level of disruption to their business model

"Last year revenue was bad but order intake was great. This situation is still going on. I'm not sure if we have a comparable situation but our challenge was to move out of automotive industry." [Anonymous]

THE ANNUAL REVENUE ZIGZAG EXPERIENCE

- There's always a level of zig-zag annual growth levels in the sector, especially as some companies are relatively small and may sign up bigger and bigger projects
- If such projects move from one year to another it can mean the difference between a good and a bad year

"Yeah, as you grow then it will happen that what you don't sign this year will come next year and you get this zigzag effect, but it will even out over time. 2023 was a bit disappointing in that sense. In 2024 the orders came, but 2023 it was not on the level we wanted." [Lowpad]

- Even some of the more faster growing companies experience hiccups along the way to revenue growth, with some level of annual zigzag between growth and decline

"In 2023 we had 7% decline in revenue and that was I think the first time ever we had a decline. First year of COVID it was just flat. So it's the first time we had a decline in revenue which is not nice." [Anonymous]

OVERWHELMINGLY POSITIVE OUTLOOK FOR 2024. MAY INCLUDE SOME LEVEL OF POSTPONED PROJECTS FROM 2023 THAWING

OVERWHELMINGLY POSITIVE 2024

- Interviews (conducted Aug-Sep 2024) suggest 2024 is a very good year

"We're growing, and we have 12 consecutive years of growth. We all know that the Covid years were slightly tougher, but we have had stable growth and that is good. I'm confident that we can keep the growth trend going." [Kollmorgen]

"In 2024 the market was steadying and slowly growing again. Thus, we return to a steady growth path starting in 3Q24." [SICK]

"For 2024 it is definitely growth. We hope for a bit more. I think the macroeconomics also kick in here at some point. Q4 is always a kind of black box. Usually a lot of things happen in Q4." [NODE Robotics]

"We were a startup company 4-5 years ago and now we are growing rapidly more than the market… definitely more than the market." [K.Hartwall]

"It's been really good growth here for us in 2024." [JBT Corp]

"This year 2024 is our strongest start ever, both on order intake and delivery of projects. The breaking point here was somewhere around the shift of the calendar year. The first 6-8 months has been very very good." [Toyota MH]

"We have already blown away the current year sales targets. And it's still only August if my calendar is correct. There will be significant increase in 2024." [Seegrid]

AGV & AMR ROBOTICS MARKET, 2024 GROWTH SENTIMENT (%)
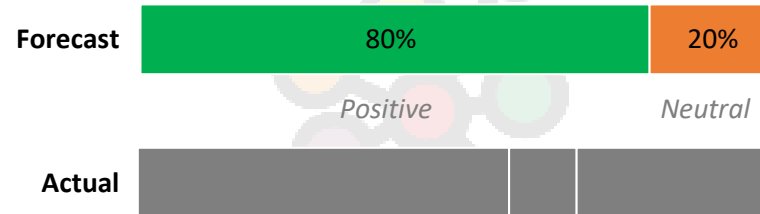
Forecast	80%	20%
	Positive	*Neutral*
Actual		

Source: STIQ Research & Analysis. Share of interviewees that reported positive v neutral v negative sentiment
Note: Focus on growth % in 2024 v 2023. Forecast = survey responses in 3Q23, Actual = survey responses in 3Q25 (to be published in Nov 2025)

"In 2024 our sales have grown even more. There has been adoption of new customers. There was a bit of uncertainty connected to the acquisition… this has been clarified and we are here to stay… clearly it just takes time to create the right level of trust and the feeling that this is actually the case." [Sevensense]

"Yeah, I believe this year in 2024, we will even break even. So that's good." [Lowpad]

"I'd say 2024 has been surprisingly good. I was expecting the first year in Europe to be very, very slow because we only got the CE certificate in February." [Tusk Robotics]

"Growth-wise this year 2024 will be around 60-70% up on 2023." [Synaos]

"2024 is much better than 2023." [Rapyuta Robotics]

"According to our factory, by the end of Aug 2024 shipments already meet the total amount of 2023. We're expecting to double again." [ForwardX]

… SOME GROWTH CONCERNS?

- Some level of project postponements remain in the market

"Currently, 2024 looks promising. We are already yet somewhere in a comparable range to 2023 and we will surpass it." [Knapp]

"For 2024 it will be a little bit harder because European countries, and in Chinese domestic, there are a lot of projects that are postponed. There is some planning for AMR. This year I will say no way will it be double. So maybe only 20-30% growth." [IplusMobot]

- A level of bewilderment why AGV & AMR is doing so well when there are concerns around the world

"In 2024 we have started really well, which is slightly counterintuitive because the world is slowing down in general. China is slowing down somewhat; Europe is slowing down. The only region that is growing is North America. There may be a misalignment between automation and the rest of industry." [Bluebotics]

FLATTISH GROWTH FOR SOME, BUT THIS CAN VARY BETWEEN YEARS FOR MHE COMPANIES. ORDER INTAKE AND SALES PIPELINES VERY POSITIVE

2024 FLATTISH WITH OPTIMISM FOR 2025

- While some experienced a relatively flat 2024, there is significant scope for optimism for 2025 and 2026

"It's more or less flat at the moment. Steep revenue growth is not yet there. But if you look to the sales forecast, then we do see this huge potential and huge interest internationally. And we see a lot of potential there … So 2024 will be similar to last year, but in 2025-26… we have a lot of large companies in our focus who are very interested, and some of them are doing paid tests and demos which we completed successfully." [Movanis]

"We see some green shoots in terms of adoption of industrial automation and we also see a bull case that we're trying to kind of address head on." [Thoro.ai]

- Inflation is one key inhibitor which should improve with lower interest rates

"There's a huge inflation problem in America right now. I expected some growth of even 15% this year… it did not happen. It's flat right now." [Scott Automation]

ORDER INTAKE/PIPELINE

- Some vendors have experienced significant uplift in order intake with revenue expected to cross over into 2025

"The order intake has been crazy good. We've never been so successful. Last year, I think we had >20% in order intake. And in 2024, it's not over yet, but right now we are also >20% over 2023. Our backlog has never been bigger than today." [Safelog]

- Sales funnels are growing and remain very positive overall

Overall, in terms of funnel size, this year has been quite good. We had a lot of opportunities in our funnel. And also seeing the difference in the market from 2-3 years ago to now, we can say that the market has matured a lot." [Kinexon]

"We're starting to see some larger deals where it's not just 2-3 robots. We're starting to see folks come to us, site unseen, first deals, 10-15 robots. We have 3 outsize deals right now with new logos." [Vecna Robotics]

"The health of the pipeline is key, but also, we have been in the external market for 4 years. Of course, we have to be on a growth journey." [idealworks]

"There's still huge opportunities out there for automating and especially within intralogistics. So even though some companies are reluctant to invest, they still have a lot of needs. They still have a lot of projects lined up. So they're still just postponing these projects. They're not cancelling them." [MIR]

"Our funnel is solid right now. We're working on our numbers for next year and right now we're not projecting it to be a huge growth year, but we're not looking at retraction either. And 2024 was big growth here for us." [JBT Corp]

GLOBAL AGV & AMR ROBOTICS MARKET GROWTH DEVELOPMENT 2022-2024

Key: 2022 2024
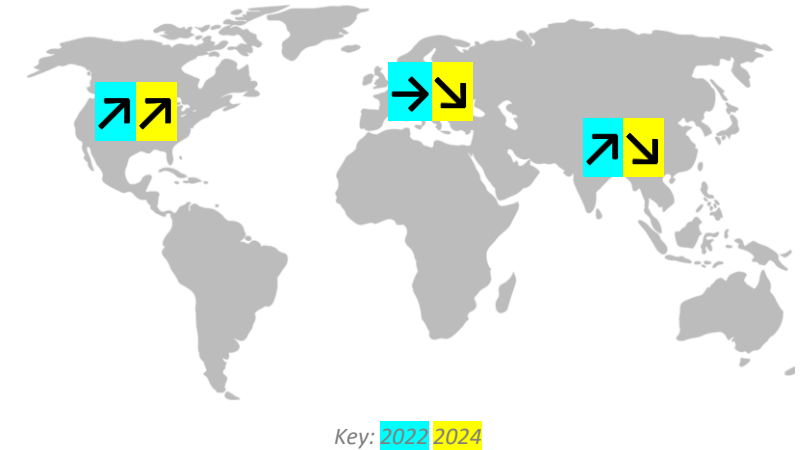
Source: STIQ Ltd Research & Analysis

"Across all our core business areas, we saw a strong increase from 2023 to 2024. It was quite solid." [idealworks]

INCREASINGLY DIFFICULT TO PREDICT THE NEAR FUTURE. VERY FEW COMPANIES MAKE PUBLIC PREDICITONS ABOUT A POSITIVE 2025

DIFFICULT TO PREDICT THE NEAR FUTURE

- Apparently there is a seasonality to orders which may relate to the end of budget years with an increase in Q4 every year

"2024 is shaping up to have growth. But it's still a hockey stick to watch the end of the year." [MIR]

"We've been here for six years. And every year in Q4 is always a hockey stick. In the end of Q3, right now, it's a small hockey stick and then in Q4 it's a big hockey stick. It's the market tendency." [MIR]

- And forecasting in a post-Covid world appears to have become more volatile or influenced by factors beyond the control of customers

"It's the same challenge in 2025. This is a huge change post-pandemic. On one hand, our customers struggle assessing upsides, and on the other hand, some completely miss their goals. This was much easier for everyone pre-pandemic." [Bluebotics]

"So we hear a lot of AGV & AMR manufacturers find it really hard to plan the business at the moment. We have prepared for that market situation to continue. This means the projects in the field are slower than planned, and being delayed. It's not something we can actually influence, it's really our customer side. But that's what we have seen a lot." [Accerion]

- The near future and longer term looks positive, but there may be significant fluctuation in between individual years

"We could see some opening up of the floodgates in 2025. We have seen some deals that are just delayed in paperwork, which is typical for financial reticence, verbal commitments that haven't finalized the signatures and whatever." [Vecna Robotics]

"But what the actual revenue will be this year, I don't know but in the end, especially in the long run, I'm very optimistic." [Accerion]

"Our outlook for 2025 is neutral due to some delays in RFQs and projects being pushed to the following year. Our order book looks strong and we expect growth in 2025. But as I said, it's difficult to predict due to market shifts and delays, which makes it hard to determine how this will impact us throughout the year." [idealworks]

LARGELY POSITIVE 2025

- Some very positive about 2025, but there are plenty of unknowns in the market

"Our forecast… if this lineup continues like now, then I believe we'll have black figures definitely next year in 2025." [Lowpad]

"2025 looks very positive for us." [Opteran]

"We are pleased with the current developments. While I can't provide specific numbers for 2025, I can share that in 2024 we introduced the NDC Flex concept. This initiative allows us to expand the range of projects we can undertake, and we've received positive feedback so far. I'm confident that we'll have another successful year." [Kollmorgen]

- The average AGV & AMR customer takes 2-3 years before they have gained confidence to scale up solutions

"2025 is going to be even better because the companies that are making big investments this year are starting to see real benefits from that. And then I think the number of companies being willing and needing to make big investments will only increase. We have several customers that started their journey with us 2 years ago and year 3 is generally a bit of an inflection point for that journey. We're doing great this year and we have high hopes that next year will be even better." [Seegrid]

- Component and software vendors follow AGV & AMR sales which may take a similar amount of time to scale up

"When someone sells a machine, we make some revenue off of that. Our focus for now has been securing the first contracts and what we're going to start to see for us in 2025 is that actually robots, more robots being deployed and our revenue scale… same with RTLS." [Opteran]

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INTERVIEWS SUGGEST NORTH AMERICAN MARKET REMAINS HOT. VERY STRONG INTEREST IN THE US MARKET FROM INTERNATIONAL VENDORS

NA EXPERIENCING GOOD MARKET GROWTH

- The North American market (with the US in particular) continues to experience relatively high levels of growth

"Growth has been stronger in North America." [JBT Corp]

"North America is great, really big companies doing big volume. That's great." [Bluebotics]

"I think the US market is stable. It's the best market right now, I think. China is going down." [KeyXtech]

"Our main focus areas for mobile robot solutions are Europe, the United States and China, but interesting markets are also in Japan, Taiwan and South Korea. We see the highest growth potential in the United States, however." [SICK]

"North America and Western Europe are our primary markets right now." [Zebra Technologies]

- The North American market appears hotter than Europe

"We also get more inquiries from US for the AMR so we can see that the market is booming and the inquiries are growing, especially comparing with Europe." [IplusMobot]

NA AN ATTRACTIVE MARKET

- Continued growth in the North American market is attracting more attention from international vendors

"The US is booming. It's really growing heavily and they're still doing quick decisions. So, the US market is super interesting." [Synaos]

"It's obvious the US market is booming because last year we saw several AMR suppliers attend the shows. But most of them are local and European suppliers. But this year, we saw more Japanese, Korean, Chinese suppliers. Almost all the Chinese AMR & AGV suppliers, they attended the US show this year." [IplusMobot]

"Demand is primarily from North America in 2024. The big change compared with last year is it was our first year starting to build our US operation… recruiting our Japan team and also having some presence in Korea… and we also started exploring Europe. We started our global expansion. In 2023 mainly we were building up the team building up pipelines, joining trade shows." [ForwardX]

"We're considering overseas expansion but our priority is to build scalable footprint first here in Japan, and then replicate. We already have our AMR in the US as for our current overseas business." [Rapyuta Robotics]

"Internationalization has always been part of our strategy, and we've already established a presence in the US." [idealworks]

"I think some European companies have established subsidiaries now because I told all my customers basically there are not enough AGV suppliers in America. And now finally the automation wave has reached America." [KeyXtech]

NA VENDORS MAINTAIN DOMESTIC FOCUS

- US vendors, on the whole, are staying put in the US market partly as demand remains high

NORTH AMERICA AGV & AMR MARKET

Source: STIQ Ltd Research & Analysis

"We're making absolutely no investments going outside of the US right now, other than Canada and Mexico. That's true last year through this year, probably true next year. It could be true for several more years after that. I mean, the US market is so big." [Seegrid]

LESS AGVs THAN IN EUROPE AND CHINA

- The American market has often been compared as less developed in terms of AGVs when compared to Europe and China, which indicates there is more TAM available

"If you look at the amount of AGVs placed in China, and the amount of AGVs in Europe compared to America it is completely backwards. I think America is going to be a slower adapter to it, but it's going to come, and it's starting to come heavy." [Align]

BUT SOME NORTH AMERICAN DECISIONS REMAIN SLOW AND MAY HAVE BEEN IMPACTED IN THE RUNUP TO THE US ELECTION. 25% TARIFF IN THE US MARKET ON CHINESE BOTS

SOME DECISIONS ARE SLOW

- However, despite good market growth, there are some nascent indications that decisions may be slowing down

"But people are still pretty hesitant in the US. And then the other thing is, they also have to have their own controls people and such to stay engaged. It's not just buy it and then, oh, we've got it. No big deal. We just let it run. Once you go AGV tech, you've got to stay AGV tech." [Align]

GROWING INTEREST FROM INTEGRATORS

- Questions from the NA market have changed from end-customers to system integrators

"In 2023 we have several end-user inquiries and questions from the US. Most of the questions would be like, what's this? This forklift type of AMR, what will be the rated load? What do you have? But in 2024, we saw more and more integrators and distributors and they are interested in the AMR and ask more specific questions." [IplusMobot]

NORTH AMERICAN STANDARD LESS ONEROUS

- The perception is that US standards may be less onerous especially when compared to European standards

"North America actually, I think the requirements from North America are lower than Europe, because as you know Europe has CE certification and it will cost more, like not only the price, but also the lead time for production." [LGIM]

TARIFFS OF 25% APPLY TO CHINESE VENDORS

- Interviews suggest that import tariffs of 25% already apply to Chinese AGV & AMR vendors selling to the US

"According to WTO, our US market tariff rate is zero, but now our tariff rate is 25%. It has been for two years already. So I heard that he's going to raise it again. I don't know how much. Europe is 0%." [Anonymous]

SLOWER DECISION-MAKING IN NORTH AMERICA

25%
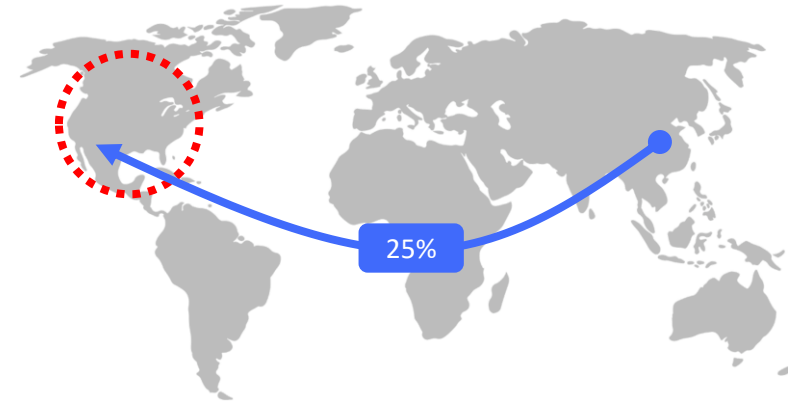
Source: STIQ Ltd Research & Analysis

EUROPE IS A MIXED BAG WITH SLOWING DECISION MAKING IN THE IMPORTANT EUROPEAN MARKET. GOOD DEMAND FROM EASTERN EUROPE

SLOWER DECISION MAKING IN GERMANY

- Decision making lead times in the important German market appear to have expanded

"Decisions in Europe just taking longer now with Germany and Europe being a low growth phase. Everything is kind of prolonged and they're redoing all the calculations. So that's what's kind of slowed down the market here a little bit. Most of Europe is growing. Germany is kind of staying on the same level, which is not great." [Synaos]

- However, there are also other European markets and applications where some vendors experience important traction

"At the moment, it's mainly Benelux and Germany where we are growing. We have quotations ongoing in almost all of Europe. We do get requests globally at the moment. And the main features that we get these more international requests is for the outdoor AGV business." [Movanis]

"We experience a lot of traction in the UK market." [Lowpad]

GERMANY, #1 EUROPEAN MARKET

- Germany is viewed as the single largest market in Europe but there is also demand in parts of Eastern Europe

"Germany is the biggest market for automation. But you know what's interesting? Eastern Europe. The biggest demand in robots we see is in Poland really because there are no people and the Polish people are creative. The German people seem to want full automation, they say 'let's think about it, let's make a project, let's plan it properly. Polish people say 'wow 25 000 you know let's get started!' And they just do it. They never phone me. They don't need any training. They don't need any explanation. They don't need people to come over to just figure it out, and it runs. So they have a need because there's no people and they are pragmatic and creative to get it running" [EP Equipment]

- While the North American market may be growing faster than Europe, the market may not be as mature compared to European peers

"Germany is our core market and then Europe in various countries, Turkey, Sweden. But most customers are in Germany. And we're going to Asia with a partner and a more structured approach in the US. And that market is definitely growing. But on average, they're not as far in automated intralogistics as in Europe." [Synaos]

EASTERN EUROPE DRIVERS

- Automotive continues to be an important sector in Europe and especially in Eastern Europe

"Most of our European customers are big names from Western Europe. But most of their factories are located in Eastern Europe. Many clients are automotive industries. They have their factories in Poland, Macedonia in some regions." [Tusk Robotics]

EUROPE AGV & AMR MARKET
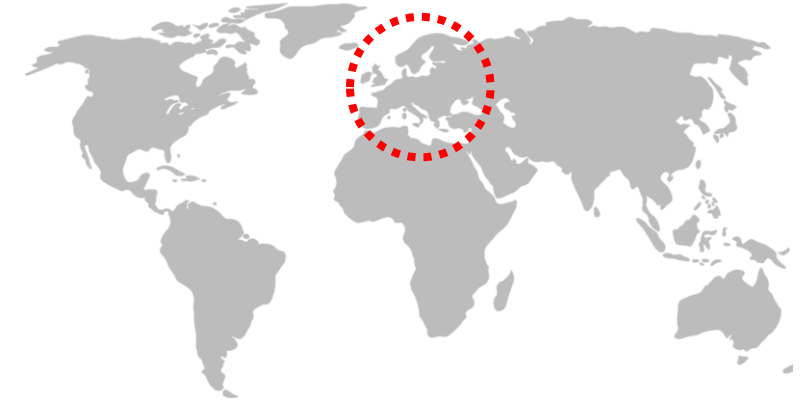
Source: STIQ Ltd Research & Analysis

"We're experiencing two different things in Europe. In Western Europe the ROI is very, very strong. labour costs are high. But in East Europe a lot of the labour is leaving to go work in West Europe. So while the ROI isn't quite as attractive, the labour availability is a driver." [ForwardX]

FOREIGN VENDORS VIEW THE EUROPEAN MARKET AS MORE FRAGMENTED AND CULTURALLY DIVERSE WHEN COMPARED TO THE US MARKET

EUROPEAN CHALLENGES

- While European customers are less price sensitive compared to Asia, there are also additional challenges

"Europe is different to Asia. We faced a lot of challenges in the products, because European customers care about the security the most. We already knew that. But we didn't expect a whole new level. For example, will employees try to put their feet underneath the fork to hurt themselves… just for the insurance? But it's actually what's happening. There were a lot of such details we didn't really take into account. So it took us a while to redesign some of the features for the CE version." [Tusk Robotics]

"In Europe, market price is not the number one. Maybe the first one is like all the solution and the safety. And also the experience for the different industries and what industries you are more focused on, what you can do. And also this is what the customer considers that we can give them, the best service. And the second one is the safety or the products test. This is the second one. And the third one I think in Europe is the price." [LGIM]

- The European market is also viewed as more fragmented when compared to especially North America

"Second hardest would be the European market, because there are so many different suppliers there already. In Europe there are also many different countries, different languages, different cultures. We don't want to push hard in Europe. But we already have several clients and project there." [IplusMobot]

- Europe is also quite a well established market

"Europe as the originator certainly is out ahead of the US market and has been quickest to lead supplying, as the US supplier base has been thin to date, however it is now growing and will soon eclipse foreign supply." [Align]

EUROPE, A HETEROGENOUS CONTINENT
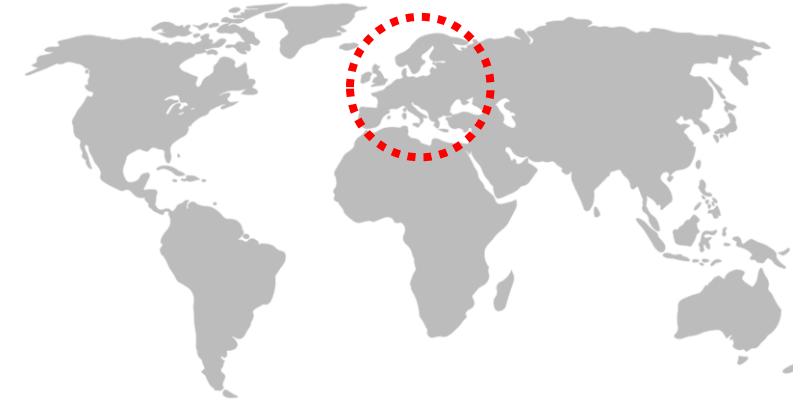
Source: STIQ Ltd Research & Analysis

NON-CHINESE ASIAN MARKET DOING OK. GROWING PRICE SENSITIVITY IN SEA WHILE KOREA, JAPAN AND SINGAPORE REMAINS RELATIVELY GOOD

NON-CHINA ASIAN MARKETS

- Overall non-Chinese Asian markets appear to be doing well

"The rest of Asia is growing. Japan, Korea, places like that. Korea, unfortunately, because it's one of the big battery producers, that was a huge opportunity and now it's slowing down. But in general, Japan, Korea, Thailand, where we have distributors, we are doing well." [Bluebotics]

- Lower interest rates in specific countries should also theoretically lower the hurdle for investments

"The interest rate in Japan is really low compared to US or UK, so the hurdle rate for the investment should be lower in Japan." [Rapyuta Robotics]

SOUTH EAST ASIA KEY 1ST MARKET

- South East Asia, Japan and South Korea (APAC) are typically the key first export markets for Chinese vendors, partially due to proximity but also culture and occasionaly shared language

"The main market for us outside of China is Southeast Asia. As I mentioned, our current main revenue comes from local partners of Southeast Asia. However, we are actively expanding our end customers in European and American market etc." [Casun]

"Up to now, APAC is biggest for us because we started with APAC and also Australia. The European market we started already and are learning about the US market since 2023. This year we're planning to register a subsidiary in the US." [IplusMobot]

INCREASING PRICE SENSITIVITY IN SEA

- The proximity to the Chinese market has also meant some price sensitivity has infused in SEA markets

"APAC they are more price sensitive. So we have to do some projects in Thailand also. We are now connected with a lot of customers in Southeast Asia and they are more price sensitive." [LGIM]

"Price-driven markets include SEA, Vietnam, India, Taiwan and of course mainland China. The Chinese suppliers are already into them for years, and they also have very cheap local suppliers. But we always say that we never want to be the cheapest because that means we need to sacrifice our quality as well. So our quotation would always be higher than most Chinese suppliers." [IplusMobot]

GOOD MARKETS, KOREA, JAPAN, SINGAPORE

- A few markets in Asia appear to perform well and may also be less price sensitive when compared to SEA

"We still think that most of the countries and regions, for example, like USA, European countries, Japan, Korea, Singapore, and Middle East even, they are still very good markets. We can still find a lot of very good partners and also clients, not only focusing on the price." [IplusMobot]

ASIA AGV & AMR MARKET
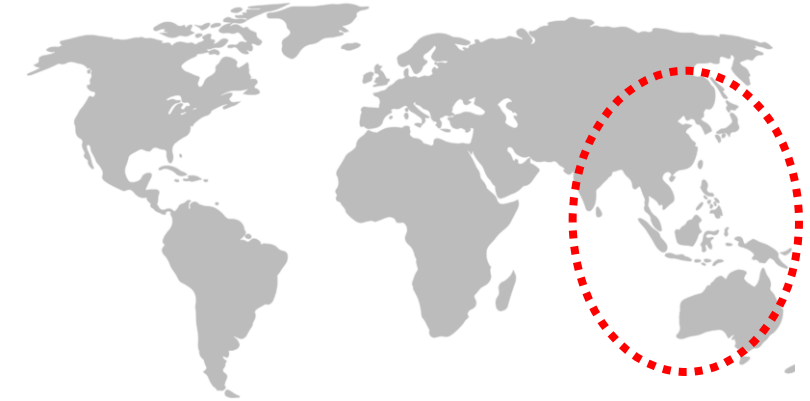
Source: STIQ Ltd Research & Analysis

- Japan is a tough market to break into for both cultural and details reasons

"We know the hardest market is Japan followed by European countries and US. Because Japanese clients request the highest quality and are very patient and careful with all documentation. They ask for documentation for installation, after-sales services, process control, and so on. We think Japan would be a very hard market for the suppliers. That's why we started there." [IplusMobot]

"So Japan now we are mainly through distributors. So we manage a few distributors to sell for us. We still go direct, but Korea is a very concentrated economy, right? So basically, it's just those big customers." [ForwardX]

CHINA: LARGEST GLOBAL MARKET WITH CONTINUING DECLINE IN 2024. HYPER COMPETITIVE CONDITIONS FORCING VENDORS TO SEEK WESTERN MARKETS

CHINA VENDOR SCALE IS DIFFERENT LEVEL

- Compared to leading competitors in the West, the scale of some Chinese vendors is tremendous and a number of projects are counted in 1000's rather than 10's or sometimes 100's for European counterparts
- Part of the reason is the amount of new factories being constructed combined with a strong automation culture

"We have delivered more than 3,000 AGV & AMR projects in 13 years." [Anonymous Chinese Vendor]

"And now we've already had more than 1,000 projects landed globally in total." [Anonymous Chinese vendor]

THE CHINESE MARKET WAS DIFFICULT IN 2023

- The Chinese domestic AGV & AMR market prospered hugely in the last decade but has suffered from declining demand since the end of lockdowns in 2023

"China is a very important market for us, especially for mobile robots. I would say it's one of the strongest markets we see. We have, of course, challenging market conditions due to high price competitiveness in China. We also encountered that the market was weak in 2023." [SICK]

- Some AGV & AMR vendors appeared to struggle with production line underutilisation in a highly saturated vendor marketplace and price competition means there are few (if any) profitable projects around

"Yes, as we all know the times have changed and it's really difficult to make a profitable project in China, actually whether in domestic market or overseas market." [Casun]

"For us, we decided to do the overseas market since 2022. During that time, we did not meet so many difficulties in the domestic market." [IplusMobot]

- Furthermore, a few vendors view the domestic market hyper competitive and consider focusing on projects in the overseas markets as an increasingly attractive option

"In the Chinese market, we heard some competitors just want to stop some of the domestic projects and do more for overseas, because they can get more profit." [IplusMobot]

SOME LEVEL OF RECOVERY IN 2024

- There appears to be some level of recovery in the Chinese AGV & AMR Robotics market in 2024, however, price pressures remain intense

"In 2024, the Chinese market is gradually recovering, with increasing customer demand. Despite high price pressure, we are achieving growing sales in this challenging environment." [SICK]

- However, labour rates are not increasing and customers appear reluctant to invest in automation

"I feel like this year we have deflation. Very different from global where inflation is a problem. So we find the labour rate is not increasing, not like overseas. This year Chinese enterprises don't have that strong drive for using robots… they don't feel like they're short in labour or anything like that. I feel the China market this year is quite weak." [ForwardX]

GLOBAL PRICE SENSITIVITY MAP FOR AGV & AMR ROBOTICS PROJECTS, 2024

Key: Severe competition / Limited/no competition
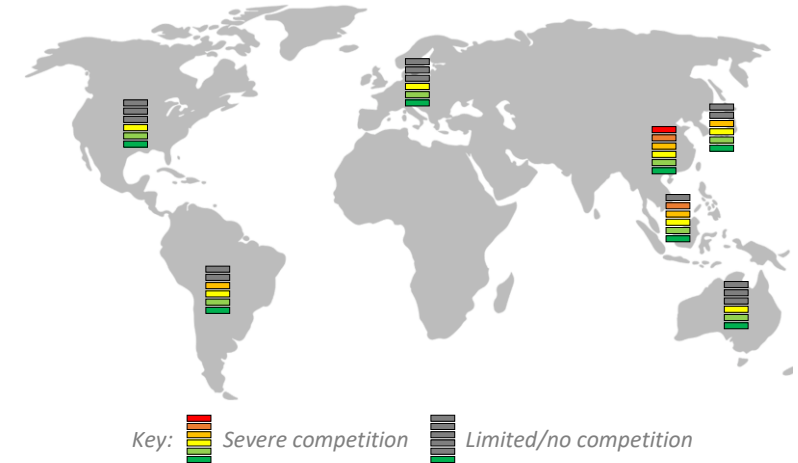
Source: STIQ Ltd Research & Analysis. Based on 50+ interviews

BUT 2025 COULD POTENTIALLY BE TOUGHER

- The Chinese market is forecast or expected to deteriorate further in 2025

"In China this year we saw a lot of projects postponed, but not very badly. We assume it will be harder in 2025. Yeah, 2025 will be harder in the domestic market." [IplusMobot]

PRESSURE FOR CHINESE VENDORS TO CHASE PROFIT MARGIN IN OVERSEAS MARKETS. SELECTIVE APPROACH TO EXPORTS INITIALLY FOCUSING ON POPULAR PRODUCTS

WESTBOUND CHINESE VENDORS

- The prevailing view is that Western markets can provide better returns as quality and efficiency is more important

"The Chinese market is highly competitive in terms of price, which makes overseas markets potentially more advantageous. Overseas customers tend to focus more on quality and efficiency rather than just price." [Casun]

- Many Chinese vendors are at different stages of their overseas expansion execution with some just starting and others having deployed 100's of projects already

"We have been developing and structuring our overseas team for over a decade. Currently, our sales investment ratio is evenly split: 50% in the domestic market and 50% overseas." [Casun]

"For the overseas market we started in 2022. And we have already landed more than c.200 projects overseas." [IplusMobot]

"Right now this year we're almost doing half-half, so half from China and half from overseas." [ForwardX]

"We sell overseas maybe from 2023. But actually, we are more focused on the overseas market from 2025, because in China market, the profit is not so good. There are so many competitors in China and we want to focus more on the overseas market like in Europe, America and Southeast Asia. We have this three-part market that we want to devote more to." [LGIM]

"The rest of Asia is growing. Japan, Korea, these markets are doing well. Some Chinese vendors had huge success when China was shut down during COVID. And now because business in China is becoming less sustainable, many producers are selling but losing money. But they have investors, so now they try to export. We are seeing them in several markets. They often start by finding local integrators to install their products." [Bluebotics]

PRODUCT RANGES OFTEN VARY GLOBALLY

- Domestic product offerings often vary from international product ranges, typically due to strategic considerations on maintenance, etc.

"In China, we do we do both. We do the XP and in China, we do full automation." [EP Equipment]

"In the overseas market we are only focused on AMR or the forklift. But in our domestic market or some markets like Southeast Asia, we also have mini load and products like that for pallet." [LGIM]

- Many AGV & AMR vendors in China are larger system integrators with a longer-term aim of exporting their entire range of products and services

"As far as wanting to become an integrator, in different markets we have a different strategy. In Europe and the US market we don't want to be an integrator because we need to devote a lot of resources to become one, and also there are a lot of bigger integrators…" [LGIM]

CHINA AGV & AMR MARKET
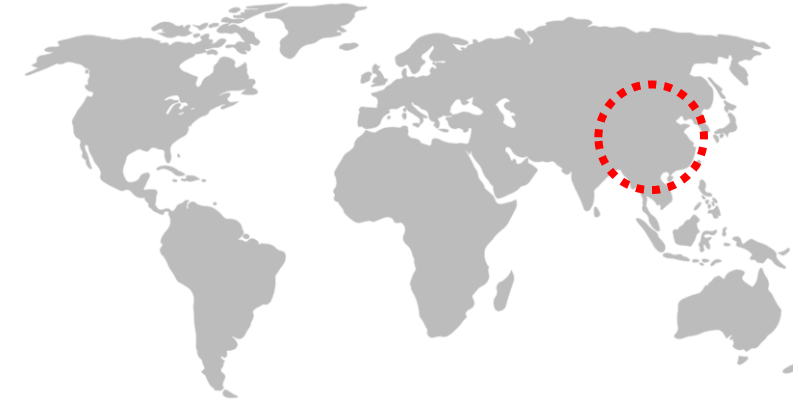
Source: STIQ Ltd Research & Analysis

THE DOMESTIC SUPPLY CHAIN ADVANTAGE

- The advantage for Chinese vendors is a well developed and established AGV & AMR component supply chain available at short notice

"All Chinese AMR suppliers, it's much more easier for us to search for parts and suppliers in domestic markets. That makes it easier to control costs." [IplusMobot]

SOME OVERSEAS SEGMENTS NOT AFFECTED BY CHINESE VENDORS. SELLING AGVs & AMRs TO CHINA IS VERY CHALLENGING. COMPONENTS SLIGHTLY EASIER

SOME OVERSEAS SEGMENTS LESS AFFECTED

- Some overseas market segments remain relatively insulated from Chinese competition, which could also indicate price not being the top key purchase criteria for some projects

"We do not run into the Chinese competitors on big projects. As a matter of fact, we don't see much of them. We know they are there. But somehow, we don't have overlapping markets yet. I'm sure that will come." [Toyota MH]

"I see Asian competitors at trade shows, in announcements, etc. But we don't compete a lot with them. I know it's coming, but we don't really see them right now." [JBT Corp]

- However, competition should be considered as Chinese domestic competition is intensifying and vendors are increasingly aiming for overseas markets

"The competition from Asia is intensifying. There is a significant rise in the number of AGV manufacturers in China, and the distinction between AGVs and AMRs there is becoming blurred. From what I have learned, robots in China are mainly based on nodes, edges, or virtual lines. They are entering the European market and the price advantage is immense." [idealworks]

- With smaller, potentially less complex systems, there appears to be some more competition

"But I think on the smaller systems, we can run into just about anyone. When you get into larger systems, it would be the more traditional material handling companies that can handle it." [Toyota MH]

"So we do see the Chinese companies entering, especially Europe, and also trying to get into Latin America and to some extent America." [MIR]

INTERNATIONAL VENDORS ON CHINA MARKET

- The Chinese market is like the rest of the global market but with additional steroids

"In China you have maybe the most extreme number of competitors and competitive technologies. But it's also a situation where there's a lot of things come up and then fade away or be acquired by someone else. There's a lot of M&A in the industry… it's kind of like a stormy sea and perhaps China even more so than other parts of the world, but it's kind of the same trend, I would say." [Kollmorgen]

EXPORTING TO THE CHINESE MARKET
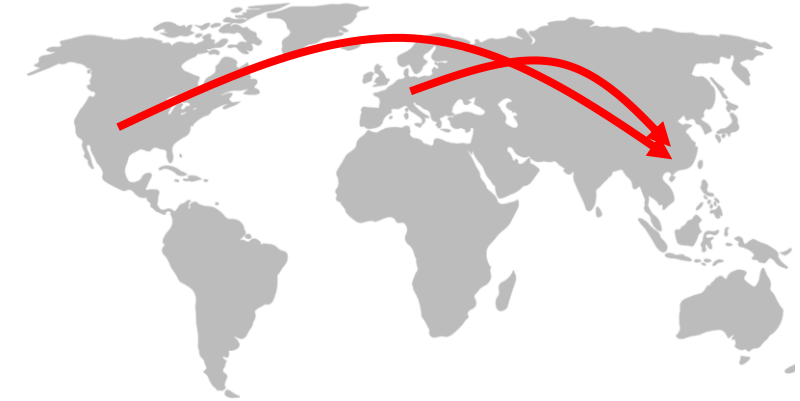
Source: STIQ Ltd Research & Analysis

- Exporting to China is typically a no no, but STIQ is aware of cases where European/North American enterprises order centrally and deploy globally, including in China

"China is certainly a difficult market, although we have had successes with customers that need high performance solutions." [Bluebotics]

"China is a tough market for non-Chinese vendors." [KeyXtech]
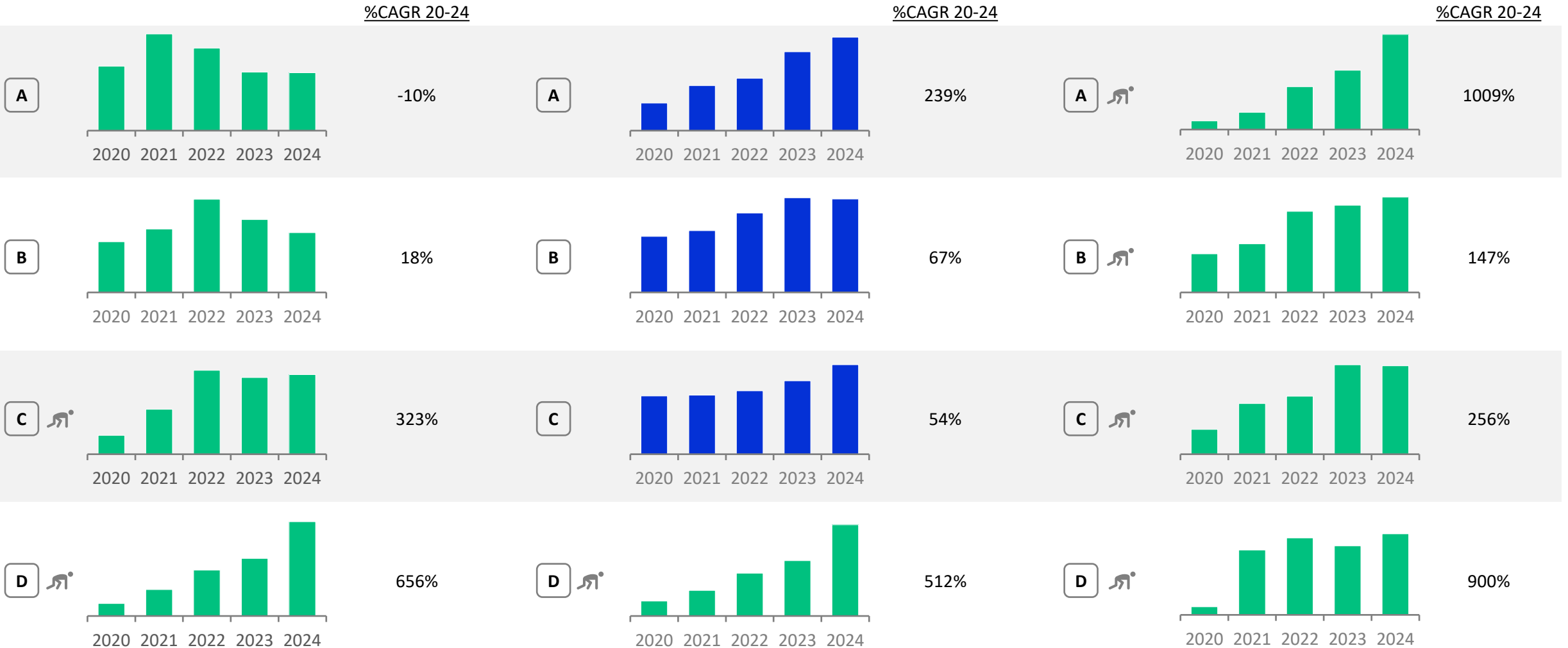
- Conditions for fast growth in the important Chinese domestic market are not currently favourable

STIQ VENDOR TRACKING (FTEs) INDICATES SOME POTENTIAL WOBBLES IN NORTH AMERICA AND ASIA. EUROPE APPEARS TO BE IN GROWTH MODE

NORTH AMERICAN VENDORS, 2020-2024 (# FTEs)

EUROPEAN VENDORS, 2020-2024 (# FTEs)

ASIAN VENDORS, 2020-2024 (# FTEs)

%CAGR 20-24   %CAGR 20-24   %CAGR 20-24

Region	A	B	C	D
North American	-10%	18%	323%	656%
European	239%	67%	54%	512%
Asian	1009%	147%	256%	900%

Key: ■ Organic growth   ■ Venture funded growth   🐒 Business <10yrs old

Source: STIQ Ltd Research & Analysis. Vendor HQ country/ continent. Numbers collated mid year every year

STIQ VENDOR TRACKING (FTEs) INDICATES SOME POTENTIAL WOBBLES IN NORTH AMERICA AND ASIA. EUROPE APPEARS TO BE IN GROWTH MODE (Cont'd)

CAVEAT - GROWTH CHARTS & NUMBERS

- This analysis is based on publicly available FTE numbers (not revenue numbers!) for 12 selected AGV & AMR Robot vendors in North America, Europe and Asia (China)

- Note that STIQ actively tracks nearly 600 companies in the sector and the selected companies act as a dipstick test

- STIQ urges readers to use charts with great care as growth, especially for VC backed companies, is often not related to the market experience

- For non-VC Funded companies (organic growth), changes to FTEs often acts as a relatively good indicator of revenue growth

- Note also that some business applications such as LinkedIn can be unreliable, banned or not popular in some countries which can also impact numbers

COMPANY SELECTION CRITERIA

- STIQ selected a variety of companies with a focus on those for whom numbers are available for the period analysed (2020-2024)

- While all selected North American and Asian companies are VC funded, some of them are believed to operate near break even

FAR LESS VC-BACKED COMPANIES IN EUROPE

- The European AGV & AMR Robotics sector in Europe is relatively mature with some vendors founded in the 1960's

- Furthermore, the European VC scene is less adventurous when compared to US and Chinese, especially in hardware related companies

- As a result, many European startups are increasingly looking to the US for funding sources

NA: VARIED 5-YEAR DEVELOPMENT

- The 5-year CAGR analysis for North American vendors varies between negative -10% to 656% with higher growth more likely for younger companies with recent funding

- Companies in existence for more than 10 years appear to have experienced huge demand in the early parts of Covid potentially as customers were unable to get staff

- However, some or all of this demand appears to have fizzled out by 2024

- There may have been some level of vendor exposure to Amazon and their explosive investment growth in warehouse automation in the early part of Covid

- However, Amazon cancelled a lot of their projects from 2022

EU: STEADY 5-YEAR GROWTH

- There is uniform growth at all of the selected European companies, including three organic revenue growth businesses

- Only one vendor appears to have halted recruitment in 2024 which could be an indication of their industry focus, distribution model or any other specifics to their business

AS: TREMENDOUS 5-YEAR GROWTH

- All Asian vendors are of Chinese origin and are typically difficult to analyse using public FTE numbers as access to social networks such as LinkedIn is limited or restricted

- However, it is well known the Chinese domestic market is the largest single market for mobile robots globally with many many younger and VC funded vendors

- Growth of many of these vendors has been nothing short of magnificent

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THE AUTOMOTIVE SECTOR DOMINATES DEMAND IN THE AGV & AMR ROBOTICS SECTOR. CONTINUED DEMAND IN NORTH AMERICA AND ASIA, EUROPE SUBDUED

AUTOMOTIVE, PRIMARY DEMAND DRIVER

- Interviews suggest the automotive industry remains the number one demand driver with pharma and logistics increasing, but with different dynamics

"Automotive is still a very considerable part of our funnel. But what we also see is that a lot of projects get delayed or cancelled at the last minute because of budget constraints and the overall situation that we currently see with European automotive sector. But when it comes to RFQs that are sent out, automotive is still the number one. Then pharma is definitely coming both in the US and in Europe and they are actually still lower compared in size, but very serious when it comes to going to implementation. What has really surprised me is that we now get very serious interest from the logistics sector, parcel sorting, third-party logistics." [Kinexon]

"I think for us still the majority of the big RFQs come from the automotive industry." [Navitec]

- The automotive sector is the largest single customer type in the AGV & AMR market and often sets the pace for the entire sector

"The automotive sector is very forward thinking. The rest of industrial is pretty forward thinking on this, because they have similar problems to automotive. We're starting to see a lot more activity in things like battery, electronics, and microprocessor, because of things like the CHIPS Act and the push to EV cars. They have to build these plants and they don't have people to staff it." [OTTO by Rockwell Automation]

"I would say 80% of the leads and the projects is indeed manufacturing, so automotive, home appliances, production and assembly." [EP Equipment]

CONTINUED DEMAND FROM AUTOMOTIVE

- There is continued demand from the automotive sector driven largely by the shift to EVs

"We still see the commitment to electrification and investment in the automotive sector. That's what's driving demand there. They're continuing with their strategy and haven't retracted." [JBT Corp]

"We still see more demand from the manufacturing areas of different verticals than e-commerce or something like that." [MIR]

"Certainly any high-cost manufacturing environment will continue to be a strong player in 2025. And that clearly is automotive, it's clearly tier one suppliers, any unionized environment will be an excellent opportunity." [Seegrid]

- However, the European market is perhaps not so great

"So it's not changed that much it's still automotive and electronics, so that's also why we're hurting, you might say, a bit in the automotive, both due still to the war in Ukraine. Of course that recovered a bit, but also the whole 'going away from EV' a lot of projects in the automotive. These EV projects are being halted or paused which is affecting some of the investments." [MIR]

AUTOMOTIVE DEMAND IN 2025, SUBDUED

- Interviews and general media coverage indicates a challenging market for automotive manufacturers, especially in Europe

AUTOMOTIVE SECTOR SHORT TERM OUTLOOK AS A DEMAND DRIVER FOR AGV & AMR SECTOR
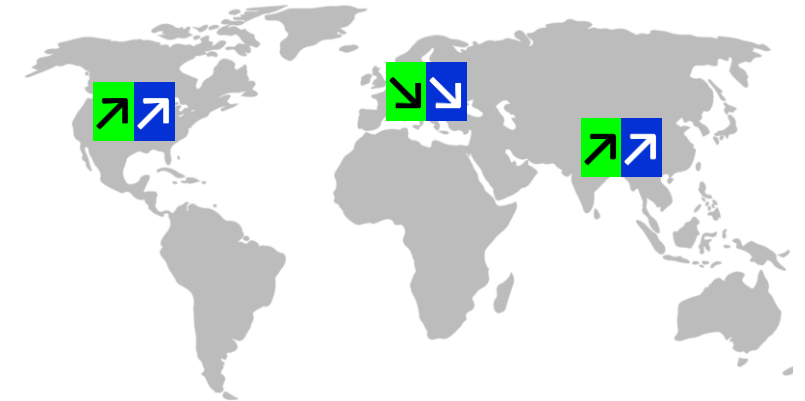
Key: 2024 2025

Source: STIQ Ltd Research & Analysis. Based on analysis of news media coverage and interviews

"My expectation for 2025 is... we have to catch up with some emerging sectors such as pharma and couriers. For automotive, my outlook is not the best one based on what I've seen this year." [Kinexon]

- There's a growing demand for profitability across the European automotive sector

"The pressure for economies of scale, for profitability is growing across the automotive industry." [idealworks]

AUTOMOTIVE DEPLOYMENTS RARELY SCALE (OUTSIDE CHINA). MULTIPLE CAR MANUFACTURER INITIATIVES TO PRODUCE AGVs & AMRs EITHER DIRECTLY OR INDIRECTLY

AUTOMOTIVE PROJECTS RARELY SCALE

- While automotive projects are very large, they rarely scale significantly (compared to the ecommerce sector)

"The exception in scaling projects is the automotive sector. Automotive already starts with larger systems, often 100+ vehicles. Since many of the big players in automotive have facilities from the Far East to Europe to America, you can very quickly copy that system from one location to the next. So that scaling is done usually very quickly. Scaling of a system in the same location happens, but its rare." [AGV Consult]

- However, in the hot Chinese market some EV automotive manufacturers seems to experience growth often associated with ecommerce retailers

"We have two major industries. One is warehouse and the other is the automotive industry. We're not doing general manufacturing in China. We're mainly focusing on the automotive industry... the EV sector is very, very strong in China. Customers we serve double or at least grow hugely every year. They're building new factories... over 10 new factories every year." [ForwardX]

CUSTOMER OR INCREASINGLY COMPETITOR

- Quite a few automotive manufacturers have also dabbled in the AGV & AMR sector with various level of success

"We saw that Hyundai and Toyota tried to develop the AMR or AGV, but eventually they are searching for partners among AMR suppliers. They might be still trying to do some development for the AMR, but they only supplied to their internal clients." [Anonymous]

- In STIQs view this has been more relevant in the Asian and European car manufacturing sector

- Involvement can be either directly or indirectly

"Volvo Group owns about 70% of our company SDLG. First we did AGV & AMR automation because our own factory needed some solution for logistics. And then we found some other vehicles maker, or automatic maker like trucks, or also the excavator, or some other truck makers need the logistic solution the same as us." [LGIM]

"It has happened that automotive manufacturers try to build their own vehicles with our navigation. But typically there's more interest in the fleet manager. They are looking for a fleet controller that can fulfil the production need and then they put out RFQs. Usually there are absolute requirements that you have to fulfil before you can even quote." [Navitec]

- And, as the largest customer sector, customers are also often aware of their purchasing power

"Automotive has terrible terms... Unless you are a what I would call a first-year integrator, constantly getting orders from them, which we are not." [Anonymous]

OTHER SECTORS NEED TO SHARPEN UP. WAREHOUSE & DISTRIBUTION, 3PLs HAVE DRIVEN UP DEMAND FOR AUTONOMOUS FORKLIFTS

OTHER SECTORS NEED TO CATCH UP

- Non-automotive sectors need to up their pace in terms of mobile robot knowledge and adoption

"Automotive is always at the forefront of automation, facing the greatest pressure on profitability and keeping production in Europe. Others will need to catch up as the shortage of skilled labour, which we have been discussing for years, is becoming a reality." [idealworks]

- STIQs research has evidenced some vendors are focused on serving certain industries and/or applications which will also reflect their views on industry demand

- However, many vendors also take a more generic market approach

WAREHOUSING & DISTRIBUTION

- There is a good level of demand from own-operated warehouse and distribution clients

"The lion's share of our customers are in warehousing and distribution." [Vecna Robotics]

"We have 2 types of customers – warehouse and manufacturing. Warehouse, their job is to store. We have a lot of customers in the pipeline for the storing & picking from rack and floor storage, etc." [Rapyuta Robotics]

- The retail sector also overlaps with warehousing and 3PL sectors

"We serve mainly retail business with their own warehouses and also logistics companies, so moving pallets in warehouses." [Toyota MH]

3PLs SECTOR DYNAMICS v CONTRACT LENGTH

- 3PLs serve any industry but has other dynamics as contracts often vary in length on average 3-5 years which often is directly related to their investment/ROI horizon

"Just to be clear, retail, food and beverage manufacturing. Obviously 3PL serves these markets. For example, we have 2 customers in 3PL that move pet food." [Vecna Robotics]

- Some 3PLs are more technologically adventurous and are also experimenting with robots

"Some customers are actually building the hardware themselves. I was very surprised to not only see it once but twice. They do hardware integration and buy in navigation software. My assumption is that they do it on their own because they are so price sensitive and that everything on the market is too expensive. The fleet they are looking into is actually quite big, a 3-digit fleet size that they want to start implementing." [Kinexon]

- The 3PL sector (in common with warehousing & distribution) is also more focused on vertical moves

"3PL is a major market, absolutely. Bigger than manufacturing from a pure size perspective. It's just a different product. It looks similar... well, a forklift robot goes and picks up a pallet and puts down a pallet. And it looks the same thing as manufacturing, but it's not. 3PLs have more vertical workflows. They have narrower aisles. They have different scale, different price tolerance." [OTTO by Rockwell Automation]

AGV & AMR FORKLIFTS GROWING WELL

- The autonomous forklift segment is experiencing significant growth

"The forklift market had strong years throughout Covid. I think we have had record breaking years on the manual side over the last 3 years. But in the AGV business 2021 was a very strong year. We won a couple of big projects that year, so that helped us a lot. And then 2022-23 have been about 15% growth. We are only halfway into this year and it could be the opposite from last year with a weak finish, you never know. But right now, if I make a forecast, we would be at least double up from the year before. It's hard to know what is market pull and what is actually our achievements." [Toyota MH]

CONTINUED DEMAND FROM NEW ENERGY, F&B, CPG, ELECTRONICS. PHARMA LESS PRICE SENSITIVE. HOSPITALS FICKLE, BUT GOOD CURRENT GROWTH

CONTINUED DEMAND FROM NEW ENERGY

• Batteries, windpower, etc. continues to drive up demand

"Yeah, for 2023 LiOn battery obviously would be the number one industry for us, but also we have panel industry… LCD and also we have semiconductor and electronics. So three main industries lead the year of 2023 for us." [IplusMobot]

"The growth comes from two areas for us. One new product, so new product, and new sectors. We're doing a lot in the wind sector at the moment for leaving blades and that's growing really well. And then also territory growth. So we've got a subsidiary office in the US, one in France, one in Germany, and they're all growing, so as we decided to move outside of the UK, and we're between 70-80% export these days as well, so a lot of growth is coming outside the UK." [Mastermover]

• However, there seems to have been some slowing down, especially in batteries

"There was huge excitement about producing batteries. Now this is slowing down." [Bluebotics]

F&B, CPG STRONG IN NORTH AMERICA

• In North America, F&B and CPG remains very strong

"F&B and CPG is huge for us. We've developed a little bit of a niche in automotive and automotive suppliers." [Vecna Robotics]

"CPG and F&B sectors have been good." [OTTO by Rockwell Automation]

ELECTRONICS SECTOR REMAIN STRONG

• Electronics remains a good sector and demand has returned to pre-Covid levels

"The electronics sector is still interesting. Not like during Covid, but at a normal pace." [MIR]

• Customers tend to be relatively fluent and often order a few vehicles and only in certain circumstances require additional assistance

"We already have trained customers who are doing installations from scratch around the globe on their own. They are for example globally operating electronics manufacturing companies. Sometimes they simply order vehicles and we don't even know the use cases. They install it completely on their own. Other times they ask us to be on site for 3 days to assist." [Knapp]

PHARMA LESS PRICE SENSITIVE SECTOR

• Pharma has traditionally been an ok sector for AGV & AMR vendors and enjoys the added advantage of being less price sensitive

"And then what we also can see from sectors like pharma is that they are not as sensitive in terms of the budget right now as automotive companies are, for example." [Kinexon]

HOSPITAL SECTOR DEMAND CAN BE FICKLE

• Hospitals are primarily greenfield opportunities and can be very long running pipeline projects

"Hospitals are more greenfield opportunities. Projects are much more out there when we're bidding … it's going to happen in 3-5years or something like that." [JBT Corp]

• The sector is highly cyclical with specific dynamics

"Hospitals is very cyclical, very kind of up and down. But it's been really solid for us. It has been an active market and not just in North America, I mean globally." [JBT Corp]

"Hospitals is a little strange because you don't see a really big customer normally that has 10 different sites. There's a few like that, but not many. We've gotten some big orders in hospitals." [JBT Corp]

• Hospitals are mainly a greenfield opportunity due to key limitations of existing buildings

"Lifts are the trickiest part in hospital environments. If a customer doesn't have that infrastructure, and we call them lifts, because typically, there's patient elevators, which are nice and pretty. Then there's lifts behind the scene for moving materials, trash, etc. We typically design for those lifts. If those lifts are not there, you still can do some automation, but it will limit what you can do. Because you don't want patients waiting for materials to be moved in the lift and so on. So that becomes truly a bottleneck to fit through." [JBT Corp]

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FORKTRUCK, A GROWING SEGMENT

- For navigation vendors, the forklift segment appeared to be a growing market

"The counterbalance forklift segment is booming. It was already going well last year, as counterbalance vehicles are needed in North America due to the types of pallets they use. I'm surprised why this vehicle type is growing so quickly now, since it was clear for years that you needed to produce counterbalanced trucks to move pallets there." [Bluebotics]

"Well, maybe an indication is that forklifts grew faster than the mouse around the globe… in warehousing, in manufacturing, in automotive, but also in other industries. But last year was such a good year that it basically didn't matter in which industry the customer was, they were doing better than the year before." [Navitec]

"There's a strong push towards using more forklift vehicles. Just because they are more versatile, they can pick up from the floor where these mouse types always need these extra stations. I think they are growing more." [NODE Robotics]

MOUSE SEGMENT, LOW BARRIERS TO ENTRY

- STIQ interviews for the 2024 report highlighted a sharp move into pallet solutions for plenty of companies and increased activity among forktruck OEMs

- While this trend began just before and during Covid with plenty of pallet jack type solutions, this seems to have consolidated somewhat as we're exiting Covid

"I think we see less and less demand for those mouse solutions. It's kind of easy to develop a mouse vehicle if you want to get into AGVs & AMRs. But it's a lot more complex to develop a robust forklift. I think I saw that as a clear trend that even the well-established AMR companies who entered the market with mouse vehicles are now also bringing at least small forklifts like low lifters. So I'm sure there will be a space for the mouse also." [Toyota MH]

GROWING PALLETS FOCUS

- While the pallet focus is nothing new, there appears to have been something of a resurgence in the AGV & AMR sector to focus on pallet movements partly due to labour issues

"It's tighter than normal labour, because forklift drivers require a kind of license, which takes in a full complete day of training. So it's tighter than the regular market, which is already tight." [Rapyuta Robotics]

"An important driver of our customers is the issue that they are not able to find enough workforce. This was one of several reasons why we developed an AMR for pallets. [Knapp]

- The primary reason appears to be that adding infrastructure for managing pallets to mouse vehicles can simply make the product too expensive

SAMPLE FORKTRUCK FORM FACTORS (SIMPLIFIED)

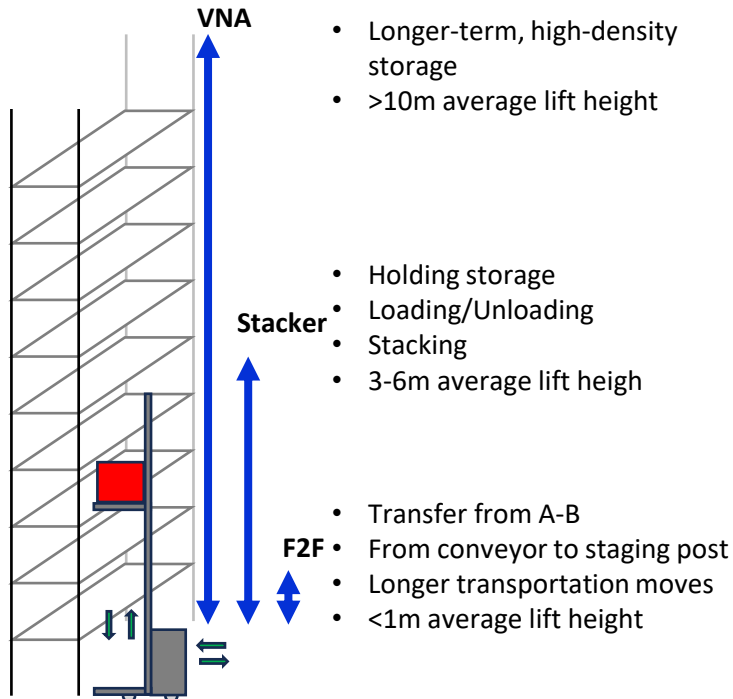| Stacker | Counterbalance Stacker | Reach Truck |
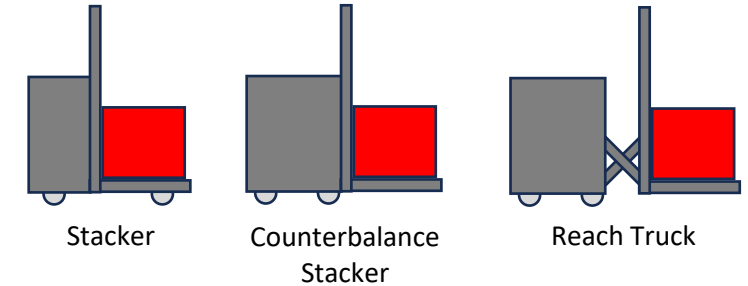
Source: STIQ Ltd Research & Analysis

"So the pallet space is something you might say we are catching up to the key players in that segment. But there's also a lot of other players entering that market." [MIR]

THREE PRIMARY FORKTRUCK LIFT HEIGHT ZONES

VNA
- Longer-term, high-density storage
- >10m average lift height

Stacker
- Holding storage
- Loading/Unloading
- Stacking
- 3-6m average lift heigh

F2F
- Transfer from A-B
- From conveyor to staging post
- Longer transportation moves
- <1m average lift height

Source: STIQ Ltd Research & Analysis

- The impression is also that the mouse segment is also largely commoditised

"I think there's kind of two answers to that as we've always had our sights on pallet movements and we stay true to our founding nature in that regard. And then that [mouse] is a much lower price, lower margin, much more commoditized market that we don't have any interest in playing it." [Seegrid]

- Offering forklifts has a definitive advantage in the European market with standardized pallets, but also in the 3PL segment, etc.

"If you want to get into a volume business, you're going to have to compete in the forklift world. And to do that, you'd have to build a forklift very efficiently." [Scott Automation]

VOLUME MOVES ARE F2F

- The vast volume of pallet moves are F2F type transports, from end of line to staging, from staging to outbound, etc.

"Of course, there's movements in narrow aisles up on the rack movements, but when you count the movements throughout the facility, throughout any period of time, the significant movements are essentially floor to floor, floor to conveyor, conveyor to floor." [Seegrid]

"We focus mainly on the movements of pallets. In that field, there lifting height is not high. It is mostly on the ground F2F, from conveyor to floor, or floor to conveyor. Because this is the majority of pallet movements, and these are easy to handle to commission, it is easy to maintain." [K.Hartwall]

TRUCK LOADING & UNLOADING

- However, truck loading & unloading is also a popular application (see also STIQs Loading & Unloading reports here)

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THE AGV & AMR SOFTWARE LANDSCAPE CAN BE DIVIDED INTO THREE BASIC LAYERS: ONBOARD (ON VEHICLE), ORCHESTRATION AND OFFICE TOOLS SOFTWARE

SIMPLIFIED AMR HARDWARE + SOFTWARE COMPONENTS LANDSCAPE

Back Office SW Tools: Simulator, Remote Assistance, Deployment Tools

Orchestration Layer SW: Fleet Manager, IMS

Onboard SW: RTLS, Camera on Manual Vehicle

AGV/AMR Vehicle: Controllers, IMU, Comms, Motors, Batteries, Compute Unit (Robot Navigation, Obstacle Avoidance, SLAM Localisation + Mapping, Safety), Sensors (3D Lidar, Camera, 2D Lidar)
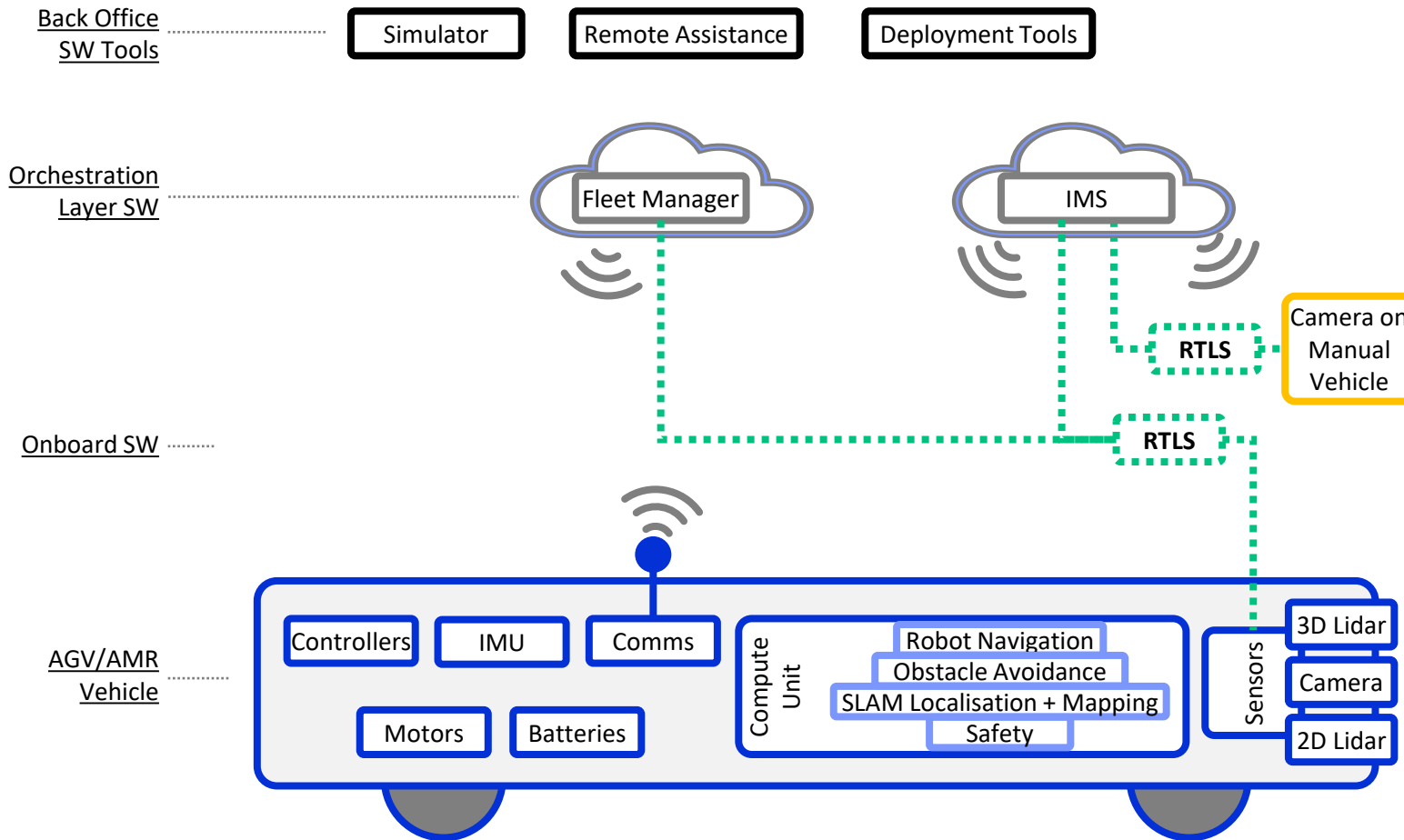
Key: ▬ Hardware (robot) ▬ Software (on robot) ┅ RTLS services ▬ Non-autonomous asset tracking ▬ AGV & AMR Back-office tools

Source: STIQ Ltd Research & Analysis

THE AGV & AMR SECTOR CAN BE CONFUSING

- There are multiple component and software options for constructing an AGV or an AMR robot, which is often confusing for casual observers

"When you look at the competitive landscape for us as an automation solution provider, many companies have other scopes. There are some companies that only do localization. And then there are some companies that do the whole logistic facilities. This means that it's sometimes hard to, in a generalized way, talk about the competitive landscape or talk about competitors because you're not always providing the same parts of the solution or the same solution." [Kollmorgen]

THREE BASIC AGV & AMR SOFTWARE LAYERS

- There are three basic software layers for AGV & AMR robots including onboard software, fleet manager and project or back-office tools

- Onboard software includes Navigation, Obstacle avoidance (if required), Location & mapping, Safety, etc.

- Orchestration software is typically a Fleet Management tool instructing every robot where to go and what to do

- Back office software tools include AGV & AMR project delivery software from simulation to remote assistance/control, deployment tools, etc.

- Each of these software layers continues to evolve and we outline some of these developments in this report

- For additional context and insights, download previous STIQ AGV & AMR Robotics reports here

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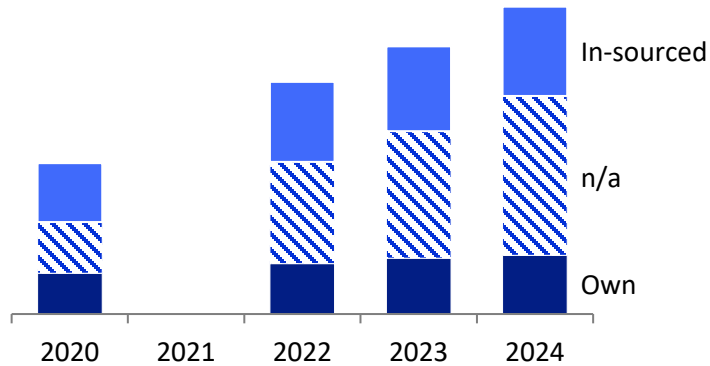A REGAL REXNORD BRAND

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AT LEAST A THIRD OF KNOWN ROBOT VENDORS PROCURE NAVIGATION SOFTWARE. AGV TECHNOLOGIES LARGELY COMMODITISED

## NUMBER OF ROBOT VENDORS BY NAVIGATION STACK USED, 2020-2024 (#)

Source: STIQ Research & Analysis. Not tracked in 2021
NOTE: Use chart with caution! Shows the number of AGV & AMR Robotics companies using an outsourced solution to STIQs knowledge (as confirmed by buyer or vendor). Contact STIQ Ltd for more information on this
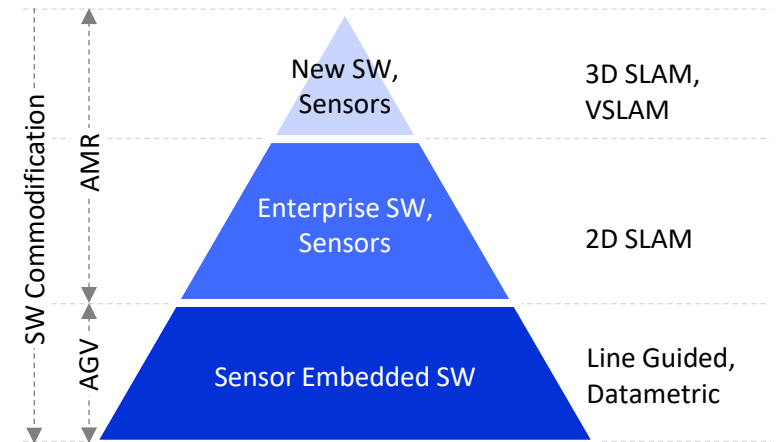
NAVIGATION TECHNOLOGY + SLAM (LOCALIZATION) VENDORS, 2010-2024 (#)
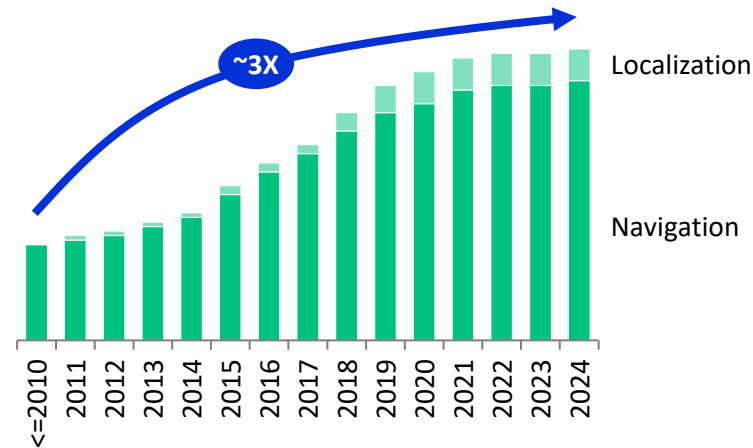
Source: STIQ Ltd Research & Analysis. Tracking year company founded, not when navigation product was offered

AGV & AMR NAVIGATION TECHNOLOGIES, STAGE OF COMMODIFICATION

Source: STIQ Ltd Research & Analysis

NAVIGATION: INSOURCED OR OWN

- Navigation software can be split into AGV and AMR, where AGV is largely sensor embedded and vendors typically focus on fleet management functionality
- AMRs tend to require navigation software and there are a number of navigation software specialists in the market
- In 2024, about a third of all the vehicle vendors (c.500) identified by STIQ Ltd in-sourced navigation software and about half were unknown with the remainder producing their own navigation software

STIQ TRACKS C.60 NAVIGATION VENDORS

- STIQ currently tracks nearly 60 vendors of navigation technology globally and about 10 SLAM Localization specialists
- The Navigation segment formed in the 1990s with the development of forktruck navigation solutions using Lidar and reflectors and evolved quickly in the 2010's with the development of SLAM and open-source packages, such as ROS
- There are just over three times as many vendors in 2024 compared to 2010

NAVIGATION SOFTWARE EVOLUTION

- AGV navigation is already commoditised and largely sensor embedded with few (if any) companies developing their own navigation stacks
- AMR technologies, such as 2D SLAM are widespread in the sector and have just started appearing in the market as sensor embedded solutions

"The PicoScan150-LOC is our latest addition, featuring built-in 2D SLAM localization software in a 2D LiDAR sensor. This plug-and-play solution works right out of the box—simply mount it on your vehicle, and it's ready to operate." [SICK]

THE NAVIGATION BUSINESS DEVELOPMENT TIMELINE MAY FOLLOW THE KETCHUP BOTTLE EFFECT. FIRST NOTHING, THEN LITTLE OR NOTHING AND THEN EVERYTHING

THE NAVIGATION BUSINESS MODEL

- Navigation software vendors typically supply robot navigation software and fleet management software
- Customers for navigation software are most frequently companies that want to offer mobile robots, or perhaps have a range of AGVs they wish to complement with AMR robots as well
- In some cases, customers are new to mobile robots and sales can take a long time to materialise as the customer needs to first develop a vehicle/s and stabilise the design and then sell it to their customers (the end customer)
- Hence, volumes can take time to build up and significant revenue growth can often take years, especially for new navigation software vendors entering the sector

"So usually the revenue growth comes from your existing customer that you have served for five years or 10 years, and they are just growing heavily. And we have seen 100% growth for some of our customers between the year, our financial year is 22 to 23 middle to middle to next year. So they're in our top 20, I think 15 of them were growing heavily." [Navitec]

"Sales opportunities are new companies entering the AMR sector or when an existing vendor is adding a new robot or upgrading existing vehicles. These are the typical points in time when they obviously want to change something or develop something new. Some are switching from competitors and just like saying, okay, I want to be more flexible." [NODE Robotics]

TYPICAL SOFTWARE BUSINESS DEVELOPMENT TIMELINE IN THE AGV & AMR ROBOTICS SECTOR
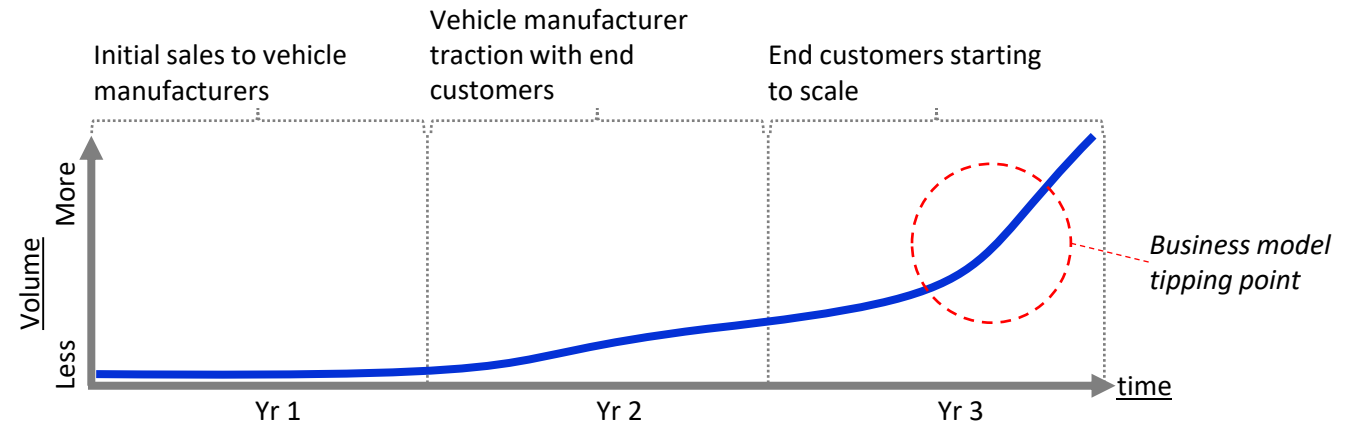
Source: STIQ Ltd Research & Analysis
Note: The business model tipping can occur at different points (earlier/later) for different businesses depending on ownership, funding and other variables

"Revenue model varies by complexity of the use case and level of support that the customer needs when transitioning from current generation perception to vision based solution. Significant revenues come at the scaling phase. It is important to help customers get there quickly" [RGo Robotics]

BUSINESS MODEL KETCHUP EFFECT

- For new navigation vendors revenue may take several years as it is largely reliant on secondary sales
- This can often be akin to "the ketchup effect" where at first nothing happens and then nothing happens only for everything to happen at a tipping point – the business model tipping point
- Getting to this point may take several years

AGV & AMR NAVIGATION TECHNOLOGIES VARY FROM LINE GUIDANCE TO VISUAL SLAM. NASCENT USE OF MULTIPLE NAVIGATION MODALITIES

THE MOST COMMON AGV & AMR NAVIGATION & LOCALIZATION TECHNOLOGIES

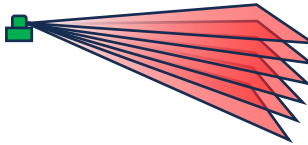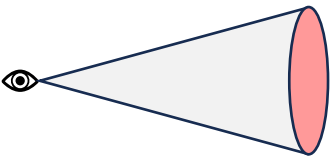| Sensor Illustration	Sensor	Description (simplified)
	Line guided	• Vehicle follows painted lines or magnetic tape, etc. High Accuracy and relatively cheap option. No barriers to entry
	Datametric	• Vehicle follows QR codes stuck on the floor in matrix pattern. Robots typically turn 90, 180 or 270 degrees on turns. Low barriers to entry
	2D Lidar	• Vehicle follows 2D map created with single layer detection Lidar. Most commonly used sensor for AMRs. Aka 2D SLAM or Contour Navigation, Natural Feature. Most popular safety Lidars are 2D Lidars • Often used with reflectors for additional accuracy with forktrucks
	3D Lidar	• Vehicle follows map created by multi-layer Lidar detection. Increasingly popular in some forktruck and complex AMR applications. Aka 3D SLAM. Map is made up from a 'point cloud'
	Visual	• Frequently used for additional space context, i.e. there is a human, box, another vehicle, etc. in the way. Popular with more recent vendors. When combined with TOF sensor, also used for Navigation. Aka Visual SLAM (VSLAM), 3D SLAM
	Radar	• Mainly used for safety applications and obstacle avoidance. Early stage developments in the AGV & AMR sector

AGV (floor markers/guides)

AMR Natural Navigation (SLAM)

Source: STIQ Ltd Research & Analysis

COMMON AGV & AMR NAVIGATION TECH

• In general, the acronym AGV denotes that vehicles follow guides that are stuck on a floor surface, such as painted lines, magnetic tape (can also be embedded in floors), datametric codes, etc.

• The AMR acronym typically denotes vehicles that use virtual maps (SLAM) to navigate

• Selecting the best navigation technology is often related to the application environment, the application itself, the vendor, the stability of the navigation solution, etc.

SENSOR FUSION INCREASINGLY COMMON

• Note that it is becoming increasingly common to fuse input from several sensors (aka Sensor Fusion) to create stronger mapping and sensing capabilities

• There is also an emerging trend for using multiple sensors for navigation, i.e. VSLAM for longer routes and line guidance when docking to a station

OBSTACLE AVOIDANCE (OR NOT)

• The first question for anyone looking to buy AGVs or AMRs should be if they really need the option of obstacle avoidance or if it is simply a "good to have" option

• AGVs have typically not included obstacle avoidance and staff working around the vehicles have been taught not to leave anything in the way of these vehicles

• AMRs typically come with obstacle avoidance

• Sensor fusion and newer technologies can also allow older type of navigation technologies such as AGVs to do obstacle avoidance

2D SLAM NAVIGATION IS CURRENTLY THE LEADING AMR NAVIGATION TECHNOLOGY

ESTIMATED AMR NAVIGATION TECHNOLOGIES MARKET SHARE (%)

2D SLAM   3D SLAM, VSLAM

Source: STIQ Ltd Research & Analysis. Note 2D SLAM includes reflector navigation. Excludes AGV navigation technologies

DIFFERENCES BY AGV & AMR FORM FACTORS

- Navigation software cannot be directly transferred between form factors as these have different kinetics and complexities

- In general, the mouse form factor has received the most attention from startups

"Mouse vehicles are the most common vehicle type. It's a market segment where we face the toughest competition, at least from our perspective. The price pressure for these vehicles is fierce, and it definitely makes it a more challenging segment." [Kollmorgen]

TYPICAL LOCATION OF 2D NAVIGATION & SAFETY SENSORS ON AGV & AMR ROBOTS
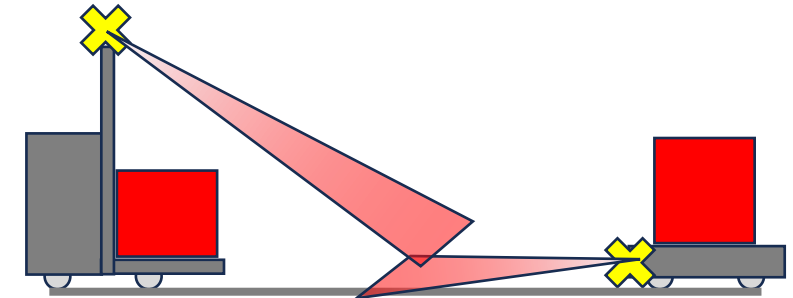
Source: STIQ Ltd Research & Analysis

2D SLAM THE LEADING NAVIGATION TECH

- 2D SLAM is currently the leading navigation technology in the sector but other solutions, such as 3D SLAM and VSLAM are emerging and growing fast

"2D SLAM is now the industry standard. We have a strong 2D LiDAR portfolio and also offer world-class 2D contour localization software. Meanwhile, 3D LiDAR localization is gaining traction in the market. The choice between these technologies depends on the specific application requirements. Beyond our 2D solutions, SICK is actively enhancing its 3D portfolio. Our multiScan and Visionary product lines introduce 3D sensors that are perfectly tailored for use in AMRs." [SICK]

2D SLAM IS A FIT FOR PURPOSE TECHNOLOGY IN THE CURRENT MARKET. VSLAM MAY BE SUPERIOR IN A RAPIDLY EVOLVING MARKET

HYPOTHETICAL DEMAND FOR NAVIGATION TECHNOLOGIES IN NEW, MORE DYNAMIC ENVIRONMENTS AS THE MARKET MATURES AND STRETCHES BEYOND LEGACY APPLICATIONS AND INDUSTRIES
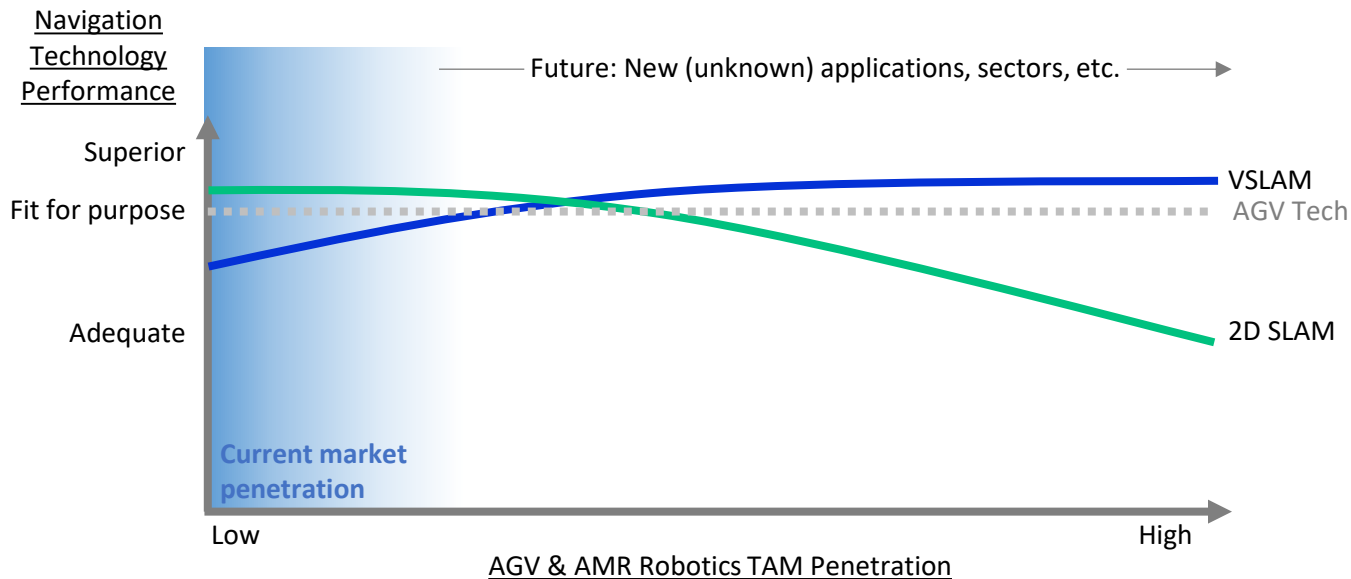
Source: STIQ Ltd Research & Analysis. Visual SLAM for navigation/obstacle avoidance + contextual purposes. Does not include solutions such as 3D SLAM (Lidar based), etc. AGV Tech included as a benchmark. See also STIQs Future of Warehouse Automation reports
[1] Hypothetical developments may include completely new applications. TAM + penetration level is hypothetical

- Dynamic environments can be a challenge for more traditional SLAM approaches, or where customers wish to take more ownership of their AMR solution

"Dynamic environments are a challenge for traditional 2D SLAM. And the push for automation in more and more logistics and more dynamic manufacturing scenarios creates a need for very robust and flexible AMR solutions. And it is clear that if you have to install reflectors, for example, if you have to add physical infrastructure, you don't have this flexibility." [Sevensense]

VSLAM, A GROWING TECHNOLOGY

- While VSLAM is an emerging technology, some end customers and use cases are increasingly requesting camera based approaches as part of RFP's

"There is a shift to VSLAM as end customers are requiring more adaptable, more flexible AMR solutions to shorten and simplify commissioning time. We even started to see RFPs by end customers indicating VSLAM based localization as a requirement. AMR solution providers, autonomy providers and smart sensors providers are looking to add VSLAM based localization to their offering. Deployment and commissioning toolchain is also critical" [RGo Robotics]

- The technology has been adopted by a few companies for navigation and recognition

AN EVOLVING MARKET MAY REQUIRE VSLAM

- As the AGV & AMR Robotics market continues to develop and evolve with ever larger deployments and new applications/ use cases, there will likely be more demand for additional navigation technologies

"I think the higher volume of deployment we're starting to see, the more this becomes a problem, because it probably wasn't seen as a problem because there was such low volume of deployments and they were all kind of magnetic line following robots. But now you're starting to see an emergence of more flexibility of these robots. The coexistence problem is a problem." [Opteran]

ADVANTAGES OF VSLAM INCLUDE A MORE DETAILED WORLDVIEW, LESS ARDUOUS COMMISSIONING, ETC.

VSLAM OFFERS A MORE DETAILED VIEW

- VSLAM is an improvement on 2D SLAM with additional ability to contextualise scenes

"For instance, with cameras, we don't understand only where there is an obstacle, we also understand what this obstacle is. We can add a semantic layer." [Sevensense]

- One of the main issue with some of the current 2D approaches is losing maps in, for example, highly repetitive environments

"The problem with many camera and Lidar-based systems is that features often look the same. You can move and find a feature, but it could be the same feature that was 100 meters back. It's a really common problem on why systems get lost. Our technology looks at the entire environment rather than looking for those tiny features. We can understand small nuances that many approaches in SLAM today can't do, to add that robustness factor. It's a really common problem that we hear about actually from these systems." [Opteran]

- In the current market, VSLAM remains a bit more expensive compared to other navigation solutions, but there are advantages, such as map management

"You need to do a lot of map cleaning with 2D SLAM. Less so with VSLAM." [Sevensense]

- However, nearly all sensors used for navigation in the market come with trade offs

"All sensors in the market all have trade-offs. Lidar is expensive and requires a lot of compute and the cost of your machine is higher. Compare that to VSLAM today, and the main trade-off is the setup and environmental factors. Cameras may be lower cost, but they're difficult to commission and set up. If you have large changes in scenery, that becomes a problem for the maps, or for example, environmental factors like you make a map and the light conditions change... We don't use high-definition cameras. Instead, we use low definition, low resolution cameras, but at very high frame rates. Those cameras are about $10 each." [Opteran]

SENSOR FUSION, AN OPTION TO VSLAM?

- Sensor fusion may be the way to go rather than any particular localization technology

"A lot of people are asking for VSLAM and when you ask them why, it feels like it's mostly a buzzword. They don't have a real use case or pain for it. And we are heavily convinced that if you really want to scale broadly to different use case environments, you need different sensor modalities. It won't be just one single sensor modality. It won't be just cameras. It won't be just lidars." [NODE Robotics]

- VSLAM vendors also use sensor fusion to enhance and confirm localization estimates

"For localization solution to meet production requirements it needs to provide consistent performance. For that VSLAM is not enough. To meet availability and reliability we combined additional layers of algorithms and multi-modality by using different types of sensors." [RGo Robotics]

THE VSLAM v 2D SLAM VIEW

VSLAM view using a fisheye lens. Dots indicate feature extraction (to create a point cloud)
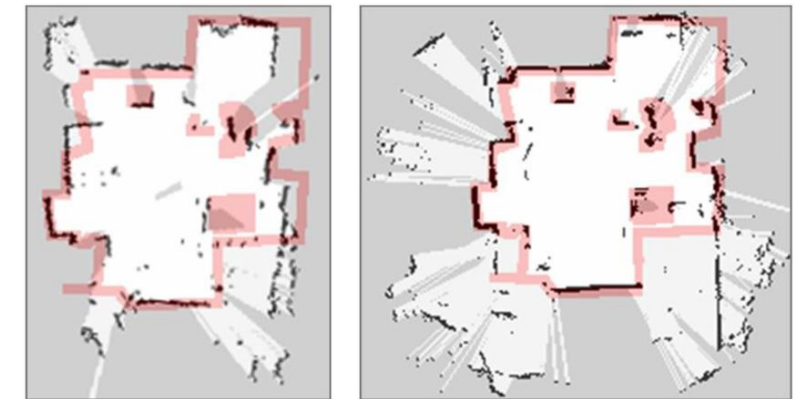
2D SLAM view

Image Source: SIGMM (to), Researchgate (bottom)

VSLAM HAS FAST EMERGED AS A MORE COST EFFECTIVE RTLS ALTERNATIVE (ALSO ENABLING THE EVOLUTION OF AFM TO IMS)

ROBOT LOCALIZATION

- Localization has been given its own segment in the AGV & AMR Robotics sector as many vendors appear to buy externally developed solutions

"Our industry-proven LiDAR-LOC sets us apart in the field of localization. From our experience, most companies do not develop localization solutions in-house. While some attempt it, many fail because it's far more complex than it seems. Developing a basic localization software using ROS might work well in a controlled test environment, but real-world applications often expose significant challenges. Expertise is crucial to create robust solutions and maintain reliable performance in real-world conditions." [SICK]

VISUAL SLAM ALSO USED AS RTLS

- The aim of some vendors is to provide a simple conversion kit for AGV owners/vendors to add AMR type navigation capabilities

"Today we're really focused on solving localization, similar to your magnetic line. The more manufacturing style use case." [Opteran]

RTLS MAY BE A BIGGER OPPORTUNITY

- The RTLS opportunity appears to be larger than the AGV & AMR Robotics market on its own since manual vehicles also come into play

"In terms of size of revenues, the potential RTLS volume is still bigger than AMR." [RGo Robotics]

"So we're moving into, for example, RTLS, as I've talked to you about before, and scaling to a few other industries that all relate to that end-to-end supply chain manufacturing." [Opteran]

- RTLS options include UWB technology which is typically more expensive as it requires additional installation of transponders

"We see valuable use cases for UWB when it comes to precision. We have two RTLS solutions right now. We have RTLS Pro, which gives you best precision and very high update rate and then we have RTLS Mesh. But when it comes to AGV & AMR fleet management, it's typically sufficient to have a good enough position of manually operated vehicles. Here, we have partnered to offer a VSLAM solution." [Kinexon]

- Other localization vendors are considering the relatively new RTLS opportunity

"We're not currently being used for RTLS, but we are in talks." [Accerion]

LOCALIZATION INCLUDED IN ROBOTS, VSLAM INCREASINGLY USED WITH MANUAL VEHICLES

Localization part of SW stack

RTLS (VSLAM) added to manual vehicles
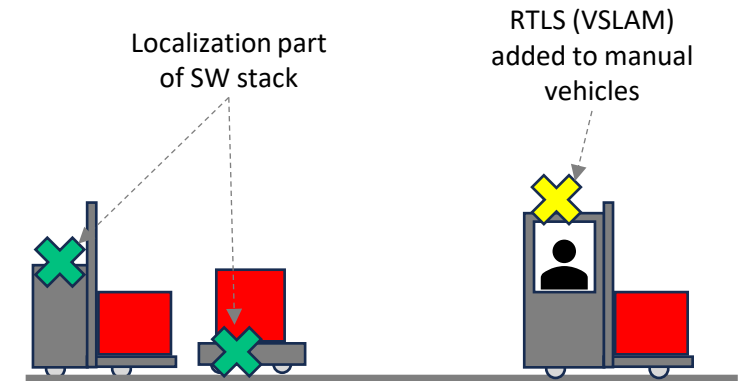
Source: STIQ Ltd Research & Analysis

OUTDOOR NAVIGATION IS AVAILABLE BY MANY NAVIGATION VENDORS, BUT MAY NOT BE A HUGE OPPORTUNITY

OUTDOOR NAVIGATION APPLICATIONS

- STIQ interviews with end customers have highlighted an interest in mobile robots moving outdoor between buildings on the same campus

- Nearly all navigation vendors have executed projects including some level of outdoor navigation

"The one outdoor navigation application that we have and is public, is the one at Barcelona airport." [Bluebotics]

- There are many different applications for outdoor navigation and this can often be combined with vehicles moving indoors as well

"Outdoor operation can apply to many different applications. In the past, when you wanted to automate, you needed AGVs indoors and then the transfer to the next building was usually handled by big manual vehicles. If companies had money, they might automate this outdoor model, but it remained a separate solution. So, you had AGVs in hall 1, a different vehicle for outdoor transfer, then different vehicles in hall 2 – not so efficient! Now we are more able to say, listen guys, the same vehicle can do the whole job everywhere. Thanks to sensor fusion, you just go in and out, no question, no problems." [Bluebotics]

"Mostly or always, I think it's two different buildings. Very common one is connecting the production plant with the warehouse plant, which are very often two different buildings." [Movanis]

- However, outdoor navigation is not currently thought to be a huge market opportunity for AGV & AMR navigation vendors

**"I'm not expecting huge volume for outdoor." [Bluebotics]**

- But quite a few vendors have already generated such projects

"We go in between buildings. We can go outside. Most companies won't do that. We've done purely outdoor rated vehicles, which most companies won't touch. And we also go up into larger capacities. And so from our standpoint, a lot of companies are looking for a pretty broad array of capacity when you get right down to it." [Scott Automation]

- And, some vendors are developing more resilient systems

"So for sun and rain we have almost no limitations. So only if its this very heavy thunderstorm rain, then at some point you will start to see the raindrops and then start to stop for these as well. Then you can drive through this light fog, but when it becomes a bit more dense fog, at some point some of the sensors start to become unreliable and become a bit more complex. So we are planning new technology in the software algorithms that will come out at the end of this year to make it more robust against fog. But at some point you will have it. But like I said, if you look at the amount of hours a year that there is fog and the same for snow." [Movanis]

AGVs & AMRs MOVING PAYLOADS IN-/ OUTDOOR BETWEEN BUILDINGS ON PLANTS
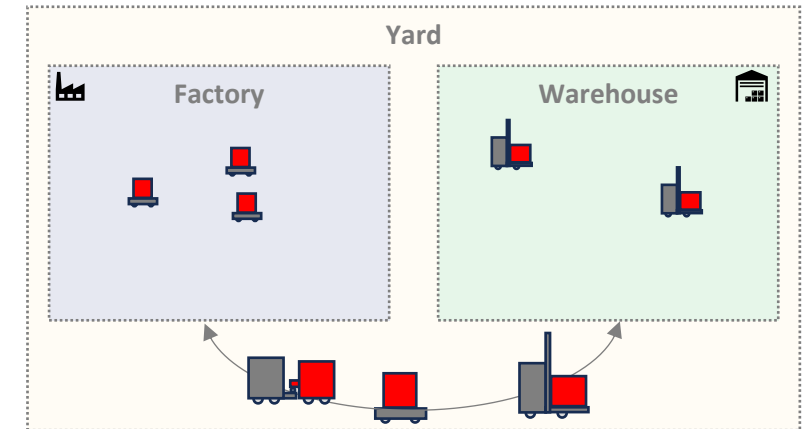
Source: STIQ Ltd Research & Analysis

AUTONOMOUS CAR INFLUENCES

- There are increasing autonomous car influences in the AGV & AMR sector

"Most of the team here is from self-driving. I came from Uber and a lot of my colleagues came from various self-driving startups… our central thesis was that we could apply the same principles, the same technology for indoor industrial automation." [Thoro.ai]

"Our CTO comes from autonomous driving space." [ForwardX]

CONTENTS

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Sensor Intelligence.

THE FLEET MANAGER HAS RECEIVED A LOT OF ATTENTION TO IMPROVE USABILITY FOR END CUSTOMERS COMBINED WITH EXPANDED FUNCTIONALITY

ROLE OF THE FLEET MANAGER (SINGLE VENDOR)
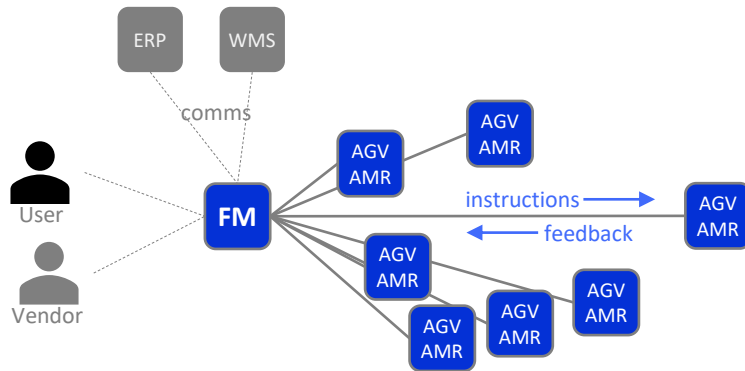
Source: STIQ Ltd Research & Analysis

FLEET MANAGEMENT ATTENTION

- Interviews suggest a lot of vendors have increased their attention on making the Fleet Manager easier to work and interact with end customers

"We're releasing a new fleet manager, which we call MIR fleet enterprise. And that has an updated UI, but the more important thing is the enterprise part of it, which is the cybersecurity that it brings. Now I cannot remember the specific standard, but I can find it. Because the bigger companies, they have growing cybersecurity requirements, plus the EU Resilience Act is coming slowly, and fully implemented in 2027." [MIR]

"We have really made an emphasis to push for more functionality in our fleet manager. As a software provider, it is often about adding new functionality rather than launching new products. " [Kollmorgen]

"We worked a lot on improving our fleet management software. A lot of features included to make the picking process more efficient." [Lowpad]

- This may partly be driven by end customers increasing maturity with mobile robots and a willingness to engage with changing routes, orders, orchestration, etc. of robot fleets

"We have a new concept we call NDC Flex which spans across many of our tools and products. One part of NDC Flex is about enabling what is referred to as end user flexibility, where we with some boundaries, enable the end user to make changes to their setup, configuration, etc. It's something that we see more and more asked for in the market." [Kollmorgen]

MORE THAN A FLEET MANAGER

- Several vendors, especially those with a larger product range, are actively expanding FM functionality

"We have integrated our vehicles with the Kollmorgen system manager and then we have our own WES on top of that. One of the more important parts of our portfolio is our fleet management software and a WES that allows us to combine many things… besides the AGV forklifts we also have an integrated solution for radio shuttles. I believe we are the first in the market. It's a fully standardized system with the integration of AGV trucks and radio shuttles." [Toyota MH]

"We are beginning to integrate with the broader suite of Zebra's technology. Our long-term vision is BYOD where you will no longer have to buy devices as a function of the as-a-service model. You'll be able to approach any one of our robots with a variety of Zebra devices that you have to execute the pick." [Zebra Technologies]

WES/WCS INCREASINGLY FEATURING

- Warehouse related software layers such as the WES and WCS increasingly feature mobile robot functionality

"Our WES layer is configurable rather than that you have to code for the integration. You still have to program the transports in the FM, but we move a lot of the logic up into our WES." [Toyota MH]

"From last year we migrated the business model. We are still an AGV & AMR integrator. But we realized that the software that we had developed was far, far better than current solutions that we see in the market… this software that integrated with several internal systems like ERPs, MESs, or WCSs. So we thought, why don't we actually keep improving this software to be used by other integrators? Our path actually is to become a WCS." [Moontech]

VDA5050 + RTLS HAVE ENABLED AN EVOLUTION OF THE HUMBLE FLEET MANAGER INTO AFM AND IMS FOR MORE COMPLEX INTRALOGISTICS MANAGEMENT

FLEET MANAGER, AGNOSTIC FLEET MANAGER, AND INTRALOGISTICS MANAGEMENT SYSTEM

Fleet Manager
(Single Vendor Fleet)

Enabler:
-

Agnostic Fleet Manager
(Multi Vendor Fleet)

Enabler:
VDA5050

Intralogistics Management System
(Mixed Manual & Autonomous Fleet)

Enabler:
VDA5050 +
SLAM RTLS

Key: ■ Vendor A   ■ Vendor B   ■ Vendor C   👤 Manually operated vehicle/ person   ■ AFM   ■ IMS   ■— Forktruck

Source: STIQ Ltd Research & Analysis

EMERGENCE OF MULTI VENDOR FLEETS

- Fleet Managers manage order orchestration and connects to other systems, such as fire systems, doors, etc. for smooth operation of AGV & AMR fleets

- Customers typically get a Fleet Manager every time they buy robots from a new vendor

- An AFM/IMS is typically bought from a third-party vendor which often has ready made integrations with some vendors

- The AFM/IMS can theoretically manage, orchestrate, etc. any AGV & AMR which is VDA5050 enabled

- However, some vendors and system integrators are also considering developing such tools, primarily the AFM type

"We see a potential in widening our product range also for a software-only product… We have VDA5050 interfaces, so why not share this with other companies?" [Safelog]

"We will need to keep this role of being integrators, especially for the clients that we have really close by. For situations where we are further away from customers, we want to exploit the software licensing." [Moontech]

WHY AFM + IMS?

- The primary market driver for the emergence of the AFM was the German automotive sector's development of VDA5050, a standard communication interface for mobile robots

- IMS is a step further beyond just managing robot traffic and also includes tracking and management of manual vehicles which may also include other movable assets

- A key driver for the IMS is the evolution of VSLAM which currently allows for a reasonably accurate tracking of manual vehicles and assets without any infrastructure installation work

"We're an enabling technology at the end of the day. This is why partnership with FM vendors or with WMS or with integrators is important." [RGo Robotics]
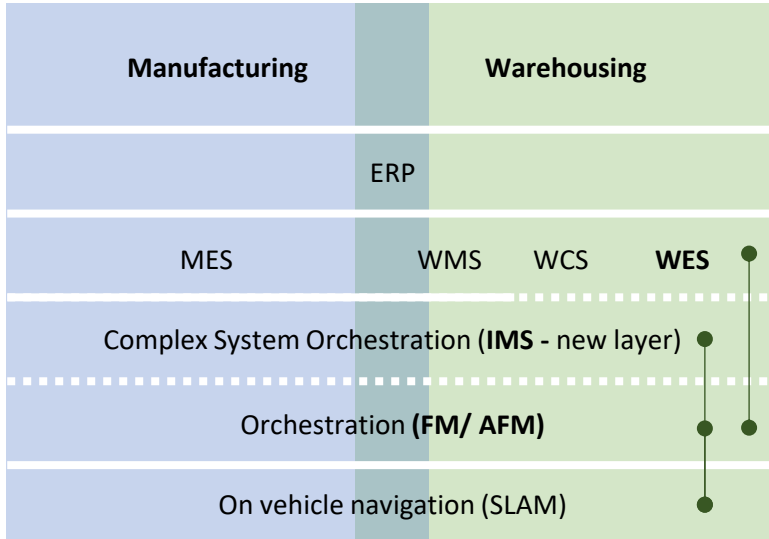
THE AGV & AMR FLEET MANAGER IS INCREASINGLY OVERLAPPING WITH OTHER WAREHOUSE SOFTWARE

AGV & AMR SOFTWARE HIERARCHY

Transportation applications   *Storage & retrieval applications*

Manufacturing		Warehousing	
	ERP		
MES	WMS	WCS	**WES**
Complex System Orchestration (**IMS** - new layer)			
Orchestration **(FM/ AFM)**			
On vehicle navigation (SLAM)			

Key: ●——● *Relationship, enabling technologies, overlapping technologies*

Source: STIQ Ltd Research & Analysis

ENTER THE IMS AND THE WES

- WES and IMS are relatively new software packages with similar conceptual functionality – to optimise workflows with mobile robots, people and, sometimes also, manual vehicles/ workers

- While the WES comes from a storage & retrieval background and is focused on maximising throughput, the IMS originates from manufacturing and is focused on maintaining takt times in transportation missions

- The recent explosion in WES vendors (see also STIQs WMS report) has largely been due to the influx of mobile robots (mainly PA-AMR) in ecommerce storage & retrieval applications, but is increasingly also overlapping with case and pallet load applications (AGV & AMR Robotics)

- IMS software is largely enabled by relatively cheaper RTLS solutions, such as SLAM software – also used in AMRs

- These two packages are increasingly also targeting and penetrating the AGV & AMR Robotics sector

INCREASING COMPLEXITY PUSHING THE IMS

- Increasing complexity when there are multiple transportation moves that need to happen concurrently, has pushed the development of the IMS

"The role of an intralogistics person changed a lot in the last years, I would say. That the demands are high to explain the simple words because not only the complexity of the material flow changed, now you have different roles. Transportation from the warehouse to the product is no longer done directly. Instead, multiple steps involving different trucks and mobile robots have become the norm. The concept of material flow is getting more complex and it's changing all the time. It's not like a one-time complex system made. It's like a monthly changing system, which is having a high complexity in the end." [NAiSE]

- The IMS is focused on interoperability between AGV & AMR vendors and manual vehicles and operators

"This is the big thing that interoperability, VDA5050, and including forklifts and humans, is really picking up." [Synaos]

THE WES FOCUS ON STORAGE & RETRIEVAL

- WES for warehouse storage & retrieval/ picking applications have a very specific focus on minimising walking distance between picks + increasing throughput

"There's the elimination of long walks. Everyone can do this. There is the speeding up of the task. How fast can you find the bin, search for the item, grab it, confirm it, put it, and transition to your next pick. Everyone's got those six pick steps that they must get through. The question is, what are you doing to enable that picker to be faster? Fundamentally, these follow the laws of physics. There's only so much time you can extract from a 10 sec pick to make it more efficient. The point of diminishing returns on accelerating the time in front of the pick location happens really fast. We have been focused on minimizing the distance between pick locations. This is also where all these different methodologies start popping up. They start looking at what are the different approaches we can take to minimize the distance between pick locations." [Zebra Technologies]

CALCULATING A STRICT ROI ON AFMs AND IMSs CAN BE DIFFICULT AS THE PRIMARY FUNCTION IS UNBLOCKING OF FURTHER, AND ADVANCED/COMPLEX, AUTOMATION

WHERE IS THE ROI OF THE AFM OR IMS?

- Calculating a strict return on investment on AFMs or IMSs which enable management of multiple vendors and manual fleets is difficult to ascertain

- While there are some savings on not having to buy multiple fleet managers from each robot vendor, there can be other indirect savings, such as limiting crashes between manual vehicles and robots

"It's a common problem at this automotive manufacturer, robots getting smashed into by manual vehicles. It's also a common problem elsewhere. We've heard it from multiple other manufacturers." [Anonymous]

- However, there is no simple answer to ROI of a consolidated single dashboard for all vendors for the AFM and manual vehicles with the IMS

"The market is maturing. More and more people are getting the problems we are solving. The pain is out there and is getting bigger and we're addressing that. ROI is often not the biggest problem. The biggest problem now is how well educated are the customers? Are they stepping into the single vendor trap? Or are they smart enough to take the right steps from the beginning?" [Synaos]

"ROI or performance increase… this is one of the 1st questions always coming from our customers, but there is no simple answer for that, because we are not that kind of solution which sells the software because you as a customer will be able to increase your performance by 50% or something like that." [NAiSE]

REMOVING BOTTLENECKS TO AUTOMATION

- Rather than a pure ROI, the AFM and IMS both act as unblocking systems to further, more complex automation solutions which can lead to further performance improvements and optimisations

"Our solution was initially built for complex automation. So highly dependable, huge fleets, different hardwares, different vendors. We are incorporating manual traffic now. So we are really covering the whole transition from manual traffic into complex automation, and even complex automation together with manual forklift traffic." [Synaos]

"The increasing of performance depends on the use case itself. There are also blocking points. For example, if you want to automate more and more transportations, but you can't because you need different robots. And that's the blocking point. We are removing these blocking points to be able to increase the performance… and that's how the intralogistics flows will be optimised." [NAiSE]

WHEN TO INSTALL AN AFM?

- The decision to go for an AFM is often part of a wider strategic AGV & AMR review where companies have likely strong support from top management

"A client of ours started with the fleet management software and then they did a POC in their HQ to start integrating different kinds of AMR suppliers. Now they have three different vendors with multiple AGVs, AMRs. I think they realized early on that they might need different vendors because they have new and old facilities. The old facilities are much more restrictive in terms of what technology you can choose from." [Kinexon]

SIMPLIFIED RESPONSIBILITY LOCUS FOR SYSTEM THROUGHPUT MAY CHANGE WITH AN AFM/ IMS

	Customer	AGV/ AMR Vendor	AFM/ IMS Vendor
No AFM/ IMS		X	
With AFM/ IMS	X		

Source: STIQ Ltd Research & Analysis
Note: There are and will be variations where customers and suppliers make alternative arrangements. Potential customers should contact suppliers to get a better overview

AFM & RESPONSIBILITY FOR THROUGHPUT

- There are some questions around responsibility for throughput when several different AGV & AMR systems are connected to a single orchestration engine

"From the vendor's perspective, using an agnostic fleet manager will change the responsibility matrix for AGV & AMR deployments… This has to be clearly communicated to the customer from the beginning and it has to be clear that the customer itself will be the global supplier from this moment. He will be responsible for the whole setup and robot suppliers will be responsible for the robots and we will be responsible for our software solution." [NAiSE]

THE IMS IS ALSO ENABLING A NEW OPENING FOR A SYSTEM INTEGRATOR APPROACH IN THE AGV & AMR SECTOR

IMS IS MORE IN MANUFACTURING AREA

- IMSs are currently more active in manufacturing and production environments rather than pure warehouses or distribution locations

"I would say for now we are in the transfer zone from the warehouse to the manufacturer and in the manufacturing itself where you have the mixed operation of AGV, different manufacturers, and also not AGV." [NAiSE]

NOT ALL IMS PROJECTS INCLUDE ROBOTS

- The evolution of the fleet manager into the IMS is also pushing vendors into consulting projects, not always including AGVs & AMRs

"Not all our projects involve robots. We just launched the manual forklift part of our IMP product. And we're doing our first project now, but we're just starting that side of the business." [Synaos]

"Not all our projects include robots anymore. We are now running projects where our software serves as the automation platform, operating 3rd party devices with those clients." [idealworks]

EVOLUTION OF THE SYSTEM INTEGRATOR

- Some AFM vendors are taking the approach whereby they shoulder more responsibility for fleets which is akin to a system integrator approach in the market

"What we clearly see in the market is that clients don't want to manage multiple contracts with several suppliers. It's not practical and clients are hesitant. And this is why we are a single point of contact for our customer, integrating partner robots fully into our automation platform. Full integration means we take responsibility for fleet and traffic optimization." [idealworks]

- There are also other, sometimes growing, pressures on vendors to supply a larger solution than just the robots which may force a new way of working

"I don't consider we are a system integrator, but you're right. What we see more and more clients actually telling us, is 'hey, guys, we're buying robots from you and it's a €5m project, it's €3.5-4m robots. I want you to supply the racks and the conveyor, etc. as well'. So, we are pushed into this system integrator box which I'm not super comfortable with. I know Asian companies take whatever they can, but we are probably more European in this regard. I consider system integration as being, for good reason, a business segment which exists today. I'm not sure I want to compete frontally with this." [Balyo]

- However, this would also likely cause friction with reseller partners and potentially also disrupt carefully developed business models

NEW BUSINESS MODELS SLOWLY EMERGING IN THE AGV & AMR ROBOTICS SPACE??
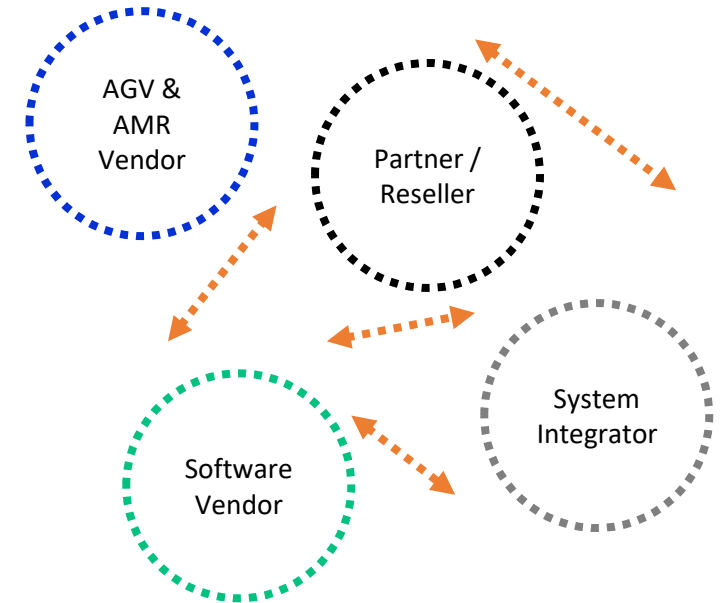
Source: STIQ Ltd Research & Analysis
Note: Currently some ambiguity in the marketplace

INCREASING ADOPTION OF VDA5050 GLOBALLY, BUT REQUIREMENTS ARE PRIMARILY COMING FROM THE EUROPEAN AUTOMOTIVE SUPPLY CHAIN

VDA5050, INCREASINGLY PREVALENT

- For software vendors there is increasing demand or requirements to be VDA5050 compliant

"Revenue-wise, VDA5050 is not a big part, but it's increasingly required and asked for. 2 years ago it was at trial level, but now we have projects which are running with VDA5050… either on the FM side connecting to other manufacturers navigation stacks or the other way around where we have VDA on our on-board stack and then connecting to someone else's FM. Both of these applications do exist today and the question comes more often." [Navitec]

NORTH AMERICA, LESS ADOPTED

- North American vendors are increasingly hearing about VDA5050, but it seems less about customer requirements and more of media coverage

"We're definitely hearing more about VDA5050 and interoperability these days. But we're hearing it in a very practical way. I think most people realize it's not something that you can go do today, but certainly you can align yourself with and you can mature your solution into it as the standard matures. If it becomes meaningful in the market, we will align ourselves to it without a doubt and we're doing the things required in our software." [Seegrid]

- Some vendors with potential international focus are taking a proactive approach

"You see it on every RFP, are you VDA compliant? It's pretty clear that it's a requirement to have VDA. We're the first AMR vendor to market VDA compatibility in North America." [OTTO by Rockwell Automation]

CHINESE VENDORS ADOPTING VDA5050

- Plenty of Chinese vendors have adopted VDA5050 as it is a requirement to supply the influential European automotive sector (including parts of the automotive supply chain)

"VDA5050 is usually required by very big automobile manufacturing companies and they already have a lot of AGVs from different brands. So actually, they are using it. And also, we do have a lot of partners. We have already applied this VDA5050." [Casun]

"Our fleet manager is VDA 5050 certified. Because from European countries, more and more clients ask for that. It's actually automotive clients." [IplusMobot]

VDA5050 A EUROPEAN THING (FOR NOW)

- VDA5050 appears to be primarily a European automotive sector requirement for now

"Some of the USA clients mentioned that, even non automotive industry clients, but we have not landed this kind of project in USA yet. We get some questions from there and they ask whether you can apply for VDA5050." [IplusMobot]

- Other standards are emerging slowly, but are not currently as well developed and/or demand is lacking

"Our multi-vendor, AGV & AMR fleet management, is built on top of the VDA5050 standard. We are observing other standards such as Massrobotics, but it is still not sufficient for the kind of application that we do." [Kinexon]

VDA5050 STANDARD USE BY END CUSTOMERS AND VENDORS, GLOBALLY (INTERVIEWS)
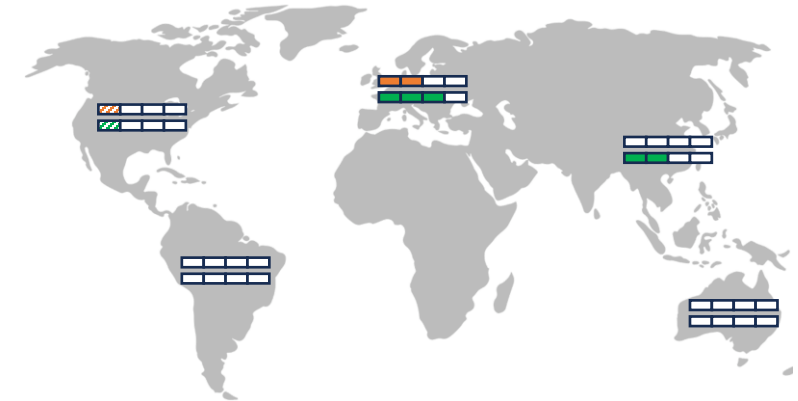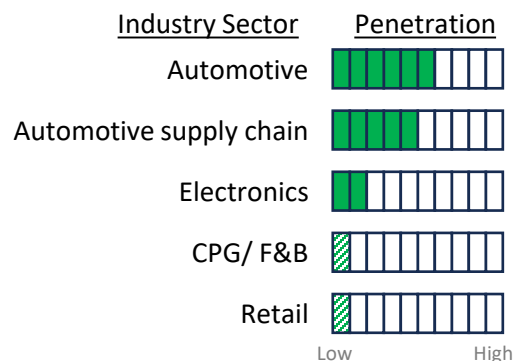
Key:
- Customers frequently requesting VDA5050
- Majority of vendors have adopted VDA5050
- No VDA5050 requirements/adoption

Source: STIQ Ltd Research & Analysis

VDA5050 IS THE LEADING STANDARD COMMUNICATIONS CANDIDATE, BUT A FEW IMPORTANT DEVELOPMENTS REMAIN AND THE SECTOR FOCUS MAY HAVE TO EXPAND

GLOBAL VDA5050 INDUSTRY PENETRATION

Industry Sector	Penetration
Automotive	
Automotive supply chain	
Electronics	
CPG/ F&B	
Retail	

Low   High

Source: STIQ Ltd Research & Analysis

VDA5050 MAINLY AN AUTOMOTIVE THING

- While some non-automotive sector customers ask about VDA5050, it is not a requirement and among some customers it is not even discussed

"None of our customers ask for VDA5050. We are focused more on warehousing and retailers." [Lowpad]

"VDA5050 is not a strict requirement, it's more like just check if you are compliant or customers are just asking for it to be prepared for the future." [Knapp]

- Vendors are monitoring developments and are ready to develop VDA5050 interfaces if required by customers

"VDA5050 is becoming a topic, we're sure about that, currently we're watching it pretty closely and are prepared to implement it. Currently VDA5050 requirements are mostly coming from production industries." [Knapp]

- When there are questions re VDA5050 from the non-automotive sector, it tends to be more of a checkbox exercise without any functional requirements

"We've seen non-automotive sectors asking for VDA5050, but typically they list all standard interfaces like do you support VDA5050, do you support MassRobotics, do you support ROS…" [Navitec]

VDA, NOT ALL ENCOMPASSING… YET

- The VDA5050 standard is increasingly the more likely candidate for global domination in the AGV & AMR sector

- However, the standard is not all encompassing and lacks in certain important areas where there is a level of interpretation

"One VDA 5050 implementation is not like the other. It leaves room for how you interpret certain parts of it. We are talking to all the relevant VDA5050 fleet manager providers and we see some of the differences. Maybe it converges in the future because it's still early days… there are some things that are not yet really well covered by VDA5050." [NODE Robotics]

"VDA 5050 in my mind to be honest still doesn't fully support the warehousing environment. It doesn't define it well enough." [Navitec]

LIMITER ON ADVANCED DEVELOPMENTS?

- Some of the criticism of VDA5050 is that the standard often acts as a lowest common denominator, especially for more advanced technology providers

"Some of the more autonomous systems will lose their autonomy level when they will be used in a VDA5050 based communication environment, because then the fleet manager will be master of their autonomy." [NAiSE]

"There are some limitations with VDA5050… compared to what technology we are currently having and our ability to be innovative on certain solutions. For example, deviating from a track, so obstacle avoidance driving on to an obstacle, these kind of situations. We don't have it at the moment and also my hope actually is a bit that there will be a next generation there that allows us to be a bit more flexible on a few things like this obstacle avoidance and also being able to just focus on the traffic management and not the entire stack above. Because currently VDA5050, if you're using it, traffic management is typically on a rather low level and so you cannot do any innovation anymore on transport optimization or WMS system." [Movanis]

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PARTS OF THE AGV & AMR DEPLOYMENT PROCESS HAVE RECEIVED MORE ATTENTION, SUCH AS COMMISSIONING

THE VEHICLE COMMISSIONING TOOLS, ETC.

- There has been a lot of focus on fleet managers and other tools to manage vehicles once they are deployed and perhaps a bit less on the back end of building AGV systems, commissioning them, etc.

"We launched a new cloud platform, Cirrus, for easier commissioning. It's all part of making it easier to work with our system. So it's a product to speed up the commission phase and make it simpler to commission systems. The main idea of this is for us to drive projects. Because we want the projects to be easy to execute, and this is a tool to make them faster to execute." [Kollmorgen]

"I think a lot of companies are focusing on the robot itself. And then there's a different industry now about fleet management. But I think everybody's missing the tool chain behind the projects. Like you need a professional tool chain to successfully master a project." [Anonymous]

- This also includes the project management of AGV projects helping staff, partners and resellers to minimise disruption

"Our software toolchain makes it more predictable. Obviously, I also want to be quicker. I think half of the time can be saved. But what's more important is that you only need the time that's planned. The extra days are much more expensive because you got to stick to the plan. Otherwise it's a financial disaster. You're postponing and not getting ready. You have to go there again. This is really hard to make money out of a project if you're not reliable on your planning." [Safelog]

NAVIGATION TECH AND COMMISSIONING

- There may be some advantages with certain navigation technologies during the commissioning phase, such as VSLAM for example

"You can put effort during the commissioning time by spending more money and spending more time to make every solution more robust to some extent. The question is how much do you want to invest into this? How much can robotics be scalable? Because the problem of adoption of robotics is the upfront cost and the upfront time, the upfront investment, where you have to stop operations, where you have to block everything, where there is a very steep learning curve where you need to have experts on site. So you remove the cost, you speed up the process, you remove the need for experts. And here it is. This is why VSLAM has an advantage." [Sevensense]

- However, every navigation technology has advantages (and disadvantages)

SIMPLIFIED AGV & AMR PROJECT PHASES FROM PRE-SALES TO POST-SALES

PRE-SALES → AGREE KPI's → PLAN → BUILD → COMMISSION → TEST → RAMP UP → POST-SALES

Source: STIQ Ltd Research & Analysis

SECTOR SOFTWARE TRENDS INCLUDE SOLUTION COMBOS, SENSOR MANUFACTURERS PIVOTING INTO SOFTWARE VENDORS, AND INCREASING CYBERSECURITY PRESSURES

COMBINATIONS

- STIQ is increasingly seeing more and more vendors combining forktruck AGVs & AMRs with pallet shuttle solutions to form more of a storage solution

"What we are implementing at the moment is the combination of AGVs with what we call moving racks or mobile racks. I guess you can put this in the context of high-density storage where you have very compact storage without having to go to cranes or other mechanized solutions." [Toyota MH]

- These solutions are also overlapping with WES functionality

"The cool thing is that it's a fully integrated system in the sense that it's a plug & play software that you don't need to customize. You configure the system and program it together with the radio shuttles and there's a storage function as well so we can manage the goods in the racking system in our software." [Toyota MH]

THE NAVIGATION SPACE HOTTING UP

- There is growing pressure on sensor providers to offer more software with their hardware

"SICK aims to evolve into a comprehensive solution provider, offering best-fit sensor hardware and application software. Our approach is flexible and adaptable, allowing us to integrate seamlessly into existing client systems." [SICK]

- STIQ have also noticed companies like Sony and Intel offer additional software to their sensor hardware, such as embedded SLAM localisation, navigation and fleet management software

"Sony's entry into the mobile robot automation market signals that the industry is still growing, with strong demand and promising opportunities. It's a positive indication of the market's potential." [SICK]

CYBERSECURITY, A GROWING ISSUE

- Cybersecurity is a fast growing topic in the sector as the world is facing increasing geopolitical polarization

"Nowadays more cybersecurity and software requirements are asked for by some key accounts and users." [IplusMobot]

- For vendors, this is likely to lead to more work in pre-sales or during project quotation processes

"About cybersecurity, different clients have different requests. We have a very huge potential client from US and they have c.30-40 questions to ask us, only for cybersecurity. But we have a secure solution." [IplusMobot]

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THERE IS DEMAND FOR CUSTOMISED VEHICLES, BUT MANAGING THE CUSTOM MADE PROCESS IS OFTEN A COMPLEX RESOURCE MANAGEMENT CHALLENGE

TREND TOWARDS MORE SERIALISED VEHICLES

Highly Configurable

Custom Made   Off the shelf
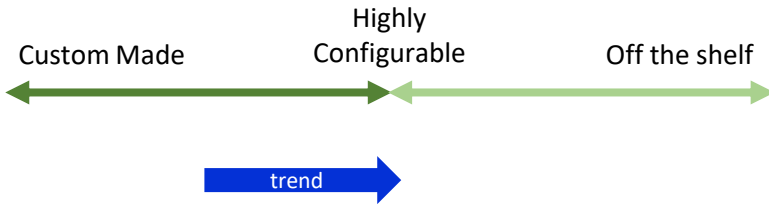
trend

Source: STIQ Ltd Research & Analysis

A TREND AWAY FROM CUSTOM VEHICLES?

- There appears to be a general trend among companies that have produced custom vehicles towards reducing their exposure to bespoke, often due to intensive resource requirements

"We now focus on standard vehicles and really on what I call our core customers more. We decided to do fewer custom vehicles. We always talk about an 80-20 rule and we want to do 80% of our systems with more standard vehicles. And we'll still do 20% with custom. That's how we scale. Then we really focused on certain key customers that we've been doing a lot of work with. We also created teams for key customers, streamlined and make ourselves easier to work with. Those customers have been hitting on all cylinders and they're committed to automation, enterprise wide." [JBT Corp]

- A recent trend is customers ordering more serialised vehicles instead of custom, potentially due to longer lead times and other issues with custom vehicles

"There was a very interesting shift during the summer. I think historically we've had as high as 50% of sort of modifications. Sometimes it's very small modifications, just extending the forks or adding small changes. But sometimes we also do really special vehicles. Over the summer we've managed to sell a lot more standard vehicles." [Toyota MH]

STANDARD VEHICLES ARE EASIER TO SCALE

- Its far easier to scale a business with standard serialised vehicles than a complete custom set up where a vendor relies to a large extent on the available human resources for generating designs, etc.

"For us, it's super important in terms of scaling our business. Because if it's standard, you can just replicate with our factory. As soon as you have customization and specialties you depend on the availability of people. We hope that trend towards off the shelf continues. But it could be many things there. Perhaps our sales force is maturing in the sense that they are better at offering standard solutions. And also perhaps customers realize that if I go with standard vehicles, I get my solution quicker. So lead times could drive that. But I'm speculating now, I honestly don't know for a fact." [Toyota MH]

- And of course, software customisation can also be part of bespoke vehicles

"So we are coming from a situation where we had the majority of systems needing customization as special software. And now I would say 95% is standard on that system level." [Toyota MH]

DIFFERENT PRICE LEVELS FOR CUSTOM AGVs

- The price tag for custom vehicles typically starts at a very different level to serial vehicles, typically from $500k and upwards depending on payloads, environments, tech required, etc.

"I'm in the process of bidding a 3-vehicle system right now for $6m. It's 3 trucks. Some people say, oh, you only sold three trucks? Perhaps they sold $6m worth of those mouse vehicles at $20k a pop. They're in the 100's of vehicles. It's very different." [Scott Automation]

SAMPLE CUSTOM PROJECT

- Every custom vehicle is unique even though they use conceptually similar features, such as a conveyor top

"One of the jobs we're delivering on now is a conveyance line where we remove two sections of the conveyors and put 2 AGVs in its place. As the product comes on the conveyance, we take it out of there, deliver it somewhere else, and then we bring it back in and let it continue conveying. It's very unique and for something that is 50" long and weighs 20,000lbs. It's 2 huge conveyor AGVs and we're swapping in and out and breaking the conveying line, letting them do work, bringing it back in and reintroducing it to the line." [Align]

CUSTOM AGV & AMR CAN BE A PROCESS OF CHICKEN v EGG SITUATION. WHICH COMES FIRST?

CAPEX BUDGETING AND ENGINEERING

- For bespoke AGVs & AMRs it can be difficult to manage customer expectations throughout the process of capital budgeting and the final design

"The biggest challenge in this space is everybody buys capital equipment based on a capital expenditure budget, and they have to place a purchase order for the equipment. But, in the selling process the customer doesn't know if they're going to get that approved or not. So they only put so much work into the design. Of course they would love us to design it fully for them for free at that phase. But, we're not going to put $'s in engineering just in case they want to buy it. We have to limit our scope of engineering and work with the customer to make the best estimation of what it takes to do everything. But once they place the order, suddenly their interest level goes up a lot higher. We get them the design and the specifics of all the detail. And suddenly they go, oh, we forgot about this bracket we had hanging down. And oh, we found another model that we need to do. So now that you're getting real about it and suddenly you got to make all the details matter. I call it a dog-bone effect. Everybody thinks that the way this industry works or how it should work is that the closer that we get to delivery, the more defined we should get with our delivery days. But the reality is it looks more like a dog bone. It's a hot mess up front with the customer and then we get really fast and build and as we get towards the end then it turns into another hot mess because now everything's got to come together in a custom thing. So that ultimately is the challenge… everything we build for the most part is a beta." [Align]

THE CUSTOM VEHICLE PROCESS CAN BE LIKENED TO A DOG BONE PROCESS

Vehicle Estimate → Project Budget → Project Sign Off → Vehicle Build Phase → Order Change Management

Source: STIQ Ltd Research & Analysis

- Unknown and additional engineering challenges can lead to difficult decisions in the R&D process

"The challenge for custom AGV & AMR is price control, the problem for the control of price as you know, if we make a mass production for the products or it can save or we can argue with our supplier… But for those who customize the products, we need to devote more R&D. And we also need some new structure." [LGIM]

- Resources for developing new custom vehicles is typically limited and may also incur extra costs

"We think of our design engineers as a limited resource, and we only have so many of them. So it's engineering availability, but also cost. Lead times are also something that is creeping up and up and up, and was exaggerated by Covid. Customers started to voice frustration with lead times for all this custom design work. Now we're able to respond a lot quicker with more standard vehicles." [JBT Corp]

CUSTOM VEHICLES

- Some vendors develop custom vehicles and attempt to serialise some of those designs to sell in greater volumes in other verticals

"We follow the customer journey. So when a customer has a problem, we solve it. That creates a product. And then we try to standardize that product and offer it to other markets, other companies in the same sector, or we push it across sectors." [Mastermover]

"We still absolutely do customized trucks. No doubt about it. So we're going to be additive in nature to chase, I'll say, the conventional forklift market that might be additive. And over time, hopefully produce more copy-paste versions, although I've never really seen very few copy-paste. It's a standard forklift, really. There's no such thing." [Scott Automation]

- Offering bespoke or custom vehicles can be viewed as a USP

"If people want their AGVs in different shapes, sizes, payloads, lengths, widths, speeds, all of those things. That's the vehicle design and that's what we bring to the market and we partner up with the experts in the other two areas and that's what creates us a unique position and that's where we've had success where we've gone into companies like Toyota where obviously there are many kinds of towing AGVs already in the market, but our level of customisation is what's put us in there and what's allowed us to grow." [Mastermover]

MANY CUSTOM VEHICLES ARE REMOTE CONTROLLED RATHER THAN AUTONOMOUS. SPARE PART MANAGEMENT A THORNY ISSUE FOR CUSTOMER-VENDOR RELATIONSHIP

CUSTOM AND REMOTE CONTROL

- In the custom space, there can also be a significant proportion of remote controlled vehicles as opposed to automatic or autonomously controlled AGVs & AMRs

"I think it's probably more 20% of what we build is AGV and 80% of it is non-AGV right now. A lot of what we build with RF controllers can be converted to AGV. The biggest problem with heavy loads are the heavier the load gets, the less units per month somebody produces. And so the less units per month they produce, generally speaking, the number of moves it makes doesn't necessarily justify being an AGV. So sometimes they'll start out like, 'hey, we think maybe we'd like an AGV', but by the time they get done and crossing and really think about it, they're like, 'ah, let's just go with RF to start with, and maybe we can turn this into it an AGV later'." [Align]

PREDOMINANTLY CUSTOM MOUSE VEHICLES

- Fully bespoke forktrucks are less common than mouse type vehicles, partically due to the higher complexity of forktrucks

"We have our own production line and we have our own factory to produce AMRs. We can make them ourselves. And also the customized structure based on the AMR and heavy load products and also the outdoor heavy load products. It's all made by ourselves. But like forklift, we do not make the forklift the body, we just make the controller. So for this part it's not our own made, but we will integrate our system." [LGIM]

SPARE PARTS AND CUSTOM VEHICLES

- Many vendors of custom vehicles try to use as a broad range of off the shelf products for their vehicles to minimise issues with spare parts

"Actually, maybe in China for the spare parts production is not a big problem. We can keep some spare parts in stock. So that also costs a lot. We will transport to our Europe office and we have warehousing in Europe and also in America, in Mexico and Thailand, we have different spare parts centers. So they can help us to make it more convenient for customers for the spare parts requirements. [LGIM]

- However, STIQs conversations with vendors of custom vehicles nearly always touch on spare part management and that customers sometimes want to save up front costs on not producing extra of custom parts

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SYSTEM INTEGRATORS ARE NOT IDEAL PARTNERS, BUT CAN BE USEFUL. RAMPING UP A RESELLER GENERALLY TAKES >1 YEAR BEFORE A FIRST SALE

SYSTEM INTEGRATORS, LESS THAN IDEAL NOW

- Warehouse Automation System Integrators can often seem like the best type of partner for AGV & AMR vendors, but typically have low awareness of the complexities of openly navigating mobile robots

"We've realized that system integrators were not that knowledgeable. So, honestly, right now we're pushing much more direct sales than integrators themselves." [Anonymous]

"What we sell is still somewhat too complex to system integrators… they are very good at integrating AutoStore. Why? It's a black box. When you install mobile robots, you have to take care of the floor, the Wi-Fi, of the pallet quality, the rack quality, storage densities… the whole space, almost millimetre-wise. And if you're not sufficiently, I would say, interested in this kind of stuff, you miss stuff and you **** it up." [Anonymous]

- Supply chain consultants are less involved in AGV & AMR projects as they rarely get involved in brownfield opportunities

"Once in a while we get contacted by supply chain consultants, but not that much. They mostly get involved in greenfield projects and not that much in brownfield projects." [Lowpad]

SOME SYSTEM INTEGRATORS CAN BE USEFUL

- While some integrators are lacking mobile robotics experience, they do have other significant expertise and an often great customer base they may exploit

"Firstly we have integrators, but they do not have AMR experience. They have plenty of experience of production line integration. So this is the kind of potential client. And 2nd would be distributors that did industrial or collaborative arms. And through the time, they found that their clients are interested and ask about AMRs. So they started to think about, okay, maybe we can do some distributions for the AMRs. This has also happened, mostly in North America." [IplusMobot]

"Our distributors come from various backgrounds, so some of them have experience working with MIR, with Low-pad, with Geek+, etc. And some others, they have the background, in the traditional machines like the FNC something, and they didn't really have experience with the AGVs, so they are new to the market. And some others, they are, themselves, a manufacturer of the robots." [Tusk Robotics]

- Furthermore, some of the larger system integrators may be interested in going it alone

"We found a lot of the very big integrators, they want to do the AMR themselves, but they dropped out of that. Because they have other product lines. We have >300 employees only working on AMR. So for them, it can maybe be hard to allocate resources on developing AMRs." [IplusMobot]

RAMPING UP THE RESELLER CHANNEL

- Setting up a reseller/ distribution organisation is often the ambition of vendors, but it takes time and effort to generate a reliable revenue stream from these

RAMP-UP LEAD TIMES VARIES, BUT GENERALLY IN EXCESS OF A YEAR BEFORE THE FIRST SALE
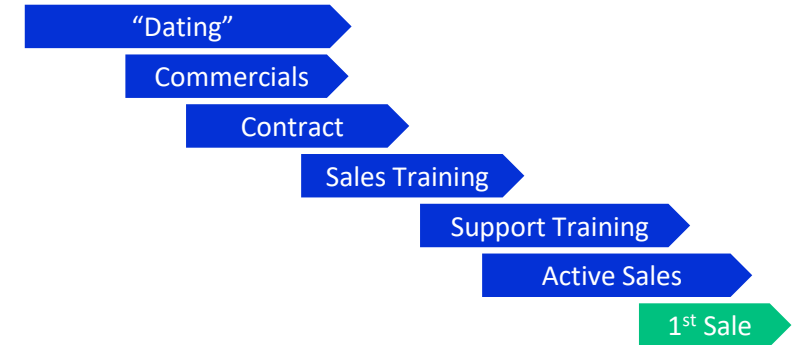
Source: STIQ Ltd Research & Analysis. Timelines vary for every company and different technologies/ systems/ solutions

"… Ideally, we are going for partners, distributors and system integrators to cover their local regions. But there's a ramp up period of getting to know each other and learning the sales, learning the deployment, etc. And then there's another phase of go to market for them. So kind of a first sales cycle that is often… we're looking at over 12 months probably… 18 months from the day that they have signed the contract." [ForwardX]

RAAS IS EMERGING AS A BUSINESS MODEL IN NORTH AMERICA. THE REST OF THE WORLD PREFERS STANDARD CAPEX OR LEASING ARRANGEMENTS

WHAT DOES RAAS MEAN?

- The RaaS business model has been largely championed by VC-backed startups as an alternative to the popular SaaS model in the software space

- The model is largely a North American phenomenon with few RaaS customers in Europe and Asia (yet)

- There are a variety of RaaS models, but the most commonly used in the "Rental" model, whereby a customer signs up to a flat monthly fee for a duration of a few years

- Up to now, this was only accepted by customers for the PA-AMR segment (see STIQs G2P Solutions report), but appears to have become more accepted also in the AGV & AMR Robotics sector

LOWERING BARRIERS TO CUSTOMER BUY-IN

- One of the advantages of RaaS is that it can lower barriers to adopting AGVs & AMRs

- Some vendors have pushed RaaS now with a majority of customer engagements on a RaaS basis

"When Craig came in, the mandate was, let's differentiate ourselves with having a scalable product and move to a RaaS model. When I got here, I was told by the old guard, it won't happen. We tried, we announced it last year, no one was buying this way. Fast forward now and 95% of our customer engagements are RaaS. I actually think it's more, but 95% of our customer engagements are RaaS and almost 100% of our quotes are RaaS." [Vecna Robotics]

- Some vendors view RaaS as a financing option whereby the performance of the system should increase as customers continue to pay year on year

"I think if you're not radically changing the performance of your system from one quarter to the next, and using an a sa-service model, there's nothing more than a financing exercise wrapped up in a warranty. If you're going to pay for something over and over and over again, the performance of the system should incrementally get better over time so that your relative spend goes down." [Zebra Technologies]

RAAS PRIMARILY ACCEPTED IN NORTH AMERICA

Source: STIQ Ltd Research & Analysis

POST-DEPLOYMENT "RECURRING" REVENUE SOURCES SUCH AS MAINTENANCE REPRESENT A SMALL SHARE OF TOTAL REVENUE IN THE AGV & AMR SECTOR

POST-DEPLOYMENT REVENUE STREAMS

- STIQs 2024 MHE System Integrator report (download here), highlighted that as much as 20-30% of annual revenue is generated from maintenance and other post deployment services

- In the AGV & AMR sector, this revenue stream is largely lacking among vendors whom often have to work on near 100% new business streams

"Maintenance and service is at least 20-25% at some of the legacy MHE players. But keep in mind, they have the opposite formula and are 80-90% recurring customers with a low volume of new customers." [Balyo]

- A lower rate of maintenance is forcing vendors to keep pushing for new projects and business

"Because we started from scratch in 2021 so 90% of what we do is really new business, new customers." [Balyo]

- Few vendors provided any range of numbers for maintenance with younger vendors obviously near 0% and some of the legacy players starting to enjoy some level of recurring revenue from maintenance contracts

"I would think aftersales maintenance revenue is close to 10%. It's growing more and more." [Safelog]

"Service and maintenance for us is in the neighborhood of 20%-ish." [Seegrid]

ESTIMATED POST-DEPLOYMENT MAINTENANCE REVENUE SHARE (%)
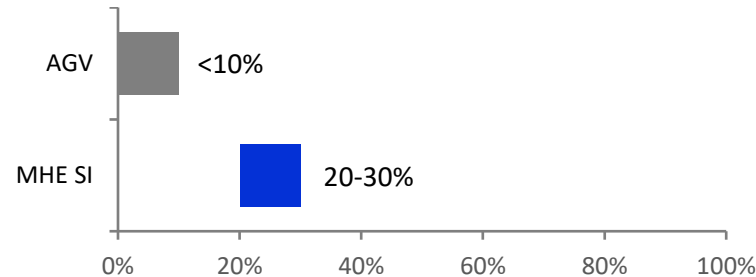
Source: STIQ Ltd Research & Analysis

MAINTENANCE CONTRACTS ADVANTAGES

- Service & maintenance revenue is more than just revenue, it is also a chance to be first in the queue to find out about new potential projects with customers

"In my days it used to be maybe 10-15% of total revenue. And that was mainly because a lot of customers didn't have any experience, they didn't have the right capabilities in-house to do the preventive maintenance stuff. We would offer that as a maintenance contract and that's how you got your revenue. And of course, the good thing for an AGV company is once you could keep tabs very closely on your customers you know what they're planning already so you can be very early on in the competition race for any new projects." [AGV Consult]

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EXPERT 1 (EX-CEO): THE HOSPITAL AGV & AMR MARKET SUFFERS FROM A BROWNFIELD PROBLEM

THE HOSPITAL MARKET FOR AGVs & AMRs

- The hospital market emerged in North America in the 80's and 90's and later developed in Europe in the 2000's and 2010's

"In the late 80s, early 90s, there was a short period of a lot of activity in hospital AGVs, mostly in North America. Around 2000-2010 that finally reached the European market. Part of that development in Europe was due to a vendor deciding to sell & implement systems in Europe after they had done a couple in America. And that's what triggered other vendors to also get involved." [AGV Consult]

- The current hospital AGV & AMR market appears to be served by a few experienced players

"Nowadays, the hospitals market is more or less a local market where you have a couple of vendors who have the experience to implement these systems. You have 2-3 in North America and maybe 3-4 in Europe." [AGV Consult]

- However, while there are prominent players, the hospital vertical also appears fragmented with no clear leader and plenty of other companies involved

"It's a very fractured market. There are no clear market leaders in the hospitals market." [AGV Consult]

THE HOSPITAL [BROWNFIELD] PROBLEM

- Deploying AGVs & AMRs in existing (brownfield) hospitals nearly always has problems of space and aisle width to design dedicated robot highways

- Furthermore, any interaction with people may slow down a system which is detrimental to time sensitive missions

"The main problem in hospitals is the layout of the buildings. Especially if you have to implement the system in a brownfield situation, that's always a main challenge. Because if you want to have a good productive system, you need 'robot highways' where you can have two-way traffic. If you have only one-way traffic, you need a lot more vehicles, and it's going to be very expensive for the end user. So the payback time then is way longer than it should be. Aisle width is one of the main concerns. The other concern is vertical transportation. You need elevators that are dedicated for your vehicles where you don't have the interference of the general public. Robots need to have their own exclusive elevators because otherwise, there is no saying how long it's going to take them if you allow for the public to interact with these vehicles." [AGV Consult]

- For example, warm food deliveries need to be delivered to wards within a certain time frame

"And then there are certain material flows in hospitals that are key in terms of delivery time. One of the main things, of course, is food delivery. The warm dinners and lunches and all these trays have to be delivered to the wards, to the patient floors within a certain time. Otherwise, you'll get cold food." [AGV Consult]

- Mobile robots with lower payloads, so called "PA-AMR" type robots (see STIQ G2P Solutions report here) and 'restaurant delivery robots', have also started appearing in hospital environments

"AMRs are now starting to enter the picture which are allowed to drive into patient areas delivering medication or lab samples. These vehicles are typically smaller with lower payload capacity and interact with the general public. You see a lot of these vehicles just dancing around in the hallways of the patient floors… more or less it's a gimmick. Perhaps people like the idea that they have robots? But you have to be very careful in the design of the system that you make sure that these smaller vehicles don't do the time critical deliveries because then they won't function." [AGV Consult]

## IMPORTANCE OF THE FLEET MANAGER

- Software is key to successful functioning of an AGV & AMR fleet in any sector, perhaps more so in hospital environments

"People tend to forget that it's not the vehicle, it's the software, especially the fleet management software which is where the real diamond should be. And that's where you deliver an application that can talk to other applications that has all the capabilities and functionality you need as a user. But that takes time to build up that expertise and to translate all your experience into that software. It takes probably 5-10 years before you get to that point. And until then, it's always a struggle." [AGV Consult]

EXPERT 1 (EX-CEO): AGV & AMR SUCCESS MAY BE OFFERING A STANDARD RANGE AND PARTNERING, EVEN WITH COMPETITORS

OFFERING STANDARD SOLUTIONS WITH CONFIGURATIONS RATHER THAN CUSTOM
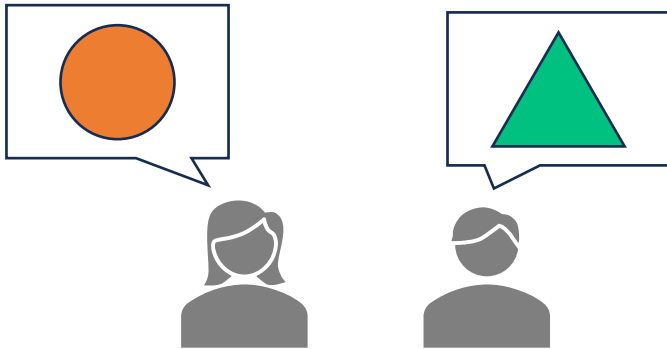
Note: Unless your business is custom solutions
Source: STIQ Ltd Research & Analysis

A PATH TO SUCCESS IN AGV & AMR

- Offering a standardized range of vehicles can be the key to success, possibly with a level of configuration options rather than complete customization

"For an AGV company to become successful, they need to focus on standardization of their equipment. Because if you keep listening to your customers about what extra functionality they want and you keep developing different versions of the same model, you end up losing. And it's far more important to understand your customer and to guide them through what they really need." [AGV Consult]

- Depending on which sector a vendor wants to serve, there are typically a range of suitable vehicles

"There are typical designs that you would need depending on which market you want to serve." [AGV Consult]

- Customers rarely know what robot/s they need and educating your sales staff is also part of standardization

"Customers often don't have a clue, they just think, oh, this is the best thing since sliced bread. Can you do this or that? And sales guys definitely want to please their customers. Yeah, of course we can do that. And then the engineers go crazy about what they have to do now again. So that is one very important strategic decision to keep your model range limited."

- A capable and mature fleet manager is another key to larger deployments (>5 vehicles)

"The next thing is to have a fleet management suite software product that has a lot of capabilities. You need to really focus on to make sure that you can offer integration because at the end of the day these are almost never standalone systems and have to be integrated with existing software." [AGV Consult]

PARTNERSHIPS – ANOTHER KEY TO SUCCESS?

- Partnering, even with competitors, can be another key to success, especially where you lack experience

"Partner with your competition as much as you can. Don't try... not invented here syndrome. If you want to enter a new market and you just don't have the right vehicle or software capabilities but it is a market that you want to get into, don't be afraid to partner with somebody who is your competitor… make sure you're always open to new alliances, new partnerships. That's another really important strategic decision." [AGV Consult]

- If you want to enter a specific market where you do not have a suitable vehicle option, partnering may be an option to ensure a project win

"We partnered... when we started in the hospital market, we didn't have the right vehicle. It took us 5 years to develop our own. In the beginning we teamed up with a European vendor and made a very good agreement where they would focus on the European market and we would do the North American market. We would use their vehicle, but we would do project management and all the software and all the integration. That worked out very well." [AGV Consult]

- Partnering is a potential route to new markets where others have already been active and learned the hard way how to go about projects

"Because what you see is you have the old guys, and my company used to be one of the old guys who had been around for many, many years. We had learned through many mistakes and bad projects… we had learned what not to do. But what you see now is with all these new companies, they have found a new application. They know how to do one thing well, and then of course their shareholders start screaming that they need to grow, grow, grow and then they venture into other applications, forklifts, etc. and then all of a sudden you see that, oh, this is a totally different beast. We're not quite ready for that. So there is sort of an automatic break being implemented that they don't have the breadth yet to become a truly successful company." [AGV Consult]

EXPERT 1 (EX-CEO): CHINESE VENDORS CAN BE IMPORTANT PARTNERS. EXAGGERATED AGV & AMR MARKET GROWTH EXPECATIONS AROUND, BUT SIGNIFICANT TAM

## ASIAN VENDORS, PARTNER OR DISAPPEAR?

- Chinese vendors should perhaps worry some vendors as their pricing advantage is clear and partnering can be an option for some vendors

"We should be worried about Chinese vendors because their vehicle pricing is probably 30-40% of prices here in the West. They can not only develop something very quickly in software, but also new vehicles and more. Their pricing is just off the books, I mean, you cannot compete with them. I have been advising a number of my former colleagues, be smart about it, have those guys manufacture particular vehicles for you while you still maintain control of your software. At least you're able to reduce your price for your customers. I know that the Chinese are perfectly happy with that. They want to see volume and usually have a lot of manufacturing capability. So for them, it's okay if they can sell vehicles. They have, of course, in the back of their mind that at the end of the day, they will take over. But this is at least a possibility for Western companies to stay in the race because otherwise you'll be blown away… because you're too expensive." [AGV Consult]

- At the very least, Western vendors should strategically consider partnering with Chinese manufacturers

"That's the strategic move that a lot of European and American companies need to consider. Because you cannot compete against Chinese labour rates. Not only can they build vehicles very cheap, but they also have so many software guys who have studied in the West, have great university degrees. I mean, they have so much potential that if you do not join them in some way, you might lose out." [AGV Consult]

VARIOUS PROSPECTS FOR AGV & AMR ROBOTICS SECTOR GROWTH
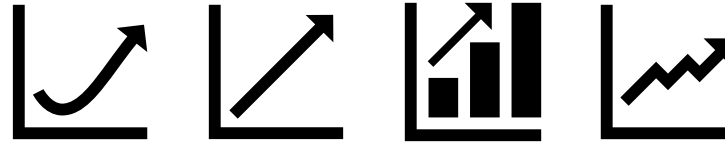
Source: STIQ Ltd Research & Analysis

DEFINITELY MARKET GROWTH (HOW MUCH?)

- While there is evidenced growth in the AGV & AMR market, some industry reports may be exaggerating growth prospects

"Back in the days when I was CEO of an AGV company, we saw market reports that always had a CAGR of between 7-9%. So it was always, whoa… There are a lot more manufacturers of AGVs nowadays and there is also a lot more demand. I am completely certain that the market is going to grow, although not as quickly as some people may hope." [AGV Consult]

- There is significant TAM, but penetration remains low

EXPERT 2: PROJECTS OFTEN START WITH CONSIDERING CONVEYORS OR AGV & AMR. SECTOR EXPERIENCE IS PARAMOUNT TO SUCCESS

AGV OR CONVEYOR?

- The primary competing option for AGVs & AMRs is conveyors and is typically a consideration when analysing potential automation of goods transportation

"In the pre-study phase customers are often thinking should I get an AGV/AMR here or should I have conveyors? What's the best here for the most flexible and effective solution." [Grow Automation]

EXPERIENCE OF AGVs & AMRs IS PARAMOUNT

- Some knowledge of each step in the AGV & AMR supply chain process is paramount to running a successful businesses

"In the realm of AGV & AMR, it is essential to have comprehensive knowledge and experience, as they are key components for success in this field. It is not enough to be knowledgeable in a specific area; a thorough understanding of the entire delivery chain from sales to post-sales support is also required. The AGV and AMR sector is known for its complexity and necessitates skilled professionals. This complexity is further intensified by diverse customer environments. Substantial experience is crucial in effectively managing these variations and ultimately attaining a profitable outcome." [Grow Automation]

PROPENSITY FOR OVERSELLING?

- Sales-people may have other priorities than engineering staff and getting a project may be more important than understanding potential for complexities
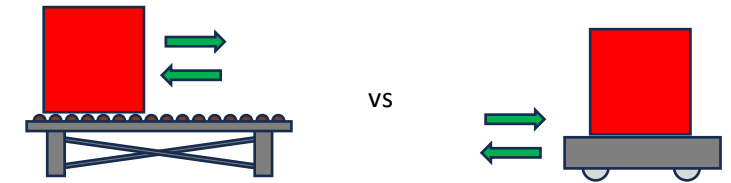
"While the sales team may have good intentions, they may not fully understand all the intricacies of the business. Failing to address these issues early on in the project, through double-checking, system specification, and validation with customers, can create challenges due to the need for integration rather than standard product sales." [Grow Automation]

DOUBLE CHECKING PROJECT PARAMETERS

- Part of project management is to double check important data points provided by customers

"During the sales phase, layouts provided by customers may dictate station locations and route planning for AGVs. However, these plans are not always accurate. Minor discrepancies, such as a racking position being slightly off, can have significant implications, such as preventing two vehicles from meeting at the same point or affecting the efficiency of vehicle operations, leading to delays. It is crucial to consider these factors and prioritize double-checking to ensure accuracy. Taking measurements and conducting thorough quality checks are recommended practices. Unfortunately, time constraints can limit the ability to perform these checks, leading to potential issues later in the project, such as resource shortages and non-profitable solutions. It is essential to address these challenges proactively to avoid such setbacks." [Grow Automation]

CUSTOMER CHOICE OF CONVEYORS VERSUS MOBILE ROBOTS?

- Reliable for continuous flows
- Inflexible, can disrupt floor flows
- Single point of failure
- Requires standardisation

- Flexible with built-in redundancy
- Space efficient
- Requires good floors, open access
- May require software integration

Source: STIQ Ltd Research & Analysis

SIMULATION CAN BE A USEFUL TOOL

- Simulation can be a good way to try different scenarios and options, but only if the input parameters and tool is correct

"Simulation is effective only when accurate parameters are included. Production cycles, flow dynamics, and various variables must be meticulously defined for a successful simulation. Additionally, using the appropriate simulation tool is crucial. Some tools may focus solely on factors like AGV speed, neglecting essential aspects such as traffic management." [Grow Automation]

EXPERT 2: AN AGV & AMR PLUG & PLAY FUTURE IS HIGHLY UNLIKELY. SYSTEMS ARE OFTEN RIGHT SIZED FOR PARTICULAR FUNCTIONS AND HIGH QUANTITY SCALING IS RARE

A PLUG & PLAY AGV & AMR FUTURE UNLIKELY

- The complexities of installing and managing AGV & AMR fleets is such that sending AGV & AMR in the post to customers is an unlikely future and some involvement of an expert may always be required

"I don't think we will not come to the full send it by post for customers to install a system. Maybe you can do 1-2 robots as a customer if you have in house experience." [Grow Automation]

- Even smaller deployments require experts, whether these are external or internal, as there are many details that are only learned by experience

"Effective traffic management is still a crucial aspect that requires experience to handle properly. I believe that as AMR technology continues to develop and mature, many larger customers will establish dedicated departments for AGVs. As the use of AGVs becomes more widespread in these companies, they will likely prefer to have their own staff trained in managing and troubleshooting these systems. This allows for quicker response times in case of any issues or downtime. Therefore, it will be in the customer's best interest to build internal expertise in handling AGV systems as more solutions are implemented." [Grow Automation]

COMMISSIONING CAN TAKE A LOT OF TIME

- Getting systems up and running can be a big chunk of a project

"Commissioning normally takes quite a lot of time. Compressing this can of course save you money." [Grow Automation]

SCALING AGV & AMR DEPLOYMENTS

- AGVs & AMRs are typically deployed in relatively stable throughput environments and hence rarely scale in a similar way to ecommerce installations (see also STIQs G2P Solutions report here)

"Solutions can scale. But if we see in the future, I think flexibility for the systems is quite important. Scalability is about the production level or how much more output you should have and so on. You scale the system to be able to handle those kind of increases in production level. So that's, then you put in 1-2 more AGVs to do 10-20 more transports an hour and so on." [Grow Automation]

- Scaling an AGV & AMR installation may also cause congestion as systems are typically highly optimised to minimize costs

"You can scale systems, it's not so difficult to put in 1-2 more AGVs. But if it's too small a space for an AGV to drive then you might cause delays somewhere in the system. It is a fact. It's simply like that. You don't want to have highways in the factory. You want to keep it as small as possible so you don't take up too much space with the AGVs. It's costly. And you do an effective layout and have some kind of planned queuing. But if you put more AGVs in that area, then of course you will have more queuing and inefficiency." [Grow Automation]

AGVs & AMRs BY MAIL, AN UNLIKELY FUTURE SCENARIO FOR FIRST TIME CUSTOMERS

Source: STIQ Ltd Research & Analysis. Microsoft image library

OPTIMIZATION

- Optimization can also be an option for newer installations rather than adding more vehicles which may be costly

"The first step for the customer is to optimize the system. Often there may be room for improvements once a new solution has settled in and then you don't have to buy 1-2 more AGVs. It's a lot cheaper to do the optimization than to add more vehicles." [Grow Automation]

EXPERT 2: AMR MARKETING IS DUMBING DOWN THE AGV, BUT THERE IS NOT MUCH DIFFERENCE WITH AMRs, AND AGVs FOSTER HEALTHY WORK ENVIRONMENT BEHAVIOUR

MARKETING: AGV = STUPID, AMR = SMART?

- A lot of marketing in the sector in the last 5 years has focused obstacle avoidance capabilities of AMRs versus AGVs which appears to have had an effect on buyers

"There is extensive marketing of obstacle avoidance technology with AMRs, positioning them as smarter alternatives to traditional AGVs. And due to the complexity of the technical aspect, management teams lacking expertise in the field may lean towards AMRs. " [Grow Automation]

- There is a sense in the market that the AGV may be old technology and AMR newer, more smart technology

"It's actually like that. Because they are so bought in by the marketing… that AGVs are stupid and AMRs are smart… easy to integrate and easy to run as well." [Grow Automation]

- The difference between an AGV & AMR is not significant and both can perform similar actions (with technology enhancements)

"The differences between an AGV and an AMR is actually not that big. A decade ago, testing of obstacle avoidance technology using safety scanners on AGVs yielded inconclusive results. Rather than providing only benefits, one could observe potential drawbacks in certain scenarios." [Grow Automation]

AGVs FORCES A HEALTHY ENVIRONMENT

- AGVs may actually help to foster order and a healthy workplace for customers after overcoming early issues with items in the way of AGVs

"One benefit of implementing an AGV system is the promotion of order within the facility. Staff members are encouraged to place items in designated locations, as the AGV system will halt if its path is obstructed. Initially, after the installation of an AGV system, there may be instances of items being misplaced by employees, leading to corrections and improved organization. In contrast, with an AMR system that can navigate around obstacles, there is a risk of creating a disorderly environment as items may be placed haphazardly. This can result in system delays as AMRs need to navigate around obstacles. While obstacle avoidance technology may be beneficial in the initial stages, in the long run, it can lead to a lack of structure and order within the system." [Grow Automation]

POSITIVES FROM THE STARTUP INFLUX

- The influx of startups in the AGV & AMR sector is forcing a lot of the legacy vendors to improve their software and some of the more recent entrants to widen their product ranges

"One key distinction between traditional AGV suppliers and emerging AMR startups is typically that the software developed by new AMR startups is designed to be easily customizable by customers, allowing them to make changes independently. This customer-centric approach sets them apart from traditional AGV suppliers. However, it's also essential for these new AMR suppliers to expand their product range to cater to customer demands." [Grow Automation]

- The ease-of-use software capabilities of new entrants may disrupt legacy vendor's business models unless they also develop improved capabilities

"It will become much easier for customers to make changes independently. Traditional suppliers who have been in the industry for a long time had a business model that involved delivering these systems that customers found difficult to install and modify themselves. These suppliers now need to adapt and improve their offerings to remain competitive against AMR suppliers, who have emerged with solutions that make it easier for customers to adjust layout, station positioning, and some other factors." [Grow Automation]

EXPERT 3: THERE ARE FEW TECHNOLOGY BARRIERS TO ENTRY. PROJECTS ARE OFTEN OPERATIONS CRITICAL AND RELYING ON NEW TECHNOLOGY MAY BE DAUNTING

FEW TECHNOLOGY BARRIERS TO ENTRY

- A virtual absence of technology barriers may have saturated the number of vendors in the sector

"It doesn't surprise me there are more vendors in the sector… SLAM seems like an easy way in. And I think it's great for some stuff, and pretty poor for other things… until somebody gets it figured out totally. And of course, this is probably also the white-haired guy talking." [No Risk Automation]

- Some of the more recent entrants may have great robots, but may lack a solution

"They don't have a solution, and that's the problem. It's hard to sell something when all you have is a vehicle with the newest tech stuff. Well, that's great. But how do I save money or make money with this new tool? And that's where most of these companies come into the market. If they market well, they survive for a while." [No Risk Automation]

THIS THING NEEDS TO WORK. BOTTOM LINE

- In a sector where deployments form a critical part of operations, tried & tested technology may just be easier to rely on and have ironed out many of the edge cases

"Sometimes the older stuff just seems to work a little bit better." [No Risk Automation]

- In the early days of SLAM, the technology might not have been mature for prime time, but the marketing message worked perfectly and got potential customers excited

THE AGV & AMR PROJECT BUMP IS COMING, BUT WHEN AND HOW?

Project Bump

AGV & AMR Robotics project timeline $$

Source: STIQ Ltd Research & Analysis

"The marketing of SLAM was genius. But the technology probably wasn't ready for what we were trying to do with it. But it was genius because people bought into it pretty quickly." [No Risk Automation]

- SLAM technology is good for some applications and perhaps less good at other applications

"SLAM is good, but when you go to a forklift and decide to go to 15-20 feet in the air, then everything changes. And that's where everybody gets in trouble." [No Risk Automation]

- Bottom line on any project is it needs to work

"It needs to work." [No Risk Automation]

THE AGV & AMR "BUMP" IS COMING

- During the commissioning phase there are nearly always unforeseen circumstances and having an experienced PM and staff on site can help reduce the project impact

"We called it the bump... The bump is coming and when it hits, you're going to lose $1,500/day until you get back on track. This can be a lift motor has gone down and you forgot to pack a spare. Now you got to wait a week to get it from your supplier while you try to work around it. That's where you lose your money. That's where every company loses money in this field… is what happens at site. Because you can only plan so much and you can only take so much with you. I don't know of a single project where a bump didn't occur somewhere. It's not always the vendor's fault and it could be that a conveyor is down. Bigger companies, no problem, they charge $7,500/day and then customer's fixing thing ASAP. But smaller companies don't want to charge that. They don't want to necessarily disrupt the relationship. They go, well, all right, let's see if we can do something else. And the whole PM plan goes out the window with all kinds of things happening. Yeah, the money is lost on site, no doubt about that. The bump is coming and you got to be prepared. That's why you need a good PM and good people on site." [No Risk Automation]

EXPERT 3: COVID BOOSTED KNOWLEDGE OF AGV & AMR. INCREASED SECTOR PARTNERING MAY DRIVE FURTHER AND FASTER GROWTH

AGV & AMR, POST-COVID COMMODITY?

- In recent years it seems questions from customers have focused more on price and lead times rather than specifics as was previously the case

"Years back we used to get 100's of questions like what size is your drive motor? How much current does it pull? How accurate is your laser? Just a ton of technical questions from engineers about stuff trying to understand whether technically it works right or does it make sense. People don't ask very specific questions anymore. This stuff (AGVs & AMRs) has literally become conveyors. It's simply, how much does it cost and when can you get it here? There are very few questions around specifics and why is one better than the other? We all know the answers, but the questions don't come anymore. It's a strange world. It's come down to cost and delivery time. I think the pandemic certainly helped a ton of that." [No Risk Automation]

- Covid may have boosted some of the knowledge among potential customers and perhaps somewhat also commoditised AGVs & AMRs

"I think the pandemic got us to a point where people realized that automation wasn't just about saving money. It was, what do I do if I can't find people?" [No Risk Automation]

SLOWER BUSINESS DUE TO INTEREST RATES

- The cost of money appears to have impacted a lot of projects with plenty of postponements occurring

- This could partly also be influenced by the impending election (this report will be published after the election outcome is known)

"What I'm hearing is that people want to automate but can't do it. I think that they've put projects on hold just because of interest rates and every four years this kind of happens… there's up to an election where nothing seems to sell. And then after the election, there's this pent-up demand. But I think it's access to capital has been causing an awful lot of problems with this. And a lot of companies have been averse to leasing." [No Risk Automation]

AN IDEA FOR SHARPER MARKET GROWTH

- A case can be made for AGV & AMR vendors to become more agnostic with their vehicle parks and VDA5050 may have evolved at the right time to enable vendors to become more akin to system integrators

"If the market's going to grow, not from a vendor side, but from the customer side… The ability to have multiple vendors in a plant is important, simply because not one of them can do everything. I mean, let's take a look at the AGV & AMR manufacturers of the world. They're good at certain things, but other things they're not so good at. And if those systems don't talk, you get islands of automation. How much can you turn the lights out in a factory if you only have one supplier? I think vendors need to start acting more like integrators, being able to take on more of the plant." [No Risk Automation]

- However, there may be significant barriers to engaging and partnering with perceived competitors and taking on extra risk with another supplier

"I think that many companies, especially the smaller ones, just don't want to be involved in the risk of taking on those products or projects… the hard part is making stuff move around." [No Risk Automation]

FOREIGN VENDORS IN THE US MARKET

- There appears to have been an influx of overseas vendors targeting the US market

"I noticed at Modex there were more Asian AGV & AMR, companies than there were US based vendors… there was a bunch of European as well." [No Risk Automation]

SYSTEM INTEGRATOR: INDUSTRIAL ROBOT INTEGRATORS OFTEN WORK WITH PALLETIZATION APPLICATIONS WHERE AGVs & AMRs MAY BE A SUITABLE ADD-ON

A PURE AGV & AMR SYSTEM INTEGRATOR

- There are very few pureplay AGV & AMR system integrators (STIQ report on System Integrators) and the ones that are in the market tend to be industrial robot integrators or automation machinery companies

"We're a systems integrator. We don't make any robots. We do make things that go on top of robots. We also buy things that go on top of robots and we modify them potentially as needed to our customer specifications." [Acieta]

- The AGV & AMR group emerged as the company's focus on palletizing solutions overlapped with pallet transfers

"The Acieta RoBEX AMR group emerged naturally because we're focused on palletizing solutions for our customers. We needed to not only manage the palletizing process but also handle the removal of full pallets and the delivery of empty pallets to production lines." [Acieta]

FOCUS ON REAL BUSINESS PROBLEMS

- The company is focused on solving production requirements whether it be a pure AGV & AMR project or as part of a larger turnkey solution including other forms of automation

"We are focused on full end-to-end solutions and are not in the business of proving technology and trying to deploy a POC. We have ways of doing that in-house or there's enough deployments out there where we can do a site reference for a customer. Either we can leverage an existing customer or we can work with our OEM partners to leverage a direct customer of theirs to showcase a system. We try not to get into that crawl-walk-run scenario. We want to solve the problem a client is having today. The technology is there and there's enough proof in the pudding that guys like me and my colleagues have done over the last 10 years to prove the stuff works that we don't necessarily need to do demos or end up in pilot purgatory anymore with customers just looking to kick the tires or get their feet wet." [Acieta]

- Typical clients are more experienced with automation and are aware of the problem and the technology to solve it, rather than customers with no experience of automation

"A client could be someone with experience deploying these things. They know what they need. They know how they need it to work, and they just need a little bit of engineering support and expertise to knock it out quickly, where it's not the company's first rodeo. That's really where we come in, to get the job done quickly, and build whatever custom thing on top of it needs to happen in short order." [Acieta]

ROI REMAINS CHALLENGING

- As a pure system integrator in the AGV & AMR sector, ROI can often be a challenge

"A challenge in this market is ROI. Hardware comes at a premium price, oftentimes for good reasons. Because there's a lot of technology on AMRs and you need it because you want the safest robot in the world. You want all the safety sensors you can get, all those buttons and all those lights to make sure that it's visible too. That comes with a price. You want to have a fleet manager and an analytics dashboard so that you can make sure that your investment is doing exactly what you need it to do. That also comes with a price. We find that we're still right up against it. The margins on the ROI calculations are right there. We're still going for 24 months ROI that the customer seems to be very locked into in a lot of cases."

- Some customers appears to have moved on from a strict 12, 24, 36 month ROI to viewing automation as a strategic business consideration and as a capacity release function

"In rare cases, we do see customers kind of expanding that 24 month ROI thought process and saying that automation is an investment in a longer-term plan and how we run our business. And I've seen some customers open that up to a 36-60 or even a 72 month ROI process, which is a lot more forgivable." [Acieta]

SYSTEM INTEGRATOR: A BACKGROUND IN MANUFACTURING HAS FOCUSED THE BUSINESS ON THE MOUSE FORM FACTOR

MOUSE FORM FACTOR FOCUS (FOR NOW)

- Due to the focus of the business, its primary attention has been on the mouse form factor

"We see in manufacturing that the mouse form factor makes a lot of sense simply because we are doing a lot of end-of-line type of interactions. It's going to be top modules that are pulling up to a conveyor or pulling up to another piece of machinery. But it also has to do with the spatial requirements. Even though, in manufacturing, they would love to maybe avoid having something pick up off of a stand, say a pallet, and maximize that space. They still don't have the room to have a forktruck moving around. We are seeing more of the forked vehicles and the larger capacity… more standard self-driving vehicles in spaces that are larger." [Acieta]

- However, if requirements for other form factors emerge, there are plenty of options in the market that could fill potential gaps in the offering

"There's a lot of options out there. And when I came on board, we had focused on partnering with specific key vendors right off the bat. We are also exploring other technologies to fill in any application gaps." [Acieta]

- And there seems to be plenty of potential partnership options as the US market is universally popular among international vendors

"What I hear across the board is everyone wants to enter into the US AMR market." [Acieta]

- However, partnering is increasingly complex for a variety of reasons, and securing a secure and stable supply may be more important than achieving the best price today

"I pay attention to the geopolitical concerns. Mostly, I'm worried about the cost. It's a double-edged sword because we do see that there are providers out of China and Japan and South Korea with potentially good products that fill a gap for what we're looking for. But the uncertainty is that if they're priced right for us today, are they going to be priced right for us tomorrow? So how much investment should we make in training and marketing those solutions if they're going to just make that commercial conversation more complex, or not ideal, for our customers at the end of the day? They're very appealing a lot of times because of the cost today and because there are different form factors that can do something that our current partners maybe don't do today. But there is some uncertainty…" [Acieta]

THE POC MAKING A COMEBACK?

- The (dreaded) POC appears to be making a comeback in the North American market which could muddy commercial opportunities as customers with real problems and projects may opt for POCs instead

"It seems POC purgatory coming back. I've been talking with a lot of people in this space and it seems that way. You see it sometimes from the OEMs. A lot of people are advertising hey, book your demo with us now or something like that and we'll come out and so on. I don't know if it's an indication of a slow market? People are just trying to get some traction by getting out there. I think it's kind of dangerous for the space because again, we've gotten so far." [Acieta]

- While POCs are a good way for vendors to show investors they are doing well, it is less good for growing the market as the POC process is often very limited and often shelved after a few weeks as no one takes full responsibility, etc.

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END CUSTOMER 1: IS THERE LIFE AFTER MANUAL FORKLIFTS? SIGNIFICANT AND GROWING INTEREST IN HOW ROBOTS MAY BE ABLE TO TRANSFORM OPERATIONS

WHAT'S AFTER THE MANUAL FORKLIFT?

- Mobile robots have grown in importance globally but there appears to be a lack of suitable products for specific customers, such as carriers

"We've seen mobile robotics has exploded, especially in the 3PL and warehousing space, e-commerce and fulfillment… But I think the parcel carrier segment is a little different in the sense that we've have 1000's of meters of conveyors and cross-belt sorters… and we've been doing that for 3 decades or whatever… But there's been a huge growth of pallets and non-conveyable things and we've got nothing better than the humble forklift. We have a few AGV & AMR deployments, but I think we're asking what comes after the forklift… for all the big reasons you hear in the industry – labour shortages, safety, maintaining capacity and labour availability. Not to mention wage inflation in many parts of the world. So, we've got to do something about the pallets and the non-conveyables. And, OK, we can do what we know, which is conveyors. And there are some things out there for that. Or, we figure out how to use mobile robots. We've tried many things over the years. Some have been successful, most not." [Anonymous]

ROBOTS OF INCREASING IMPORTANCE

- There has been a huge influx of robotics in fulfillment warehouses and one of the aims is to increase automation using robots

"We saw this huge growth of mobile robots for fulfillment in our 3PL division. But we have a massive carrier division that haven't really adopted robotics at the same clip. My role is setting up what is kind of the new technology agenda and about half of it is robotics related." [Anonymous]

- Robots include robotic arms as well as mobile robots

"Robotics for us includes robot induction, depalletizing, unloading, etc. I think we need to push the big companies to develop a lighter, still industrial grade, but less precise arm at a little bit lower cost. There's a lot of stuff happening with that." [Anonymous]

- The company have dabbled in mobile robots with a small number of successful installations, but overall there appears to be significant scope for doing more

"With mobile robotics… we have two kinds of our first successful implementations, one of them predates my time. We have another one in NA, and I think that's it. We have one G2P system in Asia, and we have a lot of plans to do more with AMRs & AGVs in our greenfield locations, but we've not been very successful getting AMRs & AGVs into our brownfields." [Anonymous]

TRANSFORMATION TO "WE DO ROBOTICS"

- There seems to be a strong will to automate and with that comes a lot of organisational challenges and changes not only with the physical, but also with the mental ownership of systems and solutions

CHANGING WORKING CULTURE FROM MANUAL TO MANUAL + ROBOT & COLLABORATIVE

Source: STIQ Ltd Research & Analysis

"We've been doing what we do for decades. I think we're at an inflection point where we have a few deployments. I think it could be 1-2-3yrs where we stand the next major deployment up, and the whole organization has to go on that journey. Everything from the building construction to, of course, the ones most excited about it i.e. the engineers… we need to not just take physical ownership but it needs to be psychologically owned by our operators and the people, the maintenance folks and the finance people who are looking at the whole investment case. That whole organization has to go with it to say, yes, this is what we do. We do robotics. So that's where we are at." [Anonymous]

END-CUSTOMER 1: HOWEVER, THERE ARE SIGNIFICANT CHALLENGES WITH THE SPECIFIC INDUSTRY, SHORT AND HIGHLY INTENSIVE OPERATIONAL WINDOWS

TWO PRIMARY SPECIFIC SECTOR CHALLENGES

- A major challenge in the carrier sector (especially in the express segment) is a very high workload in a short time

"The biggest challenge we have is in the parcel express and courier logistic space is we usually have a one shift operation. We maybe have shifts that are 4-7hr and we have a very short, intense sort window. It's called Overnight Express for a reason. So we don't have 2-3 shifts to amortize and automate labour. That's the first challenge."

- Furthermore, there is a lack of uniformity of parcel and shipment sizes

"The second challenge is no two items that we handle are alike. When you go to a typical fulfillment centre or warehouse, you have a finite set of package types or case types. For us… our specifications can be anything up to 2 kgs, a small flat box… It could be documents. It could be a pillowy polybag with garments in it. Conveyable stuff is anything up to 30 kgs and then there's a really weird category between 30-70 kgs that we call non-conveyables. After that, everything that's on a pallet. There is an extreme variation of pallet loads and weights that we work with." [Anonymous]

NOT AIMING FOR FULL 100% AUTOMATION

- The aim is to automate a majority (85-90%) of all shipments per category and to retain manual operations for awkward sizes, payloads, etc.

"We never talk about automating 100%. We always talk about a sweet spot of maybe 85-90% of our pallet mix for example. And we would maintain forklifts for the remaining 10-15%. What we have seen with induction robots, etc. is if we design something that can do the upper limit of our parcel specification, we need a much more robust and much bigger robotic arm. It's a lot more engineering, both on a mechanical and software side, to handle that upper limit when, in fact, it's only 10% or less of the material. We think about how do we call out the non-robot friendly material and handle that manually, but then try to get still a meaningful percentage, 85-90% that we can handle with a robotic system." [Anonymous]

- Indoor transfers, specifically of pallets appears to be the lowest hanging fruit

"If I look at that flow of offloading it, processing it, and then distributing it to where the destination needs to go. We'll probably look at the distribution piece. So everything goes to a central point to get x-rayed and re-weighted and measured, dimensioned. And then from there, it goes to any number of distribution points. And that piece, at least, is kind of where we have done in the past, which worked well. That's where we'll probably build up more of the competence and the experience and then probably think of a few greenfields where we can really, really blue sky, like say, okay, what do we want to do about the unloading piece. The loading piece I'm less confident about, but the indoor transport, that's where I think we just lose a lot of time, a lot of productivity and we pay expensive people to do that." [Anonymous]

LOW HANGING FRUIT IN WAREHOUSES
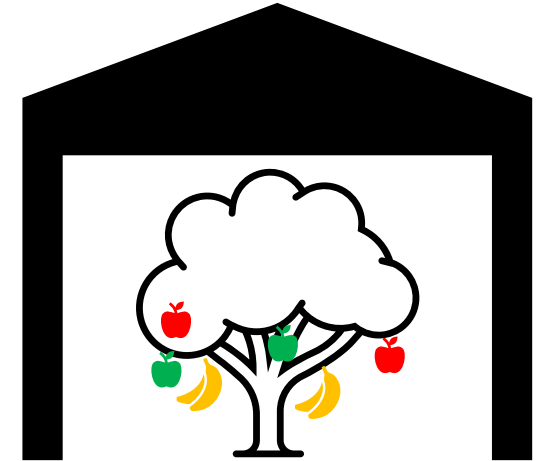
Source: STIQ Ltd Research & Analysis

- Managing intralogistics flows should be the low hanging fruit for solution providers

"The transportation within buildings… that's the low hanging fruit as I see it." [Anonymous]

END-CUSTOMER 1: THE BUSINESS CASE APPEARS TO BE WAITING FOR A SUITABLE SOLUTION DESPITE THE CURRENT INVESTMENT CLIMATE

THE BUSINESS CASE FOR AUTOMATION

- There are three major drivers for starting to automate processes in the carrier space

"The first major problem statement is cost and simply how do we achieve a much lower cost of handling? The second piece is safety. We're on a mission to lower our lost time incidents. We've halved the number of incidents and every year there's a couple hundred fewer incidents. Every person we can send home safely at the end of the day counts. Most of the injuries happen around forklifts. The third is labour. It can be hard to quantify. There's an unquantifiable hassle of recruiting, training and onboarding… how much time it takes to get someone productive? It's not just looking at the staffing plan for this much volume. I need 24 forklift drivers. Do I have any butts in the seats driving them? What skill level are they? How long have they been with us? Do they really know what they're doing? And so on." [Anonymous]

BUT THERE ARE ALSO LIMITATIONS

- The strategic drivers are there, but the business operation is different to a typical 3PL with 2 or 3 shifts and activity is limited to a narrow window of opportunity

"There's a fairly compelling case but then the challenge becomes operations. We need to move 10,000 pieces in a 30,000sqm building in 3hrs. In a perfect world, if you go into one of our facilities during the day, it's empty. There's not a box, there's no shipping in sight. But at some time in the evening it's slam full. There's a lot of things moving, a lot of people working and by six o'clock, it's all empty again and everyone goes home. It's a very specific and unique part of the business." [Anonymous]

SUCCESSFUL/ UNSUCCESSFUL ROI CALCS.

ROI requests go/stop by time to return

<3 yrs   3-6 yrs   >6 yrs
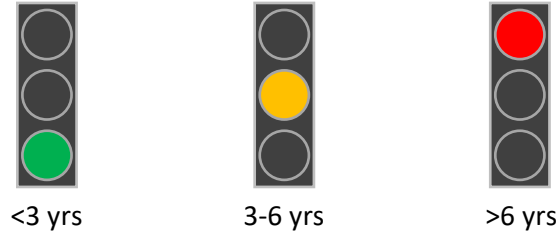
Source: STIQ Ltd Research & Analysis

THE PALLET HANDLING OPPORTUNITY

- Pallet handling is significantly more expensive when compared to other shipping formats

"We're very efficient at handling the small stuff, parcels and flyers… our cost per piece to handle one of those in a facility is a few cents. For boxes it's a bit more. But with a pallet, it's a few euros. It's still single digits, but every single handling cost is significantly higher because I need one guy to take it out of the truck, then to buffer it, then another person picks it up and puts it through a weighing dimensioning x-ray. Then another person takes it out there and buffers it. Then they put it in the container. So 4-5 forklift drivers have touched this thing before it's even come into the building and out of the building." [Anonymous]

ROI MAY PIVOT TOWARDS BUILDING CAPACITY

- ROI is generally accepted at <3yrs, however, there are some signs the business may consider other ways to view ROI, such as future proofing

"An ROI of less than 3yrs is very interesting. If it's between5-6yrs, it'll get considered. And if it's 7-10, it'll probably get shelved. But the funny thing is that we're sort of overcoming… we're kind of sitting in front of a significant step change in the sense that 30 years ago our sort concept was all manual. We had primary, secondary, tertiary sort with people pushing stuff all over conveyors, and then the crossbelt came in. And we design a crossbelt sorter, not for the year and the volume that the facility opens, we design it for 15 years in the future. And we build that whole physical thing and it sits underutilized for a decade or maybe half a decade and nobody bats an eyelash." [Anonymous]

- However, the case for investing in automation may be a bit tougher right now, but there is a continuing underlying requirement

"The other thing right now is that it's been a challenging year for our sector. So investments are also going to be tricky for this sector… But at the same time, that's also a reason to automate." [Anonymous]

END-CUSTOMER 1: THROWING DOWN THE GAUNTLET TO VENDORS, BIG OPPORTUNITY WITH VERY SPECIFIC ENGINEERING REQUIREMENTS AND LIMITATIONS

CARRIERS, AN UNATTRACTIVE OPPORTUNITY?

- The interviewee reached out to STIQ to feature in the AGV & AMR report highlighting its specific requirement which appears to have been treated as a low priority investment case for sector vendors

"We have three value drivers, cost, safety and labour. After this, speed and throughput are the biggest engineering challenges for our use case of point-to-point handling… we're like the unpopular, unathletic kid who gets picked last for the team. I feel like we're not necessarily the #1 customer for a lot of these vendors." [Anonymous]

- If you have specific requirements that are not met by the market, why not feature in STIQ reports? Contact us

THE ENGINEERING CHALLENGE

- The average speed and actual utilisation of robots may have to improve to be a useful tool for this market segment

"Definitely the speed of robots needs to go up. And what can the robot do from just a sheer specification perspective? One of the big KPIs on the projects that we've done is what's the average speed of the robot? Are you actually reaching the highest speed it can? Because it's really easy to look at a specification sheet and say, oh, it only goes 0.5m/s, I want 2m/s. But when it's living in your facility are the floors, driveways, is everything set up in a way that the robot can do its most? And any machine from a throughput and cycle time perspective, they're almost always underutilized. compared to what they really can do. Speed is definitely an issue." [Anonymous]

- There appears to be a missing software puzzle piece

"What I think we're missing a bit is we have like a ton of great hardware. There's a lot of great improvements with things like SLAM, etc. Those are fantastic and the basics are there with the cameras and the software and everything. What we're missing is the software layer with path planning and the execution task engine. Very few vendors offer a compelling solution." [Anonymous]

MAJORITY BROWNFIELD OPPORTUNITIES

- The vast majority of facilities are brownfield designed for manual handling and adding mobile robots to this is definitely a challenge as opportunities for expanding buildings can be extremely limited

"One of the biggest challenges is we designed aisles to have 2 forklifts traversing in each direction plus walkways and then a bit of staging material. If we now want to add 2 lanes for robots and then forklifts can drive on the outside, what do you take away? The walkways, the buffer space? Space is a huge issue. Most of our biggest facilities are on airport property where space is extremely expensive. Expansion capacity is limited and you have a very small plot of land that you need to get the most productivity per sqm that you can possibly get." [Anonymous]

- Some tough decisions may have to be made for a wider scale automation transformation

"90% or more of our facilities are brownfields. We renew or add 5-10% green fields annually. We have to retrofit a solution whether we like it or not. And, we'll be looking into this in the next couple of years. It's going to be making tough decisions about how do we prioritize space for some point-to-point handling or distribution…" [Anonymous]

COLLABORATIVE v NON-COLLABORATIVE

- This could be a collaborative system

"We can have people and forklifts. That deployment is probably the most sensible for us. if we replace 80-120 forklifts in a building, my assumption is we're going to land with some similar number of robots if they're 1:1. We've seen some concepts and proposals where you have a mouse or deck load robot with a carrier that can have 3 pallets. I think the simpler we can keep the hardware and also try to control our environment a bit more, that's going to be how we're going to be successful with dedicated or semi-dedicated driveways." [Anonymous]

- The company is also open to non-collaborative solution

"I think it could probably be a non-collaborative system. Smaller goods is very efficient for now and would most likely stay the same. That stuff works. But we have a ground floor where there's all the heavy stuff is jumbled around a bit like a junkyard. There's rhyme and reason to it. We could just say this is the caged off non-conveyable area and pallets enter via a roller, it does its thing and it comes out at the right destination. Off you go… a bit like a G2P system, but just full of pallets. Basically a forklift put the pallet in the system, it gets sorted, and then you have the same setup on the outside. That would be that sort of the vision if you will." [Anonymous]

- The process is akin to cross-docking but with added payload variation complexity

"If you really strip it down, this could be cross docking. I'm not sure how close or how far away we are from having that. I think just to get things started we will need to at this point… we have a much bigger existing network."

END-CUSTOMER 2: THE BUSINESS CASE FOR AUTOMATION IS MADE EASIER WHEN FACTORING IN WAGE INFLATION. WAR IS IMPORTANT DRIVER FOR ROBOTICS

THE BUSINESS CASE, ADDING INFLATION

- The business case for automation is relatively clear as wage inflation drives up operational costs at a fast rate

"Wage inflation is real and it's starting to make warehousing a more pressing cost issue. And that's what's driving this demand. Everyone is thinking about how to remove costs from the P&L. And honestly, that's the real question they're asking. They freeze it in terms of efficiency and all this fancy stuff." [Anonymous]

- Labour costs and rates can be hugely different between various countries and can affect ROI

"What's also really interesting is the diversity of markets we operate in... Turkey, Romania, Greece, Serbia, UK... it's a very different and broad range of salaries." [Anonymous]

- Inflation is also a key reason to drive automation up the agenda and priorities as operating costs in some countries are being pushed by inflationary pressures and the cost of automation is also increasing

"Inflation is also different in different countries. For example in Turkey we're paying 43% more than last year. It's crazy. This is also a thing about timing of these projects. I wish I could speak to many more transformation managers and just tell them that when you have these ideas and you push it initially and when you get push back... inflation will teach everyone a lesson. If you don't do the project today, you'll be out of business tomorrow for sure." [Anonymous]

- With inflation rising fast, the need to reduce overheads from the P&L appears to have gained more urgency

"We have >10 projects right now that will take out X FTEs from the business and save $Xm starting next year." [Anonymous]

CONFLICT ZONES DRIVING UP DEMAND

- Lack of labour is typically used by vendors as a reason to automate and while there is some truth to this, it is an actual and real issue especially in conflict areas such as Ukraine, Russia and Israel

"War is driving automation... Actually there's not many guys left in the warehouse... in Ukraine and Israel... and one of the drivers is the current warehouse people have left and there's not enough people. One of our sites are trying to make this automated warehouse for future proofing. In Ukraine it's the same story, for example forklift drivers, most of them have gone to war. One of the risks with AGVs in a conflict zone is that if you get the wrong sort of AGV that has radio frequency systems or emits anything radio frequency, enemy forces can spot it on radar and may think it's moving coordinates and could potentially become a target." [Anonymous]

ROI: 25% IRR CALCULATION

$$25\% \text{ IRR} = \frac{\text{Future Value}}{\text{Present Value}}^{\frac{1}{\text{Periods}}} -1$$

Source: STIQ Ltd Research & Analysis

25% IRR, ROI TO INCLUDE INFLATION

- ROI is set very strict at 25% IRR level which can make investments challenging

"For us ROI is 25% IRR. You get nothing if its lower than this. Our team controls about >$100m per year as a sort of budget. That's $300-400m over the next 3-4 years. We have to spend $100m a year to help business units to generate these projects. It's hectic. But, it's very difficult to spend $100m... it's very challenging. You can come up with all kinds of stuff you want to spend $100m on but if there isn't 25% IRR... and that's very difficult." [Anonymous]

END-CUSTOMER 2: CALCULATING DEMAND AND NEVER DESIGNING FOR PEAK (UNLESS YOU HAVE THE BUDGET). DEVELOPING A COOKIE CUTTER APPROACH TO SELECTION

CALCULATING DEMAND, # ROBOTS

- The more historical data visibility, the better decisions can be taken, especially for businesses with stable growth

"We take up to 10 years data… if we can get a WMS dump as far as 10 years back, we use it. Because it's the same calculation we're going to do to create a bell curve. The more data, theoretically the more accuracy. The less data we have, the less accurate we are in forecasting. Peaks should be fine until the business either grows, which is always a good thing. Then, because there's a point of diminishing returns where the more AGVs you add, you start to diminishing productivity in your given space. So you need to be careful with that and think about, okay, right, if there's expansion or business growth, how do you tackle that problem?" [Anonymous]

NEVER DESIGN FOR PEAK

- Peak periods vary between businesses, but where there is a relatively short peak, designing solutions for peak may not make commercial sense

"You should never design for peak… if you design for peak, okay, great… you've got a lot of money. But that system is not right sized. Because peak would only happen maybe two weeks in a year. And it will only happen for a couple of hours. There's no point over-sizing the system. You right-size it by looking at that bell curve and design it to average price to standard deviation. And that's it." [Anonymous]

DEVELOPING A COOKIE CUTTER PROCESS

- The first step is to match the process and vendor and then the second step is to right size the project

"I think once you build that first Excel sheet on how to compare processes and vendors, every other project is the same thing. You look at the process. What should I automate here? Match it to the type and try and start to get an idea of the vendor. Then the next thing you really should look at to right size the system… for example in terms of pallet flows. You 100% need to look at 365 days every single day. What was the pallet flow? Then you build a bell curve to show you what your average is. My trick, or not a real trick, statistically it's advice to design for average plus two standard deviation. Because that covers over 90% of the possible eventualities." [Anonymous]
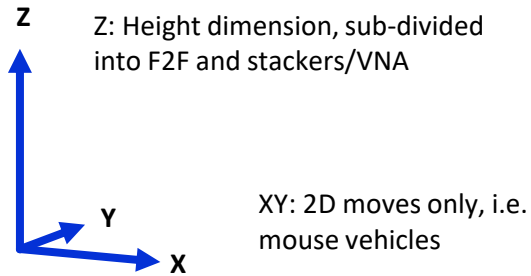
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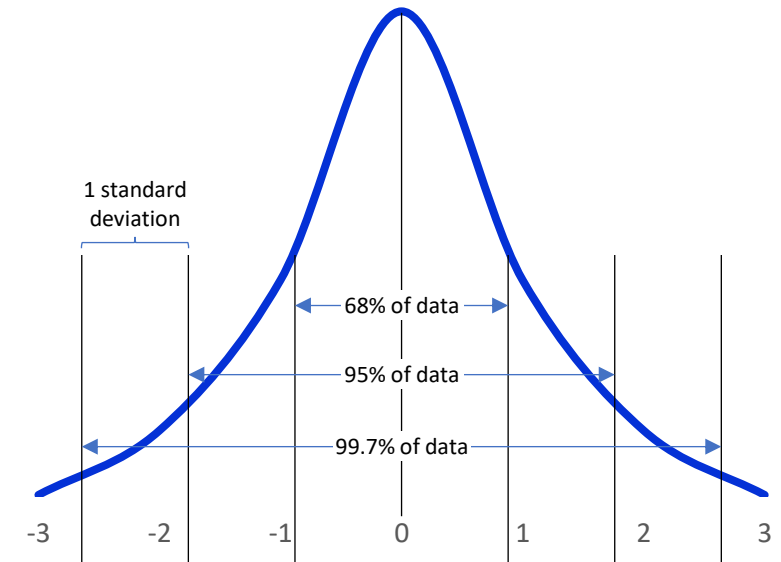
Source: STIQ Ltd Research & Analysis. Wikipedia info [source]

END-CUSTOMER 2: VENDOR SELECTION REQUIRES CAREFUL CONSIDERATIONS AND COMPARISONS WITH MANUAL AND MANUAL+ SCENARIOS AS WELL

VENDOR SEGMENTATION BY DIMENSIONS

Z: Height dimension, sub-divided into F2F and stackers/VNA

XY: 2D moves only, i.e. mouse vehicles

Source: STIQ Ltd Research & Analysis

OPPORTUNITIY AND VENDOR MAPPING

- Manufacturers are often relatively advanced with process mapping, and this company has already identified 10+ processes that can be suitable for mobile robots

"The first thing we do is list out all the processes in the warehouse. There's something like 12-13 processes, from inbound all the way to outbound and all the mixes in between picking and then getting it out. So once you have those processes listed out, you then need to know another set of things. You need to know the different types of AGVs." [Anonymous]

- The task after identifying opportunities becomes to marry up these with suitable vendors

"We have categorized vendors into XY, XYZ so we know which vendors have the full capability of 2.5 and 3D or to sort of match out in a matrix, who has what technology." [Anonymous]

VENDOR SELECTION

- It is important to select the right partner or partners for projects and do proper due diligence

"It's important to select the right partner there because you want to future-proof the system. You have to be thinking, okay, because my current vendor doesn't have all my range how to future proof any new requirements. So you're always thinking future proof." [Anonymous]

- Is there a requirement to automate the entire process or can a larger chunk of the process be automated with a good ROI?

"What part of the process is required? If it's lifting in the process, can we do it with a platform and put it on a pick and drop location for a manual forklift driver to pick up on the other side? If it's the full thing that we need to do, maybe we need a stacker to pick up from the floor… Because we need to be able to pick from the floor rather all those processes and understand it by category of AGVs." [Anonymous]

- Matching vendors with suitable processes can include splitting workflows into multiple individual parts

"What can the AGV do? What volumes are you processing? Pallets off the truck manually. They usually sit in the marshall lane in typical warehouses and then move to put away. I'm looking at the trip from marshall lane to put away is split into two. There will be a XY trip, which is moving A-B. And there might also be a lift into a rack (Z). We try to split those process, the movements in the process, to understand what the capability of AGVs we require." [Anonymous]

EXAMPLE AUTOMATION PROCESSES

- Marshalling inbound pallets is often a suitable process that can be automated depending on throughput

"One example I can give is the process of getting a pallet off a truck to the staging area. So that's inbound marshalling. You need a forklift to unload the trailer. Unloading with AGVs is still a bit too slow and that's not a process we can automate yet. The sensors can't really match it up and getting into the truck is slow. So we'd rather do that manually. But the marshalling process from the staging area is possible to automate." [Anonymous]

- Another suitable process is receiving pallets from production and put away into storage, however, extending and building conveyors remains an option

"One thing in our warehouses is receiving pallets from a conveyor, receiving pallets from production. Well, it's quite a typical warehouse application. So in that application, for example, you would instantly know that you need a stacker type of AMRs, AGVs. If not, I would have to spend over $100K modifying my conveyor to have pick and drop points. Do you have the budget for that? But the drawback in that is the stacker vehicle is more expensive, perhaps 20-30% more expensive than that platform, just the vehicle alone. So that's 100K you spend in modifying the V-conveyor. It might be a one-off cost, but you get a whole lot cheaper system when you multiply it by saying you need 10. So there's several scenarios to play into selection." [Anonymous]

END-CUSTOMER 3: FUTURE PROOFING CONSIDERATIONS FOR A POTENTIAL FUTURE WITH MULTIPLE DIFFERENT AGV & AMR VENDORS

FUTURE PROOFING MULTIPLE VENDORS

- The case for managing multiple vendors with an agnostic fleet manager is very attractive especially considering the potential for local procurement of AGVs & AMRs as an international business

"On a single site with 2 vendors, you can handle that complexity. But in >100 warehouses? But I can't realistically force a guy in Turkey to go and buy a European high-level equipment when he can buy it from a local Turkish guy for a third of the price. This is where conversations with vendor agnostic FM vendors come in. Ultimately, I know where this is going... maybe in the next 3yrs... again, we could hire a guy and he would sit here, control the whole fleet, literally. Because I don't think you need that many people to control AGVs anymore." [Anonymous]

LOCAL STRATEGY DEVIATIONS

- While some companies operate centralised warehouse design and procurement offices, local strategies may also play a role in buying decisions

"Different sites will have different strategies." [Anonymous]

AGV & AMR LARGELY A COMMODITY?

- The impression is that the core offering of AGVs & AMRs is largely (more or less) commoditised

"The AGV technology for me right now is so commoditized. It's the same technology as a vacuum cleaner. And it really frustrates me when engineers put so much effort in specifications... this is not an ASRS project." [Anonymous]

ASIAN VENDORS, GROWING COMPETITION

- Chinese vendors have impressed and often come with a significant cost advantage which can be difficult to ignore

"The Chinese are here and you can get this with a 75% cost reduction... 75% only Chinese project versus European vendors... it's too significant to ignore." [Anonymous]

- There are advantages and disadvantages when selecting single vendors, but cost advantages can sometimes negate some of the negatives

"So we're trying a new vendor in one of our Chinese plants. We've reviewed that technology and the main limiting thing about them is that they've got a limited range. That's it. And another vendor also has exactly the same form factor but is also selling the exact same the full range including reach trucks." [Anonymous]

FUTURE PROOFING MULTIPLE VENDORS WITH AN AGNOSTIC FLEET MANAGEMENT TOOL
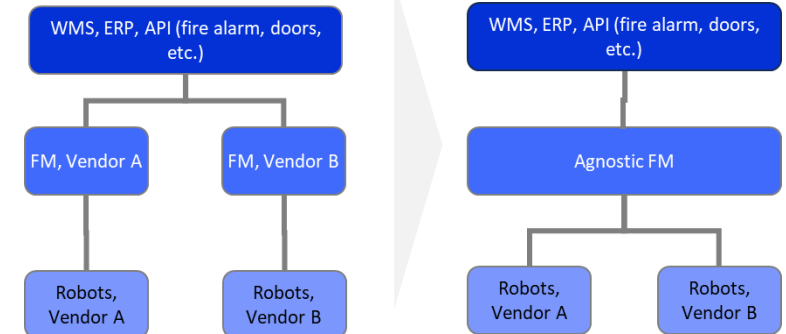
Source: STIQ Ltd Research & Analysis

END-CUSTOMER 3: INEXPERIENCE WITH MOBILE ROBOTS MAY ADD OPERATIONAL PRESSURES AND ADDITIONAL COSTS INITIALLY. INFLATION ADDED TO ROI CALCS

(IN)EXPERIENCE OF WORKING WITH ROBOTS

- Many STIQ interviews highlights the relative inexperience of working with and using robots in warehouse environments, especially when compared to the automotive sector

"This cultural thing with having robots in the environment is quite new to us here in the logistics sector. We have a guy from the automotive sector where they are very used to working alongside robots. I think it will take some time for our staff to get used to." [Anonymous]

- Such inexperience can also lead to inadvertent disruption of robots (and also conscious decisions to divert robots)

"We run 3 shifts and the night shift are putting some items in front of the robots disrupting the flow. I think this is a cultural issue. Only the night shift does this." [Anonymous]

- Accidents between manual and automated vehicles are not uncommon (in any industry) but may be more common where robots are more of a novelty

"A common thing is that manual vehicles and our AMRs make contact. Not necessarily bad accidents, but it means we need to restart the robot every time." [Anonymous]

- Inexperience with robots can also highlight and/or unearth other operational deficiencies once a fleet has been deployed

"At least one robot stops every day in our operations. The primary reason for this we think is Wifi interference. Our company wants to do everything on the Wifi networks and I think we have some interference, etc." [Anonymous]

WAGE INFLATION ADDED TO ROI CALCS (EXPERIENCE OF THIS BUYER)

With wage inflation   Without wage inflation

Source: STIQ Ltd Research & Analysis

POTENTIAL FOR HIDDEN COSTS

- There can be hidden costs associated with vehicles that are not always considered up front

"We replaced some of our QR code robots with AMR vehicles... SLAM navigation. But the vendor didn't tell us that we should probably have bought some additional sensors. The vehicle only recognised the forks are raised when they are above 15-20cm something. But that will increase Capex for this project as well. So they didn't tell us they have an extra module for this. But this comes at an additional cost." [Anonymous]

- Relatively inexperienced customers can expect to make a few mistakes early on if suppliers are not attentive and want to sell a unit at a lower cost

"Perhaps this is not related to your current report, but we use some other robots. The issue with those robots is the battery life. Because we have 3 shifts the battery life is limited to 2 years. We need to add that cost to the ROI calculations." [Anonymous]

INFLATION ADDED TO ROI CALCULATIONS

- This customer recently decided to add an inflation variable (wages) to automation business cases which has had a net positive effect on driving up the number of positive projects

"Our company recently made a change in how we calculate ROI and are now also including inflation in our calcs. This has been very good for us in automation as more projects get over the line." [Anonymous]

CONTENTS

GOLD SPONSORS

KOLLMORGEN
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MAG
Mobile Automation Group
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SICK
Sensor Intelligence.

ABB Mobile Robots
CH | 1988

- AGV & AMR vendor

Accerion
NL | 2015

- Component vendor

Acieta
US | 2015

- System Integrator

Addverb
IN | 2016

- AGV & AMR vendor

Agilox
AT | 2017

- AGV & AMR vendor

AGV Consult BV
NL | 2017

- Consultant

Aitech
SG | 2013

- AGV & AMR vendor

Align
US | 1967

- AGV & AMR vendor

Alstef Group
FR | 1961

- AGV & AMR vendor

Alternative Engineering
US | 1994

- AGV & AMR vendor

Anronaut
CH | 2002

- AGV & AMR vendor

Arculus
DE | 2016

- AGV & AMR vendor

Automni
BR | 2014

- AGV & AMR vendor

Balyo
FR | 2005

- AGV & AMR vendor

MAG
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powered by MHI

BlueBotics
CH | 2001

BlueBotics
Your Vehicle Navigation Partner

Let's talk automated vehicles!

- 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

Botsync Robotics
SG | 2017

- AGV & AMR vendor

Brisa
BR | 2018

- AGV & AMR vendor

Casun
CN | 2007

- AGV & AMR vendor

CEIT
SK | 1998

- AGV & AMR vendor

Chaint Corporation
CN | 1996

- AGV & AMR vendor

Cyngn
US | 2013

- SW vendor

Daifuku
JP | 1937

- AGV & AMR vendor

Daiichi Jitsugyo
JP | 1948

- AGV & AMR vendor

Dematic
US | 1819

- AGV & AMR vendor

DS Automotion
AT | 1984

- AGV & AMR vendor

DTA
ES | 1974

- AGV & AMR vendor

E80 Group
IT | 1980

- AGV & AMR vendor

EGO Robotics
CN | 2016

- AGV & AMR vendor

EP Equipment
CN | 2007

Eve Autonomy
JP | 2020

- SW vendor

Flowbotic
PT | 2022

- AGV & AMR vendor

ForwardX
CN | 2016

- AGV & AMR vendor

Galaxis Technology
CN | 2013

- AGV & AMR vendor

Gideon
HR | 2017

- AGV & AMR vendor

Grow Automation
SE | 2023

- Consultant

Guide Robotics
JP | 2020

- AGV & AMR vendor

Hakuou Group
JP | 2022

- AGV & AMR vendor

Hangcha Group
CN | 2004

- AGV & AMR vendor

Hedin Lagan
SE | 1996

- AGV & AMR vendor

Huaxiao
CN | 2006

- AGV & AMR vendor

idealworks
DE | 2020

- SW vendor

COMPANY PROFILES: I-K

IPLUSMOBOT
CN | 2016
W in cb ▶

AUTOMATE
YOUR FUTURE WITH
NEXT MOBILE INNOVATION

JBT Corp
US | 1894
W in

- AGV & AMR vendor

MAG
Mobile Automation Group
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Jungheinrich
DE | 1953

- AGV & AMR vendor

MAG
Mobile Automation Group
powered by MHI

K.Hartwall
FI | 1932
W in ▶

K.HARTWALL
Logistics Efficiency through Innovation

A-MATE® - The most compact AGVs in their class

Realize successful AGV projects in demanding environments

- 1.1 meter
- 1000 kg
- 1.5 m/s

✓ **360° safety** coverage
✓ **3D pallet and obstacle** detection
✓ **VDA 5050** interface
✓ **Multi-connective gateway A-GATE**
for easy implementation in complex systems incl. customized software and peripheral devices

Find out more: k-hartwall.com https://k-hartwall.com/products/agv-mobile-robots/

KeyXTech
US | 2014
W in

- Consultant

Kivnon
ES | 2007

- AGV & AMR vendor

MAG
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KINEXON
DE | 2012
W in ▶

KINEXON

Unified AMR & AGV Fleet Control for Smart Intralogistics

CONTACT US

- Manage a diverse fleet of 20+ mobile robot brands with VDA 5050 compliance.
- Achieve real-time asset visibility with indoor positioning system using UWB, RFID, BLE, and V-SLAM.
- Optimize material flows with digital twins for unified traffic control and resource planning.
- Eliminate manual processes by integrating WMS, MES, and ERP for end-to-end automation.

SAP Endorsed App
Premium Certified

KNAPP AG
AT | 1952
W in cb ▶

KNAPP

KNAPP is the technology partner for intelligent value chains. Headquartered in Austria, the KNAPP group provides all-in-one solutions for automation and digitalization, from production and distribution to the point of sale. Excellent service and long-term collaboration make KNAPP the strong partner behind the success of their customers in the sectors healthcare, retail, food retail, fashion, wholesale and industry.

KNAPP AG
Günter-Knapp-Straße 5-7
A-8075 Hart bei Graz
sales@knapp.com

KOLLMORGEN
SE | 1972
W in ▶

KOLLMORGEN
A REGAL REXNORD BRAND

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

Lowpad
NL | 2017

- AGV & AMR vendor

LGIM
CN | 2013

- AGV & AMR vendor

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

Mobile Industrial Robots (MiR)
DK | 2013

Automation is on the move
Optimize your material handling with industry-leading AMRs that move everything from light to heavy payloads and pallets.

✓ Proven technology with +10,000 robots sold and 10+ years in the market
✓ Global reach across 60+ countries
✓ Trusted AMR partner to the world's largest companies

MasterMover
UK | 1997

- AGV & AMR vendor

MoonTech
ES | 2019

- SW vendor

Navitec Systems
FI | 1998

Navigation & Fleet Management Software to maximize your AGV & AMR capabilities

Navitrol™
Industry-leading natural feature navigation software

- Precise and agile in any environment
- Any autonomous vehicle type
- Rich feature set
- Indoor & outdoor

Navithor™
Powerful fleet management with traffic & mission management

- VDA5050 supported
- Different vehicles in the same fleet
- Seamless integration with MES, WMS, WSC, etc.
- Full simulation capabilities

Book a free consultation

Movanis
BE | 2008

- AGV & AMR vendor

Neuron Network
JP | 2021

- AGV & AMR vendor

Naise
DE | 2017

- SW vendor

No Risk Automation
US | 2023

- Consultant

NODE Robotics
DE | 2020

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

NODE.OS modules provide:
- **Live SLAM Localization** updates the initial map during operation, ensuring robust localization even in dynamic environments
- Configurable **Autonomous Navigation** also for complex settings
- **Easy & Scalable Task Execution**, including pick-up, go-to, and drop-off using the VDA5050 standard
- **Advanced Fleet Management & Coordination Services** to efficiently coordinate collaboration between robots

Key Benefits:
✅ **Proven Reliability:** 1100+ mobile robots successfully deployed
✅ **Ease of Use:** Quick integration & independent adjustments
✅ **Modular:** Tailor solutions to your needs
✅ **Hardware Agnostic:** Stay independent & choose your ideal hardware

COMPANY PROFILES: O-S

Opteran
UK | 2019
[W] [in] [cb] [▶]

Mobile robot localization
No SLAM, no AI, just Natural Intelligence

Simple
Vision-only localization robust to light, featureless spaces & scene change

Robust
Instant infrastructure-free map building at 1KB/m² without post-processing

Affordable
Fast deployment, low-end hardware, low skill requirement

www.opteran.com

OTTO by Rockwell Automation
CA | 2008
[W] [in]

- AGV & AMR vendor

Rapyuta Robotics
JP | 2014
[W] [in]

- AGV & AMR vendor

Performance Networks
UK | 2012
[W] [in]

- Wifi specialist

Romb Technologies
HR | 2018

- SW Vendor

RGo Robotics
US | 2018
[W] [in] [cb] [▶]

Next Gen Location Aware Perception

RGo Perception Engine based on vision, AI & advanced sensor fusion

- Easy to integrate, deploy & scale
- Proven in production
- Reliable navigation everywhere
- Tracking of any mobile machines

rgorobotics.ai

Safelog
DE | 1996
[W] [in]

- AGV & AMR vendor

Scott Automation
US | 1982
[W] [in]

- AGV & AMR vendor

MAG
Mobile Automation Group
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Seegrid
US | 2003
[W] [in]

- AGV & AMR vendor

MAG
Mobile Automation Group
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Standard Robots
CN | 2015

- AGV & AMR vendor
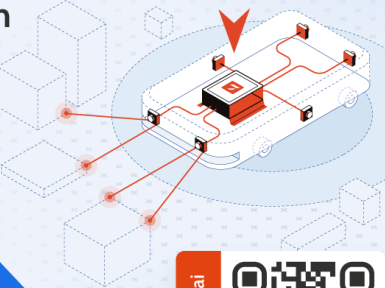
Sevensense Robotics
CH | 2018
[W] [in] [▶]

sevensense.ai

Visual SLAM localization & navigation for your AGVs and AMRs

- Increased efficiency
- Higher flexibility
- Lower total cost of ownership

▶ **Let's innovate together!**

Get in touch to explore how you can optimize your vehicles with state-of-the-art Visual AI localization and autonomy solutions.

SICK AG
DE | 1946
[W] [in] [▶]

SICK
Sensor Intelligence.

SICK is the **sensor expert** and provider of **integrated solutions** for **AGV/AMR** automation.

Latest Highlight
picoScan150-LOC

Full contour localization in one compact device

Synaos
DE | 2018
- SW vendor

Techvico
VN | 2019
- AGV & AMR vendor

Third Wave Automation
US | 2018
- AGV & AMR vendor

Thoro.ai
US | 2021
- SW vendor

Zebra Robotics Automation
US | 2024

Zebra Symmetry™ Fulfillment

Discover the only collaborative robot fulfillment workflow engineered to maximize your profits.

Learn More

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

Vecna Robotics
US | 1998
- AGV & AMR vendor

Yujin Robot
KR | 1988
- AGV & AMR vendor

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INTERVIEWS - AGV & AMR HW/SW VENDORS:

- Accerion (NL) — Managing Director
- AGV Consult (NL) — Founder
- Align (US) — CEO
- Balyo (FR) — CEO
- Bluebotics (CH) — CEO
- Casun (CN) — Marketing Manager
- EP Equipment (CN) — VP Business Development
- Flowbotic (PT) — CEO
- ForwardX (CN) — COO
- Grow Automation (SE) — Founder
- idealworks (DE) — CEO
- iPlusMobot (CN) — Overseas Business Director
- JBT Corp (US) — Application Engineering Manager
- K.Hartwall (FI) — Head of Automation
- Keyxtech (US) — Founder
- Kinexon (DE) — Sr Product Manager
- Knapp (AT) — Product Manager AGV
- Kollmorgen (SE) — Product Management Director
- LGIM (CN) — KAM
- Lowpad (NL) — Business Development Director
- Mastermover (UK) — Partner & Director
- MIR (DK) — VP Marketing & Strategy
- Moontech (ES) — CEO
- Movanis (BE) — General Manager
- NAiSE (DE) — CEO & Co-founder
- Navitec (FI) — CEO
- Neuron Net (JP) — System Engineer
- No Risk Automation (US) — Founder
- NODE Robotics (DE) — CEO & Co-founder
- Opteran (UK) — CPO
- OTTO by Rockwell Automation (CA) — VP
- Performance Networks (UK) — Founder
- Rapyuta Robotics (JP) — Product Manager AMR
- RGo Robotics (IL) — CBO, President
- Acieta (US) — Head of Autonomous MHE

- Safelog (DE) — Managing Director
- Scott Automation (US) — VP Sales Americas
- Seegrid (US) — CSO
- Sevensense (CH) — CBDO
- SICK (DE) — Strategic Product Manager
- Synaos (DE) — CEO
- Thoro.al (US) — CEO
- Toyota Industries (SE) — SVP
- Tusk Robotics (CN) — Director of Global Development
- Vecna (US) — CMO
- Zebra Robotics (US) — Head of Sales, Robotics

INTERVIEWS - USERS & BUYERS:

Multiple companies & individuals that requested anonymity from FMCG/CPG, 3PL, Manufacturing, etc.

We extend a big thank you to these contributors!

If you want to contribute your views on the sector, please contact tom@styleintelligence.com for an informal/confidential chat

EVENTS (RECOMMENDED/VISITED BY STIQ):

- Automate (US) — [Web]
- Automatica (DE) * — [Web]
- CeMAT Asia (CN) * — [Web]
- Logimat (DE) * — [Web]
- Logis-Tech Tokyo (JP) * — [Web]
- Modex (US) * — [Web]
- Promat (US) * — [Web]

*Key: * = STIQ visited/ visit planned*
>> Ask about STIQs trade show reports

GLOSSARY

3PL	Third Party Logistics
AFMS	Agnostic Fleet Manager System
AGV	Automated Guided Vehicle
AMR	Autonomous Mobile Robot
ASRS	Automatic Storage & Retrieval System
BMS	Battery Management System
CFC	Central Fulfilment Centre
CPG/FMCG	Consumer Packaged Goods (US/UK)
DC	Distribution Centre
ERP	Enterprise Resource Planning
EV	Electric Vehicle
F2F	Floor to Floor (~when moving a pallet)
F&B	Food & Beverage
Fiducial	Marker used to localise a robot
FM / FMS	Fleet Manager System
FTE	Full Time Employee
IRR	Internal Rate of Return
Kinetics	Vehicle drive wheel configuration
M&A	Mergers & Acquisitions
Odometry	Output from motion sensors
PCB	Printed Circuit Board
PLC	Programmable Logic Controller
POC	Proof Of Concept (trial)
RaaS	Robotics as a Service
ROI	Return on Investment
ROS	Robotics Operating System (ROS +ROS2)
RTLS	Real Time Location System
Sensor Fusion	Combination of multiple sensors
SLAM	Simultaneous Localisation and Mapping
SMB/SME	Small & Medium Businesses (US/UK)
TCO	Total Cost of Ownership
UWB	Ultra Wideband
VSLAM / vSLAM	Visual SLAM
WMS	Warehouse Management System

FURTHER RESOURCES: ✉

- Have questions about vendors, selection, etc and/or want to discuss details of this report – contact us for a conversation
- AGV & AMR Robotics market size data ($)

- Global trade show reports + Tech scouting ($/subscription)
- Market related consulting ($)
- Any other questions