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The state of **edge AI in manufacturing**: moving to a new paradigm

From improving employee productivity and safety to reducing operational costs and spotting product defects, manufacturers see no shortage of use cases for edge AI.

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TODAY'S MANUFACTURERS face pressure from a convergence of forces, many are largely beyond their control. Skilled worker shortages and rising labor costs are driving them to improve productivity with fewer resources. Higher prices for energy and materials constrain margins, and tariffs and geopolitical disruptions cause many to make major changes in their supply chains or restrict sales.

A recent Foundry MarketPulse survey of 500 senior enterprise decision-makers — including 170 in manufacturing — found overwhelming agreement that edge artificial intelligence (AI) technology has the potential to help overcome many of these challenges, and many manufacturers have successfully implemented solutions for specific use cases. But questions about the technology's complexity and cost are holding some back from broader deployments.

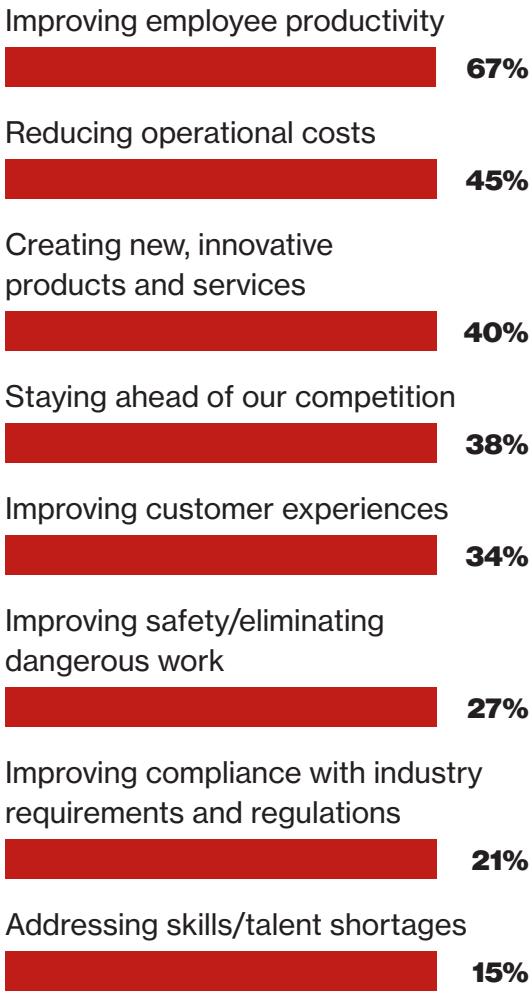
To reap the full benefits of edge AI, the survey suggests, manufacturers need to gain a better understanding of the technology and develop an implementation strategy that fits their needs and budget.

What manufacturers want from edge AI: saving money and growing revenue

Among the many challenges driving manufacturers to adopt AI solutions, an acute labor shortage tops the list. Millions of baby boom–generation workers who have spent their lives in the industry are retiring, with fewer younger workers entering the field to take their place. Even with modern advances in robotics, many plants remain shorthanded. Securing top talent means acquiring workers with skills that are in demand across many industries, not just manufacturing.

In the survey, 67% listed improving employee productivity as the top motivating factor for their interest in edge AI, and nearly half listed lowering operational costs (see Figure 1).

Figure 1 | Manufacturers' top reasons for adopting edge AI



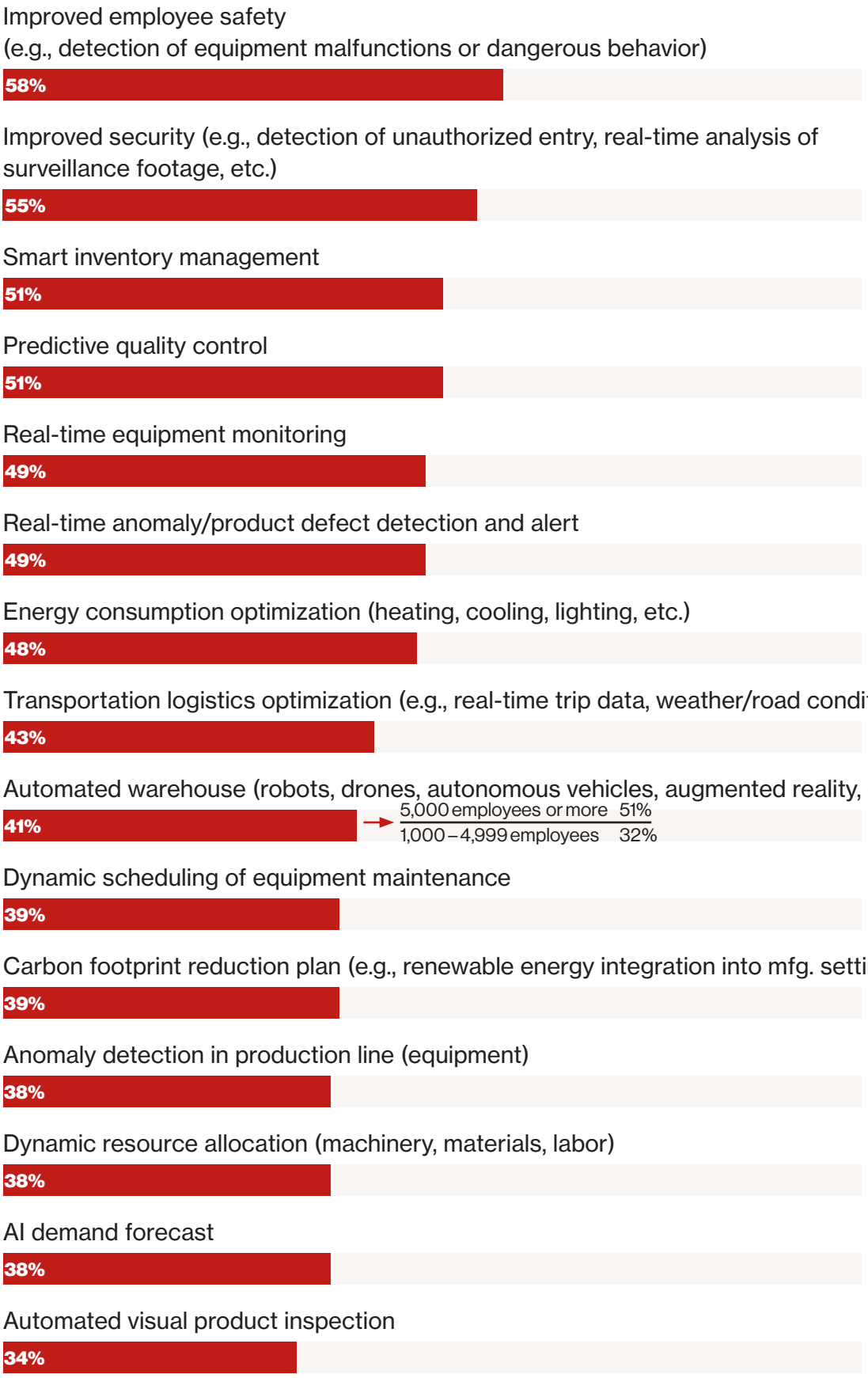
SOURCE: FOUNDRY

One way AI improves productivity and lowers costs is by enabling workers to collaborate better with digital tools. For example, an auto manufacturer may have several designers working on different systems for the same vehicle model, some working at the factory and others remotely. Using a digital twin, these teams can coordinate their work in real time, enabling them to more easily modify designs and assemble a final product faster.

Experimenting with digital tools also facilitates innovation. Among the surveyed manufacturers, 40% cited creating innovative products and services as AI's top draw.

In terms of specific edge AI use cases, manufacturers listed the most compelling as keeping workers safe and improving physical security (see Figure 2 on next page).

Figure 2 | **Edge AI's most appealing use cases for manufacturers**



SOURCE: FOUNDRY

With real-time AI monitoring of workers and equipment, factories can sound alarms to warn workers of hazardous conditions or alert supervisors to safety protocol violations.

Other critical priorities manufacturers cited are improving product quality control through predictive analytics (51%) and minimizing machine downtime with real-time monitoring, anomaly detection, and alerts (49%).

"These capabilities work together to increase efficiency, improve product condition, reduce costs, and enhance the customer experience," says Ricky Watts, industrial solutions director at Intel.

"Machines, tools, manufacturing execution systems, packaging systems — all of these systems create enormous amounts of data on their performance. Predictive analytics enables you to anticipate when something is likely to fail."

With such data at their disposal, factory managers can arrange for equipment to be serviced after hours before it breaks down and shuts down the production line.

> **Predictive maintenance improves uptime,** which increases the number of products going out the door **and improves revenue.**
>
> — **Ricky Watts**, industrial solutions director, Intel

So does defect detection. With computer vision, factories can cull products with flaws that assembly workers may not see, preventing them from being sent to customers, returned at the manufacturer's expense, and scrapped or discarded.

"If you identify and resolve issues through quality assurance, you improve yield and lower costs, because you have fewer wasted products," Watts says. "These are some of the reasons edge AI is becoming critical. All the manufacturers I'm talking to are moving toward edge-based solutions."

How manufacturers are using edge AI today

Although edge AI deployments are not yet widespread in the industry,

manufacturers are starting to integrate solutions into their ecosystems, helping solve some of the industry's greatest challenges. Here are some examples:

Improving safety

Nearly half (49%) are deploying or planning to deploy applications for the most compelling use case cited by Foundry survey respondents — improving workplace safety. For example, instead of entrusting health and safety monitoring of its workers to busy employees, a large bottling plant created an edge AI machine vision solution. It operates at nearly a thousand supervision points, recording and analyzing safety problems such as failure to wear protective gear, unsafe movements, and unauthorized access. The system, which uses no labor, automatically triggers alarms for serious incidents and informs managers of less critical problems so they can improve training.

Nipping product defects in the bud

Among the responding manufacturers, 53% are using or plan to use edge AI to improve quality control. For example, a tire manufacturer required months to train workers to manually spot tire defects but even then, many problems were missed. The company implemented an edge AI solution combining computer vision cameras and processors embedded with deep-learning inferencing tools to spot defects automatically. Now it can inspect more than 20,000 tires per day — as quickly as they come off the production line — with an accuracy rate of over 99.9%, up from 90% to 95% for human inspectors.

Improving inventory management across the supply chain

Fifty-four percent of manufacturers are implementing or planning smart inventory management. Manufacturers

typically use several different software solutions for resource planning, manufacturing execution, and warehouse management, making it difficult to coordinate real-time factory operations with actions across the supply chain. With edge AI computers and system integration software, factories can analyze production data in real time and optimize scheduling throughout the supply chain, helping them respond faster to problems and order changes.

For example, a manufacturer with 1,000 production processes involving more than 100,000 component parts set up a collaborative supply chain planning solution that now processes 5,000 orders — replete with the latest production data — in less than 10 seconds.

A more efficient, innovative future

Not surprisingly, manufacturers have high expectations for the future of edge AI technology, with 84% saying the efficiency improvements it brings are likely or extremely likely to save them time or money — the highest percentage among the three sectors studied in the survey (manufacturing, healthcare, and retail). Over 77% think increased AI adoption will help them create transformational new products and services (see Figure 3 on next page).

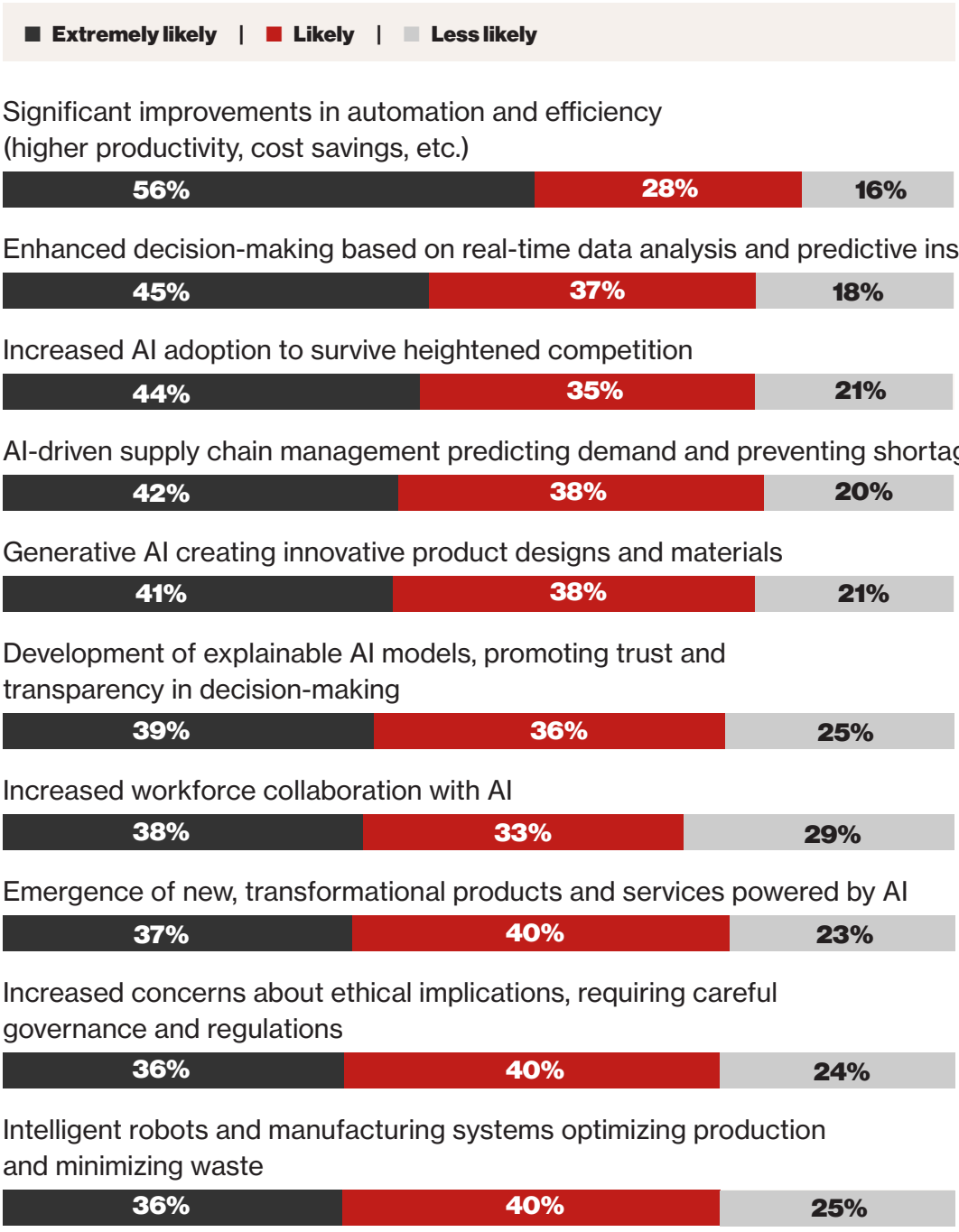
Over 77%

think increased AI adoption will help them create transformational new products and services.

— **Manufacturing respondents**

By connecting data from factory operations (operational technology, or OT) with corporate systems (IT), AI enables production managers to keep up with market trends. Among the manufacturers, 79% believe increased AI adoption will help them survive heightened competition. And elsewhere in the survey, nearly three-fourths (74%) said it has the potential to help them grow revenue.

Figure 3 | **Manufacturers' expectations of edge AI's impact**



SOURCE: FOUNDRY

In addition to learning what kind of features customers want sooner than competitors, manufacturers can employ edge AI to quickly reconfigure their production systems accordingly.

"In a typical factory environment, reconfiguring a robotics line to build a new product takes months. With AI, using all the data and compute power that's available at the edge, you can do it in minutes," Watts says.

In the future, as AI brings IT and OT systems even closer together, factories may be able to provide products tailored for individual customers — an idea once considered an impossible dream.

As an example, "If a customer wants a yellow car with blue wings and a white bumper, the color scheme would be loaded into factory machines as a customer completes his order and they will be able to customize products in near real time," Watts says.

"We're not there yet, but AI to genAI [generative AI] enabled through digital twins will get better and better, and I think procedures like this are going to happen much more quickly than people realize. Within 10 years, you won't recognize manufacturing processes."

Optimizing energy use

AI also is helping manufacturers address another crucial issue: reducing their heavy energy use and increasing sustainability. In the survey, 60% of the manufacturers said they're implementing or planning to use AI to optimize energy consumption.

AI can help in several ways, Watts says. At the most basic level, it can analyze data about workers' locations.

Areas occupied solely by machines can move to a "lights-out" environment, and robotics enhanced with AI can operate in more efficient ways to reduce energy use, thus removing unnecessary lighting and adjusting temperature settings to those that work best for equipment. As more processes are automated, more areas can be switched over, saving on energy bills.

To enable more sophisticated controls, some factories are working with partners to connect their processes with the energy grid.

"Using artificial intelligence and data at the edge, you will someday be able to adjust manufacturing processes in real time to optimize energy consumption and minimize impact to the environment while ensuring you hit production targets," Watts says.

For example, a manufacturer may have calculated it needs five million gallons of water to cool products during a particular phase of production. But AI analysis may reveal that the same water pressure is not required for the duration of the process.

"You could make real-time power adjustments at different junctures to conserve resources, reducing and recycling when possible, without impacting quality or output," he says.

Because manufacturers typically engineer systems to access the greatest amount of energy they could possibly need, many such opportunities exist to reduce consumption with fine-grained controls. Similar controls could be applied to the use of chemicals and raw materials, helping plants improve their environmental profile as well as save money.

Overcoming implementation challenges

Despite early success with edge AI solutions and enthusiasm for the technology's potential, manufacturers in the survey expressed concerns about extending their deployments. Nearly half worry about the technology's potential for malfunctions or errors; 48% have questions about cost and 45% about security and compliance. Nearly as many (41%) said they lack the internal expertise and skills for deploying and managing AI.

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Watts suggests several steps manufacturers can take to deal with their concerns and get started with edge AI:

- **Join industry consortia to further your knowledge.**

"Members of many industry groups share their experiences and learn from one another without giving away competitive secrets," Watts says. Peers at similar-size plants can answer many common questions about AI and provide a rough template for rolling out and managing solutions.

- **Make sure you have the skills, resources, and cooperation you need.**

"Do you have the right people and processes in place for edge AI deployments? You need people who understand the technology," Watts says. "You also need to make sure your IT people are working very closely with their OT manufacturing counterparts to produce the best outcome."

- **Plan AI integrations holistically.**

"If you're a small manufacturer and you buy a one-off solution to fix a particular process, it's probably OK. But if you want to scale, you need to be more proactive about what you are trying to do," Watts says.

It's helpful to create a task force to determine priorities and set a strategy for deployments. Make sure senior leaders are engaged throughout the process to avoid silos and maintain momentum.

- **Work with partners to build a coordinated AI ecosystem.**

"AI is an evolving journey," Watts says. "You need to build systems collectively and involve partners across the spectrum, including infrastructure and systems suppliers, hardware providers, software vendors, and systems integrators. They've all got great experience they can share to help you plan and scale for success."

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The high-speed road ahead

Today's manufacturers are eager to deploy edge AI to solve some of their most pressing problems. Although the technology can do that, companies should prepare for it to do much more as the pace of innovation accelerates.

"We are basically at Chapter 1 with edge AI," Watt says. "From generative AI and digital twins to the metaverse and beyond, we are going to see manufacturing evolve much faster in the next 10 to 15 years than it has in the last 100. To remain competitive, leaders need to work with people they trust to build a pathway to the AI future."

To learn how edge AI can help your organization attain new levels of efficiency and productivity, visit Edge AI: Bring AI to Your Edge Computing Environment.

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