

BREAKBULK AMERICAS

The Impact of Autonomous Technology on Future Ports

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ABSTRACT >

Autonomous technology is poised to revolutionize the ports and logistics sector by enhancing efficiency, safety, and sustainability. Innovations such as autonomous cranes, trucks, and port equipment will streamline operations, reduce errors, and prevent downtime. The global smart ports market was valued at \$2.0 billion in 2022, and is projected to reach \$15.5 billion by 2032, growing at a CAGR of 23.1% from 2023 to 2032. (Karn & Prasad 2023) The rapid growth of AI and Industry 4.0 technologies is already optimizing supply chains and driving a new era of trade logistics. Furthermore, autonomous systems can operate around the clock, offering cost savings, improved safety, and reduced environmental impact. This study explores these trends and their implications for the future of global trade.

INTRODUCTION >

The ports and logistics industry is on the cusp of significant transformation, driven by advancements in autonomous technology. Our team compiled this study for the Breakbulk Industry. In it, we draw on academic research, industry reports, and real-life data to highlight some key sector developments. Adopting Autonomous equipment in the port sector, including cranes and trucks, promises to enhance operational efficiency and minimize human errors. Integrating AI and V2X communication will revolutionize logistics management, while autonomous unmanned surface vehicles (USVs) will enable new capabilities, such as autonomous berthing. Beyond cost and efficiency improvements, these technologies will drive sustainability efforts by reducing energy consumption and CO2 emissions. As we enter a new era, ports are set to become more agile, automated, and competitive globally.

DISCUSSION >

An intelligent port integrates V2X Technology, Artificial Intelligence, Unmanned Surface Vessel (USV), and Active Digital Twinning, converting to Industry 4.0 for an efficient workflow. Smart ports integrate 5G technology into their operations, re-engineering the communication between each vessel and technology to provide a real-time reading to operators. (Rendon 2022) USVs are vessels, and with the help of their 5G technology and V2X technology, these machines can move promptly across the area of operation, with automated tasks assigned to each vessel without the presence of humans. (Li 2023) Industry 4.0 technology is necessary as we enter a new era of artificial machine learning (Giraldo 2024); as China's leading port industry takes place, it beats all other countries with conventional port technology in numbers across the board while other countries struggle to maintain entry of goods from China. (Hart 2021) By 2025, it is anticipated that 6,000 to 7,000 L4 autonomous container trucks will come into service in China's ports, which would increase the automation penetration rate to over 20%. (Wei 2022)

Port Automated Driving Market Size in China, 2019-2025E

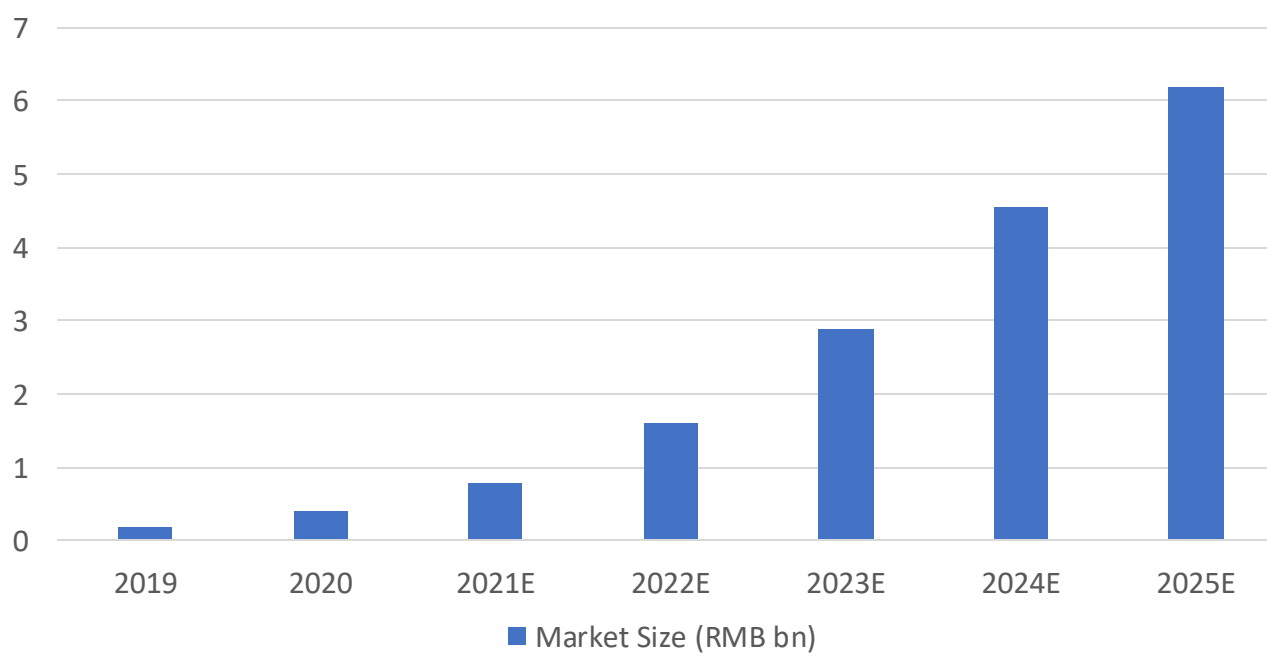


Figure 1: Port Automated Driving Report, 2021



Image Source: Istockphoto.com

METHODOLOGY >



Graphic Source: Istockphoto.com

STEP 01 **QUANTITATIVE RESEARCH**

Learning more about the topic: What is autonomous technology? And how is it going to change the future of ports?

STEP 02 **SOURCES**

Peer-reviewed articles related to autonomous technology along with government websites, non-government websites, and trade associations.

STEP 03 **FINDINGS**

Types of autonomous technology used in ports that will be fully integrated and advanced in the future: Active digital twinning, AI, Industry 4.0, V2X technology, and Unmanned surface vessels.

STEP 04 **POSITIVE OUTCOMES**

After thorough research: human-machine interactions, increased productivity, cost savings, better sustainability, and an increase in global trade will be the positive outcomes autonomous technology will have in future ports.

SOLUTIONS >

- Human-machine interactions** - Autonomous technology has many benefits that increase safety between humans and machines at ports. With technological advancements, improving safety while utilizing autonomous container movement is impossible. Furthermore, remote driving capabilities will allow operators to guide these autonomous vehicles in and out of ports, eliminating the risk of many accidents and hazardous situations.
- Increased Productivity**-With autonomous technology, efficiency at ports will rise considerably. Without human drivers, autonomous vehicles can operate 24/7 without any rest periods, leading to quicker turnaround times and greater capacity. The Chinese Port of Caofeidian saw a reduction in labor costs by 70% combined with a 30% increase in efficiency. (Global Infrastructure Hub)
- Cost Savings**-Despite the significant cost of acquiring new technology, autonomous vehicles are gaining a lot of popularity because they offer reduced maintenance costs and lower fuel expenses. Also, labor costs will be heavily reduced due to the inability to use human drivers. The cost of employing truck drivers account for more than 50% of the total operating costs incurred by domestic ports. (Connection 2023)
- Better Sustainability**-Autonomous vehicles can optimize their routes, leading to minimal fuel consumption and ultimately reducing port carbon emissions. These vehicles will only improve as technology improves.
- Increases in Global Trade**-Autonomous sourcing can remove 90% of manual work from a sourcing event. (Thaler 2024) This will help teams find an optimal route, carrier, or supplier alternatives in case of a disruption. Automation enables teams to weigh price and delivery speed alongside other factors, such as capacity, contract terms, sustainable sourcing practices, and reliability.



Image Source: Istockphoto.com

FINDINGS >

- Active Digital Twinning**-an accurate virtual representation of an actual physical object, process, or system. A digital twin can reside on platforms coordinating manned and autonomous systems like trucks, drones, shuttles, and robots. A port-wide digital twin can greatly enable automated inspection of facilities, security, operational viewports, multimodal operation, etc. Digital twinning will lead to changes to smart ports.
- Artificial Intelligence**-AI-powered technology such as cranes and vehicles have been proven effective in optimizing container handling processes by calculating the most efficient route, speeds, and movements.
- Industry 4.0**-Port 4.0 are smart ports that use advanced technology to improve operations. Ports 4.0 offers significant benefits that can improve the efficiency and sustainability of the global supply chain. These benefits include greater efficiency, improved port safety, sustainability, and service quality.
- V2X Technology**-Vehicle-to-everything technology allows a vehicle to share information from its sensors, cameras, and internal systems with other vehicles, pedestrians, and systems using wireless data connectivity. V2X technology would allow the vehicles at the port to communicate securely and wirelessly with other infrastructure elements, such as traffic lights, road signs, and roadworks.
- Unmanned Surface Vessel (USV)**-Autonomous control of USVs will significantly impact the future of ports. Automation of USVs will help with USV path planning, path tracking, and, most importantly, autonomous berthing.

TECHNOLOGIES USED IN DIGITAL TWINS

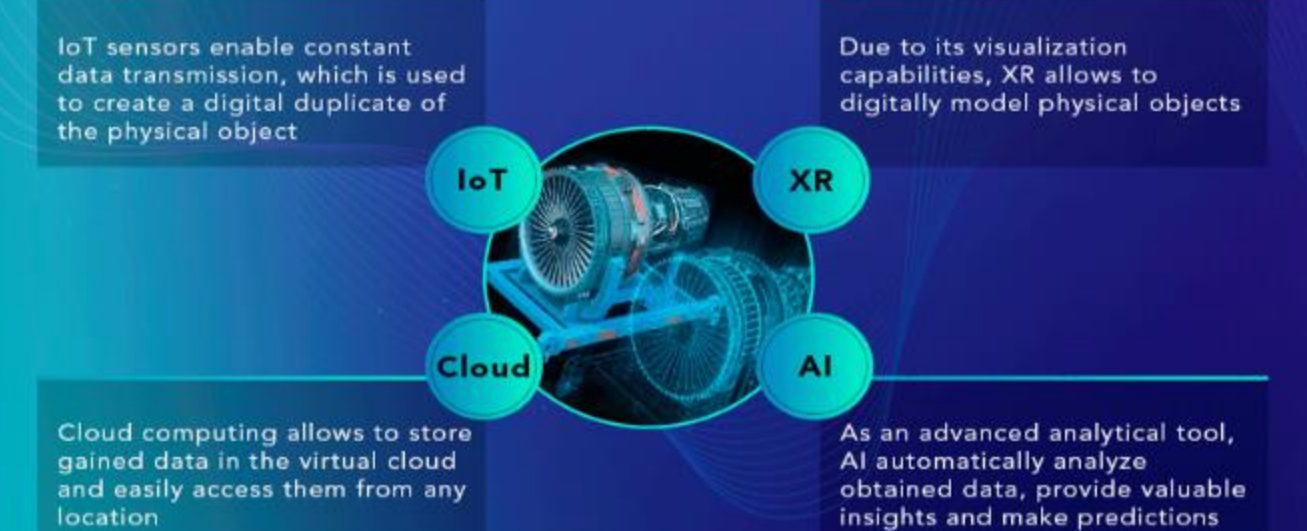


Figure 2: Digital Twin Use Cases and Applications.



Figure 3: First Autonomous Trucks in European port deployed (Choi C. 2022)

MEET THE RESEARCH TEAM



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REFERENCES



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