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Next-Gen AI Manufacturing/ Industrial Sector

Next-Gen AI: The Star of Industry 4.0

For decades, heavy industry companies – those in manufacturing, engineering, metals, textiles, chemicals, and related sectors – have pioneered advanced automation and analytics to boost efficiency, safety, profitability, sustainability, innovation, strategy and more.

Now, they find themselves at different stages in terms of their integration of physical and digital assets and their use of sensors, connectivity, robotics, computing power, and the operational models and innovations that combine human ingenuity and automation. These are the elements of the so-called Industry 4.0.

But among that cast of elements there is a principal player. Artificial intelligence (AI) is the tool that is likely to do the most to change the way industrial companies actually operate. It can introduce increasingly human-like, adaptable capabilities, and help us make sense of the trillions of bytes of data collected by industrial companies from machines, processes, assets, markets, and the environment.

To what extent are industrial companies benefiting from AI now? How quickly will organizations change to accommodate more AI-driven operations? And how will industrial companies deal with issues of trust, governance, safety, and cybersecurity?

To answer these and other questions, we conducted a survey of 515 senior leaders who have some responsibility for, involvement in, or knowledge about their organization's existing or planned use of AI. Here, we discuss what we learned from the 158 industrial sector respondents; the findings for all industries are in our Next-Gen Industrial AI report.

AI in a post-covid world

When this research was commissioned, there was a lot of hype around the potential of consumer AI, and fewer insights available on industrial AI. While we at Siemens, with over 30 years' experience in industrial AI, are no strangers to this field, we wanted to learn more about the experience of other organizations. This research sought to uncover the benefits and barriers of industrial AI applications, and to highlight its potential, especially when combined with other technologies like IoT and digital twin. Suddenly the world is a different place. However, as organizations seek to recover, rebuild and adapt in a post-covid environment, the potential of industrial AI is more relevant than ever.

So far, industrial companies have seen only modest benefits from AI, with leading use cases providing a major or moderate benefit for less than a third of companies. Those use cases include systems that intelligently optimize systems automatically (30% have experienced a major or moderate benefit), provide market or system forecasts (30%), automate and/or improve quality control (30%), improve existing products and services (29%), identify risks/issue warnings (27%), and predict asset maintenance needs (25%).

But respondents expect significantly greater benefits to be realized quite soon. In all the cases above, between 77% and 84% expect a major or moderate benefit in just three years' time. Part of this expected growth will be down to the increasing accessibility of AI, particularly for companies that do not have specialist AI capabilities.

Only 44% of respondents have an in-house team that is building customized AI-driven solutions, but many are taking advantage of products with AI functionality. For example, neural network processors are being built into machine control modules, which means that companies can buy 'off-the-shelf' visual or auditory discrimination tools (for example for quality checks or process monitoring).[1]

New opportunities where context matters

AI applications are developing rapidly, and as industrial companies increase their adoption, the next generation of innovations and applications will create new opportunities.

Much of that innovation is driven by advances in the way data is managed, generated, represented, and shared. "AI is about generating value from data," says Dr Norbert Gaus, Head of R&D for Digitalization and Automation at Siemens. "It is driven more by data than by technology."

So sometimes it will be advances in how we represent, blend and manage data that will lead to AI breakthroughs. Knowledge graphs are one example. Often visualized as giant spider-diagrams, knowledge graphs capture the meaning of, and relationships between, items in diverse data sets.

"Knowledge graphs add context to the data you're analyzing," says Gaus. "For example, machine data can be analyzed in the context of design data, including the tasks the machine is made for, the temperatures it should operate at, the key thresholds built into the parts, and so forth. To this we could add the service history of similar machines, including faults, recalls and expected inspection outcomes throughout the machine's operational life. Knowledge graphs make it much easier to augment the machine data we use to train AI models, adding valuable contextual information."

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[1]   https://press.siemens.com/global/en/pressrelease/artificial-intelligence-simatic
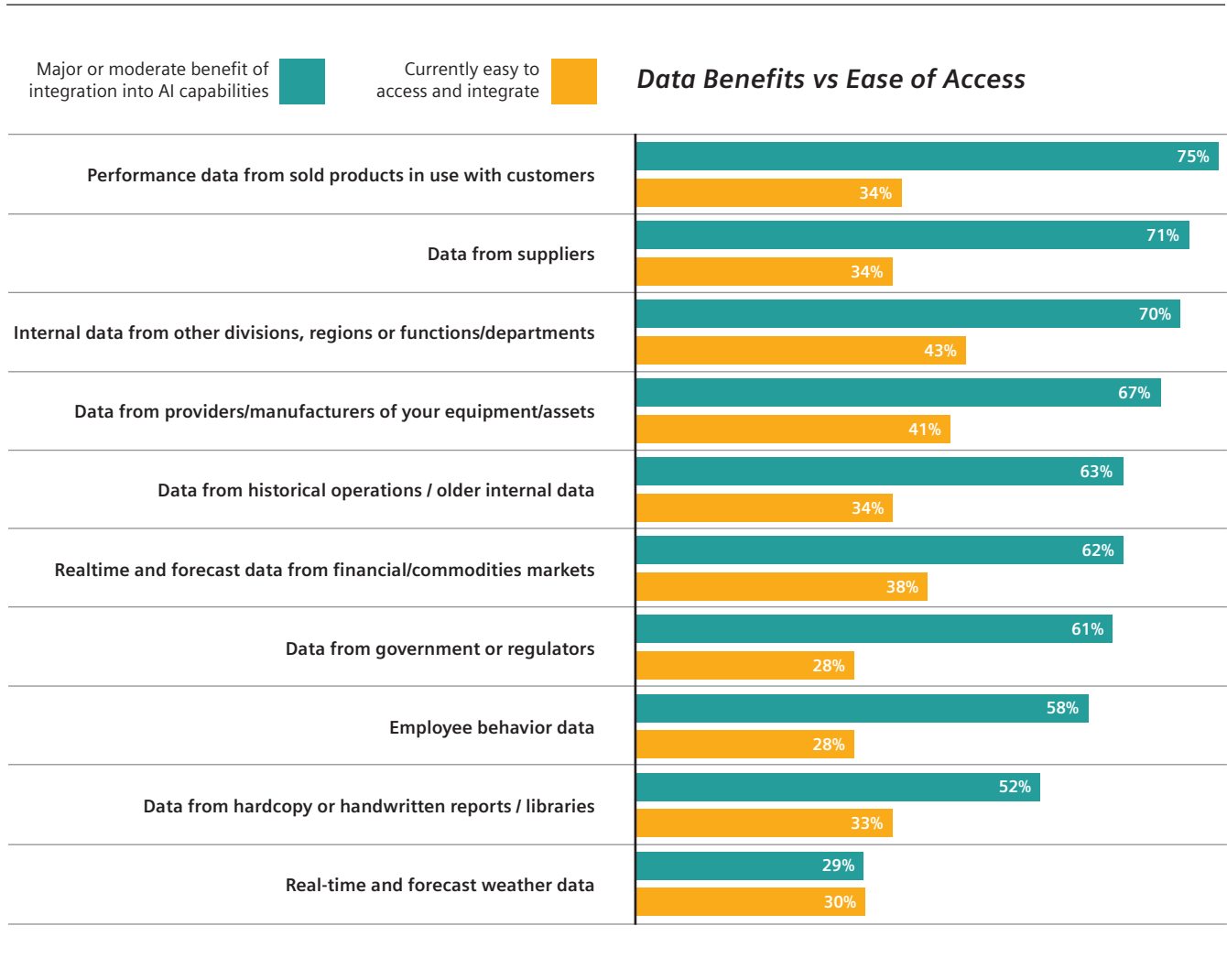
What kind of contextual data would be most useful? Performance data from sold products in use with customers (75%) came out on top in our survey, followed by data from suppliers (71%), internal data from other divisions, regions or departments (70%), and data from manufacturers of equipment or assets (67%).

AI is a powerful tool

A company that uses knowledge graphs to bring these kinds of data together would be able to train a single AI model with information about the life of previous products, operational inputs, variables, and dependencies. The AI model could identify valuable patterns and clusters in this diverse dataset, which could then drive better predictions, useful ideas, new efficiencies, and more powerful automation.

Even our respondents' top choice alone could be transformative for AI applications. Performance data from sold products can complete feedback loops that have historically been hard to close.

"This would help us understand, for example, whether something was poorly designed, whether something went wrong in the manufacturing process, or if customers are using the product in unforeseen conditions," says Gaus. "Perhaps the design makes manufacture complicated, which affects durability in certain conditions. Having these feedback loops automatically flow back from the whole product lifecycle could help us to isolate issues and improve products. For some organizations, this could be game-changing."

Major or moderate benefit of integration into AI capabilities ■	Currently easy to access and integrate ■

Data Benefits vs Ease of Access

Performance data from sold products in use with customers
- 75%
- 34%

Data from suppliers
- 71%
- 34%

Internal data from other divisions, regions or functions/departments
- 70%
- 43%

Data from providers/manufacturers of your equipment/assets
- 67%
- 41%

Data from historical operations / older internal data
- 63%
- 34%

Realtime and forecast data from financial/commodities markets
- 62%
- 38%

Data from government or regulators
- 61%
- 28%

Employee behavior data
- 58%
- 28%

Data from hardcopy or handwritten reports / libraries
- 52%
- 33%

Real-time and forecast weather data
- 29%
- 30%

AI and the big decisions: what would you do?

AI's advance, however, brings with it new challenges for industrial companies. One of the most interesting is how much confidence to have in the results, insights and decisions that are generated by AI – especially when the stakes are high.

To explore this, we asked the survey respondents to imagine that their organization had installed a brand-new AI model, called Maintain-AI, which had been trained on 20 years of performance data from the manufacturer of their machinery. We told them that Maintain-AI had recommended immediate lengthy, high-cost, disruptive refurbishment work on important machinery, but that their head of operations – with 20 years of industry experience – strongly disagrees. Having personally inspected the machinery, the head of operations says the work would be an unnecessary waste of time and money.

The 158 industrial company respondents considered this scenario, and a modest majority (58%) said that their organization would side with Maintain-AI, which suggests many are open to trusting in the results of AI-driven analysis.

It is important to point out, however, that we told respondents that Maintain-AI had outperformed the organization's best people in a year-long pilot prior to the refurbishment recommendation. With that in mind, the fact that a sizeable group (42%) still opted to go with the head of operations is more concerning: it indicates a potential bias against AI that could stop some companies from progressing.

Falling barriers, rising benefits

The relatively high proportion that opted not to trust AI in our hypothetical scenario could be attributed to industrial companies' top barriers to progress with AI. Cybersecurity risks and liability risks are both cited as major or moderate barriers by 80% of respondents. However, things may be about to change because both these barriers are expected to fall within the next three years – to 52% and 40% respectively.

Overall, our research shows that the industrial sector is positive about AI, with a clear majority (60%) reporting that their organizations are eager to use as much AI as possible. With barriers expected to fall as swiftly as benefits are expected to rise, we may be about to see the next generation of AI emerge as the star of Industry 4.0.
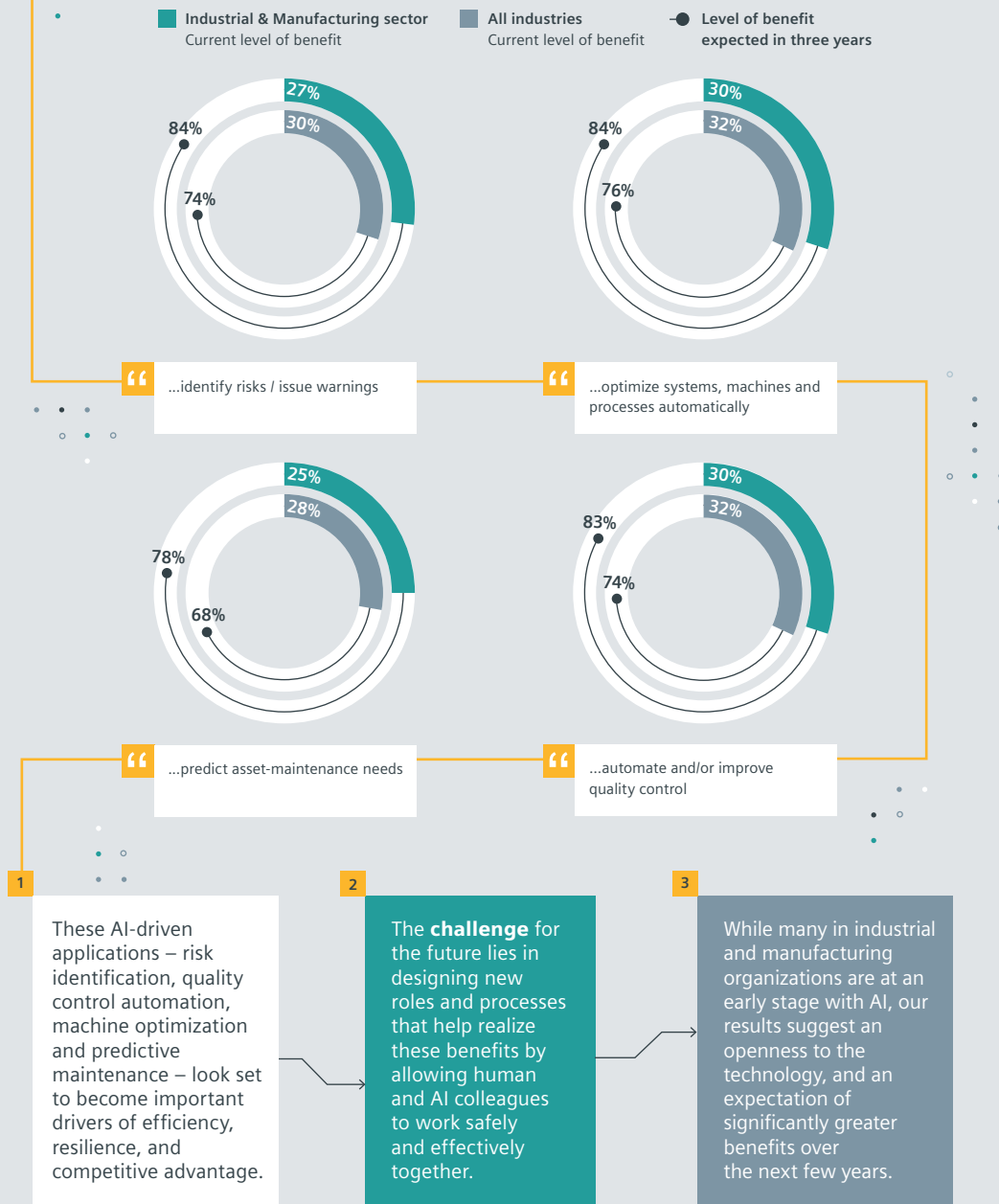
What is AI?

In this report, and the research that supports it, 'artificial intelligence' and 'AI' refer to a broad spectrum of methods or technologies that perform tasks which would normally require functions of human intelligence such as learning, judging, and problem-solving. This is more in keeping with the contemporary business understanding of AI than any technical or academic conventions.

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AI IN MANUFACTURING AND HEAVY INDUSTRY

Expectations of **future** benefits from AI-driven systems/applications that...

Industrial & Manufacturing sector
Current level of benefit

All industries
Current level of benefit

● Level of benefit expected in three years

27%
30%
84%
74%

...identify risks / issue warnings

30%
32%
84%
76%

...optimize systems, machines and processes automatically

25%
28%
78%
68%

...predict asset-maintenance needs

30%
32%
83%
74%

...automate and/or improve quality control

1
These AI-driven applications – risk identification, quality control automation, machine optimization and predictive maintenance – look set to become important drivers of efficiency, resilience, and competitive advantage.

2
The **challenge** for the future lies in designing new roles and processes that help realize these benefits by allowing human and AI colleagues to work safely and effectively together.

3
While many in industrial and manufacturing organizations are at an early stage with AI, our results suggest an openness to the technology, and an expectation of significantly greater benefits over the next few years.

ABOUT THE RESEARCH: Siemens and our research partner Longitude conducted primary research into the uses of, attitudes to, and outlooks for AI in industrial organizations. We surveyed 515 senior business leaders in the energy, industrial/manufacturing, urban infrastructure, and transportation sectors. Of the 158 industrial company respondents, 64.6% were from the manufacturing sector (e.g. engineering, electronics, automotive, food/beverage, apparel, aerospace); 28.5% were from heavy industry (e.g. metals, chemicals, textiles, paper); 5.7% were from pharmaceuticals and life sciences; and the remaining 1.2% were from agriculture and mining. In order to qualify for the survey, respondents needed to be responsible for, involved in, or knowledgeable about their organization's existing or planned use of AI and related technologies, strategies, budgets, and applications. The research included respondents from North America, Latin America, Europe, the Middle East and Africa, and Asia-Pacific and was concluded in September 2019. All respondents were from organizations with an annual revenue of at least $100 million.