wheel_me

E-BOOK | A comparison of autonomous wheels, AGVs, and AMRs

Navigating the future factory:
The path to material handling automation

Executive summary

This e-book is for manufacturing leaders wanting to enable or accelerate material handling automation.

The drive to automate is happening across plants, sites, and supply chains. When it comes to material movement, things slow down, literally. That is down to the human-led labor involved. But things are changing, with new opportunities — and challenges too.
You are invited to explore some of the key themes involved, with:

- Analysis of the business-critical need for material handling automation
- Discussion of key barriers stopping greater automation adoption
- In-depth comparison of three methods helping manufacturers automate their material handling

Thank you for downloading, and enjoy the read.

Contents

1. Automation in the industry 4.0 era

Amid the Fourth Industrial Revolution, the boundaries between digital and physical manufacturing are blurring. Networks and connections are exchanging data from remote locations to central offices. At growing volumes, velocities, and varieties.

The resulting insights mean factories are becoming smarter. More intelligent, responsive, and versatile in terms of tasks. Reducing costs, redefining the industry, and increasing the possibilities of production.

Automation is at the heart of this transformation. In multiple forms of autonomous robotics and systems. A few examples:

- **Robotic assembly**: Automated robots are assembling at greater speed, with more precision, and with dexterity similar to human workers.
- **Quality control**: Automated quality assurance means measurement inspection reliability is enhanced, with collections of 3D data and dynamic visibility.
- **3D printing**: Instead of waiting for an engineer and risking potential bottlenecks, real-time data is automatically allocating queued jobs, alerting on failed printers, even orchestrating supplies.

2. Challenges within material handling

As the digital factory takes shape and evolves, there's one area that remains primarily physical. Material handling. Manufacturers have to factor in elements such as:

- **Movement**: The direction and destination of who or what is moving materials
- **Time**: The speed that materials can be moved from one place to another
- **Quantity**: The units, and related demand, needed for production
- **Storage**: The space needed for storing and disposing of materials

These can't be easily solved with automation. It takes time – and often human labor – to assess, align and enable these elements. But here's the thing: Expertise and experience are in high demand and low supply.

3. How the skilled talent shortage is impacting manufacturers

> *US manufacturing is expected to have 2.1 million unfilled jobs by 2030 (Deloitte).*[1]

There are several reasons for this long-term and structural shift.

Reason 1: High costs

All those manual duties involved with:

- **Production**: Monitoring raw materials all the way through to final units
- **Equipment**: Tracking maintenance and replacement schedules
- **Stakeholders**: Ensuring the right information is shared at the right time

Reason 2: High turnover and no-shows

If you were to make a list of repetitive jobs, material handling would be near the top. Add in the physical nature of industrial warehouse work. Plus the risk of injury from items or equipment falling onto people.

Reason 3: Safety concerns

Forklifts remain a key part of manufacturing. According to the US Occupational Safety and Health Administration (OSHA), 11% of forklifts are involved in accidents each year.[2]

The resulting impact on risk and throughput is why manufacturers have been looking to increasingly combine automation with autonomous mobile robots.

All contribute to no-shows, with industry turnover rates reported at 31.3% and 39.9%.[3]

4. Automation and autonomy: Reshaping the future of the factory

In recent years, manufacturers have had two main options for adding automation and robotics to their operations.

1. Automated guided vehicles (AGVs)
2. Autonomous mobile robots (AMRs)

Both involve systems, designed for use in another system of material handling. The physical environment has pretty much defined how and when manufacturers use AGVs and AMRs. In terms of layout and based on how dynamic the movement is, by people and machines inside.

3. Now there's an alternative: Autonomous wheels

A robotic wheel doesn't have to be defined by its environment. You can attach groups of four and eight to existing infrastructure, machinery, and products. Turning them into self-driving robots. There's a lot to consider with these three options. Let's unpack some of the key questions and provide some answers.

4.1 Key characteristics and features of AGVs

AGVs follow a predefined route. The route is mapped using a mix of physical and virtual technology, often with planning by specialists tasked with finding the most efficient paths. The process sometimes involves modifying the automated guided vehicle's environment, adding further time to planning.

Guidance systems

AGVs use guidance systems that include laser positioning, magnetic adhesive tape, vision systems, and sensors. These mark out the path, act as navigational aids, and as safety features, sensing obstacles and stopping when there's a risk of potential collision.

Flexibility

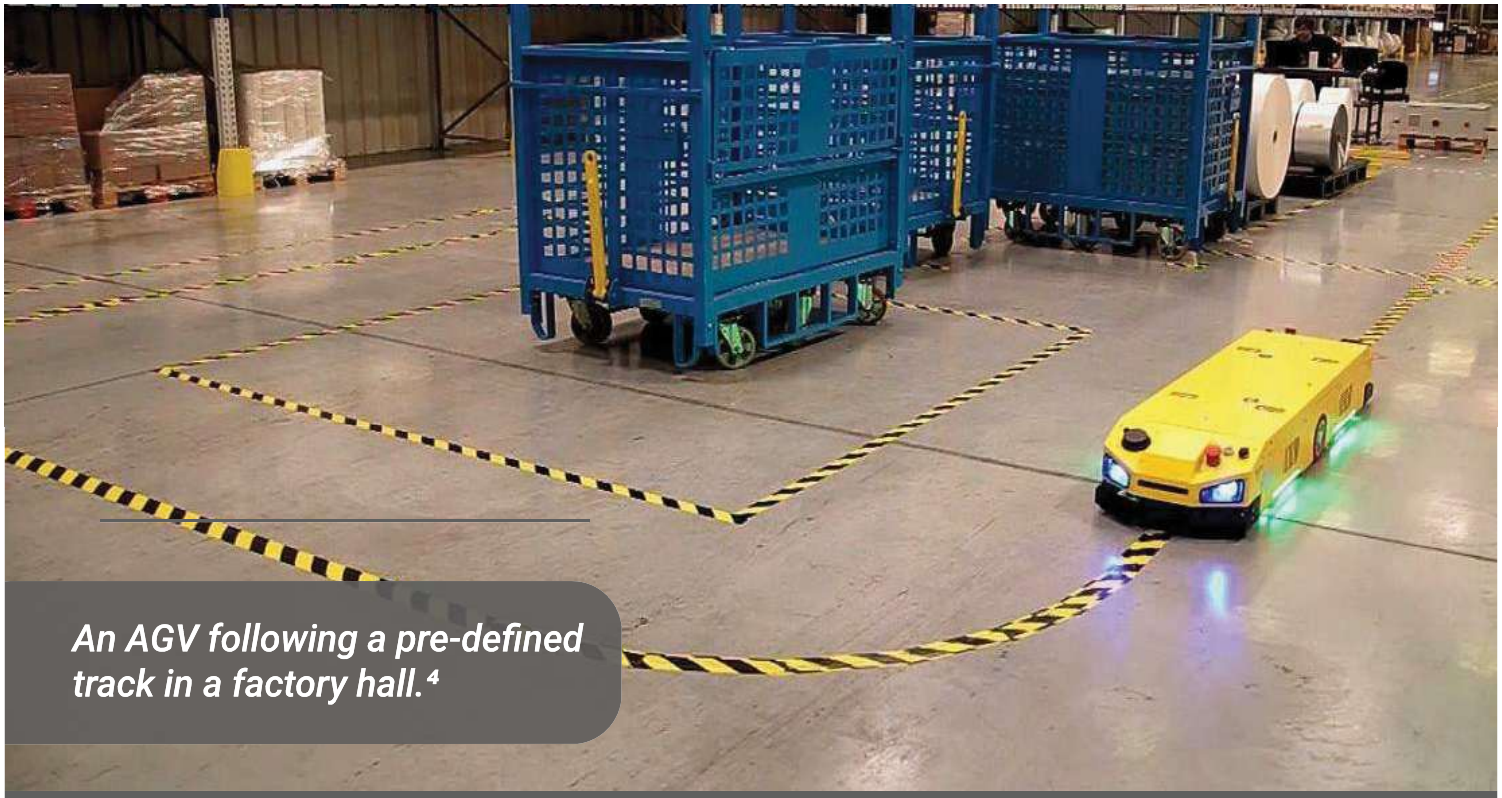
AGVs rely on its pre-programmed guidance system. Any unexpected obstacles mean the AGV is likely to stop moving, rather than improvise and change direction in real-time.

Industrial payloads

AGVs carry heavy industrial payloads. Heavyweight versions can manage up to a few hundred tons. You can equip them with forks, platforms and conveyors to load different-sized containers, racks, and pallets.

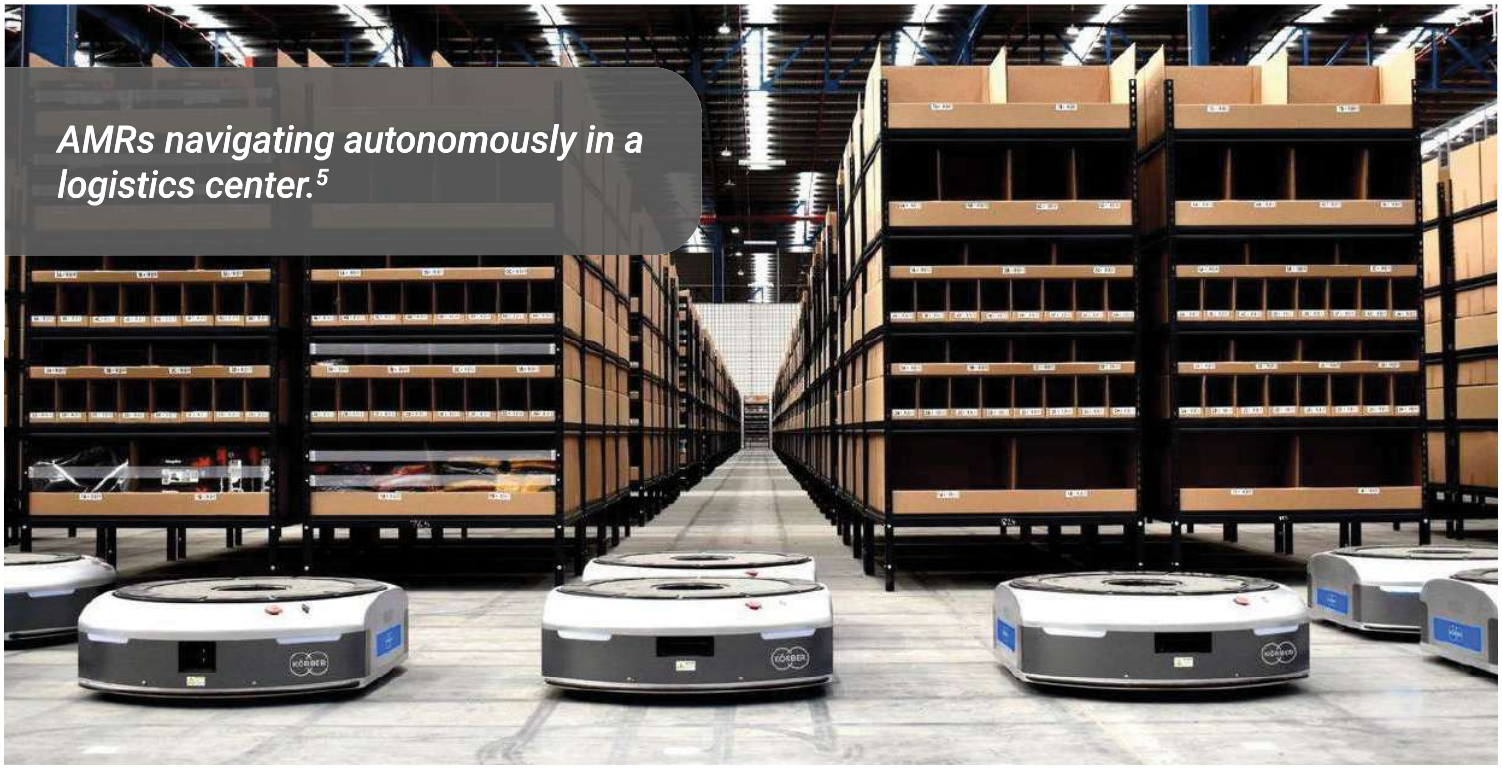
Autonomy and automation

AGVs can pick up and drop off items along predefined routes. Assuming there are no obstacles, AGVs offer automatic punctuality and predictability.



An AGV following a pre-defined track in a factory hall.[4]

4.2 Key characteristics and features of AMRs



AMRs navigating autonomously in a logistics center.[5]

Setup is often done using drag-and-drop software. There's no engineering expertise needed to set up the robotics and autonomous systems

Guidance systems
Cameras, sensors, and LiDAR allow for dynamic digital mapping, making them suited for similarly dynamic environments. If an AMR meets an obstacle, its "obstacle avoidance" approach means moving around the obstacle and toward its destination.
Flexibility

AMRs still follow predefined routes, but have the capability to adapt to surroundings and the traffic. If the layout changes, or there's greater footfall or activity, AMRs can dynamically adjust to the changes. This is one of the key advantages of autonomous mobile robots.

Industrial payloads
Increased flexibility does mean AMRs often carry less payload. As a result, AMRs are often deployed for improving efficiency and productivity. Picking products, inspecting inventory, and tugging lighter payloads when compared to AGVs.

Autonomy and automation
With both offering multiple sensors that send real-time data, material handling can become more connected. However, AMR's advanced software often requires advanced knowledge when it comes to dealing with bugs, errors and updates.

4.3 Key characteristics and features of autonomous wheels

The world's first autonomous wheel is Genius 2, from wheel.me. Genius 2 is deployed in sets of four wheels. The modular process can make almost any object a mobile robot, ready for material handling, regardless of its footprint. No need to modify shape, design, or infrastructure.

Guidance systems

Genius 2 uses smart indoor navigation technology, with LiDAR sensors giving a total 360-degree field of view, supported by 3D and ultra-wide lens cameras. Advanced navigational algorithms find the safest and most efficient routes, while making use of redundant proximity sensors. When Genius 2 meets an obstacle, the autonomous wheels replan routes on the fly, or stop if needed. The dynamic collision avoidance means they're safe to use around people operating in busy manufacturing environments.

Flexibility

Genius 2 is used across multiple industries. It is a flexible way to implement automation for material handling, without large upfront capital expenditure, or changing existing infrastructure. There's also endless flexibility in terms of use cases, warehouse layouts, and mounting to loads with different shapes, weights, and sizes.

Genius 2 autonomous wheels.

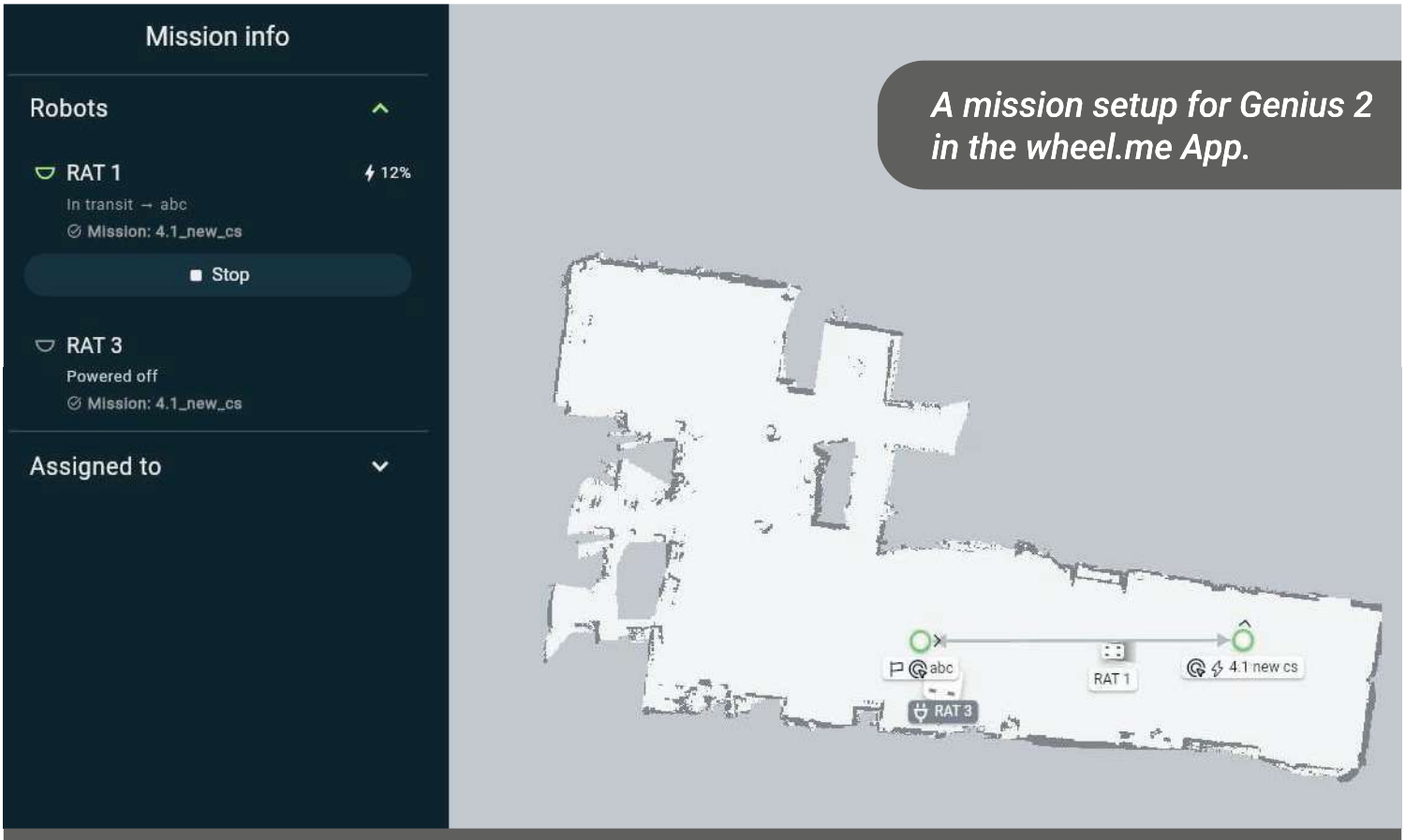
Further flexibility comes when you take a modular approach to implementation. Adding sets to test proof-of-concept, before rolling out to wider and higher-impact use cases.

Industrial payloads
Genius 2 works in sets of 4 wheels. Currently, a set of Genius 2 is capable of carrying payloads of up to 250kg (550 lbs).

Autonomy and automation
Genius 2 is used in sets of four wheels, with one wheel acting as the central “brain”, leading and synchronizing with the other wheeled mobile robotics. You can program these to work alongside other robots and humans, either independently on tasks, or in collaboration.

Data analytics
Genius 2 analyzes information collected during missions. These are predefined routes from A to B. Each mission generates data that you can use to further optimize routes, track performance, and solve logistics inefficiencies.

Usability
The wheel.me App is designed for anyone to use with Genius 2. No technical or coding expertise needed. You can use the App to configure the robots, map the facility and create a mission for your robot. It’s a user-friendly introduction to using robotics in material handling.



A mission setup for Genius 2 in the wheel.me App.

5. Technology decisions ahead: How to plot the right path?

You can start the process with a scoping document. Feel free to adapt the following prioritization plan for use in your business at the planning stage.

5.1 Prioritization plan

Treat it as a foundation to help you answer the following question: “What do we want robots to change about our existing material handling processes?”

Objective	Priority (1= highest, 6=lowest)
Improve safety record	
Optimize productivity	
Use as a scoping project before committing to a larger implementation	
Expand material handling capabilities (manage a wider range of shapes, sizes, weights)	
Scale up data collection and analytics capabilities	
Reduce costs	

5.2 Comparison checklist

After you’ve decided on your priorities, it is time to measure them against your current environment, workforce, and material handling setup. Explore questions around:

- **Layout of the environment:** Will fixed sensors be sufficient, or is the environment dynamic enough to require 360-degree obstacle detection?
- **Payload:** What are the minimum and maximum payloads to be carried?

- **Material handling equipment:** How hazardous, toxic or bulky are the payloads, and will different types of material handling equipment be needed?
- **Navigation:** Is the environment fixed or regularly changing, in terms of structure, people, and other AGVs, AMRs or autonomous wheels?
- **Current infrastructure:** How much systems integration capability does your business have now, or is likely to have in the future?

So you've completed the scoping project. If you're leaning towards AGVs or AMRs at this stage, the next part is for you.

6. Why modern material handling means looking beyond AGVs and AMRs

So far we've covered broader issues relating to AGVs, AMRs and Genius 2. Let's now start comparing each solution directly.

Costs

Investing in AGVs and AMRs means a high capital expenditure. There's potentially a longer payback period too, when you factor in time on reconfiguring environments or training staff. Genius 2 offers you a flexible and scalable solution. You won't need to invest in infrastructure. Genius 2 autonomous wheels simply get attached to your existing objects.

Maintenance

Costs from the initial AGV or AMR purchase are joined by ongoing maintenance costs. Robots with metal components require regular lubrication. This routine maintenance adds time to manufacturing processes.

Genius 2 troubleshooting can be done by your team. They just need to complete the wheel.me training. Then you can simply swap out a robotic wheel when it comes to maintenance, without your entire assembly line stopping.

Nature of environment

If your warehouse is large with a complex layout, the costs of AGV and AMR guidance systems can soon add up.

Like AMRs, Genius 2's advanced sensors enable autonomous movement. And unlike AGVs, you don't have to spend time adjusting the environment sensors, or repeatedly laying down magnetic tape. Of course, Genius 2 gives you the added advantage of lower costs. Around one-third of lower-priced AGVs and AMRs.

Interoperability

AGVs and AMRs have their own proprietary code. For manufacturers wanting to scale, the lack of interoperability means sticking with the same vendor.

One option is to invest in software integrators. But this introduces an extra link in the chain. In comparison, you can attach Genius 2 robotic wheels to most objects. Scale up or down as you need, without compatibility issues or legacy software concerns.

7. From bottlenecks to wheel-based breakthroughs

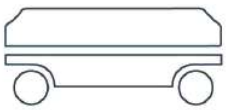
With Genius 2, it is easy to quickly configure, adapt and customize for different load sizes, shapes, and weights. For manufacturers wanting to take on a diverse fleet of autonomous vehicles, wheels offer a low-risk and low-expense way to grow. In other words, there's the flexibility that modern manufacturers need for:

- **Material handling:** Autonomous transport of raw materials, components, and finished goods between different production stations.
- **Inventory management:** Automated movement of goods within manufacturing facilities, optimizing inventory processes.
- **Assembly line support:** Integration into assembly lines for the seamless transport of raw materials, spare parts, and other components between workstations.
- **Tool and equipment transport:** Movement of tools and equipment to different areas on the factory floor for various production processes.

With a fast and simply implementation, manufacturers can realize the benefits with greater:

- **Efficiency:** Streamlined material handling and transportation processes for improved productivity and reduced downtime.
- **Cost savings**: Reallocation of labor, minimized errors, optimized use of resources
- **Accuracy and consistency:** Precise and consistent movement of goods, minimized risk of material handling errors, and a high level of accuracy in inventory management and assembly line processes.
- **Increased safety:** Reduced need for manual labor when handling heavy or hazardous materials, enhancing workplace safety for employees.

8. Differences between autonomous wheels, AGV, AMR



	Genius 2	AGV	AMR
Approach to obstacles	Collision avoiding, will move around and continue	Path following, will stop and wait until cleared	Collision avoiding, will move around and continue
Autonomous navigation	Yes	No	Yes
Hardware setup	Hardware is onboard	Engineers required to implement infrastructure	Hardware is onboard
Interoperability	High – converts existing infrastructure into mobile robots.	Low	Low
Payload	250kg | 550 lbs for 4 wheels	Several hundred tons (400 tons = 800,000lbs)	Up to around 2,000kg (4,400lbs)
Pricing	Around one-third of a lower-priced AGV or AMR	High	High
Routing	Carried out by customer using the wheel.me App	Engineers required to manually map routes	Upload or create digital map
Turning radius	Zero-point turn	High	Medium

Conclusion

This e-book has explored the challenges and opportunities surrounding material handling automation. We've compared traditional methods like AGVs and AMRs with the innovative approach offered by Genius 2, the world's first autonomous wheel system.

Genius 2 empowers manufacturers to:

- **Reduce costs and complexity**: Eliminate the need for infrastructure modifications and extensive training.
- **Improve efficiency and safety**: Streamline material handling processes and minimize human involvement in hazardous tasks.
- **Gain flexibility**: Adapt to diverse material handling needs with a modular and scalable solution.

Ready to start your automation journey?

Contact an automation expert at wheel.me: wheel.me/contact-us

Follow wheel.me: linkedin.com/company/wheel-me

References

1. https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-industry-diversity.html
2. https://www.twi-institute.com/manufacturing-employee-turnover/
3. https://www.osha.gov/sites/default/files/2022-04/Forklift%20Operator%20Safety%20Training.pptx
4. https://blog.etisoft.eu/efficient-intralogistics-with-agv-robots-automated-guided-vehicle/
5. https://www.smartb.co/what-is-an-autonomous-mobile-robot-amr/