MHP
A PORSCHE COMPANY

STUDY

INDUSTRY 4.0 BAROMETER 2024

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Foreword

Dear readers,

In the face of current global affairs, we must take proactive and decisive action. After all, the challenges before us are complex in nature. Among other things, the past year has been shaped by geopolitical tension. As a result, industrialized nations are striving more than ever for economic independence, which is in turn fueling the war for talents. To tackle this new, strained situation, businesses require innovative, pioneering solutions. Now, more than ever, executives are being forced to make decisions that could have ramifications for years to come.

Digitalization is crucial for both the development of innovations and a business's ability to remain competitive. In what is already our sixth issue of the MHP Industry 4.0 Barometer, we're going to be looking at how matters relating to digitalization have progressed in the industrial sector.

Artificial Intelligence (AI) has garnered much attention in both the media and wider society of late, not least due to the ChatGPT app. This topic is also becoming increasingly important for our customers in the production sector. As such, we have decided to make Artificial Intelligence our main focus for this year's Industry 4.0 Barometer. As the examples below show, integrating established AI solutions into their operations, will allow businesses to access a wide range of optimization opportunities. AI data will enable businesses to conduct efficient analyses, identify complex patterns and generate more accurate forecasts, so they can make (semi-)automated decisions based on the data available. Intelligent analyses can use existing sensor data to automatically check quality criteria. AI-based smart production management offers the ability to reduce lead times, increase planning stability and make processes more efficient overall. This means AI-assisted solutions can help to boost both quality and efficiency. With the aid of machine learning and advanced algorithms, AI-controlled machines can analyze and interpret tasks independently. This enables businesses to reduce the workload repetitive tasks place on their skilled workers, and offer them support when carrying out complex activities.

In order to ensure that businesses can benefit from the integration of AI solutions in the future, they will need a clear vision, innovative minds, a willingness to take risks, and all the necessary resources – which they can generate either themselves or with the aid of an experienced partner, like MHP.

Before I leave your to read on in peace, I'd just like to thank Professor Dr. Johann Kranz of LMU München University, with whom we collaborated for the sixth time to produce this issue of Industry 4.0 Barometer. My special thanks also go to the 856 experts, interviewees and people who answered surveys as part of our study. Together, we strive for pioneering solutions that offer a resistant response to crises and a better, digital future. That is, and remains, our purpose: Enabling You To Shape A Better Tomorrow.

I wish you all the best for 2024.

Yours,

Markus Wambach
COO and Member of the Board of Management
MHP Management- und IT-Beratung GmbH

Summary

The Industry 4.0 Barometer 2024 provides a comprehensive overview of the current status of Industry 4.0 in various different sectors as of 2023. It has been compiled based on surveys and interviews conducted with businesses in Germany, Austria, Switzerland, the United Kingdom, the USA, and China, which asked questions regarding their initiatives and progress in the digitalization process. The questions focused on the topic of Industrial AI.

2023 presented businesses with a number of global challenges, including international tensions, price rises, the ongoing climate change, the skilled labor shortage coming to a head, and the aftermath of the COVID-19 pandemic. As a result, businesses found themselves in an ongoing dilemma, caught between the guarantee of economic security and the resulting pressure to keep outgoings to a minimum on the one hand and, on the other, the need to invest in digitalization in order to keep pace with the competition.

The Industry 4.0 Barometer 2024's findings show that, in spite of the difficult circumstances, businesses have managed to make progress in terms of their Industry 4.0 development. In fact, the speed of digital progress has clearly increased further compared to the previous year – the implementation of automation, the integration of autonomous systems and the introduction of digital twins have all picked up pace, for example. Particularly noteworthy are the high Barometer results relating to data analysis capabilities, which is likely a

result of the hype around Artificial Intelligence (AI). This progress provides cause for optimism, as it will lay the foundations for long-term success in the integration of Industrial AI. Most businesses are only at the beginning of this journey, and still some way from capitalizing on the full potential of Artificial Intelligence in production processes. Many businesses are at least putting their first use cases into practice, in fields such as visual quality assurance.

However, a closer look at the results shows that rates of progress and implementation for both Industry 4.0 technologies and Industrial AI vary greatly from one region to the next. Overall, China and the USA are the clear frontrunners when it comes to establishing digital twins, incorporating location technology into supply chains, and using autonomous systems. China has now significantly pulled ahead of the other regions – including the USA – in terms of its integration of Industrial AI. Businesses in Europe (Germany, Austria, Switzerland and the UK) are also showing progress; however, they are lagging behind the USA, and especially China, in the use of both Industry 4.0 technologies and Industrial AI.

Historically established system landscapes and a lack of technological maturity hinder the introduction of Industry 4.0 technologies and Industrial AI. However, the trend shows that these obstacles are starting to fall away, so there remains how that businesses will overcome these challenges eventually.

The shortage of skilled labor presents a more persistent obstruction. In particular, there is a lack of qualified workers who possess the skills required to identify and integrate the opportunities AI offers in a business context, and to implement the technology in a profitable way. Yet at the same time, Industrial AI in particular has the potential to assuage the labor shortage to some extent, as AI-based solutions could be used to handle and automate less complex, repetitive and time-consuming tasks.

Despite differences between the regions in terms of the spread of Industry 4.0 and Industrial AI, the global progress provides reason to be confident. As such, it is crucial for businesses in Germany, Austria, Switzerland and the UK continue to actively work to keep pace with the international competition. Investments in basic and advanced training initiatives, the promotion of partnerships with outside AI experts, and intelligent investments in scalable IT infrastructures don't just provide a basis for the efficient use of Industrial AI – they also help to shape a promising future for digitalization.

Key results
General

The expansion of Industry 4.0 technologies is progressing apace:

Businesses have been progressing well in their use of Industry 4.0 technologies since 2022, especially in the field of automation. However, European businesses are lagging noticeably behind their global competitors.

Data as a USP – businesses are recognizing the true value of data:

High Barometer results for data analysis capabilities show that businesses have come to recognize how crucial data is in their future. It remains to be seen whether this recognition will lead to tangible strategic action or remain nothing more than an acknowledgement.

Chinas Great Firewall – obstacle or protective shield?

The study indicates that both internal and intercompany data access and exchange is seen as a significant obstacle in China. This raises the question of whether the restrictive data retention policy acts more as a barrier to innovation or a protective shield for sensitive business information.

The skilled labor shortage and the advanced training deficit – a risk for innovation?

Europe is suffering from a striking lack of qualified workers with knowledge of Industry 4.0 technologies. Businesses have stated that they are in significant need of external experts, yet investments in advanced training and relevant courses are insufficient. This raises the question of whether Europe is equipped to ensure its own future survival.

China and the USA – pioneers with a drive for experimentation:

The dynamic growth of China and the USA as the leading markets for Industry 4.0 is illustrative not only of these countries' economic ambitions, but also of their willingness to experiment in a way that sets them apart from other nations. European businesses tend to be less strategically nuanced, focusing to an excessive extent on economic feasibility and cost efficiency – possibly at the cost of potential for innovation.

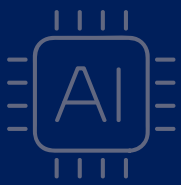
China shows highest use of AI – is this impressive progress driven by cultural acceptance or political support?

Chinese businesses are far ahead of their global competitors, using AI-based solutions in their production processes up to twice as frequently as the competition.

The progress of AI – an opportunity for European businesses, or a risk?

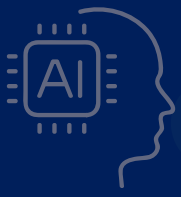
Businesses in Germany, Austria, Switzerland and the UK are lagging some way behind in their use of AI. It remains to be seen whether they can make up this ground over the next few years.

Barriers to AI – what stands in the way of progress?



The introduction of Artificial Intelligence in the production industry promises to boost efficiency, yet there are a number of obstacles that stand in the way of this progress: insufficient technological maturity, high costs up front, the lack of acceptance among users, and a widespread shortage of skilled labor.

Key results Industrial AI



Dependency on external resources for AI:
Around 70 percent of the businesses we surveyed use external AI experts to make up for their current shortfall in AI skills. An innovation-driven partnership between AI experts and company-specific knowledge will be required if the switch to AI is to be successful.

Industrial AI is a CIO matter:
The study shows that businesses that don't have a Chief Information Officer (CIO) on their Executive Board make slower progress in terms of digitalization and competitiveness – this is very important, especially in the era of Industry 4.0 and Industrial AI.

1.0

Introducing the Industry 4.0 Barometer 2024

Industry 4.0 continues to grow, and has already become a reality for many businesses. The Industry 4.0 Barometer collects information on what this reality looks like in different sectors and regions, how Industry 4.0 is regarded in each area, and the degree of maturity with which they use the various different Industry 4.0 technologies. It acts as a benchmark for the developmental status and use of different technologies and initiatives. As such, the Industry 4.0 Barometer provides inside into the gaps and areas of potential that currently exist in the Industry 4.0 context. In addition to this, it also shows how businesses can cover these gaps, utilize the potential and further extend their advantage over the competition.

1.1 Focus

In order to provide businesses with a well-founded overview of the relevant information, MHP has joined together with the Ludwig-Maximilians-Universität München (LMU) University for the sixth time to produce this Industry 4.0 Barometer. The results of this benchmark study outline the status quo of Industry 4.0 activities among businesses in the Germany, Austria and Switzerland region (DACH), the United Kingdom (UK), the United States of America (USA) and China.

Every year, the survey that acts as the basis for the study comprises four **topic clusters**:

1. **Technology:** Efficient use of Industry 4.0 technologies (supply chain transparency, digital twins, automation and autonomous systems)
2. **IT integration:** Increase in the performance of businesses' internal IT infrastructure (data analysis and IT security)
3. **Strategy and goals:** The strategic focus of Industry 4.0 activities
4. **Obstacles:** Factors with a negative impact on the implementation of Industry 4.0 technologies

In addition to the above, each study also incorporates current digitalization issues for the year in question. In 2024, Industrial AI was chosen as the main focus topic and investigated in more detail. For the purposes of this study, Industrial AI is defined as follows:

The term **"Industrial AI"** refers to the development and use in production processes of systems designed to carry out tasks that would normally be performed by human intelligence, such as learning, problem-solving and decision-making. Industrial AI uses algorithms and data to enable machines to perform human cognitive functions and adapt to new information.

1.2 Evaluation method

Five and seven-stage Likert scales were used to gather responses to the survey questions. In order to ensure clear evaluation results, the participants' responses were clustered. In addition to the distribution of the responses, the weighted mathematical average converted into a percentage, which was then used as the Barometer result in the study. Furthermore, for questions on prioritization, the participants were asked to distribute 100 points across the various response options to a statement. For calculation purposes, the five/seven-stage Likert scales were transformed into metric scales with the values 0 to 5 or 0 to 7. The metric scale values were multiplied by the respective frequencies as per the participants' question responses. After this, the weighted mathematical average was divided by 5 or 7, depending on the scale used, in order to produce a Barometer result of between 0 and 100 percent. Since the Industry 4.0 Barometer is a periodic survey, this Barometer result acts as a benchmark. In addition to this, the results were also compared against various characteristics of the participants and the businesses they represented. Responses were collected and evaluated anonymously.

1.3 Interviews and success stories

In addition to evaluating the results of the survey, the Industry 4.0 Barometer also contains interviews with industry experts and MHP success stories on the use of Industry 4.0 technologies in practice – this year, like the survey itself, including pieces from the DACH region and the UK. In addition to questions on our main focus topic, Industrial AI, the interviewees were asked for their personal assessments of the industry's current developmental status in terms of the digital transformation, and also of use cases and digitalization initiatives within their own organizations.

We conducted interviews with the following experts:

- **Julian Follner**, "Ideas Train" Project Manager (Deutsche Bahn AG)
- **Daniel Abbou**, Managing Director (German AI Association)
- **Dr. Andy Moore**, Chief Data Officer (Bentley Motors Ltd.)
- **Bernhard Winkler**, Vice President Production Rail (Knorr-Bremse Rail Vehicle Systems)

The MHP success stories present successful use cases of Industry 4.0 technologies. This year, the concrete use of AI solutions is our focus for this part of the study. In addition to outlining the initial challenges faced by the business in question, the success stories also explain how the business went about implementing its chosen solution and provide details of the key results. The MHP success story paint_it presents a smart solution created by MHP that is already being put into use by German automotive manufacturers. paint_it provides the basis for an AI-assisted quality check in the paint shop that will reduce costs and boost the efficiency of painting processes. The MHP success story Sounce presents an AI solution that uses noises to recognize and interpret acoustic patterns. Porsche AG is already using this solution in its R&D department to aid with quality checks for chassis bearings. Our final success story is DriveRadar®, by drive manufacturer SEW-EURODRIVE. This tool uses machine learning to detect anomalies in drive and automation solutions.

1.4 Participants

The results of the Industry 4.0 Barometer 2024 are based on the responses of 856 participants from German-speaking regions (Germany, Austria and Switzerland, 203 participants), the United Kingdom (UK, 201 participants), the USA (204 participants) and China (248 participants) (Figure 1).

Fig. 1: Distribution of participants by region
n = 856

The businesses that participated in the survey were heterogeneous in terms of their size. 55 percent of the participants represented small to medium-sized enterprises (SMEs) with fewer than 1,000 employees, 26 percent represented businesses with 1,000 to 9,999 employees, and 17 percent represented businesses with more than 9,999 employees (Figure 2).

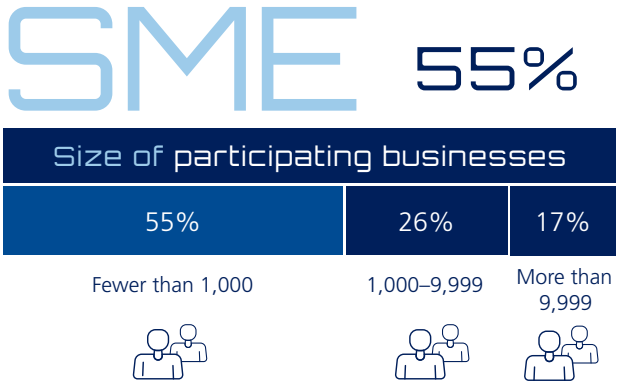


Fig. 2: Distribution of participants by size of business
n = 856

The participants were selected from all levels of company hierarchy, from the operative basis to Board level. 79 percent of the participants can be classified as working at the third level below the Executive Board or lower.

The sector with the strongest representation was information and communications technology (13 percent), followed by the automotive industry (11 percent, OEMs and suppliers), traffic and transport (11 percent) and mechanical engineering (10 percent) (Figure 3).

The departments with the strongest representation were IT (20 percent) and Production (16 percent) (Figure 4). This aligns with the focal points of the Industry 4.0 Barometer.

Fig. 3: Distribution of participants by sector
n = 856

Fig. 4: Distribution of participants by department
n = 856

2.0

Results of the study

2.1 Status quo of Industry 4.0

Technological innovations play a large role in shaping the dynamic of the global economy, and in the age of digitalization, Industry 4.0 heralds a new era of smart production. This extensive paradigm shift in the industrial sector combines progressive technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), big data, and cloud computing to increase aspects such as efficiency, flexibility and quality in production. In this context, Industry 4.0 has grown to become a global trend in which more and more businesses are starting to participate. After all, in an era of crises like the climate change, the shortage of skilled labor, geopolitical conflicts, inflation, and rising interest rates, businesses are finding that a greater degree of digitalization – and thus the successful use of Industry 4.0 – is a key factor in successfully overcoming the global challenges they face. Every company has their own methods and strategies for ensuring success against their global competition. The Industry 4.0 Barometer 2024 focuses on the DACH region (Germany, Austria and Switzerland), the UK, the USA and China – regions that are not only economic heavyweights, but are also pursuing different approaches and facing different challenges in terms of Industry 4.0. China and the USA are often seen as the pioneers when it comes to the innovative use and implementation of Industry 4.0 technologies on a large scale. This assumption needs to be questioned and verified using the results of this study. The study takes a detailed look at the current status of Industry 4.0 in the aforementioned regions, analyzes the key initiatives and developments, and identifies the challenges and opportunities each of the individual regions will have to navigate on their path toward the digital future.

2.1.1 Results of the survey

Topic Cluster 1: Technology

Supply chain transparency

The ability to locate products and components precisely plays an important role in improving the efficiency and transparency in supply chains. Real-time goods tracking enables businesses to determine the exact location of the goods, optimize their delivery times, manage their stock more effectively, and respond more quickly to unexpected interruptions in their supply chains. As such, supply chain transparency is seen not just as an efficiency booster, but also as a strategic element that improves agility and resistance at every stage of the supply chain. Realizing this, businesses have started to invest more heavily in improving the transparency of their supply chains.

54 percent of the participants stated that, at their business, they were at least partly able to locate both individual parts and end products. This is a significant improvement on the previous year's figure of 12 percentage points. This trend is also reflected in the Barometer result, which has hit 60 percent in this year's survey compared to 43 percent (2022) and 49 percent (2023) over the past two years. As such, location tracking technology produced the highest average of all the technologies included in the survey. Sensors for recording and transmitting environmental parameters and status data have also seen an average increase of 18 percent per year since 2022 (Figure 5).

When comparing individual regions, it becomes clear that the use of location tracking technologies is much more widespread in China and the USA than in Europe. In China, 66 percent of participants stated that they could partially or fully track the location of their individual parts and products, with 64 percent in the USA saying the same. By comparison, only 47 percent of UK participants said the same thing, while the number in the DACH region was a mere 36 percent. Furthermore, only two percent of the businesses surveyed in China neither used nor were planning to use location tracking technology at all. In the DACH region, this figure was 30 percent (Figure 6).

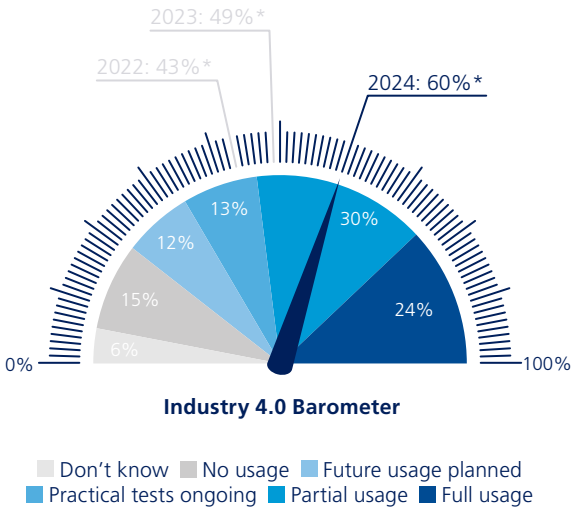
Digital twins

The fact that businesses are prepared to invest more heavily in the digitalization of their supply chains can also be seen from their use of digital twins for simulation, management and optimization purposes. The use of this technology in Logistics departments is becoming more commonplace. Since 2022, the implementation level for digital twins has risen by an average of 32 percent per year – the largest improvement in any of the technologies included in the study in this time period (Figure 7).

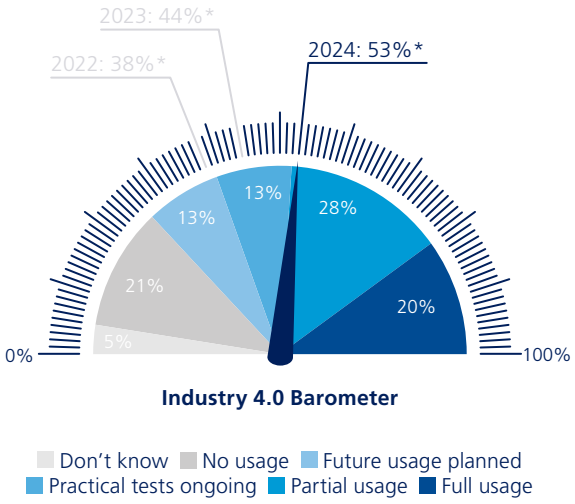
In China, 39 percent of participants stated that their Logistics departments made full use of digital twins.

Supply chain transparency

At my business, we can track the location of all of the individual parts for our products, and also that of all our end products, at every stage of the value chain.



Our systems and plants in our Production, Warehouse and Logistics departments are equipped with sensors to record and transmit environmental parameters and status data.



*Barometer result: Weighted mathematical average as a percentage

Fig. 5: Technological equipment levels at every stage of the value chain

At my business, we can track the location of all of the individual parts for our products, and also that of all our end products, at every stage of the value chain.

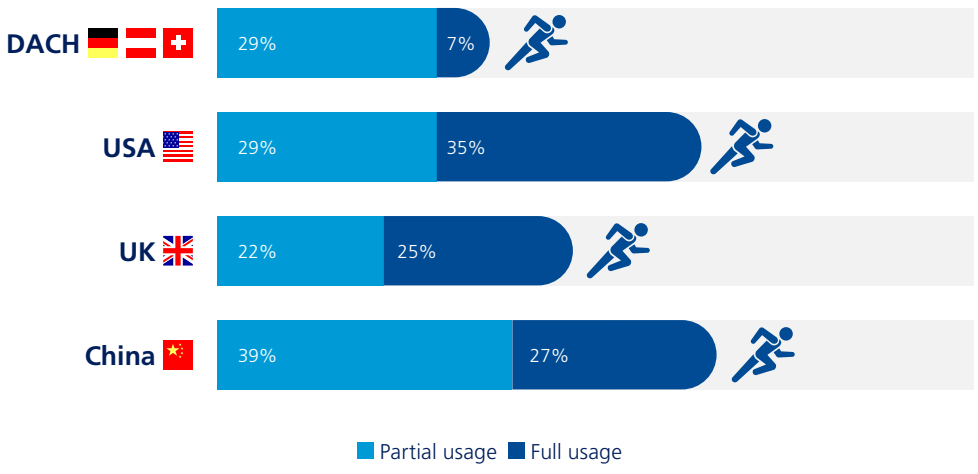
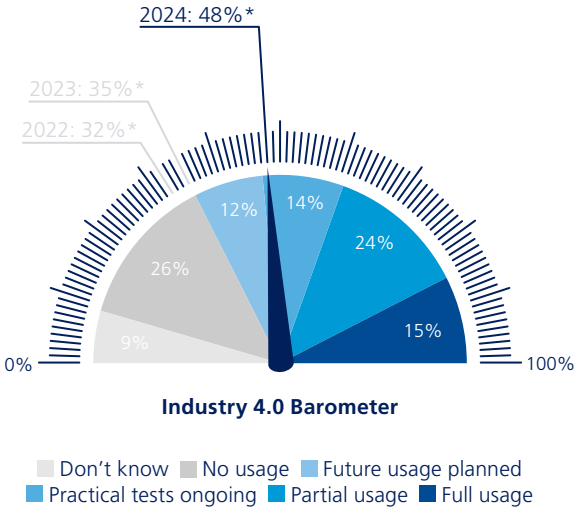


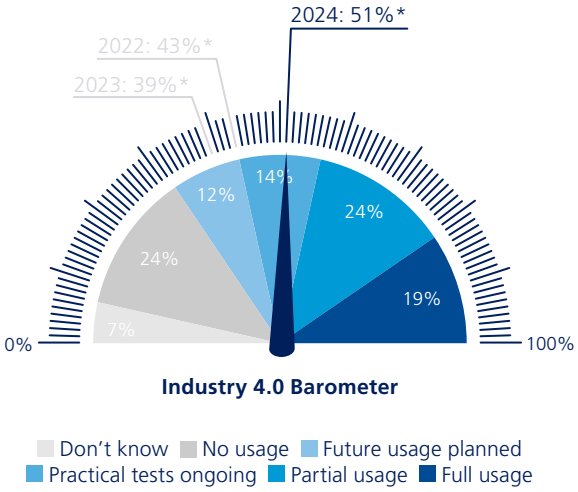
Fig. 6: Supply chain transparency by region

At my business, we use digital twins of the following aspects to map process and status data for simulation, management and optimization purposes:

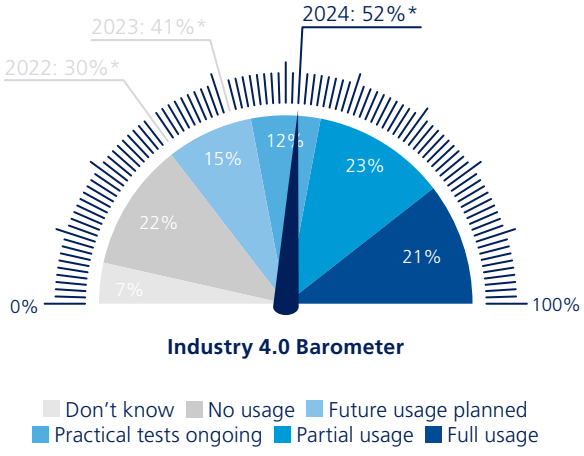
Our production facilities (e.g. factories, machines, vehicles).



Our products.



Our entire Logistics operations (incoming and outgoing goods).



*Barometer result: Weighted mathematical average as a percentage

Fig. 7: Distribution of digital twins

21 percent of participants in the USA said the same thing, but only 13 percent of those in the UK and just 5 percent of those in the DACH region (Figure 8). As such, this is another area where businesses in China are a clear distance ahead of the rest of the world.

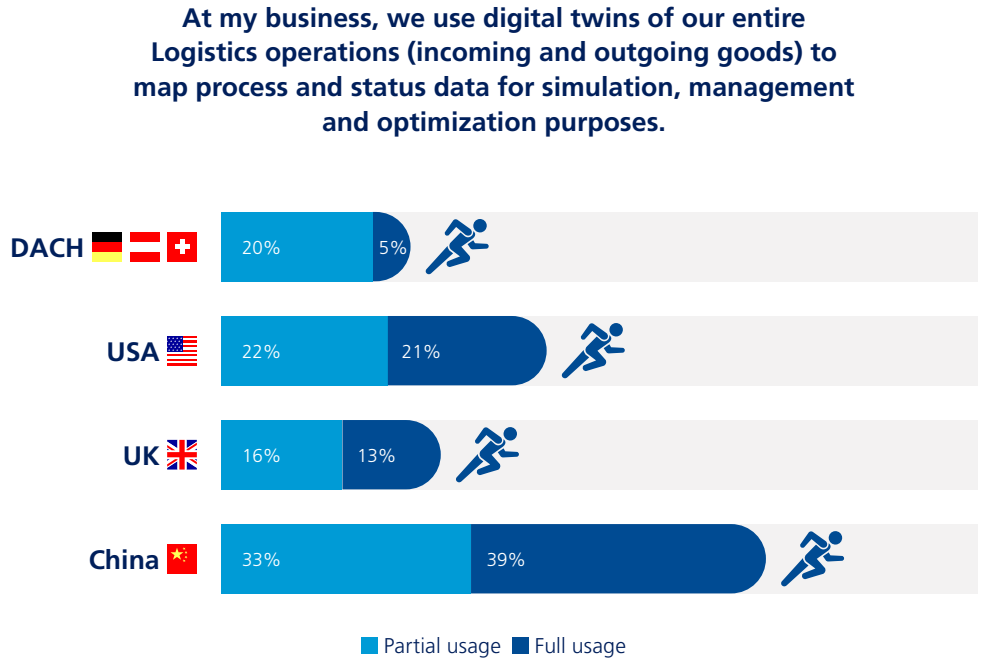
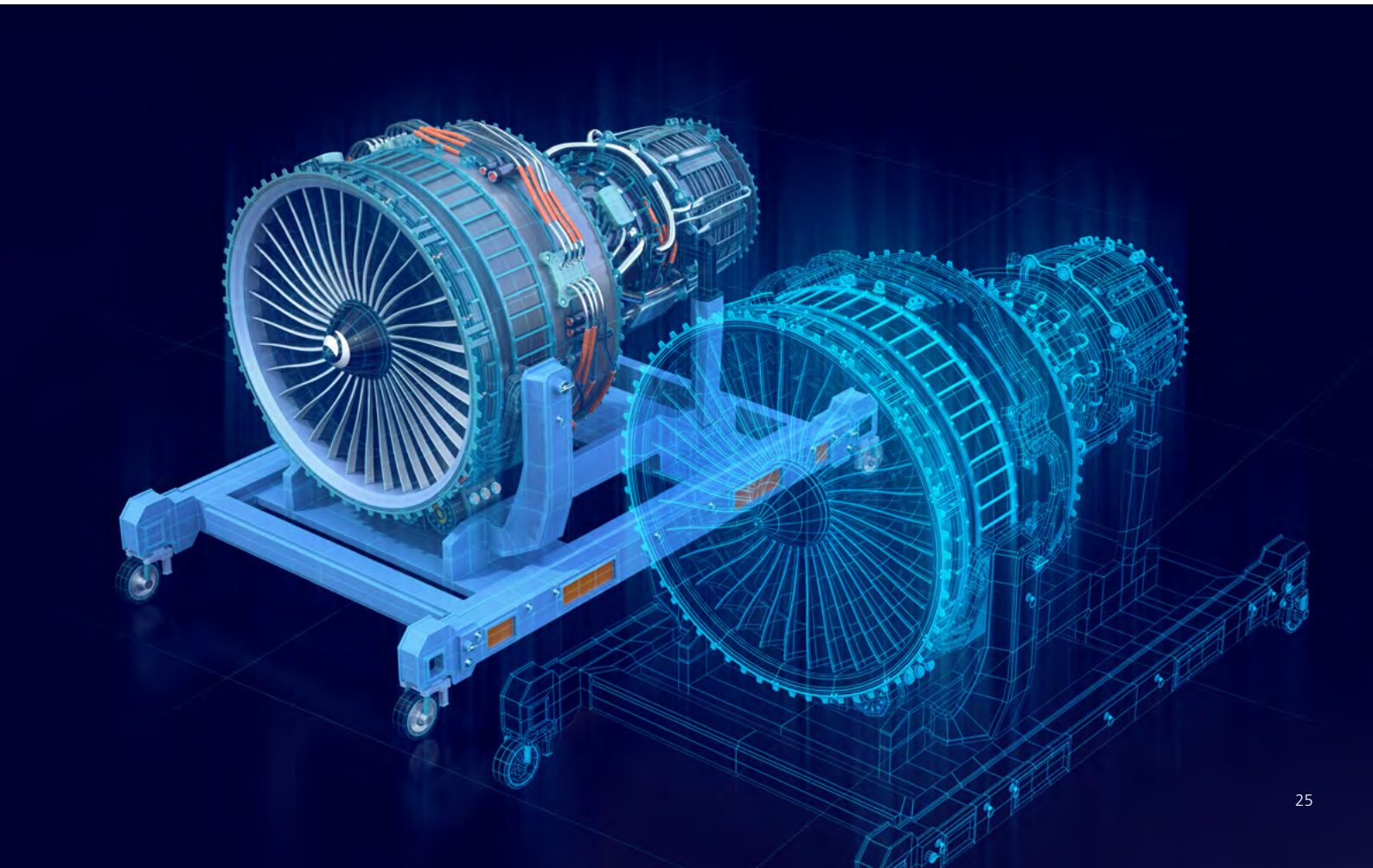


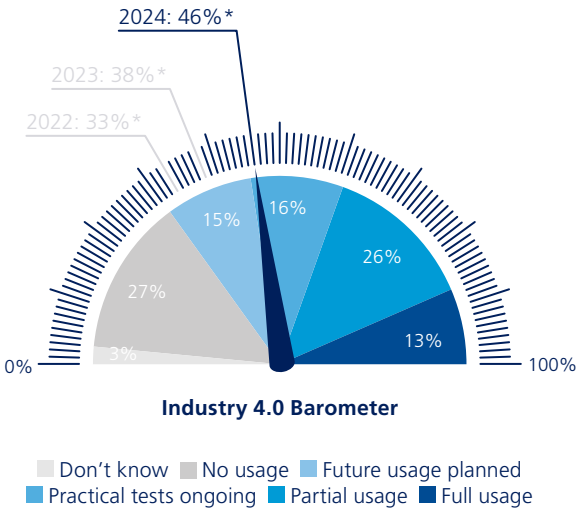
Fig. 8: Distribution of digital twin use by region



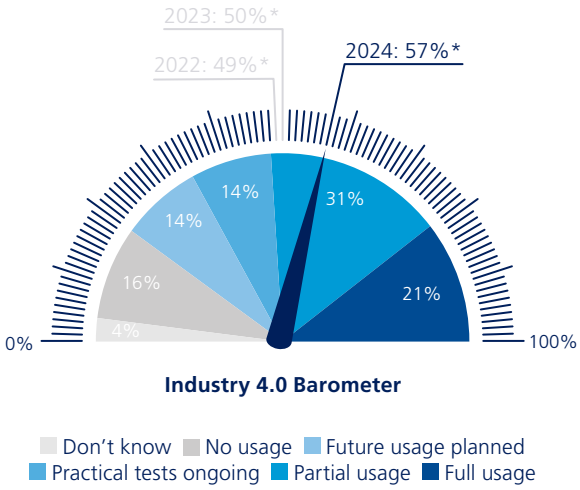
Automation and autonomous systems

Compared to digitalization of the supply chain and the use of digital twins, the use of automation and autonomous systems recorded a lower Barometer result of just 46 percent. However, there has still been huge improvement in this area compared to previous years: Since 2022, the average Barometer result has risen by 18 percent per year (Figure 9).

We use machines and robots that can act autonomously and independently manage and improve themselves.



Our systems, plants and devices exchange data automatically, independently and in real time (machine-to-machine communication).



*Barometer result: Weighted mathematical average as a percentage

Fig. 9: Degree of maturity with regard to automation and autonomous systems

When asked about the use of machines and robots that act autonomously, and manage or improve themselves, 41 percent of participants from both the DACH region and the UK stated that such technologies were not used at their business. 28 percent of participants in the USA said the same. In China, however, only 2 percent of participants agreed with the above statement. The participants supplied similar responses when asked about systems and plants that exchange information autonomously and independently (Figure 10). Once more, China is the frontrunner in this area.

The implementation of Industry 4.0 technologies clearly shows that participants from the USA and China are the leaders in all areas included in the "Technology" topic cluster, while the DACH region and the UK occupied the last two places in all areas. These positions are the result of a number of different factors. One of these is political measures: For example, the Chinese government's strategic support acts as a driver for innovation, especially for the industrial sector. In turn, this boosts Chinese businesses' technological maturity and ability to compete. Legislation in the USA provides a liberal framework, giving businesses plenty of space for technological progress, especially in the field of AI. One example of this can be seen in the market volumes for generative AI, where the USA is the market leader ahead of China and will remain so in the medium term.[1]

Because the use of Industry 4.0 technologies is already widespread and has proven successful as a result of these conditions, businesses in these countries are also more willing to innovate and take risks while doing so. As the leading innovation markets, the USA and

[1] Generative AI – USA (statista.com)

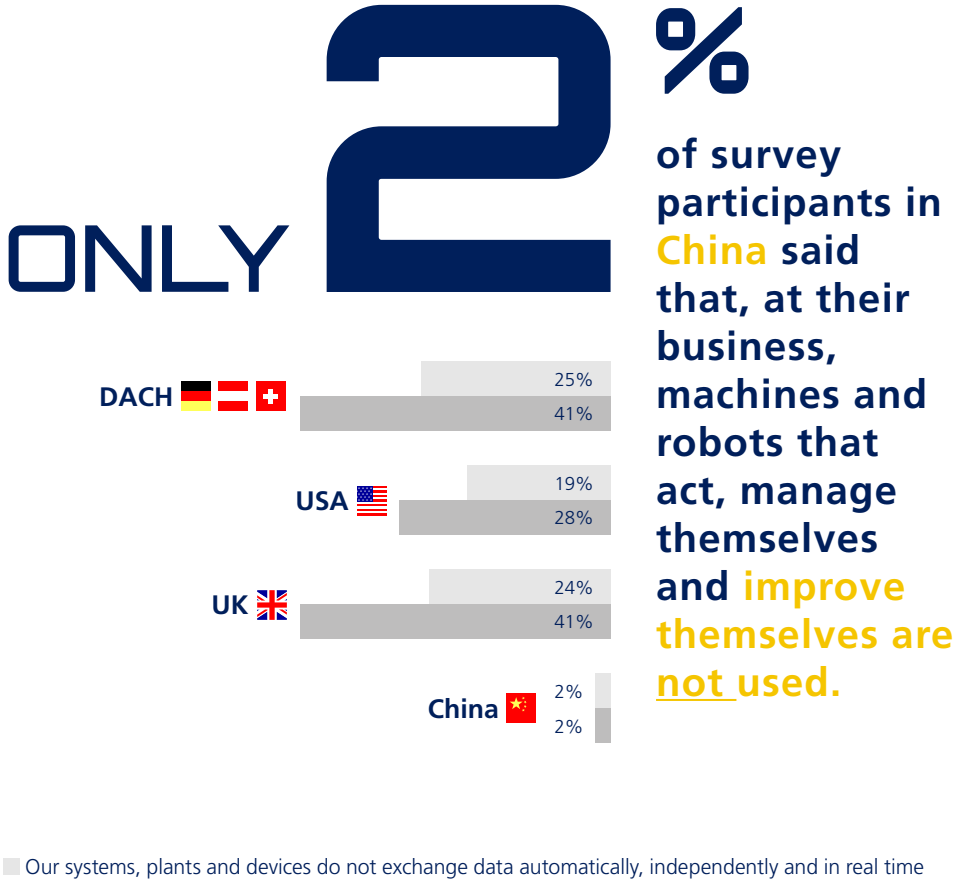


Fig. 10: Degree of maturity with regard to automation and autonomous systems by region

China are home to two major tech hubs, Silicon Valley and Shenzhen. Both these locations have a high density of start-ups and high-tech companies whose fervor for experimentation and fast market launches for new technologies is a driving force for digitalization in these areas.

Differences in innovation culture also work in favor of the development of Industry 4.0 technologies. Participative management methods are widespread in Europe, whereas management in China is shaped by the collective. In China, employee management is based on a breakdown of the goals for the planned economy. In order to create an effective culture of innovation, intensive exchanges of information and support for the best ideas are essential. After all, the effects of an innovation strategic can only be seen once it has been implemented. Thanks to its culture of innovation, the Chinese collective enjoys high user acceptance with regard to new technologies. At the same time this model also boosts the specialist knowledge of its workers.[2]

Finally, the leapfrogging phenomenon could come into play here. Due to the booming economic growth and the resulting construction of countless new production facilities, businesses in China are able to optimize the design and construction of their new plants from the ground up. In other regions, where the production facilities already exist, legacy systems need to be either integrated or replaced. This can present a significant challenge, especially for companies in the DACH region, as they may be unable to compete with the benefits their Chinese peers can offer in terms of price and quality, and are thus increasingly losing market shares to Chinese businesses as a result.

[2] Cf. Jörg Macht: China & Innovation. Was der deutsche Mittelstand von China lernen kann [What German SMEs can learn from China], FOM-Edition, Stuttgart, Germany: Springer, 2023, p. 72–73

Topic Cluster 2: IT integration

Data analysis capabilities

Data and data analysis capabilities are seen as a key factor in remaining successful in a business environment that is in a constant state of flux. This is because the right data and the ability to analyze it in the right ways enable businesses to increase their capacity for innovation, boost their efficiency and thus secure their unique selling point as an advantage over their competitors. With this in mind, an increasing number of businesses are starting to recognize the economic importance of data for their future.
In particular, the use of Artificial Intelligence that uses large quantities of data to train algorithms has generated a huge amount of hype, and led to a public discourse on the benefits and risks this technology poses. This debate is founded in the fact that, while generative and Industrial AI offer unfathomable potential, the increased use of these technologies also opens the door to a number of ethical, social and security concerns, such as how such systems will handle sensitive data (e.g. trade secrets, personal data, financial data). Furthermore, AI systems are also highly energy-intensive to train and run, as a result of which businesses are being encouraged to invest more in partnerships and ensure an increased level of modularization and compatibility on the side of the provider.

For these reasons, the data analysis capabilities of the businesses included in the survey have increased dramatically compared to previous years in all four surveyed areas (personnel skills, technological infrastructure, partially or fully automated production processes, and systematic data collection), and returned the highest Barometer results in this year's study. For example, the participants were asked to rate their businesses' data analysis capabilities with regard to production processes with partially and fully automated decision-making (e.g. through use of AI) compared to their direct competition. While the Barometer value for this area was just 36 percent in 2022 and 51 percent in 2023, it has risen to 62 percent in this year's study (Figure 12).

The central importance of data collection and processing – especially when it comes to the use of Artificial Intelligence – is explained in detail in our **main focus topic, Industrial AI**.

IT security

In the field of IT security, the situation is similar to in previous years. Generally speaking, IT security remains well-established at the businesses that took part in the survey. At the same time, the results show once again that the DACH region is lagging significantly behind the other regions, particularly in terms of the capabilities required to defend against cyber attacks: 66 percent of participants in the DACH region stated that their business possessed comprehensive and adequate capabilities to defend against cyber attacks. 75 percent of participants in the USA, 81 percent in the UK and 87 percent in China said the same thing (Figure 11).

Our business possesses comprehensive and adequate capabilities to defend against cyber attacks.

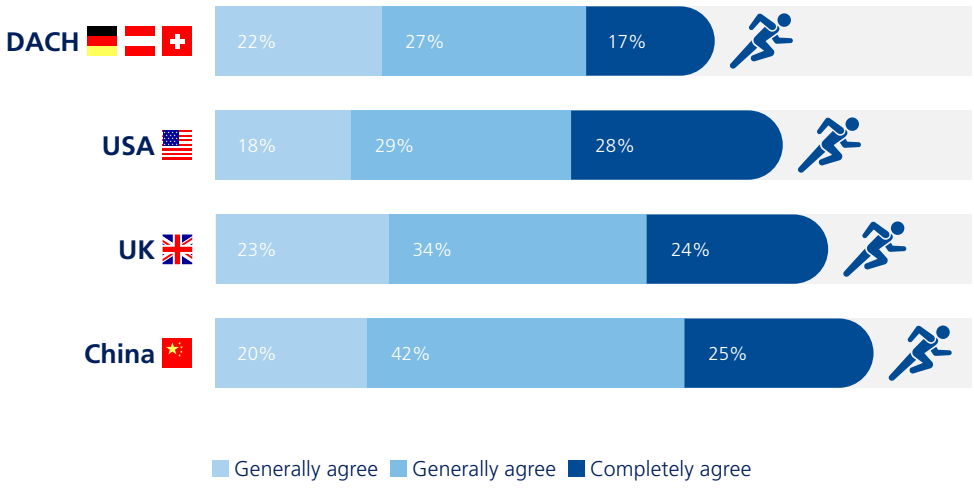
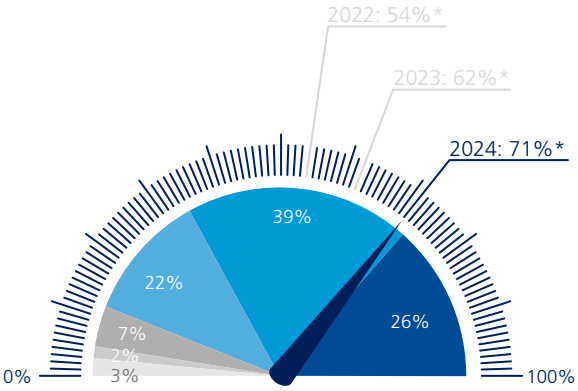


Fig. 11: IT security status

Data analysis capabilities

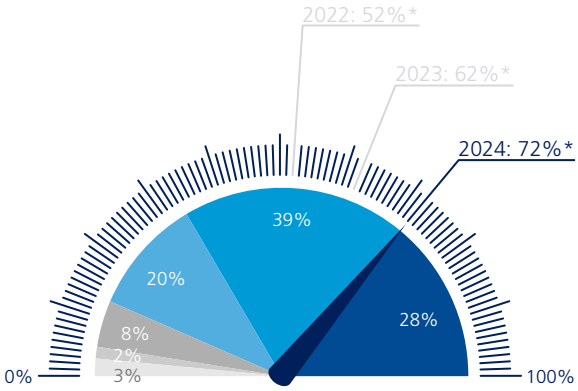
Please rate your business' data analysis capabilities compared to your direct competitors with regard to:

Personnel skills and abilities for advanced data analysis methods (e.g. data preparation, analytical algorithms, APIs).



Don't know Very bad Worse
About the same Better Very good

Technological infrastructure for advanced data analysis (e.g. company-wide data platform, analysis and visualization software, algorithm libraries).



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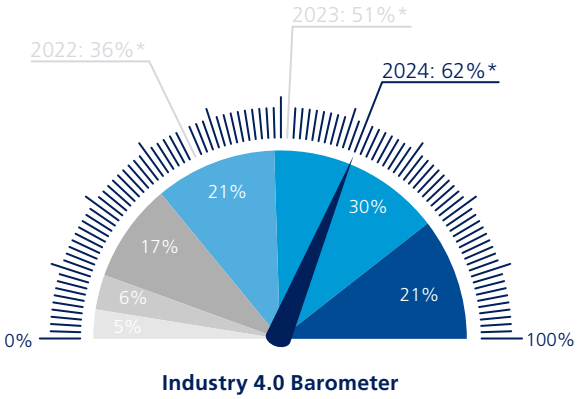
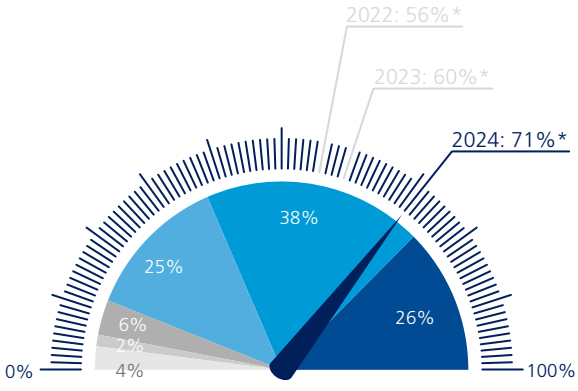
Production processes with partially and fully automated decision-making (e.g. Artificial Intelligence or machine learning).



Don't know Very bad Worse
About the same Better Very good

Systematic and continuous collection, preparation and analysis of data at every stage of the value chain.



Don't know Very bad Worse
About the same Better Very good

*Barometer result: Weighted mathematical average as a percentage

Fig. 12: Degree of maturity for data analysis capabilities

Topic Cluster 3: Strategy and goals

Unlike the other three topic clusters, the "Strategy and goals" cluster allowed the participants to rate the strategic focus of their business by allocating 100 points across five possible responses. As in the previous year, increasing economic efficiency was the most important goal for the businesses, with an average points allocation of 32, followed by increasing production/ product quality, which was allocated an average of 22 points (Figure 13). Interestingly, the focal points varied depending on the industry and region in question. The focus on economic efficiency was much stronger among businesses in the automotive industry than those in other sectors, with a deviation of 13 percent. On the other hand, participants in the automotive industry rated tapping into new market and customer segments much lower, with a deviation of 21 percent. When comparing between different regions, it became clear that while chinese businesses made increasing economic efficiency their main focus, they also placed much more importance than other regions on tapping into new market and customer segments and adapting their production flexibility.

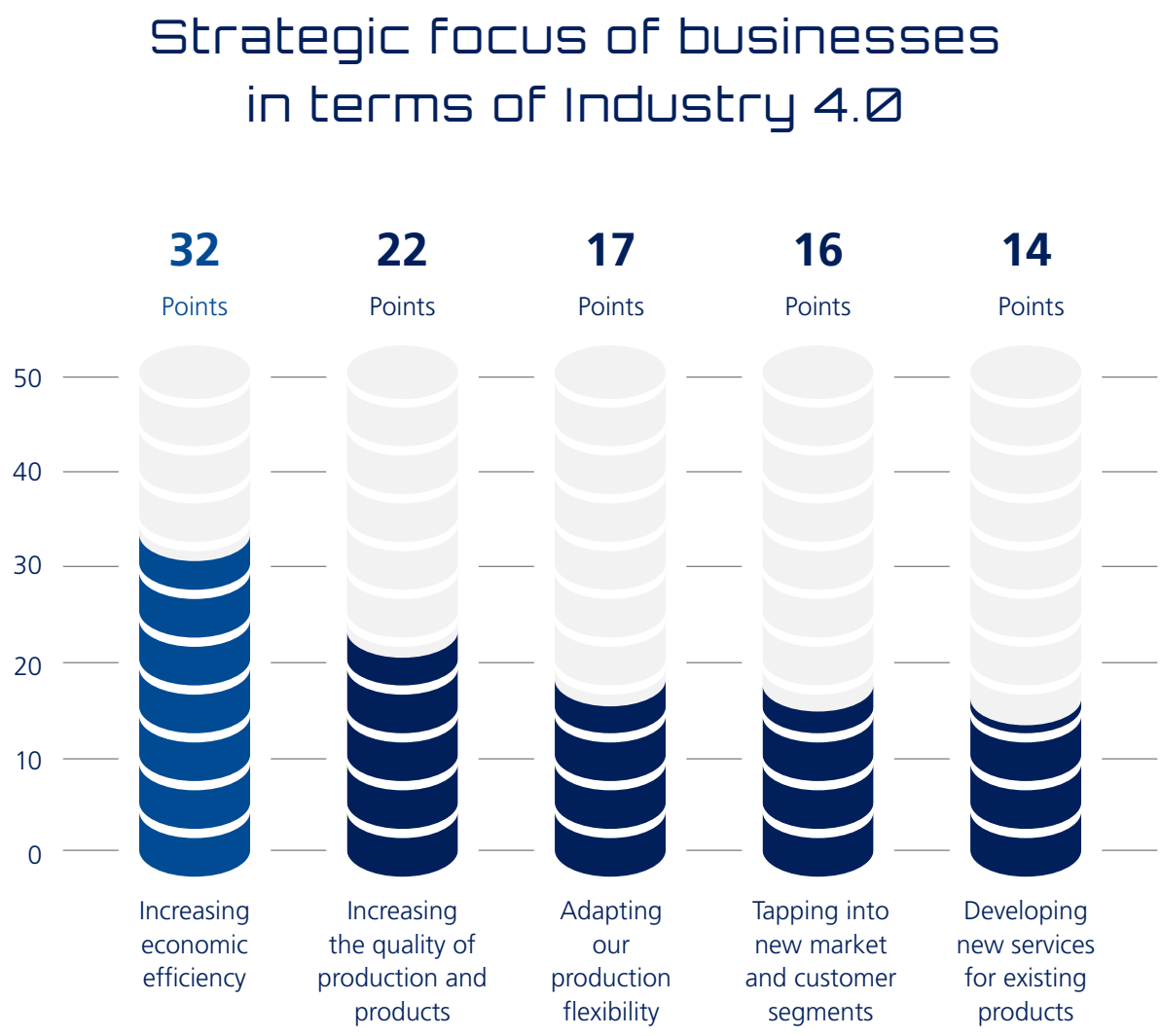


Fig. 13: Strategic focus of surveyed businesses in terms of Industry 4.0
(The participants were given the ability to assign a total of 100 points.
The results shown here are the averages for each possible response.)

Topic Cluster 4: Obstacles

As Industry 4.0 continues to make strides, employee qualification and expertise levels are both becoming increasingly important and forming an obstacle to progress. This is because specific, specialist knowledge is required in order to implement progressive Industry 4.0 technology and data analysis capabilities. As a result, these skills are in high demand among businesses and are becoming a factor in competition.

52 percent of the participants in the study named the shortage of skilled labor as the main reason for delays in the implementation of Industry 4.0 technologies. In a nutshell, while further automation reduces the need for skilled workers to carry out repetitive tasks, it also increases the need for qualified personnel in other areas, as these skills are needed to facilitate the introduction of Industry 4.0 technologies. At the same time, the speed at which Industry 4.0 technologies are being integrated could increase, which could lead to even greater qualification gaps.

The workload generated by day-to-day business and the resulting lack of resources was the second most common obstacle to be named by the participants, at 47 percent. 47 percent also listed established, legacy IT systems as a major obstacle. Uncertainty regarding ROI, which was the most common perceived obstacle last year after being named by 67 percent of participants, is now only seen as an obstacle by 43 percent of those included in the survey (Figure 14). This may be an indication that businesses are increasingly starting to recognize that the main challenge presented by these technologies is not their profitability, but rather the availability of qualified human resources.

Compared to the previous years, 2022 and 2023, all the obstacles named are on a downward trend in terms of their perceived relevance, indicating that businesses are slowly starting to overcome these challenges. This may be the result of improved employee qualifications, adjustments to the businesses' capacities, or a more reliable assessment of the ROI. It is important to ensure that employees have access to ongoing advanced training, since established job profiles are changing to keep pace with the latest developments in the industry as digitalization progresses. Another challenge facing businesses is the need to combine the company-specific knowledge of their own employees with the new technological skills the business requires.

When comparing between regions, it becomes evident that data exchange and data silos pose significant challenges for China regarding collaboration, both within businesses and with external partners. 57 percent of the Chinese businesses surveyed listed data silos as an obstacle, while only 35 percent in the DACH region, 33 percent in the UK and 28 percent in the USA did the same. The same applies to the problem of insufficient data exchange with external partners (see Figure 15). Here, the results show that the efforts being made in China to ensure an efficient exchange of data and promote collaboration may be being impeded by legal regulations, principles of data sovereignty, and technological hurdles. Strict data protection regulations, and particularly the Cybersecurity law[3], play a key role here. These laws set out strict rules for the handling of personal data, which makes data exchange more difficult. At the same time, China is placing more importance on data sovereignty, which means that data generated in China also needs to be stored and processed within the country's borders. This can lead to difficulties in terms of global data exchange and collaboration between Chinese businesses. Even with the high level of digitalization among Chinese businesses, there are still variations within the country in terms of the technological standards and platforms used. This may also be partly to blame for limiting collaboration and data exchange within the country. Time will tell whether this restrictive approach to data proves a barrier to innovation in China, or instead turns out to be a smart move in the battle for important company data on the global stage.

[3] Creemers, Rogier; Webster, Graham; Triolo, Paul, "Translation: Cybersecurity Law of the People's Republic of China (Effective June 1, 2017)" (2018). URL: https://digichina.stanford.edu/work/translation-cybersecurity-law-of-the-peoples-republic-of-china-effective-june-1-2017/ (02.02.2024)

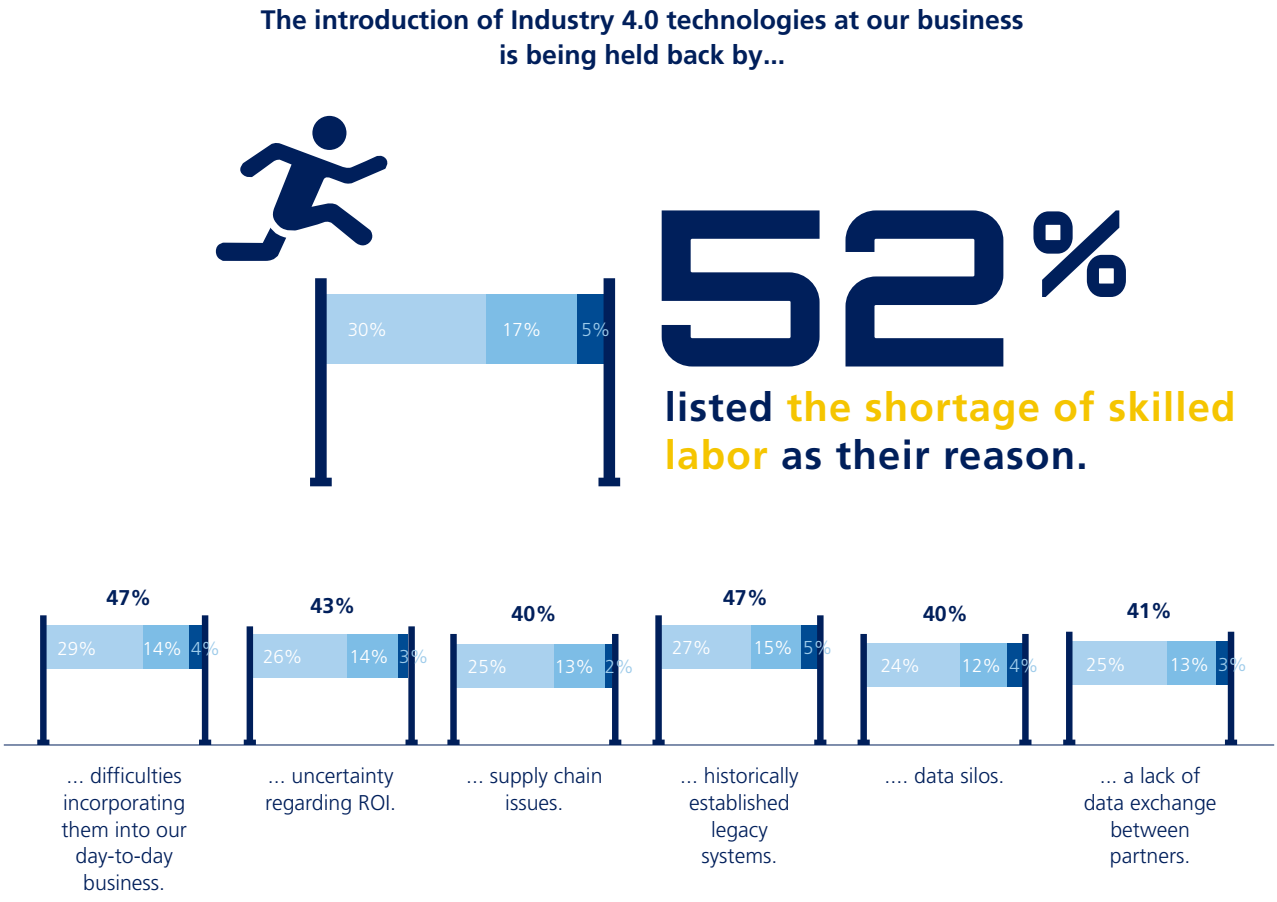


Fig. 14: Obstacles to the introduction of Industry 4.0 technologies

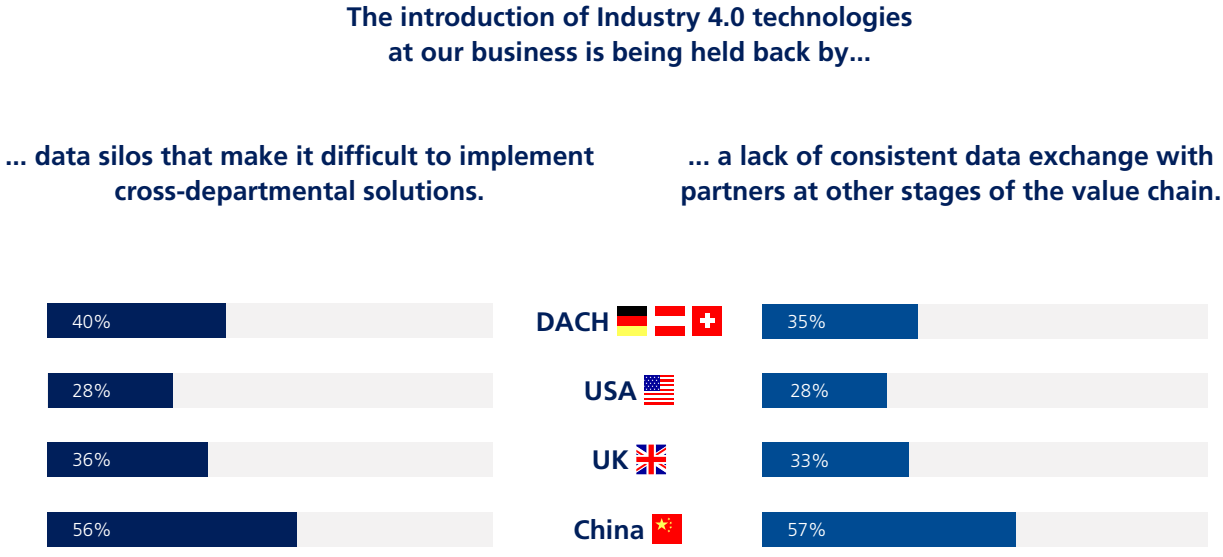


Fig. 15: Obstacles to the introduction of Industry 4.0 technologies by region

2.2 Industrial AI – Artificial Intelligence in production

Businesses are intensifying their efforts to make increased use of Artificial Intelligence (AI) as part of their digital and technological progress. Although the mathematical foundations for AI were laid in the mid-20th century, AI research as we know it today has only become possible thanks to the increasing availability of large quantities of data, increases in processing power and the progress made in the field of complex mathematical models and algorithms. As such, AI isn't actually a revolution – it is simply evolution. Nevertheless, the current accessibility of AI as good as represents a revolutionary step forward for many businesses. These businesses are increasingly starting to realize that AI technologies such as machine learning and neural networks are not just interesting in theory – they also offer untold potential for practical use. The integration of AI into production processes is causing a significant transformation in the way companies operate.

This development not only makes it possible to automate repetitive – and even complex – tasks; it also enables businesses to analyze large volumes of data quickly and recognize patterns with a high degree of precision. The resulting benefits can be felt along the entire value chain. Precise forecasts of demand allow businesses to improve their stock management and respond more flexibly to fluctuations in demand. This makes warehouse management more efficient and reduced storage and logistics costs. At the same time, AI also facilitates early identification of errors and defects, thus significantly reducing waste and scrap. As such, the implementation of AI leads to an increase in product quality, a reduction in production costs, and shorter lead times. AI facilitates a formidable boost in productivity, as it can be in use almost 24/7. This constant availability leads to significant increases in a business' automation levels and overall productivity.

In addition to the impressive potential it offers in terms of automating the value chain, AI also promises to bring changes to the landscape of work. By taking on human tasks, AI leads to fundamental alterations to job profiles. For instance, offloading repetitive tasks from human workers onto AI frees up skilled workers to focus more on the core activities associated with their role, thus boosting their individual productivity. Many companies that are struggling with the shortage of skilled labor are already noticing the potential AI offers as a means of storing knowledge, and thus compensating for the current shortage of skilled workers.

In order for businesses to effectively put all these potential benefits of Industrial AI into practical use, careful consideration and significant measures are required. Businesses need to identify the specifics of what they need and require from Industrial AI, while also carefully evaluating the opportunities and added value AI-based solutions have to offer. It is essential to take into account a whole range of aspects, including monetary, ethical, legal and social considerations. In addition to this, there are certain prerequisites that play a key role in the success of AI projects. These include the availability and quality of the data required and the qualification levels and acceptance of the business' employees with regard to new AI-based solutions. The following survey results will shed some light on how successful businesses have been in this integration process so far.

2.2.1 Results of the survey

Is the DACH region becoming the problem child of Industrial AI? In international comparisons, the DACH region is lagging particularly far behind in terms of successful use of AI in production. The UK is also behind the USA and China in almost every respect.

In order to provide a general overview on the use of Industrial AI, the participants were asked about the use of AI-based solutions in their production processes. 50 percent of the participants said that their business used Industrial AI in its production processes. In the DACH region, only 20 percent of those surveyed said that AI-based solutions were used in their businesses' production processes. The figure among UK participants was 29 percent. The use of AI-based solutions is much more widespread in the USA, where 46 percent of participants said it was used in production processes. Meanwhile, the situation in China is truly astounding: 94 percent of participants from the Asian country said that their business used AI in its production processes (Figure 16).

Does your business use AI-based solutions (e.g. predictive maintenance, detection of anomalies, autonomous robots) in its production processes?

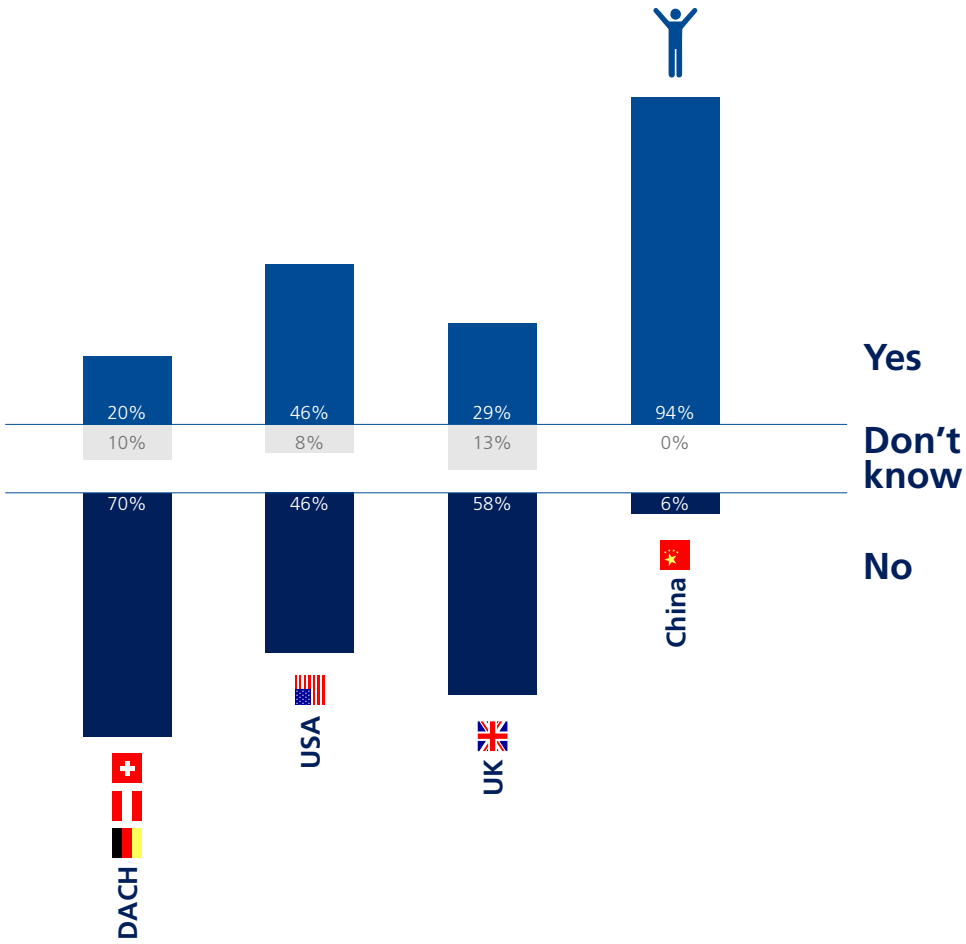


Fig. 16: Use of AI-based solutions by region

Next, the participants rated the success of the AI projects that had been implemented at their business in terms of on-time production, provision of the planned functionality and adherence to budget.

The participants in the DACH region and the UK indicated that their businesses' success in all three of these areas had been significantly lower than their peers in the UK and China. For example, only 26 percent of the participants from the DACH region and 34 percent of those from the UK were of the opinion that their business completed its AI projects on time. In China, on the other hand, 86 percent stated that they believed this to be the case. The other categories produced similar results. 89 percent confirmed that AI projects provided the functionality they had been designed for, and 82 stated that AI projects were completed within budget (Figure 17).

There were also relevant differences between the regions in terms of how the participants rated the maturity of their businesses' AI. While businesses in the DACH region and the UK posted average ratings (Stage 2) businesses in the USA believe they are on the way to establishing AI solutions (Stage 3). Chinese businesses went one step further, stating that their progress in establishing AI was already advanced, and that they were already starting to look at optimization (Stage 4) (Figure 18).

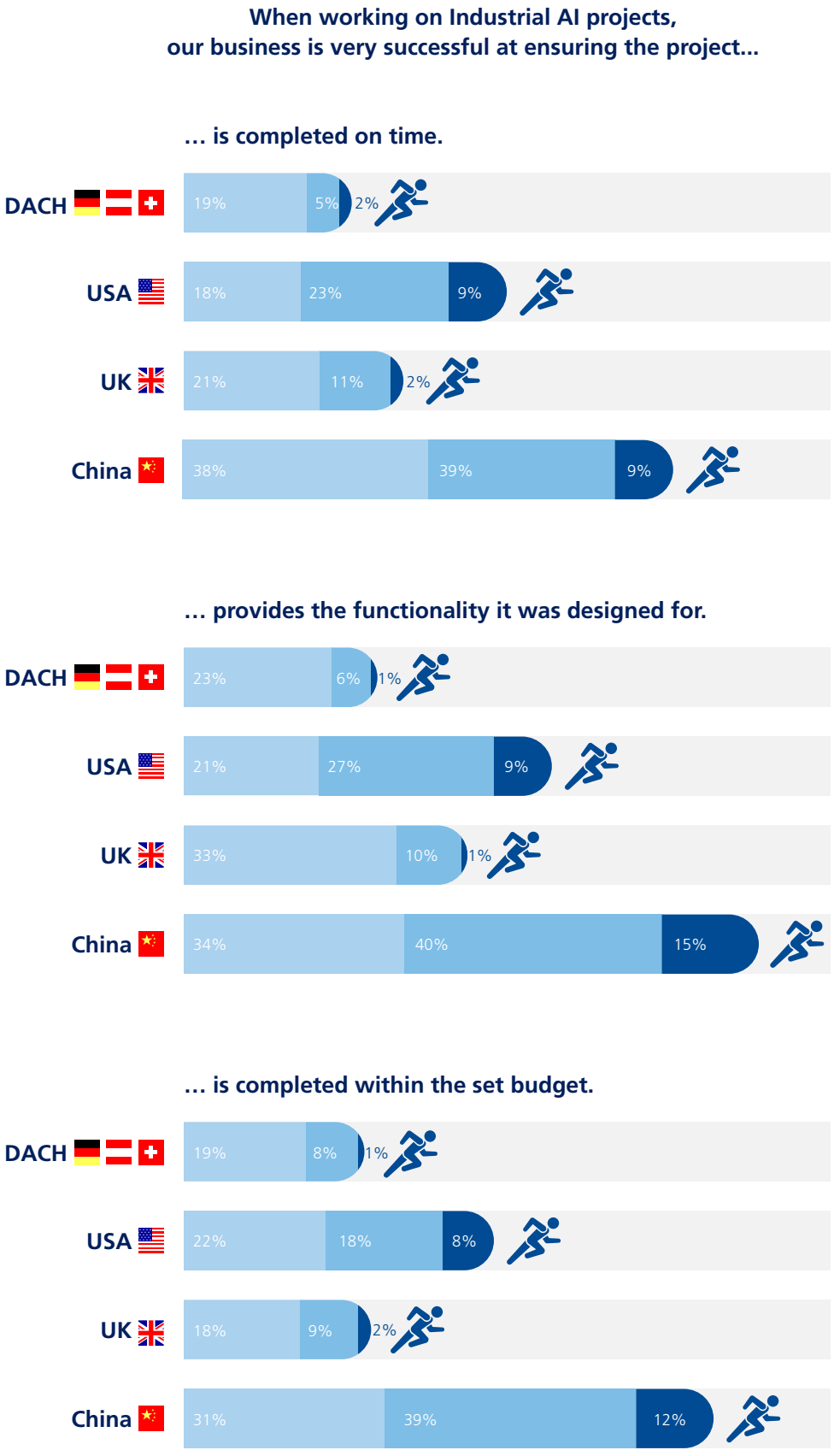


Fig. 17: Satisfaction with the use of AI projects by region

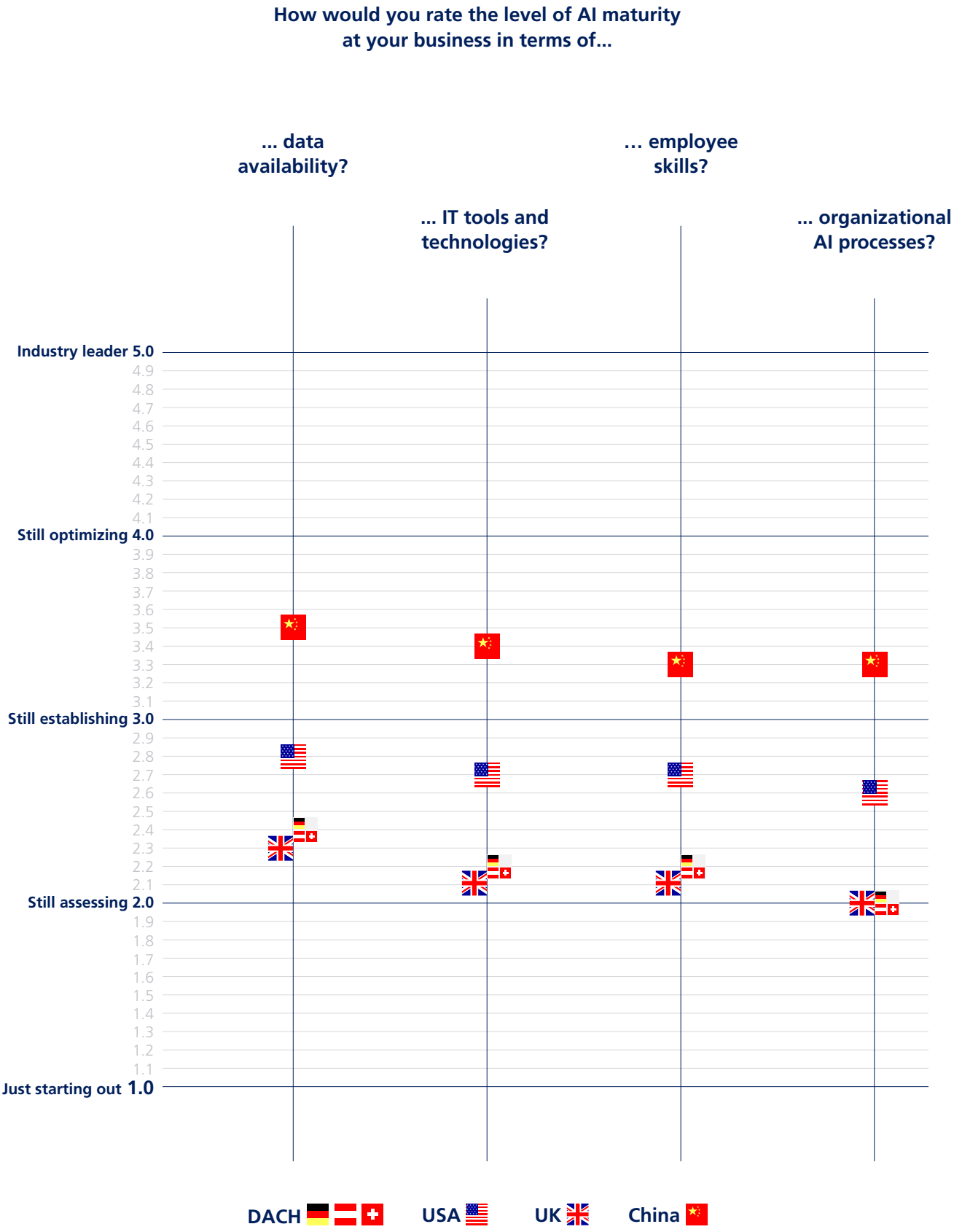


Fig. 18: Level of AI maturity at businesses by region[4]

[4] Alsheiabni, Sulaiman; Cheung, Yen; and Messom, Chris, "Towards An Artificial Intelligence Maturity Model: From Science Fiction To Business Facts" (2019). PACIS 2019 Proceedings. 46. https://aisel.aisnet.org/pacis2019/46

These results paint a concerning picture of Europe's status as an industry in terms of its use of Industrial AI. Compared to the USA and China, businesses in the DACH region and the UK seem to be lagging behind signification when it comes to the use, maturity level, perception and acceptance of the technology, as a result of which they are not yet able to benefit from Industrial AI to the same degree as their international competitors. However, there is no cause for alarm just yet. It will still be a long time until we can say for certain what tangible effect a high degree of AI maturity will have on the global competition and the shifting power dynamics between the USA, China and Europe.

However, DACH and UK businesses in particular need to start utilizing the manifold potential of Industrial AI to ensure that they do not risk falling into technological dependency and losing their competitive edge. Making up this ground in the medium to long term will be a challenge due to the range of individual requirements different businesses have when it comes to AI-based solutions. This is clear from practical examples such as that provided in our interview with Dr. Andy Moore, Chief Data Officer of Bentley Motors Ltd. Bentley realized that the company was not yet able to use AI-based quality control solutions across the board to replace human quality controllers in finding faults, because its products are produced in small volumes and with a high degree of customization. Bernhard Winkler, Vice President of Production Rail at Knorr-Bremse Rail Vehicle Systems, also reported that his company was facing a similar challenge in its production of brake systems for rail vehicles. In this case, too, the company has looked into the use of AI technology, but rejected the idea due to its low batch numbers and the high level of variance in its production. On the other hand, the company has already successfully implemented AI solutions to handle repetitive tasks outside of Production. In summary, while some businesses are already enjoying the benefits of Industrial AI in selected areas, others still need to assess just how much added value Industrial AI offers them due to their individual requirements and fields of application.

Based on the survey results, most businesses in the USA and China seem to have already overcome this hurdle. However, the need to fulfill individual requirements isn't the only factor impacting on positive ratings of AI maturity levels and the distribution of AI-based solutions – political incentives and measures also play a role. China's Next Generation Artificial Intelligence Development Plan[5], published in 2017, outlines the country's objective of becoming the leading global center of innovation for AI by 2030. With the Inflation Reduction Act (IRA)[6] of 2022, the USA is now also providing businesses with a political incentive to establish a positive environment for AI research and development. These initiatives have accelerated the digital transformation, but more than that, they have also proven to be a driving force for the successful integration of AI projects in these regions. This has increased businesses' confidence in their AI capabilities and made them more willing to take risks and experiment in the field of Industrial AI. The success of these political initiatives in China and the USA shows once again that additional political support for AI is also something worth striving for in Europe, as stressed by Daniel Abbou, Managing Director of the German AI Association.

[5] Full translation: China's 'New Generation Artificial Intelligence Development Plan' (2017) (stanford.edu)
[6] 1/23 The USA's Inflation Reduction Act (IRA) – Implications for Europe (in German) (bundesfinanzministerium.de)

Interview
Bentley Motors Ltd.

Bentley Motors Ltd. – Profile

Bentley Motors, the world's premier luxury car brand, operates from its Crewe, United Kingdom, headquarters, overseeing design, R&D, and production of its five model lines: Continental GT, Continental GT Convertible, Flying Spur, Bentayga, and Bentayga EWB. With the combination of fine craftsmanship, engineering expertise, and cutting-edge technology, Bentley exemplifies high-value British manufacturing and employs approximately 4,000 dedicated colleagues.

The Bentley Beyond100 strategy is focused on sustainability, aiming to transform the entire business and establish leadership in Sustainable Luxury Mobility. This entails a shift from being the largest producer of 12-cylinder petrol engines to having no combustion engines within a decade, reinventing Bentley as a leader in Sustainable Luxury Mobility.

Dr. Andy Moore, Chief Data Officer – Short vita

Andy has been the inaugural Chief Data Officer at Bentley since November 2022. As part of establishing and delivering the company-wide data strategy, Andy is responsible for data governance, data literacy, the data tech stack, and supporting enablement to get better value from data across the business.

Andy has two decades of experience within the automotive industry, across data, digital transformation, engineering, and program management.

Participants: **Dr. Andy Moore** (Chief Data Officer, Bentley Motors Ltd.), **Dr. Christina Reich** (MHP), **Kitty Wanke** (MHP)

Dr. Christina Reich (MHP): Can you please give us a brief overview of your responsibilities as Chief Data Officer at Bentley?

Dr. Andy Moore (Bentley): I've been in the role of Chief Data Officer for just over 12 months now. It's a new role at Bentley, so my first task is to create and embed a data strategy.

The strategy covers four pillars:

- The first pillar is governance: how we can best use, control, and protect our data.
- The second pillar is the data cloud, which is the technology we use to get the most out of our data with visualisation or machine learning products.
- The third pillar is data literacy. I strongly believe that we need to upskill the business, and that means upskilling people.
- The fourth pillar is enablement: how my team can enable Bentley to get more value from data and deliver products that accelerate the use of data across the business.

My role also involves building a new team, which is a great opportunity to bring in experienced data scientists from other companies, other industries, and our early careers programme.

Dr. Andy Moore, Chief Data Officer, Bentley Motors Ltd.

Reich: With regard to data literacy, you mentioned your data scientists and your skilled employees. Our results show that 70 percent of companies hire external AI experts to compensate for the shortage of skilled workers. How is Bentley handling this?

Moore: It's important to use a combined approach. We have an early careers programme, and we also focus on upskilling the existing workforce, because nobody knows Bentley like Bentley employees. But it's also an opportunity to bring in external experience, which gives us the chance to learn from other industries and gain expertise through our partnerships. A multi-tiered approach is key, because building a team of highly experienced AI experts is very expensive, and they may not understand the business at first. The data experts need to understand the use cases, the automotive industry, and Bentley's pain points, in particular.

Reich: At the same time, the automotive industry is facing challenges like increasing raw material prices, tighter environmental regulations, and changing market conditions. As a luxury vehicle manufacturer, is Bentley affected by these challenges to the same extent as other manufacturers, and how so?

Moore: We have certainly seen a lot of external challenges over the past four years, from Brexit to COVID to semiconductor shortages. COVID affected workforce availability, as well. We need to build greater flexibility into our business model than ever before.
Regardless of the external challenge, it's essential to have the flexibility in your business model to respond to it. And that's where data can come in to help us make data-driven decisions. We could never have predicted COVID, but we can use data to understand how deeply it's going to affect us and use that to inform our response plan.

Reich: Are you also using some specific industry 4.0 technologies to proactively address these challenges?

Moore: One example is 3D printing. Not so much for car parts because they have to go through stringent crash testing, of course, but we can use it for jigs and fixtures that might take a while to machine. That allows us to cope with a shorter life cycle; if one gets damaged, we can print a new one very quickly. And obviously the Internet of Things is relevant. A lot of our machinery is more connected than ever before, and we now have the ability to capture data from it. We're using mobile devices more than ever, and that's allowed us to move away from a more paper-driven process.

Obviously, robotics has been around for some time in the automotive industry. For a company like Bentley, with a relatively small volume, it's always a question of how much we need that. But there are certain processes like fixing the windscreen that rely on precision and repeatability, so they are an ideal task for a robot. At the other end of the spectrum is the sanding of our wood veneers. There's such artistry involved that a robot could never do it.

It is about finding the right balance. And then ultimately cloud computing and data will underpin it all, and we'll see a lot more use cases.

Reich: With regard to the transition from combustion engines to electric drives, how does electrification affect Bentley's operations, and which technologies will be key to achieving your operational goals in the future?

Moore: Part of our Beyond 100 strategy is to move to a 100-percent electric vehicle lineup, which we'll do at the end of the decade. We'll introduce a number of new models over the next six or seven years in order to fulfil that promise. We announced a 2.5 billion pound investment into Bentley, into the new models and also into the new factory. We'll build an entirely new factory within an existing footprint, which allows us to adopt new technologies and shift from a fixed production line to an AGV-led production line. That will allow us more flexibility in terms of volume, customisation, and the build process.

Reich: And how does the proliferation of AI in the automotive industry affect the competitiveness of Bentley?

Moore: There is a lot of hype around AI, and ChatGPT in particular, recently, but we have to be careful that there is a solid business case behind any implementation. As Bentley is low-volume, high-value, high-customisation, there is a balance to strike. Craftsmanship will always remain a core USP, but we might bring in AI as a cobot where it makes sense.

Some things can be truly automated, but many can't. Our quality standards are so high that AI can't do the job. A trained human operator will spot defects that AI would miss. So an AI camera system could reduce the workload, but it will never replace the trained operator.

Kitty Wanke (MHP): How would you rate the current status of AI at Bentley? Could you share some examples of successes or milestones you've had so far in your role?

Moore: Right now at Bentley, we're in a "test-and-learn" phase. We don't have widespread AI yet because we can't have an AI strategy without a data strategy. One of my tasks as CDO is to ensure that we have a solid foundation of accurate and authoritative data.

We have a number of test cases, but they're localised to a specific system. The next step will be to scale that up and combine multiple data sources to get more valuable outcomes. Our study showed that AI is highly relevant for predictive maintenance, especially in the automotive industry.

Wanke: What is the status of predictive maintenance right now?

Moore: It's starting to demonstrate the benefits more and more as we gain confidence in the machine learning model. As we start to get real results beyond the predictive results, we'll adopt it further. Maintenance is a good example, because there's plenty of IoT data for machinery, and we can look for historical patterns that help us predict when we might have issues in the future.

Wanke: What challenges do you face in integrating industrial AI, and what ways have you found to mitigate them?

Moore: The first challenge is trust and security. We need to trust the security of any environment that we use for AI. For example, we've closed access to ChatGPT on our company systems because of the risk of confidential data getting into a publicly trained model. We also need to trust the accuracy of the model, as well.

Close behind that is the cost of AI when moving it to the cloud. For a company the size of Bentley, storage cost is not too much of an issue, but compute cost is. There needs to be an ongoing risk-reward evaluation and a solid business case behind any use of AI.

Wanke: When you spoke about the four pillars, you also mentioned enablement and the workforce. From your perspective, what impact is AI having on the automotive labour market in terms of skills and work processes?

Moore: This is why I'm passionate about rolling out the data literacy programme from the shopfloor right through to management. Data affects everybody, whether they're fully aware of it or not. So we start with the basics and then build that knowledge according to role and need, as well as when new technology comes along. What we're seeing now is an acceleration of technology adoption faster than anything we've ever seen before. It's key to keep our colleagues upskilled and aware and remove concerns that AI might take over everyone's job. AI is there to help you be more effective and reduce time spent on repetitive, manual jobs. I think that AI will become important throughout the labour market in the future. It's a challenge to ensure that employees at all levels feel on board with technology. Whilst we will always need craftsmen to add the finishing touches to the Bentley, we also need people that are comfortable using data to make data-enabled decisions.

Wanke: Our survey found that predictive maintenance is a topic in the automotive industry, particularly for production leads. How do you work together with the production lead to decide which use case you want to test or establish?

Moore: This is always based on business case and impact, and there are many ideas that we can help scale once the basic building blocks are in place. For example, we can join multiple data sources like factory and field quality indications, then use natural language sifting and sentiment analysis to get a more holistic view of our quality status. We can also move towards more effective, efficient supply chains as we look to optimise our production with a fully flexible production line. Another example is using AI to optimise our inventory levels. There's a risk to both over- and under-stocking, but we can use data more efficiently to help drive those decisions. Feeding a model with a large volume of data can help to get more accurate stock predictions—far better than someone with an Excel spreadsheet trying to make a best guess.

Wanke: Now looking into the future: How do you see the future role of AI, especially in your industry? What developments do you expect in the next 5 to 10 years?

Moore: Elements of AI and natural language processing will become more widespread and built into everyday tools. When people can write code using natural language, that will really open up the opportunity to adapt. People will be able to build an AI cobot very easily, and that will create opportunities for almost

everyone to become more efficient at their job. But we obviously also pride ourselves on the customer magic and the hyper-personalised journeys for individual customers. And we can use AI to augment that by bringing together multiple data sources and suggesting next best actions to customers. And whenever our agents interact with a customer in any way, they'll be able to know a lot more about the customer and personalise the experience. That will make the brand experience much more magical for our customers in the future.

Wanke: Is there anything you want to add or something you'd like to say on a topic we haven't touched on yet?

Moore: Yes, going back to the topic of test and learn—I don't believe one single solution that solves everything exists anymore, nor should it. We need modular platforms and approaches that will remain compatible with new solutions as technology evolves at an uneven pace. One overarching system that locks in all the data is no longer acceptable in today's world or in the future. Also, the sharing of data is key, whether across systems or between suppliers and retailers. There not only needs to be a value exchange there to enable it to happen but also the barriers to exchanging data need to be much lower than they have been historically.

Interview
German AI Association

KI BUNDESVERBAND

German AI Association – Profile

Artificial intelligence is one of the key technologies of our future. The members of the German AI Association are committed to ensuring that this technology is applied in the spirit of European and democratic values. The goal is digital sovereignty for Europe. To achieve this, the Federal Republic of Germany and the EU must become attractive AI locations for entrepreneurs, where a willingness to take risks is appreciated and the spirit of innovation can thrive in the best conditions.

The German AI Association supports AI entrepreneurs by representing their interests with regard to policy, business and media. The Association's goal is to create an active, successful, and sustainable AI ecosystem in Germany and Europe. After all, only if the brightest minds and thought leaders decide to teach, conduct research, and base themselves in the European Union will we be able to compete successfully against global competition.

The German AI Association enables entrepreneurs to learn from each other's experiences and transfer these to their own companies. When ideas and information are exchanged in the Association's network, a contribution is made towards strengthening innovative capacity in Germany. Artificial intelligence can only be successful in Germany if it is accepted by the mainstream economy in all sectors. The German AI Association helps to awaken openness for AI innovations in European companies.

Daniel Abbou – Short vita

Daniel Abbou has been Managing Director of the German AI Association since May 1, 2020. His areas of responsibility include political and press communication as well as support for funding projects. Daniel Abbou previously founded AI-Hub Europe and advised politicians and companies. He was press spokesman in various ministries of finance and economics, including spokesman for Ulrich Nußbaum, the former Senator of Finance and State Secretary in the Federal Ministry for Economic Affairs. Mr. Abbou held the position of deputy government spokesman in the first Kretschmann cabinet in Baden-Württemberg. His enthusiasm for digitalization and innovation stems from his time working as a television and radio journalist focusing on new technologies.

Daniel Abbou, Managing Director, German AI Association

Participants: Daniel Abbou (Managing Director, German AI Association)**, Julian Engel** (MHP)

Julian Engel (MHP): What does the German AI Association stand for and what is your role there?

Daniel Abbou (AI Association): The German AI Association represents nearly 400 AI companies in Germany. It was founded almost five years ago. As an association, we hold stakeholder discussions with politicians, primarily the Federal Ministry for Economic Affairs and Climate Action, but also the Federal Ministry for Digital and Transport, the Federal Chancellery, and the Federal Ministry of Labour and Social Affairs. I am the first Managing Director of the German AI Association together with Vanessa Kern.

Engel: What role will AI play in Europe's future?

Abbou: I think the implications of AI in business will be huge. AI can take over the repetitive tasks that we all have to do in our areas of work. The aim is to be able to concentrate on the main tasks at work. For example, a nurse's job is to have contact with patients, not fill out Excel lists.

AI makes it possible to concentrate on the core area of an activity. AI will also take over more complex tasks in a particular framework. In the legal field, all recurring points in contract law could be taken over by AI. German tax law, as complex as it is, can also be tackled using AI. Will it replace tax advisers? No. Will there be tax advisers who won't be using AI in five years? Also no, I'd say. There will be a change in certain professional fields, and also in professional fields that don't yet think it will affect them. But this disruption will happen, I'm convinced of that. In automation, where robots are installed in factory workshops, it's also changed the job of the factory worker. And there will also be changes in jobs that are at an educationally higher level.

Engel: In our survey, we made a country comparison between the DACH regions, the UK, the USA and China, with a focus on industrial AI. What are the main challenges that companies currently have when it comes to implementing or integrating AI?

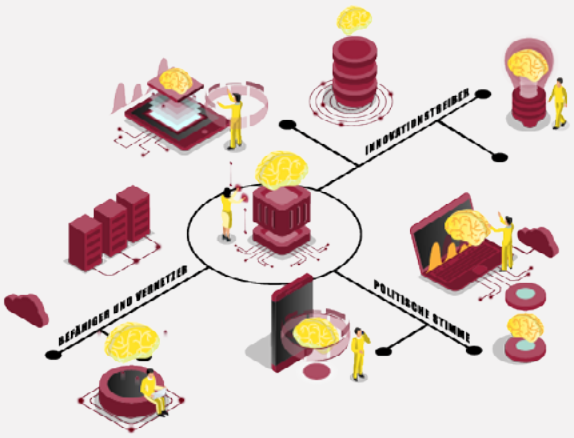
Abbou: It has to be said that, unfortunately, many areas of the German economy are not yet finished with the task of digitalization. AI without digitalization and without data in a company is difficult. There is skepticism around technology in traditional SMEs. It varies by region, but is especially prevalent in DACH. Business owners have varying access to digitalization and to data. A further problem we find in corporations is that no data sharing takes place even within the corporation itself. I would consider that to be the biggest challenge that AI entrepreneurs have when interacting with SMEs and corporations.

Engel: In the survey, we also asked about data availability and data quality. Availability is one thing, but sharing is the real obstacle. What was also interesting in our survey was that qualified employees really are very scarce. Would you also agree with that?

Abbou: Yes, definitely. Finding well-qualified staff is a huge problem. Not only for SMEs, but for AI entrepreneurs too. The lack of qualified employees exists, of course. What makes it particularly complicated is that the need for more and more data scientists is recognized within the German education system, but this is still not being addressed by means of any curricula or support measures. It's an issue that needs to be tackled. Digital media and knowledge of how to handle data, what data actually is, that's something we should learn in school or at university. Unfortunately that has only been happening to a limited extent up to now.

Engel: This makes companies dependent on service providers. There is another challenge: data protection. How do you see Europe's role regarding data protection?

Abbou: The General Data Protection Regulation (GDPR) is not the most popular regulation among AI companies. But it's also important to say that most AI companies in Germany don't use the business-to-consumer model (B2C) but are mainly in the business-to-business sector (B2B). Therefore, to a certain extent the data protection problem is not as noticeable as with a B2C business model. But of course, there's still the question of how personal data is used. For example, in health care, a very sensitive area, the GDPR is extremely serious.



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Engel: What impact do climate aspects and sustainability have on industrial AI?

Abbou: One needs to go hand in hand with the other. If I want to do something new, climate calculations will always be part of that. There will be AI models that can minimize the climate impact.

Engel: We've talked a lot about challenges and obstacles. Let's look at your success as an association. What milestones would you like to mention?

Abbou: We've made it clear to politicians and parts of the business world how relevant AI is, for example for large language models. I can even remember the first conversation with a federal ministry when someone told us it would be a really crazy idea. And three years later we can see what impact it's having, with ChatGPT for example. We were one of the first to make this point clear to stakeholders. It's our aim to highlight the opportunities, as Germany and Austria are quite good at focusing on the risks. There are simply not enough data centers in Germany and Europe that are specifically related to AI. We have also made this clear to Europe. In her State of the Union address on September 13, 2023, Ursula von der Leyen (President of the European Commission) explicitly mentioned AI access capacities for start-ups. You see that if you stick with something long enough, you get something back. That was a wonderful moment for us.

Engel: Have there been reports from members reporting a breakthrough?

Abbou: In terms of generative AI, Aleph Alpha and Lengoo obviously need mentioning. They aim to create a large European AI model. They were invited to speak at the German government's closed cabinet meeting in Meseberg. These are our two big success stories. We have few companies in the association that are filing for bankruptcy. For other firms, start-ups, or associations, a failure rate of 20 to 30 percent is normal. For us, the rate is under 10 percent. And that shows that our companies – even if they're not world-famous yet – are doing a good job and managing to establish themselves in this market.

Engel: As part of our survey, we noticed that optimism in the US and China is greater than in Europe when it comes to the use of AI-based solutions in companies. In China there is a different political approach and therefore a very different culture than in Europe. It should not be our goal to catch up with China in terms of speed. It's more about preserving our own values and developing in our own way – ethically, sustainably, and continuously becoming better. Do you share this view?

Abbou: Yes, I completely agree with you. The problem is just that, often, people focus on the potentially negative impacts rather than talking about the opportunities. I think both are okay in equal measure. But I've been to lots of events where people project their fears into AI. Often along the lines of AI is going to take over the world, and we'll end up living in a society where everything is just virtual. So I'm saying that we need to demystify the topic of AI. Nobody should use apocalyptic movies as a projection screen for their own fears about a technology that is not understood. But that's exactly what lots of people are doing. Fears arise when people don't understand things. It is our mission to allay people's fears and make AI tangible as a technology.

Engel: Finally, could you give us a brief outlook for the next five years? How do you think Germany and Europe will develop? Do you feel we're on the right track? What role will the German AI Association play?

Abbou: We are on the right track. I have an insight into nine different EU countries and I can see that there is strong motivation to address this topic. If the premises are correct, we will have integrated AI into large parts of the German and European economy in five years. However, we should be careful not to become more dependent on the large US hyperscalers. We provide our economic data for free and also pay the hyperscalers to get the results of the models. We mustn't make this mistake. In the next five years it will be crucial not to become dependent. We want to have our own European systems that are competitive.

Within the next one to two years, businesses expect the introduction of Industrial AI to have a high, perhaps even radical, impact on their production processes. However, there is still no outstanding field of application for the technology.

What impact do businesses expect Industrial AI to have in the next one to two years, and what are the most important fields of application and driving forces? The participants answered these questions as follows: 60 percent of the businesses included in the survey are expecting AI to have a high, or even radical, impact on their production processes. 27 percent forecast a moderate impact, while 13 percent expect the impact to be low to negligible (Figure 19).

The results of the question regarding the most important fields of application for Industrial AI show that there is no specific field of application that stands out from the rest. This diversity illustrates once again the fact that the benefits and added value Industrial AI has to offer are highly dependent on the existing conditions at – and requirements of – the business in question. Nevertheless, it is worth noting two fields of application that were rated slightly more important than the others by the participants. 14 percent of participants listed quality controls – businesses are obviously focusing on using AI to increase the quality of their products. This includes the use of image recognition and sensors – and particularly the analysis of the resulting data using machine learning – to detect errors at an early stage, optimize production processes, and ultimately improve the quality of the end products. In addition to this, twelve percent of the participants listed resource efficiency as important. Companies are aiming to use AI technology to reduce their energy consumption, make more efficient use of materials, and generally make their production less resource-intensive (Figure 20).

The results show that there is no clear leader in terms of important fields of application for businesses using AI. In fact, the real challenge lies in the fact that each company needs to assess the potential of AI on its own individual terms, which will help them to identify the best application for their needs. This is the exact problem that makes the use of AI difficult. The theoretical potential of the technology is enormous, but implementing it in practice is much more complicated, and requires an in-depth understanding of the subject.

How much of an impact do you expect AI to have on production processes in the future (the next 1–2 years)?

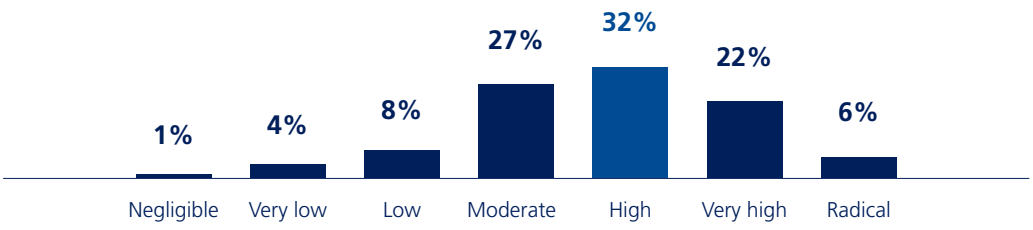


Fig. 19: Expectations for the future impact of AI on production processes

Most important fields of application for AI in production processes

14 POINTS
Quality control

12 POINTS
→ Resource efficiency

11 POINTS
→ Supply chain
→ Demand forecasting
→ Assembly/installation
→ Predictive maintenance

10 POINTS
→ Employee safety
→ Material flows

9 POINTS
→ Product design and simulation

1 POINT
→ N/A

Fig. 20: Most important fields of application for AI in production processes
(The participants were given the ability to assign a total of 100 points.
The results shown here are the averages for each possible response.)

Success Story
New Dimensions: Sounce

In the continuously developing automotive industry, it is crucial for premium vehicle manufacturers to deliver flawless quality and technical excellence. To this end, the companies conduct rigorous research and development processes (R&D). The integration of top technologies has become a must, which has opened the door for Sounce – a product from MHP. Part of the Industrial Cloud Solutions portfolio, Sounce uses the information content of acoustic signals to uncover hidden irregularities and deviations in examined parts, products, and machines. Sounce allows the identification of anomalies, the creation of clusters, and the determination of correlations between data points. This enables a significant enhancement of quality standards – using artificial intelligence as a key element.

In this success story, we look at the utilization of Sounce as part of the R&D process at Porsche and at its ability to yield valuable insights, which have resulted in the improvement of quality standards. On the one hand, the integration of these technologies has made the R&D processes at Porsche more efficient. On the other hand, there has been an improvement in quality control standards..

Read on to find out how Sounce has become an essential component in the striving for top quality in the automotive industry, redefining quality assurance and setting new benchmarks.

Use case

Chassis mounts fulfill four essential functions, which often conflict with each other during the design process. Their purpose is to transmit forces, enable defined movements, isolate noise, and dampen vibrations. For dealing with each of these requirements, different types of elastomer mounts are built into the chassis. Depending on the type there is also a risk of the chassis mounts producing unwanted noise, such as rattling, squeaking, or creaking. With sophisticated options for acoustic analysis, Sounce offers a transformative solution for an evaluation of these noises on the test stand. From the selection of different mount concepts offered by numerous suppliers at the beginning of a project to measures to ensure series-production quality, Sounce supports the vehicle manufacturer Porsche in making data-based decisions throughout the R&D process. This also means that good noise quality is ensured for the vehicle launch.

Initial situation and challenges

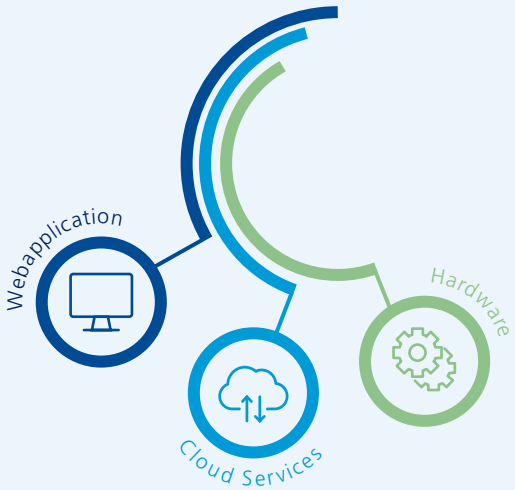
In the past, work to mitigate unwanted noise caused by the chassis mounts was mainly conducted during whole-vehicle testing on test tracks with noise and comfort lanes, with different temperature preconditioning based on the prevalent conditions in the individual sales markets. Ideally, this required prototypes with specific acoustic properties being available at the very beginning of the R&D process; in reality, these don't tend to be sufficiently mature in terms of development until a later phase. Consequently, there was a need for achieving noise mitigation for the affected chassis components by means of testing on a test stand, taking into consideration suitable load cases and peripheral components.

While the overall vehicle assessment is described using both subjective impressions and objective measurement data, the evaluation, documentation of bench tests and decision on whether the noises are relevant to customers or not are purely subjective.

Approach

To allow acoustic signals to be utilized with precision, the testing equipment of the vehicle manufacturer had to fulfill one essential requirement: a static test setup with a repetitive procedure. Realistic conditions and load cases needed to be replicated on the test rig. It was therefore crucial to be able to rely on a consistent testing environment where noise detection could be conducted in a controlled manner. With the new setup, acceleration sensors pick up the vibrations. Based on the resulting measured data, the system creates spectrograms, visual representations of the sound frequencies over time. These spectrograms serve as an enhanced data source that facilitates subsequent analysis by means of algorithms.

Unsupervised learning / machine learning: In this particular use case, unsupervised machine learning is at the core of the approach, a powerful technology that enables the system to autonomously recognize anomalies in the visualized acoustic signals that are produced in the course of the testing. Without identification or intervention by humans, Sounce can detect deviations from the norm in complex data records by itself, thus ensuring a robust and objective evaluation of each tested mount. Another advantage of using Sounce in this case is that it allows non-stop operation. Thanks to 24/7 availability, Sounce ensures that the testing process can run without interruption, which makes for maximum efficiency. This non-stop operation enables fast and continuous evaluation of supplied parts, providing the manufacturer with a competitive advantage in a sector characterized by rapid innovation.



Sounce as a modular solution

Faster supplier evaluation: This use case offers great potential with respect to the speed of evaluating the quality of bought-in parts. The system analyzes large cloud-based data volumes very quickly and provides prompt feedback on the quality of parts from different suppliers. This accelerated evaluation enables the manufacturer to make well-founded decisions, optimize its supply chain, and maintain long-term partnerships with reliable suppliers.

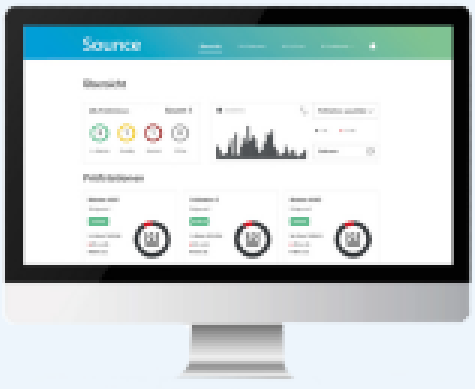
Functionality and solution

The integrated machine learning functions excel in the analysis of unstructured data and subsequent detection of patterns and groupings in the produced clusters. In the course of its unsupervised learning, the system autonomously clusters similar noises, thus enabling efficient classification of normal and abnormal acoustic patterns. In these use cases, Sounce can facilitate cause analysis. When a problem is detected, Sounce provides comprehensive information, enabling engineers to determine causes that were not evident previously. This allows customers to address arising problems proactively. In the past, the testing process depended strongly on manual intervention and human hearing to detect anomalies, which entailed the risk of human error. The AI-supported acoustic analysis provided by Sounce has automated the process.

Transparent data documentation and web-based visualization: All the data generated during the testing process is fully recorded and documented. This comprehensive data documentation enables simple checking, which means that the customer can track and investigate all the problems that may occur during the testing. The transparent data path also improves reliability and facilitates continuous improvement initiatives. The Sounce web app offers an intuitive platform for data visualization. Engineers can easily retrieve the analysis results via interactive graphics and diagrams for subsequent interpretation. In addition, the data generated during testing is analyzed in the cloud, making for speedier processing as well as faster access to the results. The results can also be accessed remotely at any time.

Results and outlook

With the combination of data recording, documentation, visualization, and analysis by Sounce, Porsche has achieved a substantial optimization of its quality assurance processes in Research & Development. Not only has Sounce helped Porsche ensure fast and reliable supplier evaluation, it has also provided a solid basis for collaboration with suppliers.



Intuitive web application

Shifting the perspective from fields of application to the concrete factors that promote the use of AI, there are two in particular that the participants clearly regard as key driving forces for the introduction of Industrial AI, and that are thus also important criteria when it comes to assessing AI projects: increased operational efficiency and cost reduction. 19 percent of the businesses included in the survey named each of these factors as a key driving force for the integration of AI. In this context, the idea of increased operational efficiency refers to the automation of production processes and optimum utilization of resources. Cost reduction covers the reduction of labor costs, minimization of errors, and the optimization of energy consumption (Figure 21). These results are also reflected in our interview with Julian Follner of Deutsche Bahn. Mr. Follner confirmed that cost reduction was the main objective behind the use of AI. He also said that improving the punctuality of the company's trains played a large role.

In your opinion, what factors will be the most important driving forces behind the use of AI in production?

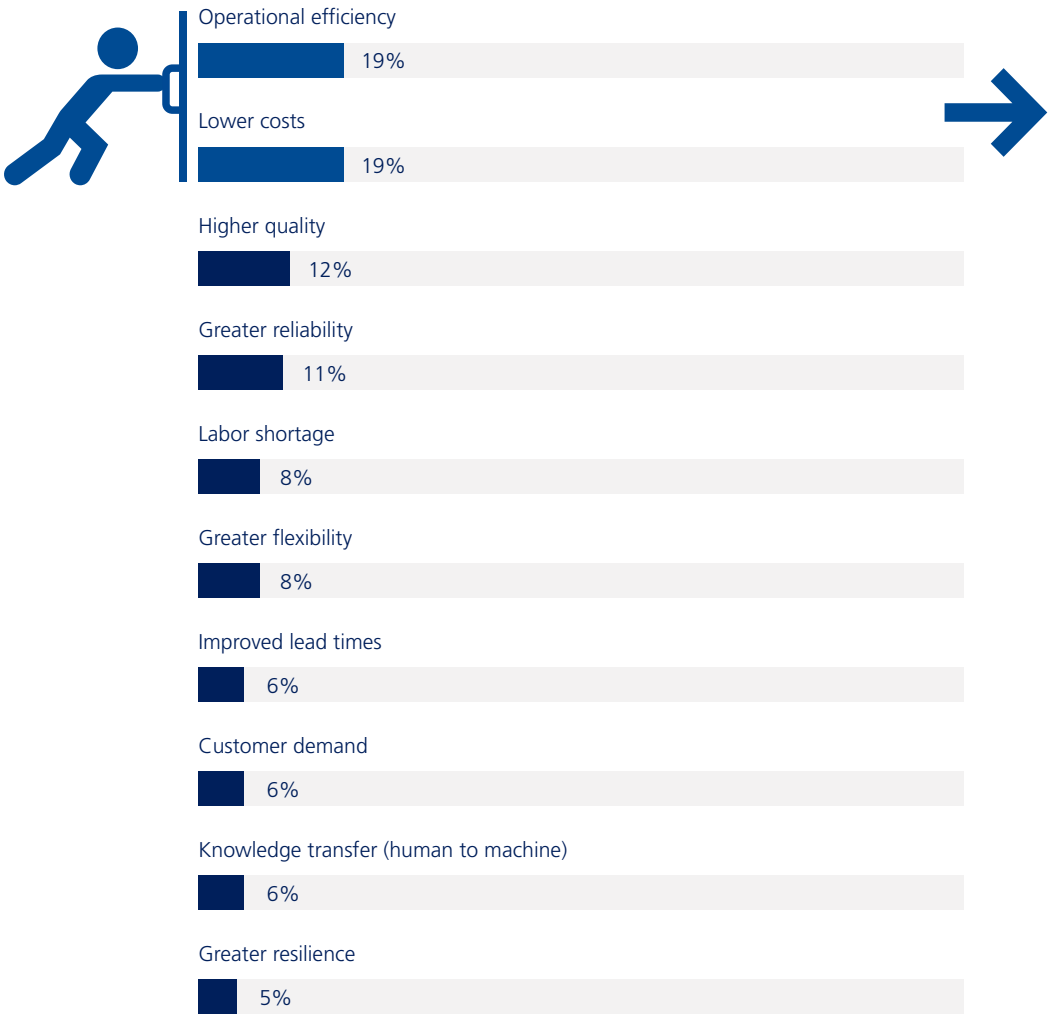


Fig. 21: Most important fields of application for AI in production processes
(The participants were given the ability to assign a total of 100 points.
The results shown here are the averages for each possible response.)

“Courage to implementation – then application ideas for I4.0 technologies will become valuable solutions for companies. The time for this is now – not tomorrow. GenAI is a good example of this. It is the responsibility of management – especially in Europe – to create the framework for experimentation and speed in the direction of efficiency and! innovation. Both together will secure the future of the company.”

Dr. Christian Fiebig
Partner
Digital Factory & Supply Chain

Interview

Knorr-Bremse Rail Vehicle Systems

Knorr-Bremse Rail Vehicle Systems – Profile

Knorr-Bremse is the global market leader in braking systems and a leading provider of other systems for rail and commercial vehicles. Knorr-Bremse's products make a significant contribution to greater safety and energy efficiency on roads and rails around the world. Some 32,600 employees at over 100 locations in more than 30 countries use their competence and motivation to satisfy customers worldwide with products and services. In 2022, Knorr-Bremse generated sales of EUR 7.1 billion in its two business divisions worldwide. For more than 115 years, the company has been an industry innovator, driving forward developments in mobility and transportation technologies and taking the lead in connected system solutions. As one of Germany's most successful industrial companies, Knorr-Bremse profits from the key global megatrends of urbanization, sustainability, digitalization, and mobility.

Bernhard Winkler – Short vita

Mr. Winkler joined Knorr-Bremse AG as a trainee after completing his studies in engineering and management in Munich. He held positions in both divisions of the company (Commercial Vehicle Systems and Rail Vehicle Systems) and worked for several years in the industrial engineering department of the Rail Vehicle Systems division. His responsibilities included coordinating Industry 4.0 initiatives with the global plants. Since May 2021, he has headed the Production central unit of the Rail Vehicle division (Production Rail) and is responsible for performance management and digital manufacturing, in addition to technology development and industrialization, production system, test stand construction, and investments and footprint.

Participants: **Bernhard Winkler** (Vice President Production Rail, Knorr-Bremse Rail Vehicle Systems), **Dr. Christina Reich** (MHP)**, Dr. Thilo Greshake** (MHP)**, Stephan Müller** (MHP)

Dr. Christina Reich (MHP): Please can you give us a brief overview of your duties as Vice President Production Rail at Knorr-Bremse AG?

Bernhard Winkler (Knorr-Bremse): I work in the Rail Vehicle Systems division at Knorr-Bremse. I'm in charge of the Production Rail central function and have global responsibility for Group-wide production-related activities across all plants. This includes typical projects for standardization, site development, the introduction and ongoing development of our production system, industrialization projects and support for location-specific technology projects. It also includes driving forward digitalization issues, as well as division-wide governance tasks like performance management and footprint development. So my area of responsibility covers all the more strategic, production-related topics that are not directly related to the daily output of a plant.

Bernhard Winkler, Vice President Production Rail, Knorr-Bremse Rail Vehicle Systems

Reich: Our survey shows that, in the DACH region, most areas of application for artificial intelligence are to be found in quality control and improving resource efficiency. In which areas of production is your focus on AI-based solutions?

Winkler: At Knorr-Bremse Rail, we predominantly operate in a typical high-mix, low-volume business. We also talk about absolutely safety-critical components. In the direct production area, the quantities and thus also the samples we can use to train AI or an algorithm are small compared to a typical automotive supplier. We have found that the algorithms and commonly used tools have not yet been designed for the characteristics of this business with comparatively smaller quantities and a huge variance. That's why we have focused more on processes in administrative

areas when it comes to AI-based solutions, because we see great potential there and the proportion of repetitive tasks is higher.

Reich: What specific use cases are there in your area as regards typical Industry 4.0 solutions?

Winkler: We are currently working intensively on connecting our production assets using an IIoT platform, with the initial aim being to have transparency around the status of assets, productivity, and so on at all times. Building on this, the aim is to ultimately create self-regulating control loops in order to reduce manual control effort. In addition, our plants are working hard on automating a wide range of processes in the direct area, in intralogistics, and in admin areas. Here, we are currently focusing intensively on robotic process automation (RPA). That's perhaps not a typical AI field, but it's the first step towards it for us. For example, we're using a bot for order management. That means all orders are automatically dispatched to the SAP system, irrespective of which channel is used to send them to the plant or service center.

Reich: What performance indicators are used at Knorr-Bremse to measure improvements brought about by the use of industrial AI?

Winkler: We look at overhead productivity, for example. That means we examine how many overheads we need in a plant in order to generate output X. More automation means fewer skilled workers are needed for some tasks. However, we're also noticing that sometimes we need more staff in other functions than we did before, such as for data preparation, process control, and programming and operating bots. Of course, other skills are needed for this, which we have to build up first. Our colleagues in Purchasing are also working very intensively with RPA and are measuring indicators such as the number of automatically processed orders and the automation level of certain subprocesses.

Reich: We saw in our survey that approximately 70 percent of companies are hiring external AI experts to compensate for the shortage of skilled workers. How are you handling this at Knorr-Bremse?

Winkler: We're taking a two-pronged approach here. Firstly, we're gradually building up internal skills, for example through vacancy filling and further training. This takes time, however, which is why we're also trying to scale using external experts. Essentially, in the central unit we are striving to drive forward new approaches, initially in the form of pilot projects in or with individual plants. In doing so, we ensure that these approaches address real problems, rather than being pure technology studies.

If an approach succeeds, it's our job to design it in such a way that it can be scaled and transferred to other plants or areas.

Reich: What are the most serious challenges you face when integrating industrial AI in the production environment? What are the barriers that have prevented AI from being used more widely up to now?

Winkler: Data quality is a major issue. For example, if the master data is not correct, the algorithm won't work at some point. That means we'll reach a limit as regards standardization in the system. Both our SAP landscape and the IT environment for our supplementary systems, such as for our quality assurance or process control issues, are very varied. This makes it necessary to keep redefining the interfaces.

Reich: What role do safety-critical aspects play in the application of industrial AI in rail systems? Is that also a factor inhibiting its use?

Winkler: Currently, we are not yet using AI as the sole means of ensuring quality in production because we have a zero defect policy. Our products are absolutely safety critical. For example, the brakes on a high-speed train simply have to work – there can be no safety issues. We have to make sure at the plant that the product is 100 percent correct. To do that, we would also have to be able to rely on AI. But we've established that our quantities are currently too small for this. We are not at that point yet. Another factor for us in terms of safety-critical aspects is, of course, cybersecurity. What interfaces or system boundaries are open, for example? How may systems be permitted to interact? What can we even roll out anyway, particularly in the cloud? This is currently really hindering us from rolling things out or scaling them.

Reich: We've seen that you've made strategic investments in AI start-ups like Rail Vision. The idea behind Rail Vision is driver assistance technology in the form of high-tech sensor systems. It enables trains to detect objects and obstacles over long distances. Please can you tell us a bit more about it? Could it be extended more widely in the near future?

Winkler: Obviously we hope so. Rail Vision is already being piloted in the field, for example by SBB in Switzerland. Ultimately it's all about both safety and productivity issues, specifically here about environment recognition during maneuvering procedures. In addition, with obstacle detection systems it may also be technically possible to look further ahead than the human eye is capable of. Accordingly, other operational procedures in rail transport could be optimized.

Reich: Compared with the digitalization and electrification of drive systems in the automotive industry, are there any particular developments in your industry that are forcing you to adapt your existing service portfolio? If so, is AI playing a major role?

Winkler: From my production perspective, I don't see any fundamental change – for example, to drive technology – in the rail industry. Pure diesel engines, for instance, will certainly tend to decline in use. But there isn't one huge technological change, as is the case with electromobility in the automotive industry. A bigger set of factors is relevant for Knorr-Bremse. These include regional market circumstances that change, and also factors that affect the product mix. There are major initiatives to digitize all freight transport in order to make it more productive. That would be a huge innovation for the rail industry. We are involved in this project. What is also important is increasing the capacity of existing infrastructure. AI is certainly an enabler or a relevant factor here, but in my opinion it's not the sole major driver of transformation in this area at the moment.

Reich: What is Knorr-Bremse's long-term strategy for the use of AI? Do you have specific goals or visions of where your shared journey with AI could go?

Winkler: In terms of production, we ultimately aim to create control loops that are as autonomous as possible with our Industry 4.0 initiatives. Although a control loop does not cover a whole plant, it can still reduce

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the increasing complexity. This arises, for example, from much more volatility in the supply chain, and also from orders postponed by customers. It entails an increasing amount of manual effort to reconcile the orders and the available materials. There are also various other drivers, which is why the manual control effort in all processes is continually increasing. At this point, we want to establish autonomous control loops, although AI will also play a role, of course.

Dr. Thilo Greshake (MHP): Based purely on your gut feeling, do you think that AI will really take over?

Winkler: I do believe that AI can be a game changer. If you look at the amount of coordination effort involved in processes nowadays, AI definitely has the potential to bring about significant optimization and economies of scale. The world has become so fast-moving and volatile that many established procedures and tools are not designed for it, and processes therefore reach their limits. For example, in some places a person-driven manual process, in which you continually ensure that the latest information is consistently incorporated, can hardly ever be performed with reasonable effort. AI can make a difference here. AI also enables the people who have previously carried out these tasks and built up a lot of expertise in the specific context to devote themselves to other activities that create more added value. However, I don't believe that AI will completely turn the world upside down in three years. But I do believe that the conditions for it must be created now. I also don't think it will be possible to automate the entire administrative field, for example. But there will be a core amount of repetitive activities that will become more and more automated.

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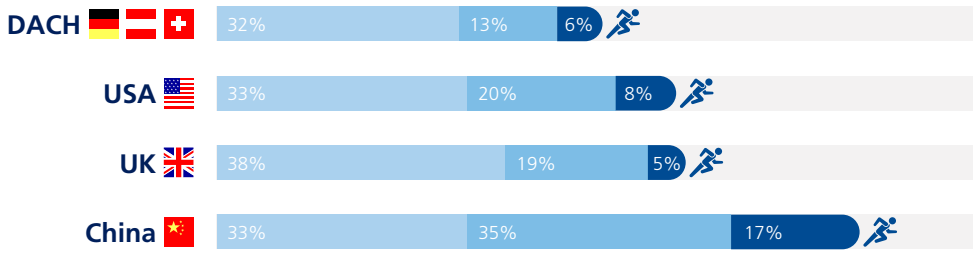
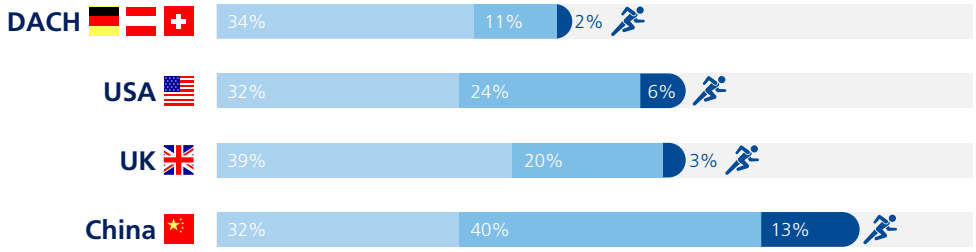
We have access to very large, unstructured or dynamic volumes of data for analysis purposes.



We are able to acquire data with the right level of detail to gain meaningful findings for AI applications.



Generally agree Agree Completely agree

Fig. 22: Data availability and quality by region

There are a number of obstacles that stand in the way of AI's development. It is open to debate whether economic, ethical, legal and social concerns are impeding development, and/ or if a lack of sufficient infrastructure or data silos is holding back progress.

The driving forces behind AI in the industrial context are impeded by a range of obstacles. The availability of valuable data for algorithms is crucial to the successful integration of AI into production processes. However, the survey results surprisingly indicate that the participants did not see data availability as a top-priority obstacle to their progress. The majority of those who took part in the survey agreed with the statement that they had access to unstructured, dynamic data. In fact, 64 percent said that they were able to receive data with the right level of detail to gain meaningful findings for AI applications. A closer look at the differences between regions shows that China has taken on a leading role in this regard, with an impressive 85 percent of participants from the country agreeing to both statements. By way of comparison, the agreement levels in the USA and the UK were some way behind, on just 60 percent. In the DACH region, only half of the businesses included in the survey believed

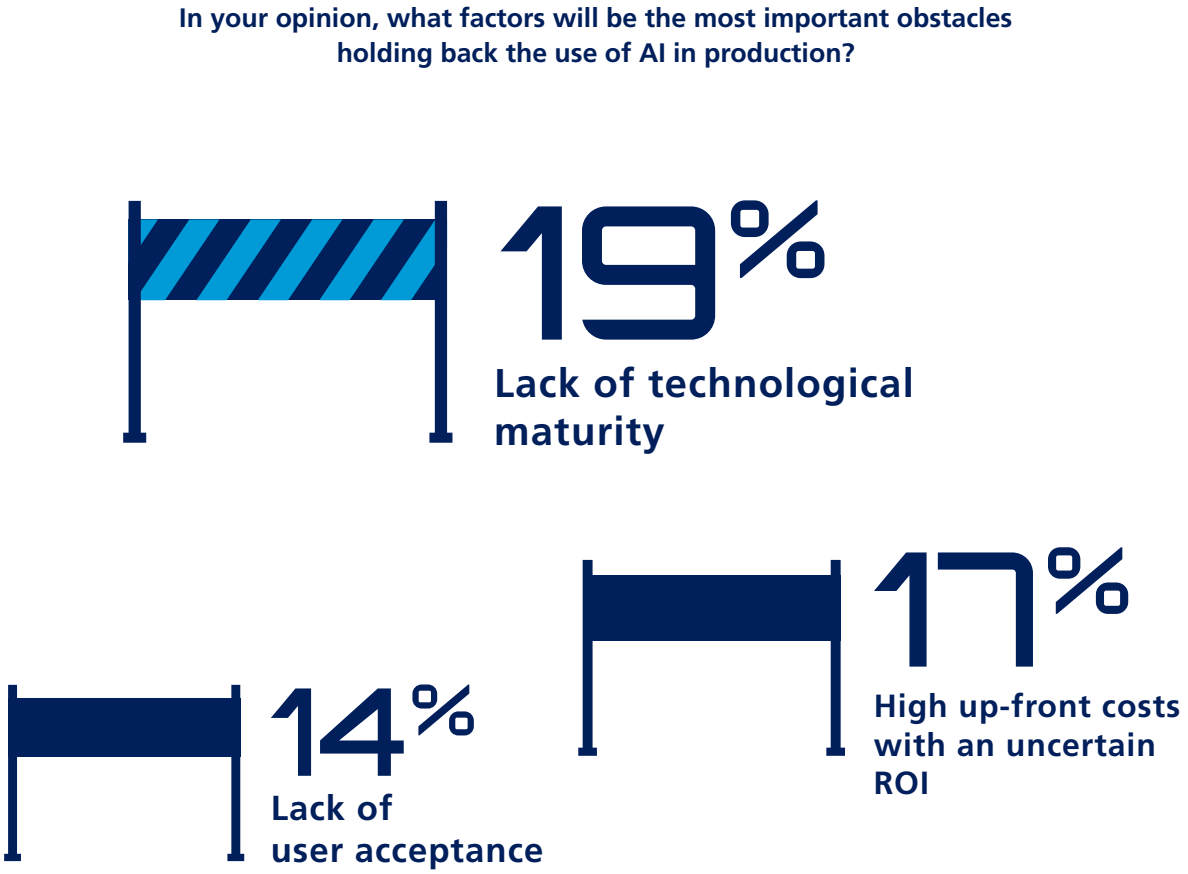


Fig. 23: Most important obstacles to the use of AI in production processes

that they had access to data of the necessary quality. The results suggest that organizations already have access to large volumes of unstructured data that they can use for analysis purposes, and are able to convert this data into the level of detail required for AI applications (Figure 22).

Since data availability and quality are clearly not the main issue, there must be other factors that are impeding the progress of Industrial AI. 19 percent of the participants attributed the problem to a lack of technological maturity – while digitalization is progressing at the businesses, they are often still using outdated machines and IT system landscapes that are not sufficiently equipped to handle the use of AI technologies. Alongside the primary obstacle of technological maturity, businesses are also prone to dragging their feet when it comes to investing in Industrial AI if they are unable to immediately quantify the ROI (17 percent). As such, businesses' willingness to invest is largely dependent on them being able to see a clear prospect of financial returns and a clear economical advantage, as stresses by Julian Follner, Project Manager for Deutsche Bahn AG's "Ideas Train" project.

In addition to this, the implementation of AI technologies requires extensive changes to work processes, and thus a willingness to accept such changes from the employees involved. Despite the growing media attention AI has received in recent years, many business still seem to hold a skeptical view of this technology. This was indicated by the fact that the participants rated user acceptance as the third most relevant obstacle, with 14 percent. Some of the most commonly listed reasons for this were workers being scared of losing their jobs, concerns regarding data processing, and a lack of trust in the reliability of the technology (Figure 23).

Success Story
SEW-EURODRIVE DriveRadar® IoT Suite

DriveRadar® – An AI-based cloud and IoT solution for a global customer base.

The DriveRadar® IoT Suite enables condition monitoring and maintenance prediction using AI services, which have been moved to the cloud thanks to the close cooperation between SEW-EURODRIVE and MHP, offering optimal scalability and maintainability.

Initial situation and challenges

SEW-EURODRIVE is a globally leading company for drive technology and automation solutions that has been renowned for its excellence in technical innovations since its foundation in 1931.

The company has its roots in the provision of first class products and services for different sectors and is currently undergoing a digital transformation involving artificial intelligence (AI). The main aim is to utilize the power of AI to boost efficiency, optimize processes, and establish new standards in automation. With the aid of strategic investments and partnerships, SEW-EURODRIVE is capable of exploiting the potential of AI in order to shape the future of drive and automation solutions and thereby strengthen its position as a forward-looking industry leader.

MHP has been supporting SEW-EURODRIVE in its efforts to achieve these objectives for several years. Among other things, MHP and SEW-EURODRIVE have collaborated on developing platforms to drive forward SEW-EURODRIVE data science solutions and to migrate these solutions to the cloud. One of these data science solutions is the "IoT Suite for applications" under the umbrella brand DriveRadar®. This IoT Suite provides condition monitoring and maintenance forecasting for applications equipped with SEW-EURODRIVE drive technology.

Find out how an on-premise AI solution developed over several years was migrated successfully to the cloud through close collaboration and the use of tried and tested architecture methods, with the aim of ensuring outstanding scalability and maintainability.

Approach and functionality

The **DriveRadar®** IoT Suite for applications is an intelligent condition monitoring system that helps SEW-EURODRIVE customers to gain insights about their machines, their equipment, and the SEW-EURODRIVE drive systems.

The special feature here is that the data originates exclusively from SEW-EURODRIVE drive technology and no additional sensors are required.

With the aid of a data collector, data can be sent to a SEW-EURODRIVE cloud storage. From that data, the DriveRadar® solution can identify malfunctions and perform anomaly detection through the use of machine learning. Not only does this enable predictive maintenance, it also opens up options for more comprehensive analyses, condition classifications, and dashboards for application engineers. MHP is helping SEW-EURODRIVE to migrate this solution to the cloud.

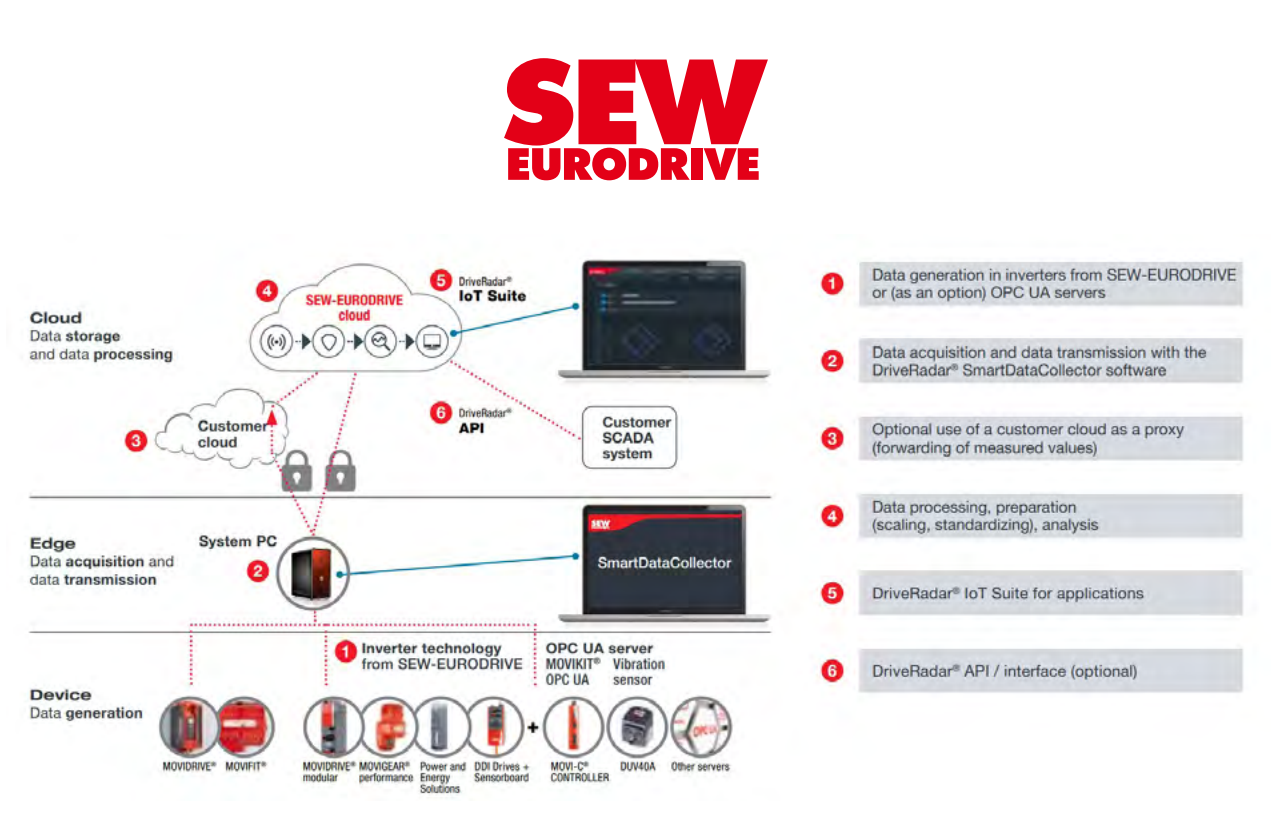
The cloud transformation started with a team from MHP supporting SEW-EURODRIVE in creating a functional cloud prototype. This prototype uses Microsoft Azure and is made available via Continuous Integration/Continuous Deployment (CI/CD) pipelines. During the course of this initial proof-of-concept phase, the communication of the existing service was divided into separate independent API calls so as to ensure smooth cloud-based service provision. MHP used its extensive AI engineering expertise to support the customer in this work. This know-how covers the development of cloud-native applications, with due regard to the tried and tested methods of the leading cloud providers, as well as the development of AI-based applications.

In the following and most recently concluded architecture project phase, MHP supported SEW-EURODRIVE in advancing from the proof-of-concept stage to a serverless architecture in the cloud. Migrating the service to a serverless architecture required not only AI engineering skills but above all also experience and knowledge of best practice in the creation of scalable, cloud-based AI service architectures. While the communication of the existing service was divided into independently acting API calls during the proof-of-concept phase, the new serverless architecture uses an event-driven communication structure that allows tasks to be performed independently by the individual components so that they can be completed separately and without any waiting times.

Results, outlook, and added value

This solution will replace the on-premise service, in effect moving it to the cloud. The decision was made to go for a serverless approach that would enable SEW-EURODRIVE to easily scale the service so that data from several hundreds of thousands of devices could be handled without SEW-EURODRIVE having to orchestrate any process dependencies – using as many "Cloud-native" components as possible. The event-driven serverless architecture is key to fulfilling the scalability criteria and facilitating subsequent system maintenance. The work on the architecture was complemented by a detailed calculation of costs that allowed the monthly costs per device for training and inference (recognition/prediction of a model) to be cut by over 80 percent. With the total number of devices at SEW-EURODRIVE customers estimated to be several tens of thousands, major cost savings will already be achieved for SEW-EURODRIVE at the time of the launch of the cloud solution.

During the design work on the architecture, it became clear on several occasions that a systematically recorded and well-documented knowledge base (requirements, architecture decision records, etc.) makes it possible to create custom-fit and resilient AI solutions quickly and conduct the collaboration between SEW-EURODRIVE as developer and vendor and MHP as service provider in a manner that is both outcome-oriented and cooperative. One of the key requirements has always been knowledge transfer and knowledge building to enhance the skill set of the SEW-EURODRIVE team as much as possible. Now that the architecture design phase has been completed, MHP will assist SEW-EURODRIVE with the implementation of the proposed architecture. The objectives are the migration of all services to the cloud-based architecture and the corresponding go-live plus any required further developments to reduce costs and increase the general fault detection rate.



Schematic of the structure of the DriveRadar® solution

Access to adequate resources is essential to the success of AI projects and was judged by 35 percent of the participants to not be at sufficient levels. 27 percent listed a lack of time as their reason, while another 27 percent referred to the lack of qualified personnel. The shortage of skilled labor in the field of AI is preventing companies from using AI to compensate for their shortage of skilled labor in other areas. This deficit could be compensated for with adequate investment in AI capabilities, such as employee training or the use of technologies and data infrastructures. On the other hand, only slightly less than half of the participants stated that their businesses were investing sufficiently in AI capabilities. Partnerships with service providers represent one potential way of reducing such investment costs and spreading the risk. However, this also means that the businesses in question would need to be willing to share the profits of their AI investment. 45 percent of the participants said that their businesses would be prepared to do this (Figure 24).

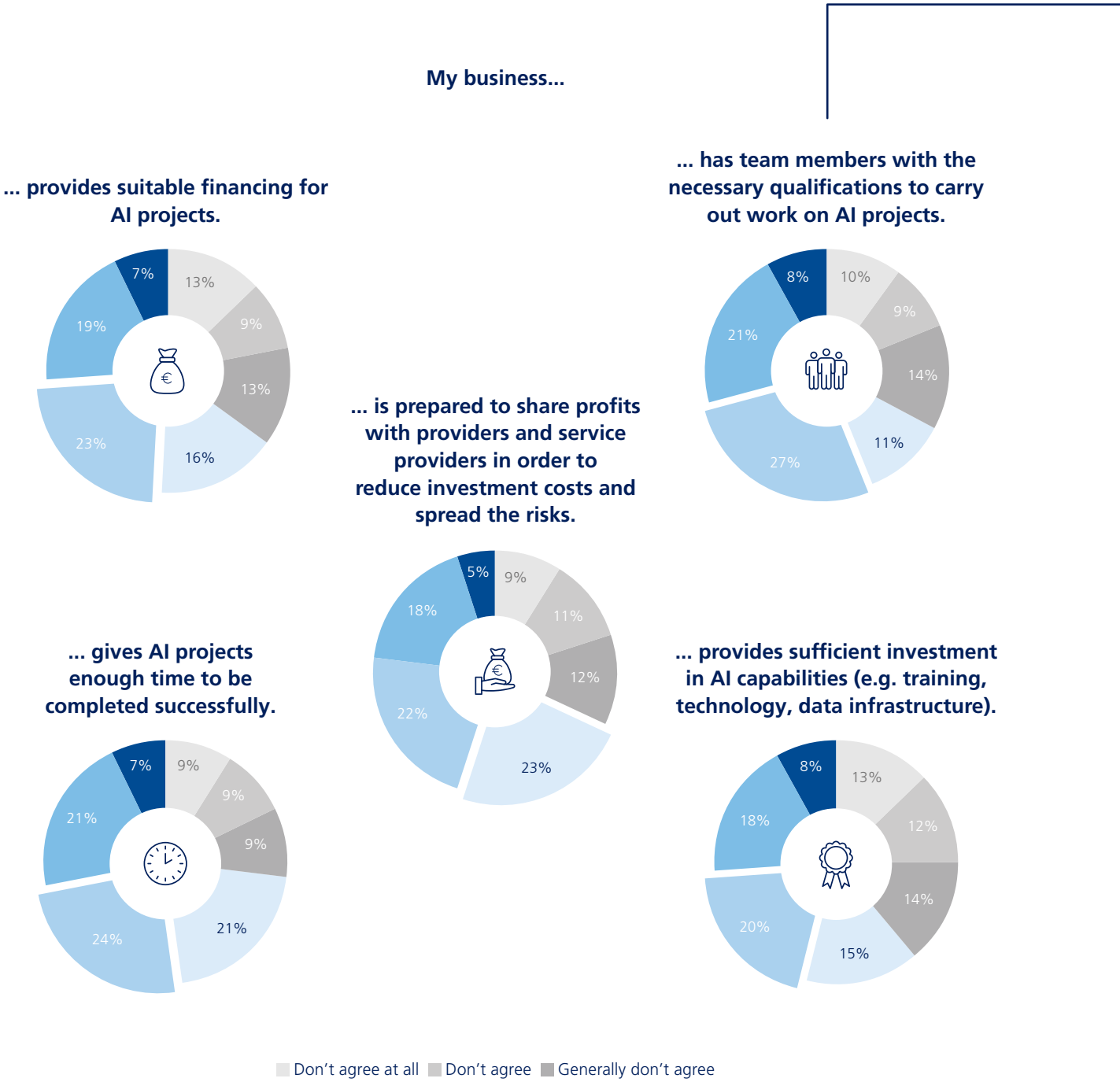


Fig. 24: Access to resources for AI projects

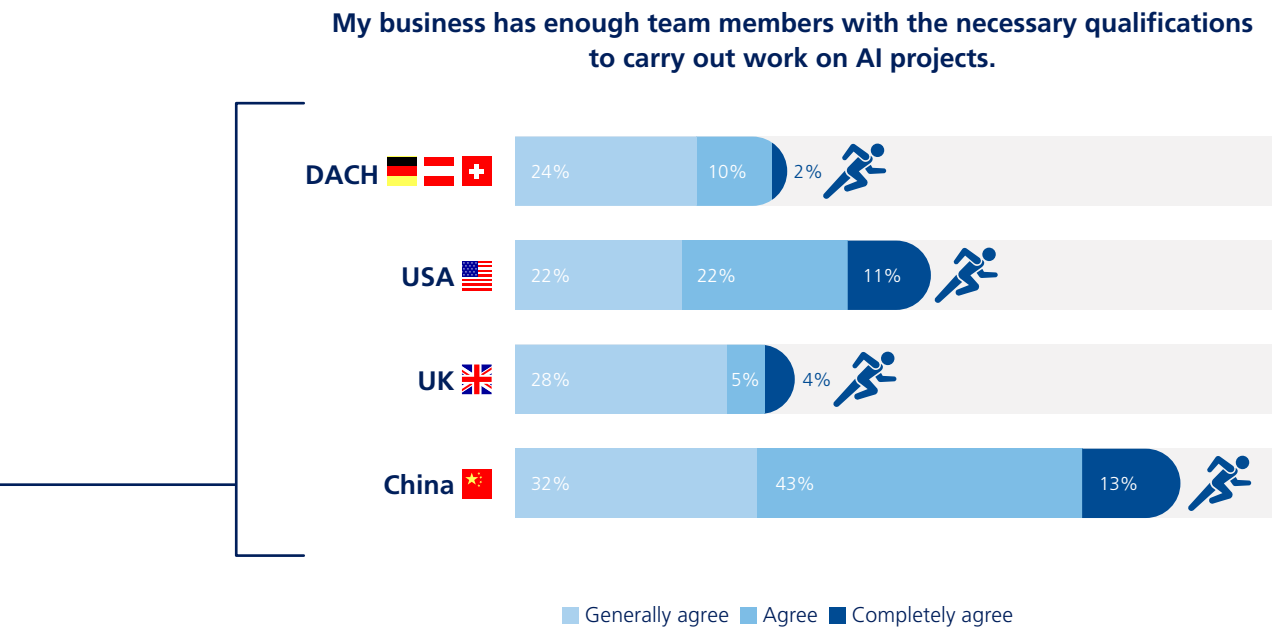


Fig. 25: AI qualifications of staff by region

A closer look at the question regarding qualified personnel once again shows clear differences between countries: The DACH region and the UK in particular lack qualified personnel with AI expertise, as demonstrated by the fact that only 36 percent of participants from the DACH region and 37 percent of those from the UK agreed with the statement that their businesses possessed sufficient qualified staff. 55 percent of participants in the USA and 88 percent of those in China agreed with this statement (Figure 25). It can thus be assumed that, particularly in China, the shortage of skilled labor does not seem to be an issue impeding the further development and use of AI. In order to provide an in-depth insight into AI capabilities, the participants were asked how much their businesses relied on external resources to handle AI work. Overall, there was a significant need for specialists and service providers with technical AI skills. Accordingly, 72 percent of participants agreed with the statement that they needed external experts, while 71 percent confirmed that they needed to subcontract to external companies possessing the necessary AI capabilities (Figure 26). In fact, Dr. Andy Moore of Bentley even sees outsourcing to external talent as advantageous, as he believes that combining in-house staff who are familiar with the company's internal processes, tools, etc. with external service providers can create the right synergies.

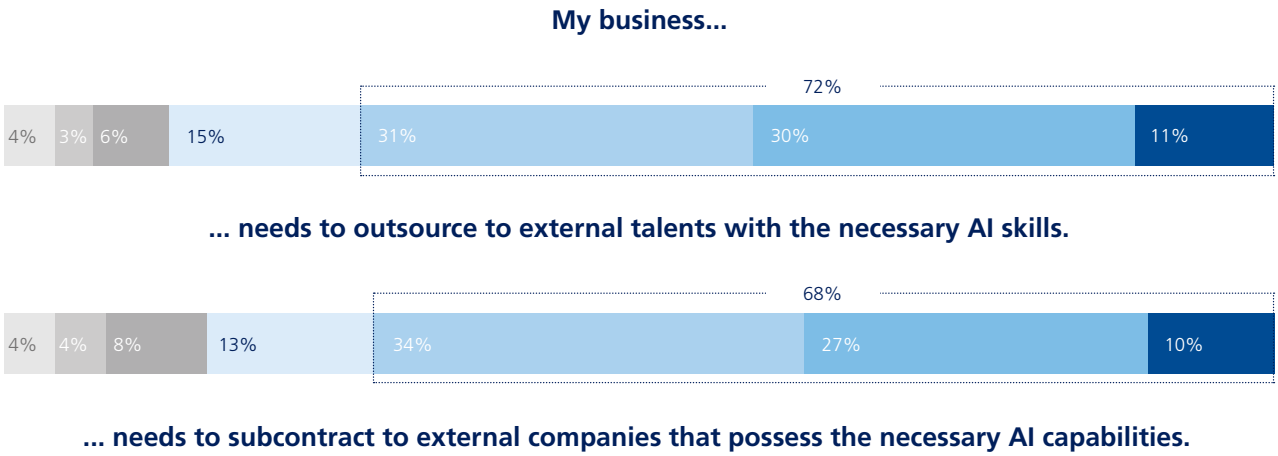


Fig. 26: Outsourcing of necessary AI capabilities to external talents and companies

Success Story
New Dimensions: paint_it

paint_it combines quality optimization, cost reduction, and efficient painting in a cloud solution – paving the way for AI-supported quality control.

Initial situation and challenges

The paint shop is a particularly important element of automobile production: it defines the design and helps to create the first impression of a car. The paint also reflects individual preferences and personal taste. Perfection is therefore all the more important. Due to the sharp rise in energy costs, paint shops in the automotive industry are facing a particular challenge, as the paint shop is by far the largest energy consumer in a plant, accounting for around 50 percent[7]. Its impact on the carbon footprint is therefore huge. A significant conflict of interest often arises between the plant management and the paint shop management due to the challenge of aligning productivity and cost reduction with sustainability requirements.

To tackle these challenges, innovative solutions are required. The software solution paint_it supports the implementation of integrated data management and analytical tools and facilitates consolidation and analysis of the data. These measures help to boost the efficiency of the painting processes while still ensuring the quality of the painted products. As no provider was able to meet the requirements and needs of a German car manufacturer, the decision was made to work with MHP to develop a proprietary software tool. The result: paint_it. The German car manufacturer is now using the solution for two different end-of-line (EOL) tests.

In the production chronology, the software is first used during the EOL test of the paintwork. Here, after the complex painting process including a dip tank and application of several layers of paint, the quality of the color, paint structure, and layer thickness is measured. After the body has been painted, other vehicle parts are assembled such as spoilers and bumpers, which the supplier delivers already painted. To ensure that no minor damages, such as scratches, occurred during assembly, the entire vehicle is tested again after assembly in the EOL test of the overall process. A color matching test ensures that the color of the supplied parts corresponds to the color of the rest of the body. paint_it was an important step in the optimization of the painting processes and is now part of the successful operational activities at the German car manufacturer.

Approach and functionality

How exactly does paint_it work and what are its key features? paint_it is the intelligent solution for fast, automated quality monitoring. Through automated quality control and a central database, paint_it boosts efficiency and reduces costs. With the planned integration of AI into the system, paint_it will also help to establish artificial intelligence as a key element of quality control.

Detailed view of the evaluation of color measurement

[7] Based on: Fraunhofer-IPA, energy efficiency in paint technology

”With paint_it, companies benefit from a flexible application, which can be used to analyze the three most important quality parameters independently of the measuring device manufacturer. The data processing optimizes the painting process and makes it future-proof.”

Moritz Gessner
Product Manager paint_it

Results

Consolidated insight into color, structure, and layer thickness of paint. The solution makes it possible to consolidate data relating to the color, paint structure, and layer thickness of paint finishes and to present it clearly in a software solution. This makes it easier to monitor these important parameters to ensure that the quality of the painted surfaces meets the required standards. Thereby, three goals can be achieved:

1. Reduction of material use
One of the most effective ways of reducing material consumption is to reduce the thickness of paint layers, e.g. by not using a primer. For certain parts, such as the hood, material consumption savings in the lower double-digit percentage range are possible. This increases quality control requirements. paint_it is compatible with automatic measuring cells but can also integrate manually collected measurements irrespective of the manufacturer, which ensures transparency and flexibility. Quality control with paint_it can result in material savings of up to 12 percent, depending on the component – a huge cost factor.

2. Reduction of energy costs
Energy costs can be reduced through process optimization – while maintaining the same production target. One example of optimization is the above-mentioned layer thickness: not only does it save material, it also reduces furnace time. The thinner the paint, the less time it needs to dry. The time in the furnace and therefore the energy costs can be reduced. Improved color synchronization also reduces the consumption of energy and material costs. For such process optimizations, data transparency is essential. paint_it creates precisely this transparency as the software evaluates quality data at the end of the production line and thus allows conclusions to be drawn about optimization potential.

3. Reduction of personnel costs
Personnel costs are crucial for competitiveness, especially in Europe. Rework is a major cost factor in the paint shop. paint_it enables a reduction in reworking hours through trend analyses, as it indicates impending quality deviations at an early stage. This results in substantial savings: with paint_it, up to 5,000 hours of rework per plant in the paint shop can be saved annually.[8]

Outlook

paint_it is used for comprehensive data collection and coordination, making it possible to lay the technological foundations for future implementation of an AI model for advanced data interpretation. In the future, an AI model will enable further interpretation of the data through proactive trend analyses, which will be achieved by integrating additional process parameter data, e.g. from painting robots, combined with quality control data. This integrative approach leads to a deeper understanding of the individual parameters, which ultimates results in the provision of AI-supported recommendations for action via a dedicated application.

[8] Data comes from a calculation for the German car manufacturer.

It is worth highlighting that companies in the UK and the DACH region, in particular, report deficits in the AI skills of their employees. In the UK, only 31 percent of the participants agreed with the statement that they had enough staff with the necessary technical AI skills. In the DACH region, this figure was 36 percent. Agreement with this statement was much higher in the USA, where 51 percent of the participants believed they possessed sufficient qualified personnel. Once again, China leads in this area, with 86 percent of participants agreeing. At the same time, Chinese businesses are also at the forefront of providing AI-related training opportunities – 91 percent of the respective participants reported offering such programs. In contrast, in the DACH region, only 29 percent of provide such training to their employees (Figure 27).

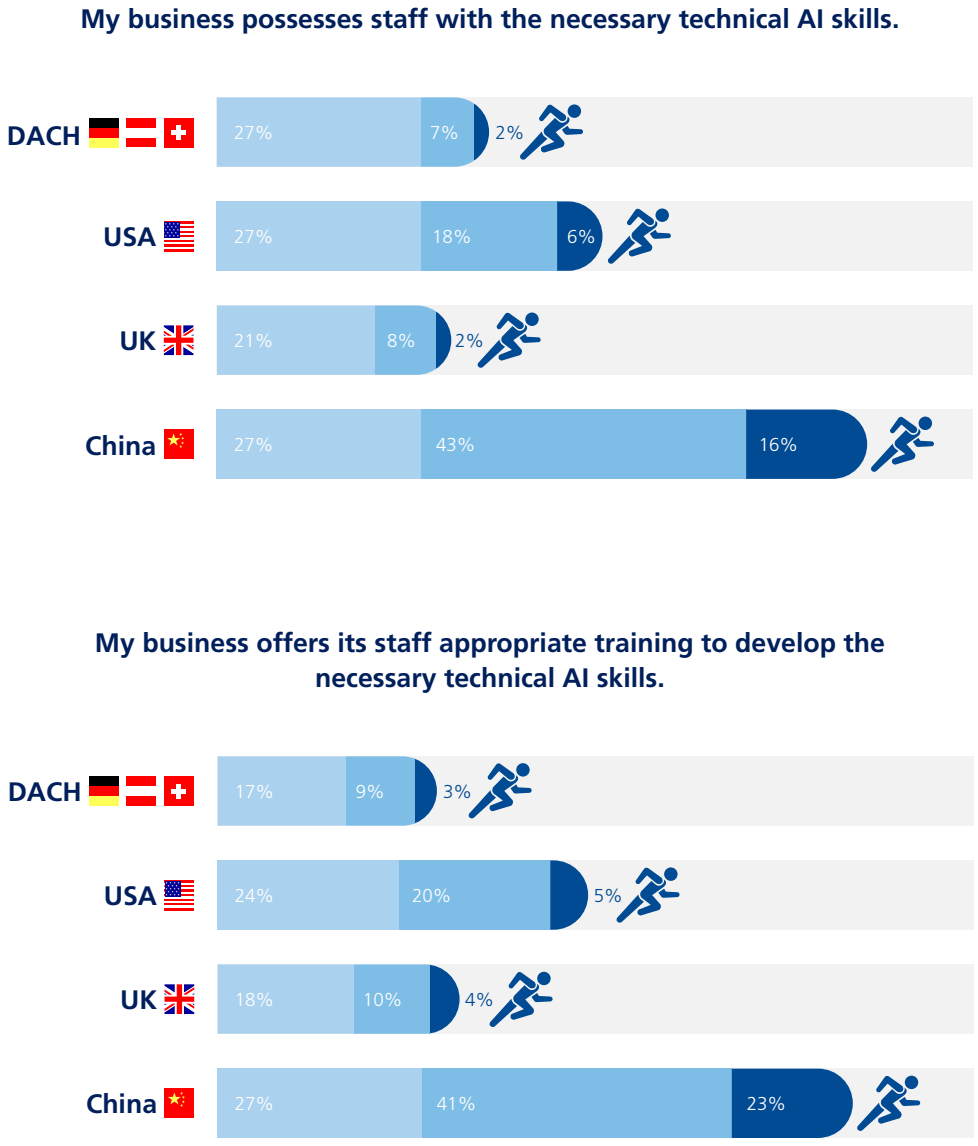


Fig. 27: AI skills at businesses by region

Interview

DB Group subsidiary "Ideas Train"

Project "Ideas Train" – Profile

With its project "Ideas Train" (original German name: "Ideenzug"), DB Regio started an offensive to convince as many people as possible to make the move from the car to the more climate-friendly railway. Thanks to novel, attractive interior design and equipment of the rail cars, rail travelers should in future have a choice on how to spend their travel time. Particularly commuters from rural areas spend a considerable time of their workaday life on the train. The idea is to enable them to use this time more efficiently and in greater comfort, for instance by already doing some work during the journey to work or by engaging in some leisure activity on the way back. DB Regio considers itself an innovation driver and intends to create concrete offerings for the different regions and their contracting authorities throughout Germany to further the development of regional rail traffic.

Julian Follner – Short vita

One of the first "Ideas Train" team members, Julian Follner joined DB subsidiary DB RegioNetze in 2016, where he developed and was responsible for what became the IdeenzugRegio. As Overall Project Manager, he then oversaw the transformation of the "Ideas Train" concept at Südostbayernbahn into a track-worthy prototype. Apart from the "Ideas Train", he managed further innovation projects, such as onboard WLAN and the provision of mobile telephony facilities along branch lines operated by Südostbayernbahn.

In addition to working on these projects, he completed part-time studies at Wilhelm Büchner Hochschule in Darmstadt. He took a Bachelor's in Technical Computer Science, specializing in Communication Technology, and a Master's in IT Management, specializing in IT Security

Participants: Julian Follner ("Ideas Train" Project Manager), **Dr. Christina Reich** (MHP), **Julian Engel** (MHP)

Dr. Christina Reich (MHP): Could you please give us a brief insight into your tasks as Project Manager for the "Ideas Train" at Deutsche Bahn?

Julian Follner (PM "Ideas Train"): I have been working at Deutsche Bahn (DB) for over seven years, among other things as Project Manager of the "Ideas Train" at Südostbayernbahn. The project was started seven years ago, prompted by the impending completion of the autobahn to Passau. It was obvious that Südostbayernbahn would lose passengers to this autobahn. The purpose of the project was to find solutions to this challenge. What can we offer our passengers to keep them on the train? Or to further the mobility transition: What can we do to make rail travel more attractive? To this end, we developed a prototype that made the first ideas accessible and tangible. The logical next step was a genuine rail car that has been used in normal operation since 7/3/2023, serving as a sort of real-life test laboratory that allows us to gain insights for the fleet and further development.

Julian Follner, "Ideas Train" Project Manager

Reich: According to our survey, the most frequent use cases for artificial intelligence (AI) in companies can be found in quality assurance, measures to increase resource efficiency, and supply chain optimization. In which areas does Deutsche Bahn use AI-based solutions and what role does the "Ideas Train" play in this?

Follner: We use AI systems to investigate damaged cars as part of predictive maintenance. For this purpose we use gantry cameras that observe the cars as they drive by and can visually detect scratches on the car body or defective window panes. This information can then be passed on directly to the workshop. In the "Ideas Train" itself, we have installed a seat detection

system. Once again using image recognition, this system recognizes whether seats are occupied or vacant and whether, for instance, there is only an object lying on a seat. By allowing accurate forecasting, this system will become very relevant for our future capacity and occupancy planning. Currently, we user laser sensors fitted to the entry doors to measure the capacity utilization of our trains. The laser sensor technology is an additional component that makes a vehicle more complex. What we are aiming for, though, is to make the vehicles simpler. We could use the recognition software to replace that technology and provide more useful information.

Reich: Could you give us some examples of concrete advantages or achievements that have been or are expected to be gained from use of these AI solutions, including the "Ideas Train"?

Follner: The camera gantry has revolutionized damage car recognition. While there is a schedule of regular maintenance inspections, similar to the mandatory TÜV inspections, the camera gantry helps provide a forecasting estimate of the time when maintenance is actually required. This technology enables us to recognize whether a car is distorted or otherwise damaged, and we can also check the wheel rim wear. This also helps with ensuring punctuality because it allows us to take quick decisions on when a car should be removed from the track and act accordingly.

Reich: How do you measure long-term use of Industrial AI in your organization? Or put another way: how are AI projects prioritized or evaluated?

Follner: As is the case with other solutions, decisions on AI solutions are made on the basis of whether we can save money in the medium term through use of the technology. However, another, even more important criterion for us is the question of whether it can help improve train punctuality. Ultimately, that is what we check out every time.

Julian Engel (MHP): What challenges does the use of the seat recognition system entail in normal operation and how did you resolve them?

Follner: There is no solution to date. That has to do with the fact that regional rail travel in Germany is organized via separate companies, so-called "Aufgabenträger" (contracting authorities). In Bavaria, for instance, Bayerische Eisenbahngesellschaft (BEG) puts out a tender for a transport contract for the track network that stipulates seat capacities and requirements relating to passenger comfort. A mileage price is calculated on the basis of these requirements and other rail transport companies can apply for the contract as well. This means that ultimately there is hardly any money left for new technology or that these technologies would need to provide great savings to compensate for the costs.

As the subject of further development is important for both the BEG and politically, there is the possibility of making use of innovation budgets for Research & Development. In that case, cost-effectiveness calculations don't play such a big role. Another influencing factor is that new technologies relating to the track or the rail cars require approval. Not only does this take one to two years to obtain, it also generates enormous costs and makes planning difficult. We also have to bear in mind that the technologies need to be agreed with the rest of Europe to ensure system interoperability.

Another crucial factor is that it is difficult to take responsibility for decisions made by the AI. This means that there often still has to be a human sitting in the background to check whether the software algorithm is working correctly. This nips cost-efficiency in the bud. Consequently, the previous way of doing things is frequently still cheaper and more secure, also from a legal point of view.

Engel: Could one driving factor for the future be that the state provides Deutsche Bahn with a greater innovation budget to enable you to use AI to a greater extent in your projects, such as the "Ideas Train"? Or what could make the crucial difference for enabling Deutsche Bahn to drive more innovation?

Follner: That's a matter of politics. The customer is not prepared to spend more money to enable us to use new technology. They demand a punctual product at rather low prices, as you can tell from the "Deutschlandticket" (€49/month, covering local and regional public transport). This ticket puts even more pressure on the system, both financially and in terms of capacity.

Engel: According to our survey, there is a shortage of AI-skilled workers. How do you see the situation?

Follner: I agree and I would even go further: We don't just have a problem finding skilled workers, but any labor. We are having trouble to attract people even for the simplest tasks in our day-to-day operation, such as cleaning the cars or the stations. Instead, we are

partly falling back on external service providers, as in the case of software for the seat recognition system. But external providers bear a certain risk. To minimize this risk, attempts are now being made to work with a spread of providers. This does mean that technologies such as the seat recognition system need to be integrated with other systems, which increases costs yet again. But the main problem is a lack of people who know how the railroad, IT, or AI works.

Engel: Who is generally involved in the integration of AI technology at your organization?

Follner: We have an IT company in our group that offers software for damaged car recognition. But in most cases, we commission external service providers. The camera gantry is used above all for the cargo trains of DB Cargo. That is a separate rail transport company. However, the camera gantry technology is part of the infrastructure of DB Netz AG, which is itself a separate company with its own interests. When we need to build something in the track environment, we also have to involve the EBA, the German Federal Railway Authority, as supervisory body. Our specialist engineers catalog and interpret the measured data and image data provided by the software and add their comments. They can, for instance, provide an evaluation on whether a wheel rim will last another half a million kilometers or whether detected damage is critical and the car needs to go into the workshop.

Engel: What long-term AI goals do you envisage in your organization? Which developments have a chance of becoming relevant in the next few years?

Follner: Predictive Maintenance will continue to be of importance. I believe that this technology may help solve the skills shortage. Currently, a so-called "Wagenmeister" (wagon inspector) checks the cars on a daily basis. While there are some junior staff to take over this role, they are far and few between. The purpose of the technologies is to relieve these people of some tasks so that they can concentrate on others that cannot yet be taken over by AI. The same goes for issues relating to timetables. Currently, timetables are still created and edited manually because the network is very complex. AI may make flexible capacity planning possible as well, for instance. Currently, the number of cars stipulated in the transport contract is made available, whatever the actual demand. Using AI, travel behavior during the previous two months as well as year-on-year changes in travel behavior could be analyzed to gain some insights for the future.

Since many people have chosen to regularly work from home, trains tend to be more sparsely occupied on Fridays. From Tuesday to Thursday, on the other hand, trains are full. To date, this could only be observed, but not systematically analyzed. In conjunction with a database, automatic counting systems could provide interesting insights very easily. These could prevent wear and tear on cars that are not needed and lower fuel consumption.

We are in the process of collecting the relevant data, bundling it in one place, and making it available for everybody. Until a few years ago, we were still working with a vast array of different systems and greatly diverse interfaces, which made the whole thing very complex.

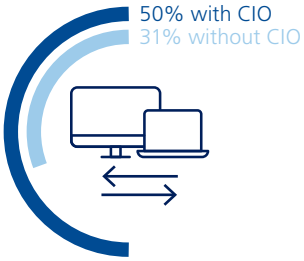
Reich: Added to this is probably the fact that you are a separate company and have to overcome more than just departmental boundaries.

Follner: That is one of the reasons. We also use systems such as signal box technology that is already over 100 years old and operated by levers and muscle power. There are no sensors on those. Instead, the stationmaster is responsible for making an entry of the train's arrival and departure time on the computer. The seat recognition system could be useful for optimizing stop times. It could enable us to tell travelers which cars are already full so that they can move towards the location where another car will stop before the train has come to a stop at the station.

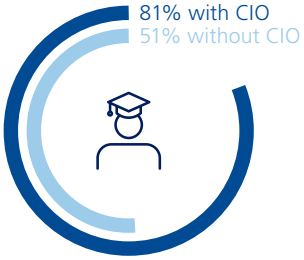
Engel: What's next for the "Ideas Train"?

Follner: The "Ideas Train" has already been in regular operation. You can check the timetable on the Südostbayernbahn website and travel on it with a normal ticket. The trial period, during which we run numerous surveys in connection with the project, is scheduled to last until the end of 2023. The tendering and awarding process for the track network is being conducted in parallel. Once that has been completed and depending on customer feedback, we can consider whether further cars are to be converted or whether some of the components are to be incorporated into the fleet.

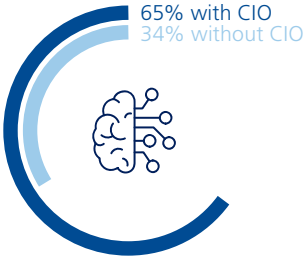
Our systems, plants and devices exchange data automatically, independently and in real time (machine-to-machine communication).



At my business, personnel skills and abilities for advanced data analysis methods are better, or even much better.



At my business, there is a high level of AI maturity in terms of our organizational AI processes.



My business provides suitable financing for AI projects.

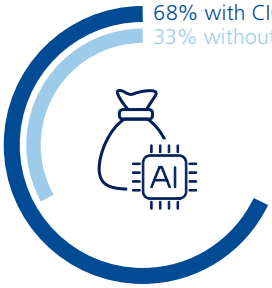


Fig. 28: Influence of CIOs on Industry 4.0 and Industrial AI

2.2.2 The role of the CIO

As part of the Industry 4.0 Barometer, the importance of the CIO for the progress of Industry 4.0 within the organization is also analyzed; this is also the case in this year's Industry 4.0 Barometer, with a special focus on Industrial AI.

48 percent of the participants stated their company had a CIO as part of their Executive Board. The international comparison revealed that Chinese businesses were once again the frontrunners here, with 83 percent stating a CIO was part of their Executive Board or Management team.

Looking at the results, a recurring pattern becomes evident: Businesses with a CIO on their Executive Board are leading in the key areas of Industry 4.0 and Industrial AI, especially in terms of Industry 4.0 technologies, data analysis capabilities, AI maturity, and the financing of AI projects.

Technology: Companies with a CIO are, on average, 61 percent more likely to deploy equipment and systems capable of automated and autonomous real-time information exchange than companies without a CIO on their Executive Board. The results show that the presence of CIOs on Executive Boards facilitates the productive implementation of Industry 4.0 technologies.

Data analysis capabilities: The difference in the participants' assessment of their data analysis capabilities compared to their competitors was particularly impressive. The surveyed companies with a CIO on their Executive Board rated their personnel's abilities and skills in advanced data analysis as 59 percent better than a company that didn't have a CIO on its Board.

AI maturity: Having a CIO as part of a business' organizational structure has a decisive impact on the maturity of AI-related organizational processes (e.g. decision-making). Participants whose businesses have a CIO rated the maturity in their business as 91 percent higher than those whose company did not have a CIO.

Financing of AI projects: The presence of CIOs on Executive Boards has a decisive impact on the implementation and efficient use of Artificial Intelligence at businesses. Accordingly, the agreement regarding the appropriate allocation of financial resources for efficient implementation of AI projects is significantly higher among participants from such businesses. Participants from organizations with a CIO on the Executive Board were 106 percent more satisfied with their

company's financing of AI projects than participants whose businesses did not have a CIO (Figure 28).

Overall, it is clear to see that companies with a CIO on their Executive Board are more successful when it comes to both the implementation of Industry 4.0 technologies and the integration of AI. A crucial factor for this could be that decisions related to Industry 4.0 and AI projects are expedited and directed by CIOs, as historically, these decisions have fallen within the purview of the IT department in most companies. Another factor could be that the presence of a CIO contributes to involving other C-level executives (CTO, CEO) in decision-making processes, thereby promoting collaboration between IT and operational departments.

2.2.3 Proposals for action

Many businesses still have a long way to go until they are using Industrial AI to its full potential. In order for this to change, it is essential for businesses to start viewing AI as an integral part of their strategy. The implementation of AI-based solutions should not be seen simply as technological progress, but rather as a strategic move that can give a business an edge over its competitors, boost its operational efficiency and help it make more efficient use of its skilled workers. To achieve this, it is essential to proactively clear the path of potential obstacles.

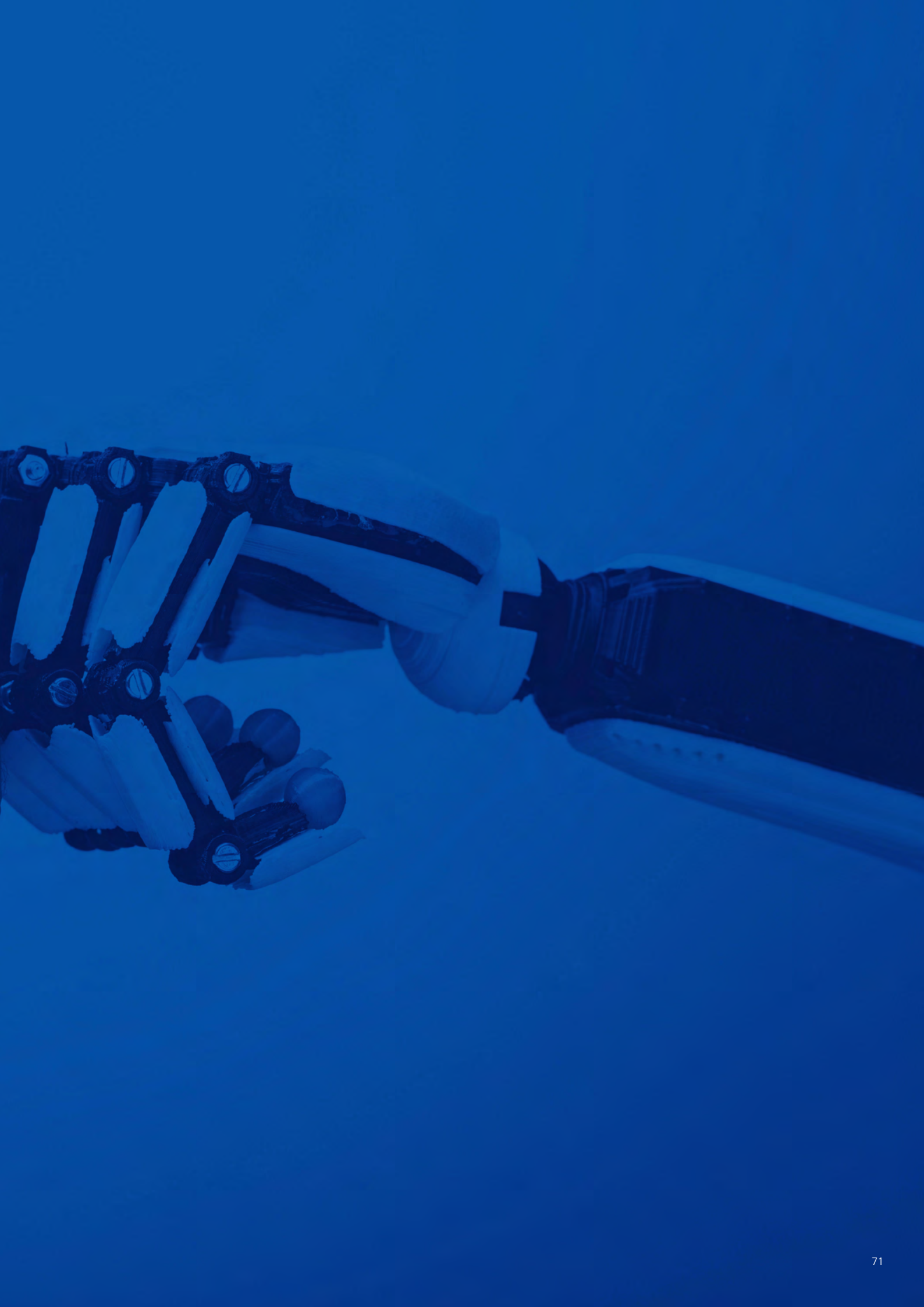
As digitization progresses within companies, outdated machinery and system landscapes are often still in use, which are not adequately prepared for the implementation of AI technologies (Figure 23). However, especially considering the tense economic situation at present, smart investments in a scalable infrastructure are advantageous. Modernizing outdated machines and systems lays the foundations for the progression of a business' digitalization, thus enabling it to make better use of the potential AI technologies have to offer and, as a result, to make itself significantly more competitive. As a result, this does imply that the business in question must accept high up-front costs with an uncertain ROI (Figure 23). There are two main factors coming into play when a business is making a concrete decision on whether to invest in AI solutions: operational efficiency and economic efficiency. A comprehensive evaluation of the ROI is required to ensure that the decision-makers understand both the short and the long-term potential of AI solutions. However, it is not enough to focus on economic aspects alone. Instead, a careful consideration of the advantages in relation to the risks and potential drawbacks is required. After all, the success of AI implementation initiatives depends not only on their economic performance, but also to a large extent on their employees' acceptance and trust in the technology (Figure 23). Targeted training opportunities, transparent communication and actively involving the workforce in the implementation process can help to emphasize the positive effects AI can have on work processes, thus improving acceptance. Pilot projects, step-by-step implementation and a holistic approach to change management provide the opportunity to demonstrate tangible benefits of AI in practice and prepare staff for the upcoming changes. In this regard, it is important to equip AI projects with comprehensive resources such as time, financial means, and skilled personnel to implement the projects successfully (Figure 24).

This goes hand-in-hand with the challenge of attracting qualified personnel and keeping them at the business (Figure 27). The shortage of skilled labor will not be solved soon and requires long-term measures. As such, it is essential to offer existing staff basic and advanced training in the field of AI, so they can be equipped with the necessary skills. At the same time, partnerships with other companies present an opportunity to ensure shared and lasting access to highly qualified experts, while involving external service providers in the process will enable businesses to learn from one another. By working with skilled internal staff who are familiar with the company and its processes, external experts can bring new specialist knowledge and innovative power to the business, thus driving the transformation process forward more quickly.

Fundamental decisions like these can be handled more easily if there is a CIO on the business' Executive Board (Figure 28). The CIO ensures that technology isn't seen simply as a supporting function for the business, but rather as an integral part of its overall strategy. Ensuring that a CIO is directly involved in strategic decisions makes it easier for businesses to align their technological investments with their overall business objectives, drive forward innovations and establish a robust IT infrastructure, which is essential for long-term success. To secure and enhance their competitiveness, companies should consider appointing a CIO or similar executive onto their Executive Boards.

3.0

Summary and outlook



“The right use of AI will determine our prosperity in the coming decades. AI is an efficiency booster and has what it takes to counteract the detrimental factors of skills shortages, demographics and location costs. Overall, I see far more opportunities than risks if we are courageous and act quickly enough.”

Dr. Oliver Kelkar
Associated Partner
Strategic Investments & Labs

For this year's edition of the Industry 4.0 Barometer, we were once again able to survey a large number of participants, conduct interviews with experts and put together MHP success stories.

In spite of ongoing global crises, it is clear that Industry 4.0 and the associated digitalization of businesses are continuing to progress successfully. Nevertheless, the results of the study indicate that the increasing global tensions are giving businesses a significant reason to invest more in stabilization and optimizing their supply chains and logistics processes. This only makes the increased use of Industry 4.0 technologies to bolster supply chain transparency, and that of digital twins to simulate, manage and optimize logistics, all the more important. These measures are seen not just as a means of boosting cost efficiency, but also as a strategic element that improves agility and resistance at every stage of the supply chain. Businesses realize that the integration of such technologies doesn't just offer operational advantages – it is also essential for ensuring that they are able to adapt to changing geopolitical circumstances.

The progress of the AI trend has played a significant role in helping businesses to recognize the importance of data and data analysis capabilities as a key factor for ensuring success and competitiveness on the global stage. The public discourse on AI is only increasing this awareness, and is pushing businesses all over the world to start looking into the potential of this technology and the applications they could use it for. The results of the survey clearly show the differences between regions in this regard. The Chinese participants rate themselves more highly than those in the DACH region, the UK and the USA in almost every area. Key examples of this include the regional differences in terms of the use of AI-based solutions and AI maturity levels.

In addition to the discussion of the potential Industrial AI has to offer, the associated risks were also highlighted. While it is clear that AI-based solutions can be used various application areas, the anticipated added value has not materialized everywhere. As such, it is essential for businesses to carefully consider the individual requirements for their use case and weigh these against the associated risks.

Current challenges for production-based AI projects at the moment are a lack of technological maturity, high up-front costs, a lack of user acceptance and the shortage of skilled labor. The latter issue has led businesses to state that they are in significant need of external experts, yet investments in advanced training and relevant courses are insufficient. As a result, Europe in particular is at risk of being cut off from the international competition, as compared to the USA and China, its level of AI maturity is low and its shortage of skilled labor more pronounced.

In addition to this, the current crises are drawing more attention to measures designed to safeguard businesses' existence, which is leading to investments in pioneering projects being put on the back burner. The results show that efficiency and economic efficiency remain the key areas of strategic focus in the field of Industry 4.0 technology, with innovation taking on a more minor role. While focusing on ROI is understandable in these challenging times, such uncertainties continue to hold businesses back from putting their digitalization roadmaps into practice. Particularly when it comes to larger investments in complex technologies or digitalization initiatives whose concrete benefits are difficult to quantify straight away, it is clear to see that an approach focusing solely on ROI is not helpful. After all, a certain amount of risk is unavoidable if you want to grasp the opportunities on offer. Nevertheless, it is important to stress that the use of Industry 4.0 technologies – and especially Artificial Intelligence – should not be accepted regardless of the cost. In fact, careful consideration of the usefulness and benefits of such technology as weighed against the associated risks and potential downsides is a must.

Outlook

The use of AI is essential for any business that hopes to remain operational and competitive in the face of diverse challenges such as increasing complexity, a growing shortage of skilled labor, and more demanding goals in terms of sustainability, flexibility and productivity. And while China and the USA seem to be further down the line in terms of their digital progress, it is crucial for European businesses to investigate the potential offered by Industrial AI and objectively question any concerns they have.

Industrial AI may still be in the early stages in the DACH region and the UK, but these regions can still tap into incredible sources of potential if they can just overcome the obstacles and continue to make progress in the field of Industry 4.0. The businesses themselves can provide the foundations for rapid progress as, right now, they don't seem to be being held back by external regulations.


4.0
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Industry 4.0 Barometer 2024
On behalf of MHP Management- und IT-Beratung GmbH:

"Thank you to everyone who took part and all our experts for your assessments and opinions. This study would not have been possible without your support. Special thanks to the LMU Munich University for the successful and consistently productive collaboration."

About MHP

As a technology and business partner, MHP has been digitizing the processes and products of its around 300 mobility and manufacturing sector customers worldwide for 27 years and providing support for their IT transformations along the entire value chain. For the management and IT consultancy, one thing is certain: digitization is one of the biggest levers on the path to a better tomorrow. This is why the Porsche AG subsidiary provides both operational and strategic consulting in areas such as customer experience and workforce transformation, supply chain and cloud solutions, platforms and ecosystems, big data and AI, as well as Industry 4.0 and intelligent products. Headquartered in Germany, the consultancy operates internationally with subsidiaries in the USA, the UK, Romania and China. More than 4,500 MHP employees are united by their pursuit of excellence and sustainable success. It is this aspiration that will continue to drive MHP – today and in the future.

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