



MACHINE NUMER: S/N 212793

**CB54684Q**

Production Capacity: 409/day

Uptime: 99%

Energy State: Active

Pressure: 42/3

Auto Errors: 0

CONNECTED

SYSTEM

- Part 02  
98%  
BN298364S
- Part 03  
95%  
LW234568F
- Part 04  
99%  
CB54684Q
- Part 05  
97%  
AA31534H

**MAINTENANCE TRAINING**

MACHINE NUMER: S/N 212793

737  
COURSE LEARNER  
COURSE SECTION

LOC: SUEZON

CEC 9313	
SYSTEM NO	SEM NO
1	584
2	784

THIS MACHINE QUALITY CAN BE IMPROVED AND MAINTAINED BY TRAINED AND EXPERIENCED PERSONNEL. THE QUALITY OF THE OPERATION OF THE MACHINE IS DEPENDENT ON THE QUALITY OF THE MAINTENANCE AND REPAIR WORK. ALL REPAIRS MUST BE PERFORMED BY TRAINED AND EXPERIENCED PERSONNEL.

MHPSTUDY

# INDUSTRY 4.0 BAROMETER 2020

” Thank you very much.

In the name of **MHP Management- und IT-Beratung:**  
To all participants for supporting the study with their  
evaluations and opinions as well as to the partners of  
our expert interviews.

A special thank you goes to the **Ludwig-Maximilians-  
University of Munich** for the successful and always  
productive cooperation.”

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February 2021



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” The Industrie 4.0 Barometer builds on MHP’s holistic consulting approach and highlights the various areas and facets of the digital transformation. “

**Markus Wambach**  
Member of the Board of Management  
Head of Consulting Services

# 01 Preface

Ladies and Gentlemen,

At the start of last year, the coronavirus pandemic meant that many companies – whether small, medium-sized, or multinational – were forced to halt production for periods of time that would previously have been unthinkable. Even before the coronavirus crisis, companies required certain essential skills – flexibility, responsiveness, and innovativeness – to compete in volatile markets with dynamic customer needs.

As far as industrial production is concerned, the past year has vividly demonstrated that a successful digital transformation to the Smart Factory will not only be crucial to the success of many companies over the next few years, but also vital for their survival. This is exactly where MHP comes in, with its aim of delivering holistic end-to-end consulting. We regard our customers as partners and provide them with dedicated support in their digital transformation – from top floor to shop floor, from strategy to implementa-

tion, and from development to sales. We stand by your side.

The Industrie 4.0 Barometer builds on our holistic approach by highlighting the different areas and facets of the digital transformation. These range from strategy, the use of technologies and the performance of IT infrastructure right through to the drivers and challenges associated with the rollout of Industrie 4.0 solutions, as well as topics such as 5G and cloud services. The annual survey allows us to keep a close eye on changes in the Industrie 4.0 maturity level and the potential for improvement, as well as to identify industry trends.

This year’s study is the third that we have published together with Prof. Johann Kranz (Ludwig Maximilian University of Munich). Our partnership with Prof. Johann Kranz is not only long-standing and based on trust, but also guarantees

the highest possible standards of excellence. Furthermore, I would like to thank the top-class experts (over 200 in number) who took the time during the challenging year that was 2020 to respond to our Industrie 4.0 Barometer study.

I hope that reading the Industrie 4.0 Barometer 2020 is a pleasurable experience for you, and I wish all of us the very best for 2021.

**Regards,**

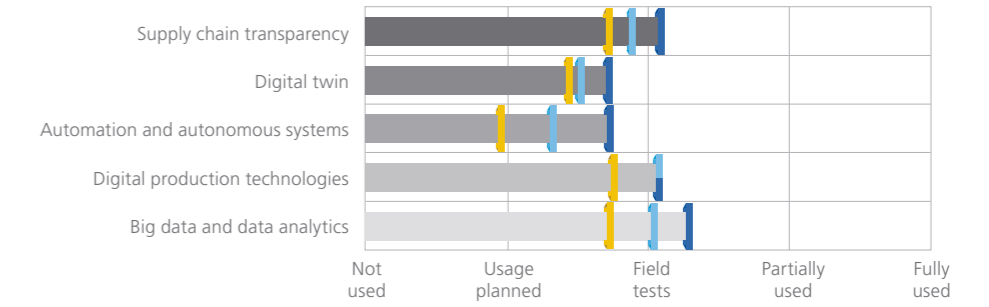


**Markus Wambach**  
Member of the Board of Management  
Head of Consulting Services

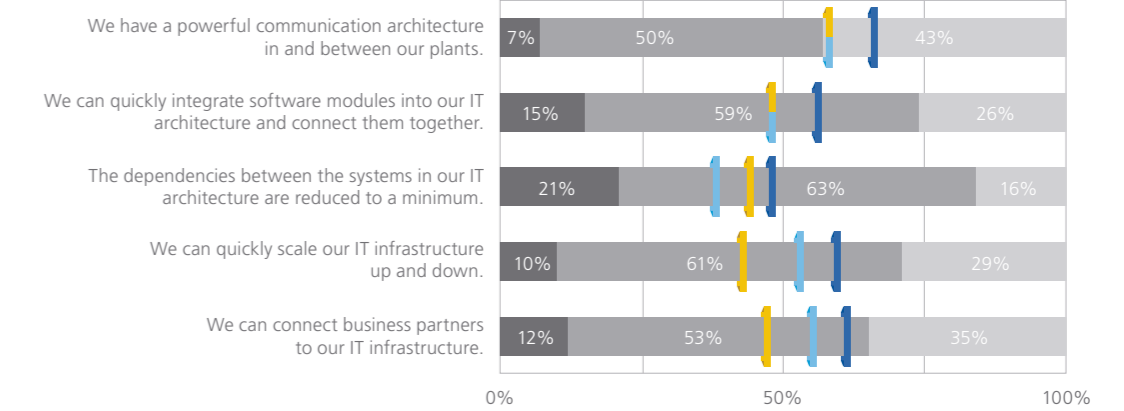
# Industry 4.0 Barometer Executive Summary 2020

## Implementation of Technology is Increasing in the Industry

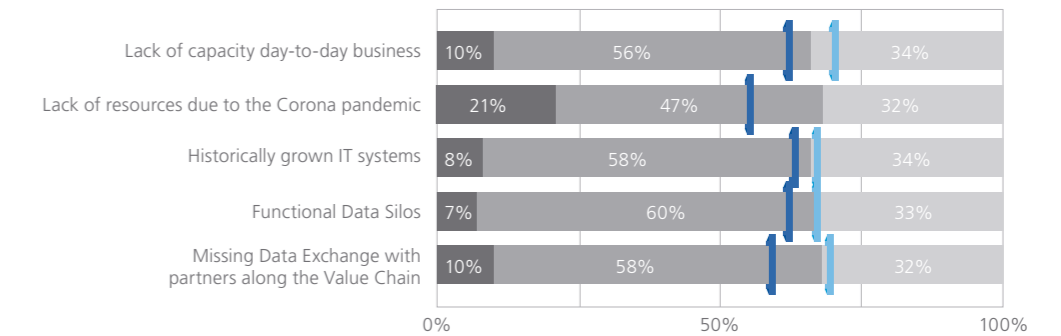
Aggregated presentation of technology penetration in German industry



## There is a Drive to Develop IT Infrastructure



## Capacity Bottlenecks and Outdated IT Infrastructures are Slowing Down Industry 4.0



Legend: Disagree (Dark Grey), Neutral (Medium Grey), Agree (Light Grey), Barometer value 2018 (Yellow), Barometer value 2019 (Blue), Barometer value 2020 (Dark Blue)

## Key Findings



**Companies whose executive management team includes a CIO display a higher Industry 4.0 maturity level.**

Extensive digitalization expertise at executive management level is the most important asset for a successful digital transformation.

**Cloud services are increasingly becoming the focus of companies, but there is still room for improvement when it comes to rollout.**

Currently, many companies are using cloud solutions for local improvements instead of global cross-departmental optimizations.

**Data analytics technologies and methods are gaining more attention, the availability of data along the value creation chain is increasing, and data silos are gradually being torn down.**

High-performance IT architectures and system landscapes can deliver competitive advantages by significantly accelerating the rollout of innovative solutions.

**As in previous years, the development of IT infrastructure is lagging behind technological progress.**

IT development is driven by technological progress.

**5G technology holds enormous potential, but it is still in its infancy as far as industrial applications are concerned.**

The majority of companies are currently still at the planning and testing phase.

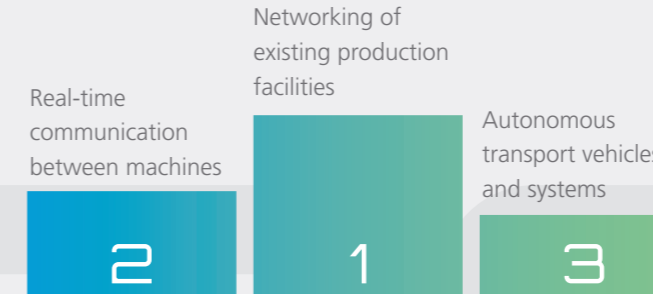
**The sheer volume of work involved in day-to-day business continues to pose a major obstacle to the introduction of Industry 4.0 technologies, in particular in the automotive sector.**

This phenomenon is being reinforced by the impacts of the coronavirus crisis, such as the widespread introduction of short-time work.

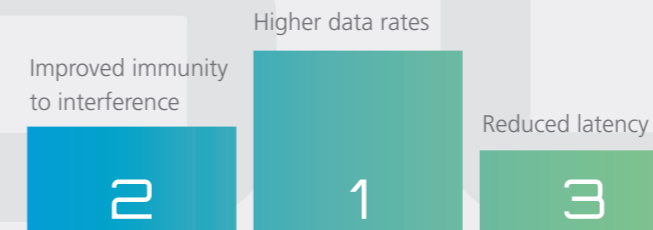
**Optimization instead of disruption – companies persist with efficiency improvements instead of developing new business models.**

The coronavirus pandemic has obscured our vision of the future.

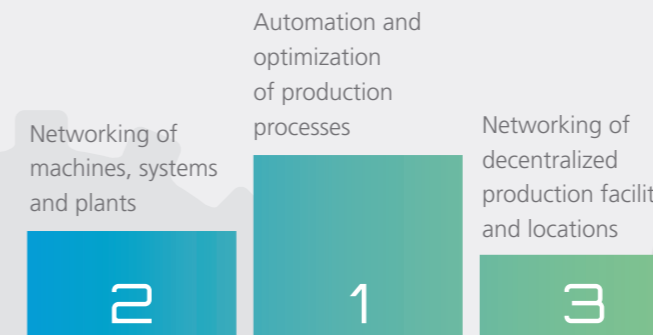
## 5G and Cloud Services are Expected to Optimize Direct Value Creation



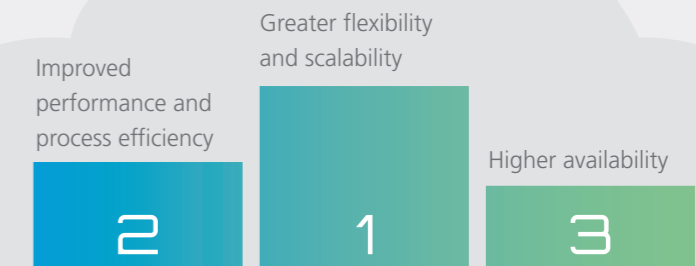
Top 3 application scenarios for 5G



Top 3 goals for 5G



Top 3 application scenarios for cloud services



Top 3 goals for cloud services

## Recommended Actions

### Build cross-industry partnerships and benefit from the pooling of skills!

Cross-industry collaboration provides access to unique expertise and additional resources, allowing partners to tap into innovation potential that would otherwise be unattainable.

### Push modular and flexible IT architectures and streamline system landscapes!

Obsolete and redundant systems need to be eliminated so that capacity can be created for a flexible and highly scalable infrastructure that enables the rapid integration of partners.

### Break down monolithic IT systems and increase data availability!

Data silos must be broken down to enable the exchange of data across departments and companies as well as to create and exploit new optimization potentials.

### Scale innovative solutions to the maximum and leverage synergies!

Industry 4.0 calls for holistic thinking and end-to-end solutions as a basis for the global scaling of optimization potential – both within the company and with external partners.

### Create space and capacity for the digital transformation!

Day-to-day business must not be a systemic obstacle to innovative projects. Due to their complexity and scope, sustainable success of Industry 4.0 solutions requires consistency and adequate resources.

### Build up digitalization expertise in the executive management team!

The executive management team needs to understand the added value as well as the rules of the digital transition and to drive cross-divisional collaboration with agile organizational models. The role of the CIO is suitable for identifying and implementing necessary changes.





# The MHP Industry 4.0 Barometer 2020

## 2.1 Details of the Study

This year's Industry 4.0 Barometer is divided into five main content-based clusters:

- **Technology:** Use of Industry 4.0 solutions
- **IT Integration:** Performance of the company's internal IT infrastructure
- **Strategy & Goals:** Strategic focus of Industry 4.0 activities
- **Drivers & Barriers:** Positive and negative factors in the implementation of Industry 4.0 solutions
- **Special Topic for 2020:** Significance and use of 5G and cloud services

The main clusters are further divided into subclusters. The developments and trends that can be observed in terms of the differing responses to the individual questions are outlined with reference to results from recent years.

## 2.2 Expert Interviews and Case Studies

In addition to the survey results, the Industry 4.0 Barometer 2020 also includes interviews with industry and research experts as well as case studies on the use of Industry 4.0 solutions in practice.

Interviewees were asked to give a personal appraisal of the current status for the German industry with regards to the digital transformation, and to provide examples of applica-

tions and digitalization initiatives within their own organization. The case studies turn a spotlight on successful use cases for Industry 4.0 solutions and technologies. They cover the initial challenges faced by the user, the procedure for implementing the solution and the most important outcomes are outlined.

## 2.3 Study Participants

The results of the Industry 4.0 Barometer 2020 are based on responses from 211 participants working at different hierarchical levels and in different functional areas within companies of various sizes that belong to various industrial sectors in German-speaking countries (Germany, Austria, Switzerland).

## 2.4 Evaluation Methodology

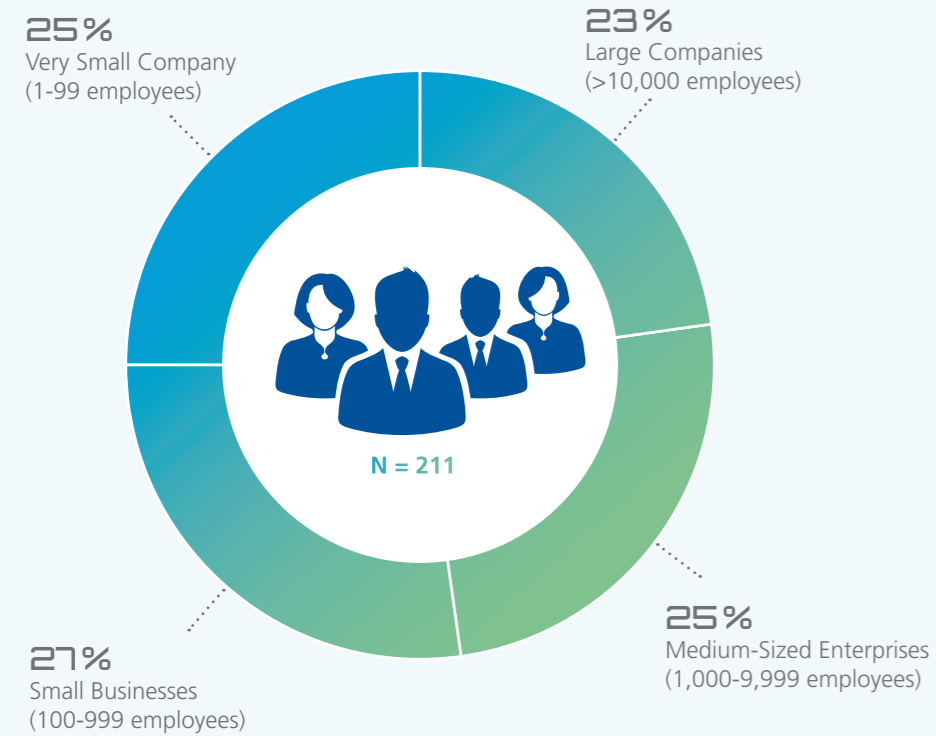
The responses to the questionnaire are based on five-point or seven-point likert scales. For a clear evaluation the participants' responses were clustered. In addition to the distribution of the responses, the weighted arithmetic mean was calculated as a percentage and is referred to as the barometer score in the study. For calculation purposes, the five-point and seven-point Likert scales were transformed into metric scales with the values 0–4 and 0–6 respectively. After multiplying the metric scale values by the respective relative frequencies from the responses to the individual questions, the weighted arithmetic mean was divided by 4 and 6 in proportion to the scale, to obtain a barometer score between 0 and 100 per cent. Given that the Industry 4.0 Barometer is a periodic survey, the barometer score can be used as a benchmark.

In addition, the results were compared on the basis of different characteristics of the participants and their companies. On the one hand, responses by participants from the automotive sector (manufacturers and suppliers) are compared against those from other industrial sectors (the reference industries). The departments to which participants belong (IT department or specialist department), the size of their company and whether their company's executive management team includes a CIO are used as further comparison criteria for evaluating results.

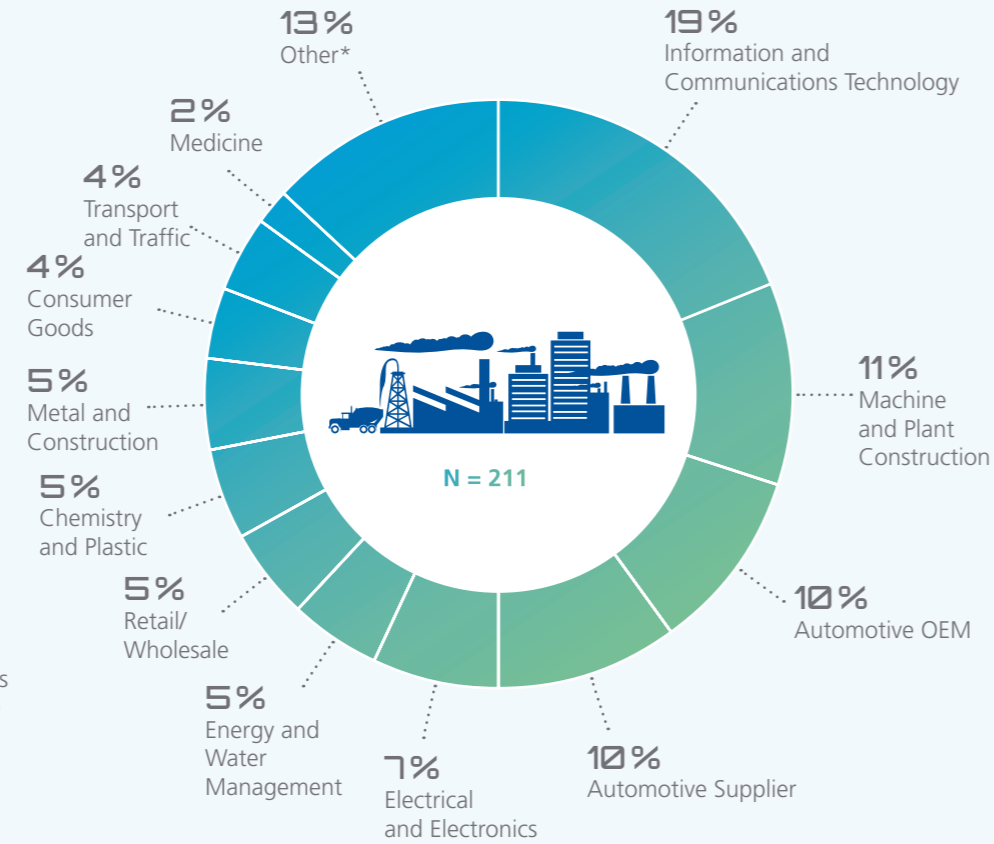
The responses were collected and evaluated anonymously.



## Company size

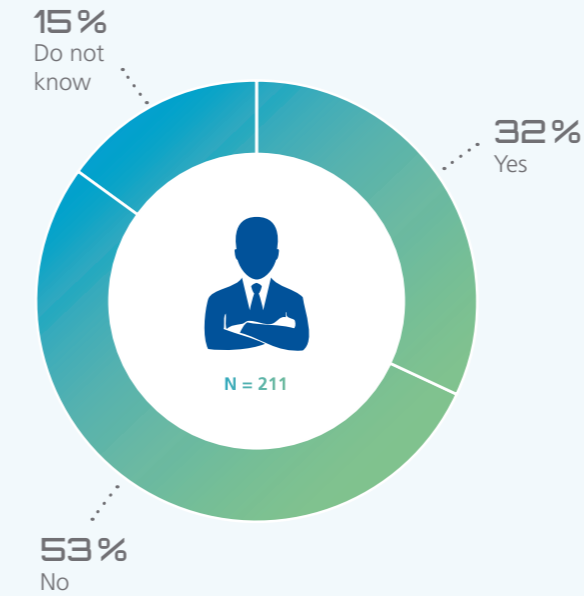


## Industry

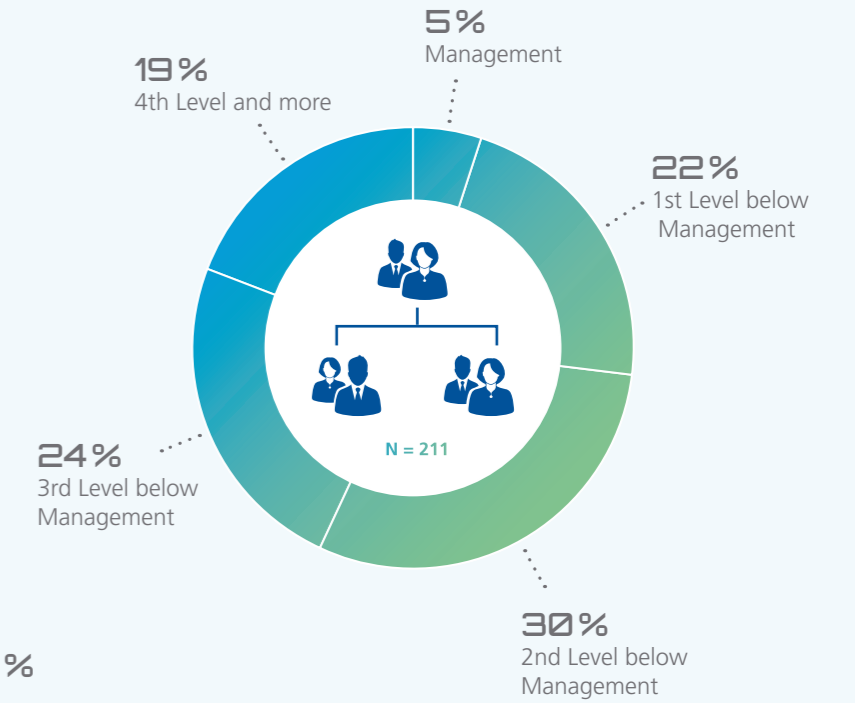


\* Communications/PR/Advertising (3%), Agriculture/Forestry (1%), Furniture (1%) and Other Industries (8%).

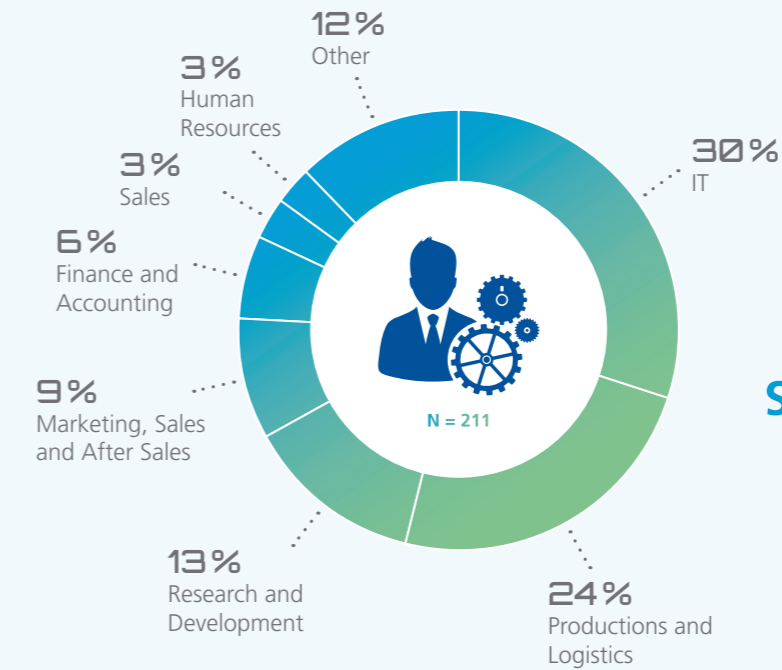
## Role of the CIO



## Hierarchy level



## Specialist department





# 03 Results of the Study

## 4.1 Technology Cluster

### Technology usage on the rise across the industry

An increase in the level of technological maturity can be observed across all sectors, particularly with regard to the use of automation solutions in manufacturing (+9 per cent). This confirms the positive trend of recent years, which must be continued for successful across-the-board digitization. There is still room for improvement, however, since many of the barometer scores are in the middle bracket. The highest scores can be observed for machine data acquisition (62 per cent) and plant remote control (66 per cent).

There has been a sharp increase (+16 per cent) in the use of sensor technologies – not only in relation to in-house data, but also along the entire value chain. Sensors can be regarded as an enabling technology, since the collected data can be evaluated using complex analytical techniques, and the findings obtained on this basis can be used for improvement measures. In particular, cross-company data collection is essential for the development of innovative end-to-end solutions for the optimization of entire supply chains.

### The automotive sector is making progress

Based on an industry comparison, the automotive sector performs better than the reference industries in terms of its use of automation solutions (+12 per cent) and digital production technologies such as 3D printing (+14 per cent). This demonstrates the pioneering role of the automotive sector. Industrial cloud platforms such as those established by Volkswagen working with Amazon Web

Services or BMW working with Microsoft are outstanding examples of collaboration, and drive forward the development of innovative production applications. The underlying cloud infrastructure makes it possible for new solutions to be scaled quickly and globally in the production network.

The factors of autonomy (+18 per cent) as well as agility and flexibility (+19 per cent) are also more significant in the automotive industry than elsewhere. Autonomous manufacturing processes and modular production technologies can increase flexibility and reduce response times in the face of dynamic customer requirements and environmental conditions, providing companies with a competitive edge.

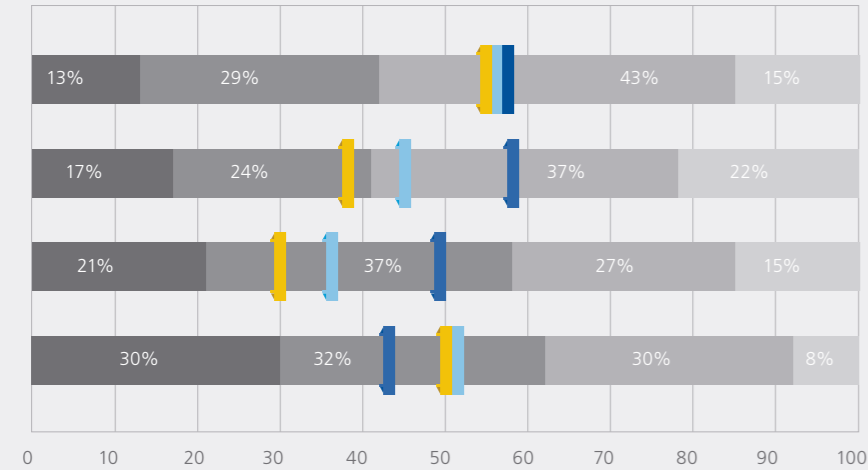
### CIOs are a driving force within the executive management team

Companies whose executive management team includes a Chief Information Officer (CIO) exhibit a higher level of technological maturity, especially when it comes to using data analysis solutions (+10 per cent). This suggests that IT and digitalization expertise at the top management level can be an advantage for a successful digital transformation. A CIO can discern the added value of a technological backbone as the basis for across-the-board digitalization of the company and drive forward this process from executive management level.

It is also noteworthy that the level of technological maturity of participants' companies varies considerably. An average of 73 per cent lies between the barometer scores of the technology frontrunners (top 20 companies in the Technology cluster) and the technology stragglers (last 20 companies in the Technology cluster).

Furthermore, it can be observed that large companies have a higher level of technological maturity (+10 per cent or higher) than small and medium-sized enterprises. This may be attributable to the increased need for innovative solutions in the face of more complex supply chains and distribution networks. On the other hand, the increased availability of financial and human resources can serve as a key driver for implementing Industry 4.0 solutions.

## Technology Supply Chain Transparency



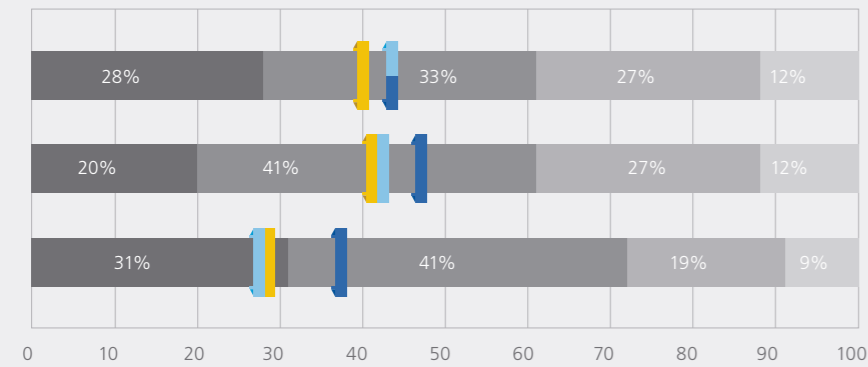
Information about components can be traced back to the manufacturer and timings can be determined.

We can locate all individual parts of our products as well as end products within our factories.

We can locate all individual parts of our products as well as end products throughout the entire value chain (from incoming logistics to production and customer service).

Our plants and systems in production, warehousing and logistics are equipped with sensors to record and transmit environmental parameters and condition data.

## Technology Digital Twin



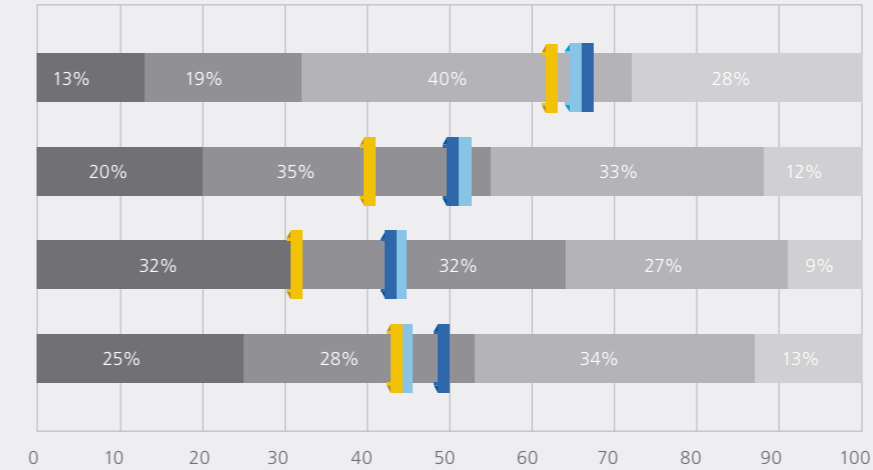
For our production facilities, we have a digital image that contains process and status data and enables simulations.

For our products, we have a digital image that contains detailed process and condition data related to the product.

For our entire value chain, we have a digital image that contains process and condition data and enables simulations.

No use
  Use in planning or practical tests
  Partial use
  Complete Use  
 Barometer value 2018
  Barometer value 2019
  Barometer value 2020

## Technology Digital Production Technologies



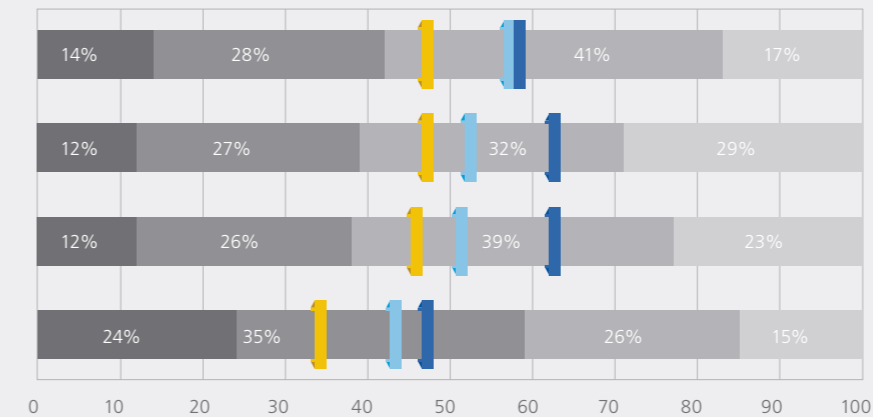
Our plants and machines can be controlled remotely via software.

Our plants and machines can be integrated into and collaborate with other plants and systems.

We integrate additive manufacturing methods into our production process (e.g. 3D printing of spare parts).

We use modular production technologies to increase agility and flexibility in our production process.

## Technology Big Data Analytics



Our plants and machines transfer their operating and machine data in order to indicate maintenance requirements and trigger them independently (condition monitoring).

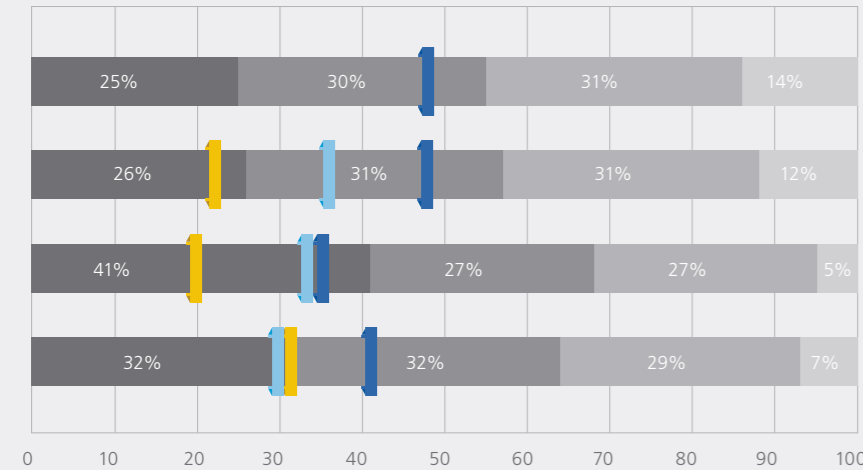
All operating and machine data of our plants and machines are recorded centrally and are available for analysis at any time.

We continuously collect and analyze data along the entire value chain (from incoming logistics to production and customer service).

We operate a central data platform with data that is made available to selected partners along the value chain.

No use
  Use in planning or practical tests
  Partial use
  Complete Use  
 Barometer value 2018
  Barometer value 2019
  Barometer value 2020

## Technology Automation and Autonomous Systems



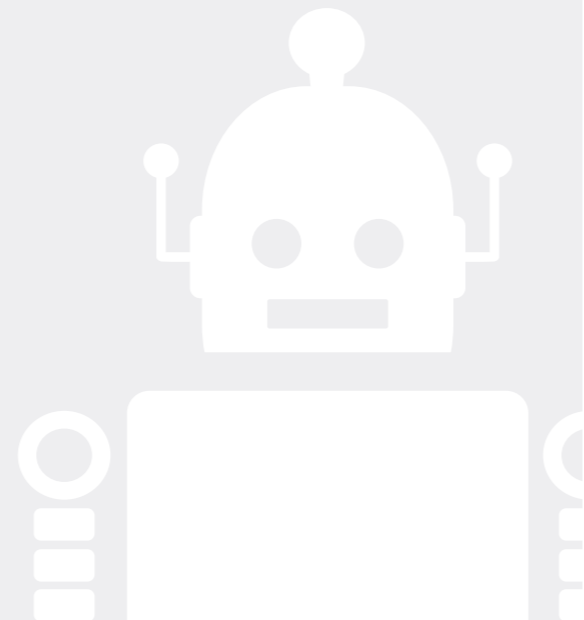
Our company operates cross-system integration software that independently and automatically controls processes in production, warehousing and logistics.

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

We use machines and robots that organize themselves autonomously.

There are business processes in production, warehousing and logistics that can independently trigger actions, control themselves or enhance themselves.

No use
  Use in planning or practical tests
  Partial use
  Complete Use  
 Barometer value 2018
  Barometer value 2019
  Barometer value 2020



“The barometer shows that companies are investing more in digital technologies. Otherwise, it reveals that Industry 4.0 is considered too much from the technical side and in silos.”

However, cross-divisional structures and strategies are crucial for success in order to realize the economic potential of the data and service layers.”

**Prof. Dr. Johann Kranz**

Leiter der Professur für Internet Business and Internet Services an der LMU München

# Expert Interview

Thomas Wölker  
REHAU



## Brief resume Thomas Wölker (REHAU):

Thomas Wölker has been Head of Integrated Business Solutions (IBS) and CIO of the REHAU Group since June 2016. As part of this role, he is responsible for the Business Information Management and Business Service Center divisions. Thomas Wölker was previously CEO and Chairman of the Management Board of ThyssenKrupp IT Services GmbH.



The REHAU Group is a polymer specialist with annual sales of around EUR 3.3 billion. The independent and stable family-owned company has approximately 20,000 employees at more than 170 locations worldwide. Around 12,000 employees work for REHAU across Europe – 8,000 of them in Germany. REHAU manufactures solutions for the construction, the automotive industry and the industrial sector. For more than 70 years, REHAU has been working on making polymer products lighter, more comfortable, safer, and more efficient. The company supplies its innovative products to countries throughout the world.

REHAU is involved in the 50 Sustainability & Climate Leaders initiative, which means that it is actively engaged in the fight against climate change through the responsible use of resources, durable and innovative products, and sustainable investments.

The interview with **Thomas Wölker** (REHAU) took place on December 16, 2020 and was moderated by **Dr. Katharina Hölck** and **Thomas Stošić** (both MHP).

## Katharina Hölck (MHP):

REHAU is an international leader in polymer-based innovations and systems. What makes your company special? As a family-owned company, does REHAU perhaps even have an advantage over large corporations when it comes to innovation projects?

## Thomas Wölker (REHAU):

REHAU is a family-owned company with a 70-plus-year history characterized by consistency and constancy. We were also able to successfully manage the year 2020 despite the crisis. The breadth of our position on the market worked to our benefit. We manufacture products for a very wide range of sectors – from the automotive industry and the construction sector through to the furniture industry.

## Thomas Stošić (MHP):

Which obstacles do you believe that REHAU needs to overcome on its path to a successful digital transformation?

## Thomas Wölker:

Our situation is typical for a company with a long history. We have extremely heterogeneous structures, many different best-of-breed solutions, and custom-designed processes in the individual plants. We are making progress toward standardization, but we still need time. **The challenge we face is to move from a very heterogeneous landscape to a standardized one. Besides our main tasks – rolling out SAP systems across the different departments, for example – we need to harmonize data structures and plant-specific hardware as well as to increase our flexibility. For example, with appropriate integration layers or data lakes, how can we make data actionable for forward-looking consider-**

**ations? I like to talk about a multimodal IT in this context. This means we have to cope with the different speeds resulting from the extreme heterogeneity of our customers in terms of digitization.** The automotive sector displays a comparatively high level of standardization, mainly due to the German OEMs in our case. In other areas like the construction sector, however, we have different challenges in regards to digitization when working together with large furniture manufacturers or with single craftsmen. For example, the backward integration as well as the forward integration are key challenges.

## Katharina Hölck:

The IT integration into production is a decisive factor towards a future-proof, efficient, and high-quality production. In your opinion, what are the keys to success when integrating digitalization solutions into traditional production processes?

## Thomas Wölker:

It is important to start with the processes and data models by always keeping the question in mind: What do I want to achieve by when? More ambitious targets, such as full digitalization up to and including digital twins, are certainly goals that we also want to achieve. As I said, however, our company is extremely heterogeneous. That means we need to start implementing rational use cases and to ensure their success is transparent and visible to everyone, including the family members who finance the company. After that, our task is to roll out use cases in a standardized approach to replicate them. This is both a critical factor and a challenge for us, and that is where we are focusing our efforts. We are currently in the process of completely digitalizing extrusion lines for the construction industry, which is one of our main revenue drivers. That involves connecting the relevant machines and replacing some of them in order to collect data and to ensure that data can be evaluated in an intelligent way. Our first steps in this direction have been a suc-

cess. Hence, we plan to continue the complete digitization of our plants within the furniture division. We would also like to continue moving forward in the automotive sector, where we are not yet quite as integrated as we had hoped. Each plant is different, and – if I may be frank – we have put things on hold for the time being after introducing standardized software at Layers 2a and 2b (ISO/OSI layer model Ed.). That is why we are currently using workarounds and proprietary developments as a means to achieve the integration and to connect to higher layers such as ERP or PLM in a second step.

## Thomas Stošić:

REHAU is working together with the University of Erlangen-Nuremberg, Leipzig University and the e-commerce provider Intershop to make products and services as durable and resource-efficient as possible. Should companies offer their customers not only new products, but also product-adjacent services in the form of new business models? How does REHAU develop its own business models?

## Thomas Wölker:

We follow a 70:20:10 approach. In future, we plan to generate 70 per cent of our sales from our core business, such as bumpers for automotive OEMs. Product-adjacent solutions and services will account for 20 per cent of our future business, such as the services we offer in connection with the supply of polymers. I can provide an example from our windows division. We do not only extrude the window frame in close cooperation with the window industry, but also offer complementary solutions in the field of safety technology by incorporating sensors developed in-house into the window frame. Moreover, we offer a service for providers that allows tradespeople to configure REHAU windows themselves in our online shop. And the last 10 per cent relates to the completely new and highly disruptive product lines that we plan to create. “Rebado” is a good example. It is a furniture system for sanitary applica-

tions. By means of the appropriate adaptor system, polymer plates can be affixed to tile section so that bathroom renovations can be carried out quickly and without any dust. **We have special teams working on our disruptive ideas who are not tied up with keeping the business going on a day-to-day basis, but are explicitly asked to devote all of their time and energy to digitalization. We regard IT and electronics expertise as critical success factors.** That is why we have integrated new product developers into our departments who possess this expertise. They always start with the product and the customer in mind. Ultimately, it is the customer we manufacture our solutions for.

**Katharina Hölck:**

As a manufacturing specialist, REHAU covers the entire value chain. For example, it delivers supplies directly to automotive manufacturers' production lines. Are your customers aware of the importance of end-to-end data availability and data analysis along the entire value chain for Industry 4.0?

**Thomas Wölker:**

The diversity of our customer base means that it would be impossible to provide a single answer to that question. Many tradespeople have not yet gone digital. We act more as a driving and supporting force in this case. In other areas, such as the automotive industry, our customers are demanding backward integration and want to know when a bumper will go into production, and when it will finally be available in the right color. **Overall, a higher level of standardization can be observed in the automotive sector than in other sectors. The greater the proximity to the OEM, the higher the degree of integration, including forward integration toward the customer. Yet the more individualized the industry – for example in the trades – the less likely it is that opportunities for integration will be leveraged.**

**Thomas Stošić:**

Research into 5G technology is constantly expanding, and the first industrial companies are also testing its potential applications. What is REHAU's position on the use of 5G?

**Thomas Wölker:**

Currently, we are in an observer role. We have not yet reached the point to test a 5G use case. Yet in spite of all the problems we face in connection with our heterogeneous structures, we are considerably more automated and digitally advanced than many of our competitors. Our IT penetration and automation levels – right through to the production line – are higher than those of our competitors in the automotive sector, which is why an additional 5G rollout would not generate enormous benefits. Matters are very different for our other divisions. In some cases, it depends on where our customers are located. At the moment, however, there are no indications that 5G would be hugely beneficial for us. In my opinion, we must first incorporate enabling technologies into our offering so that we can achieve end-to-end consistency in terms of processes and data models. Only then should we consider whether a pilot project involving 5G technology might be a good idea.

**Katharina Hölck:**

There is an ever-expanding range of cloud services. Does your company already use cloud services? Is there perhaps still untapped potential in this area?

**Thomas Wölker:**

We have been talking about changes to the IT landscape from my very first day at REHAU, four and a half years ago. At the time, REHAU was not using a single cloud application anywhere in the company. One by one, we started to move all of the company's applications into the cloud. Our Social Intranet is cloud-based, as are our WebEx technologies. We use file sharing solutions and SharePoint in

the cloud. Meanwhile, we are also working with Amazon Web Services to digitalize the data models of our extrusion lines via the cloud. We also discuss cloud-related options with the OEMs. Data protection restrictions are obviously a key factor in this respect. We are moving more and more things into the cloud. In my opinion, however, we have not yet gone far enough, since we are still using on-premise solutions in key areas such as our ERP systems. It is my firm belief that we should also move these systems into the cloud. We should turn away from hardware and transfer our operations to third parties that can supply the necessary technologies and staff.

**Katharina Hölck:**

What action does your company take to keep up with international competition?

**Thomas Wölker:**

We do a great deal. Let us take customer and market development as an example. Like many other companies, we used to have a large number of sales offices. Unsurprisingly, the ones that still operate around the world no longer reflect the state of the art. These offices are going digital, but they are places where customers can talk to us directly – “touch and feel.” At present, however, we are consolidating our sales offices, and we want to offer more digital solutions, such as our window configurators for local tradespeople. REHAU's approach therefore varies greatly between the different divisions. We are in no doubt that we need to move away from individual customer relationships. We need to make progress with our network of plants as well as our customer and market development.

**Thomas Stošić:**

The results of the Industry 4.0 Barometer 2020 reveal that companies whose executive management team includes a CIO exhibit a higher level of technological maturity than their counterparts. Do you agree with this? How do

you envision the role of the CIO in the future of digital transformation?

**Thomas Wölker:**

If you ask CIOs whether they think they ought to be part of the executive management team, many will answer, “Absolutely!”. But I see things a little differently. **I am not particularly interested in roles and hierarchies; what matters to me is having a say on the really important issues. The CFO is the IT representative at the executive management level at REHAU. It is important to me that he, as my superior, sees IT as adding value and not as a cost factor. Another decisive factor is that our top management has a strong understanding that successful digitalization is crucial to our future success, and that is an enormous help. We see digitalization as a huge opportunity rather than a threat. This mindset is much more important than the CIO's level of responsibility.**

**Katharina Hölck:**

Mr. Wölker, our warm thanks for this fascinating discussion.



## 3.2 IT Integration Cluster

### Level of IT maturity rises but remains mid-range

There is a sharp rise in the maturity level of the IT architecture compared to previous years (+9 per cent). In particular, significant improvements have been observed in the areas of modularization (+10 per cent), integration capacity (+7 per cent), and performance (+9 per cent) of IT architectures. Overall, however, the level of maturity remains at a very average of 54 per cent, which implies that there is far-reaching potential for improvement in terms of IT landscapes. It is noteworthy that companies with a CIO in the executive management team have are more integrated IT-landscape (+6 per cent). Once again, this shows that a CIO's digitalization expertise constitutes a key factor in driving forward the digital transformation within an enterprise. There is an industry-wide consensus about the increasing complexity of the IT system landscape in connection with Industry 4.0. The resulting need for the deployment of service-oriented architectures has been identified in particular by the automotive industry (+9 per cent). This trend can be attributed not only to the reduction of system dependencies and monoliths, but also to the faster integration of suppliers into existing production and logistics systems (+9 per cent).

### Technology deployment drives IT architectures

Furthermore, it can be observed that companies are pushing cooperation with partners in order to achieve global and cross-company optimization. At the same time, a growing number of companies are relying on a higher-level backbone. It follows that the use of public cloud platforms is becoming increasingly popular (60 per cent). These incorporate an adequate number of standard applications while

leaving room for the integration of new applications and the development of proprietary solutions.

Technology frontrunners, or in other words companies with a comparatively high level of technological maturity, also demonstrate a higher level of IT maturity (76 per cent). It can be concluded that the introduction of new and complex technologies gives rise to a greater need for innovative IT architectures.

### New technologies are gaining a foothold in the field of data processing

Another emergent cross-industry trend is the improvement of technical data infrastructures for the purpose of advanced data analytics (+11 per cent). The use of advanced analytical methods such as data mining and artificial intelligence is a vital prerequisite for partially and fully automated decision-making in business processes (+6 per cent).

Constantly changing parameters of complex control structures have caused the industry to recognize the existing potential and benefits of big data analytics. The flood of data continues to rise, and the growing volume of unstructured data in particular require new solutions. Innovative technologies are needed to process and analyze unstructured data from heterogeneous sources. In addition to highly available storage systems for large data volumes, such as Hadoop, more and more in-memory technologies are becoming an popular option for performing complex, real-time analysis of structured enterprise data (+11 per cent).

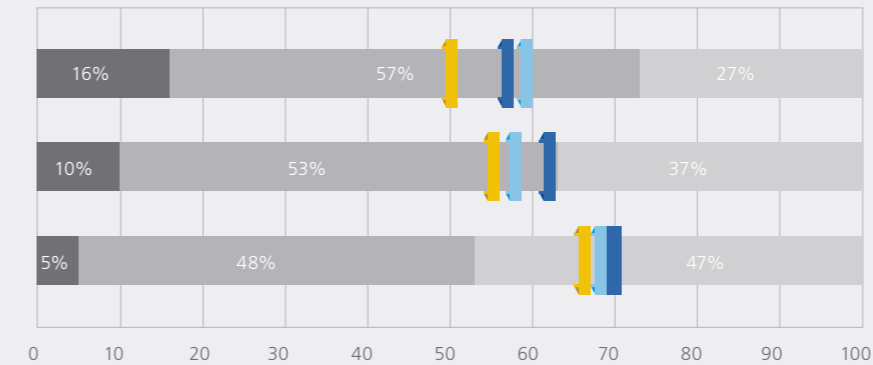
Across all industries, companies' expectations of modern and comprehensive data processing are clear: loosely coupled systems, end-to-end interoperability and high-performance processing mechanisms are key prerequisites for future efficiency gains and the development of new business models.

### IT security is highly relevant

Large companies (67 per cent) have made more progress than small and medium-sized enterprises (52 per cent) as far as the scalability of IT architectures is concerned. The use of cloud solutions has a particularly positive impact on the scalability of IT systems and applications, but can also lead to unintended security vulnerabilities.

The threat of systematic cyber attacks on individual components of IT architectures is increasing. However, the integration of recognized security standards (83 per cent) and cyber security competencies (81 per cent) is a top priority, especially for large companies. It may be inferred that the critical nature of in-house IT structures for the digital transition is increasingly being recognized, and that these structures are being given the protection they deserve.

## IT Integration IT Standards

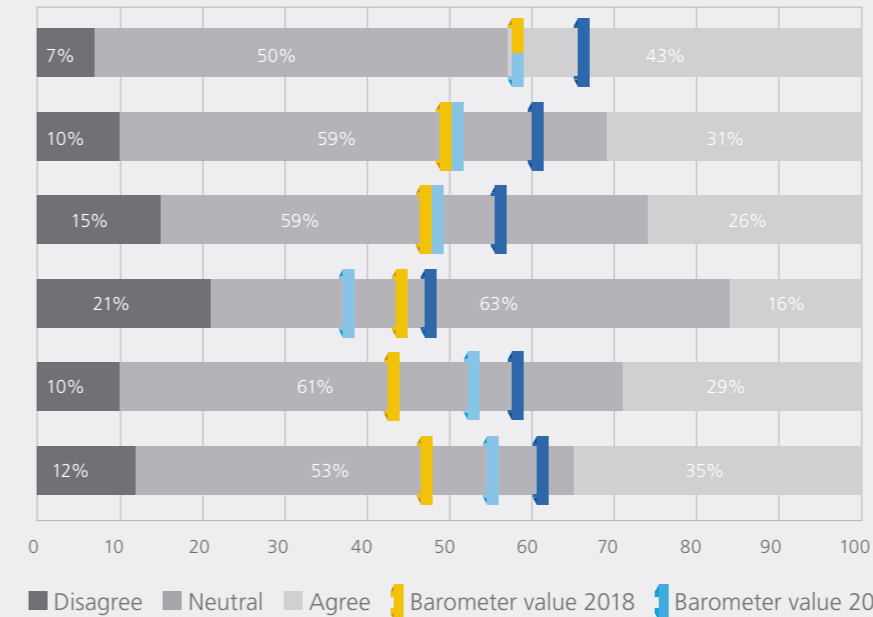


We coordinate with our partners along the value chain regarding the use of uniform communication standards and data formats for Industry 4.0 projects.

Where possible, we use open and non-proprietary\* standards for communication in our plants, devices, systems and products to ensure the interoperability of our systems.

Our IT infrastructure and those of our partners follow industry standards.

## IT Integration IT Architecture and Scalability



We have a powerful communication architecture in and between our plants.

All of our business processes are built on an integrated, service-oriented IT architecture.

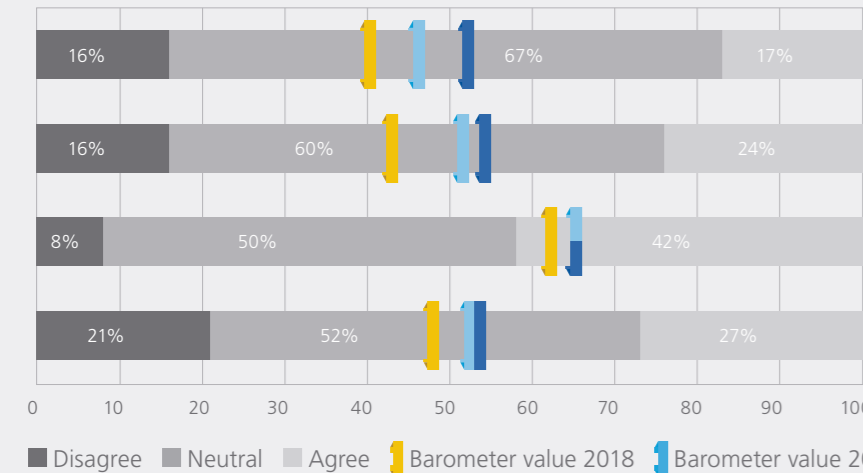
Our IT architecture is based on the modular principle, i.e. software modules can be quickly integrated and connected together via defined interfaces.

The dependencies between the systems in our IT architecture are reduced to a minimum.

We can quickly scale our IT infrastructure up and down (e.g. by using cloud solutions).

We can connect business partners via application programming interfaces (APIs).

## IT Integration Platform and Connectivity



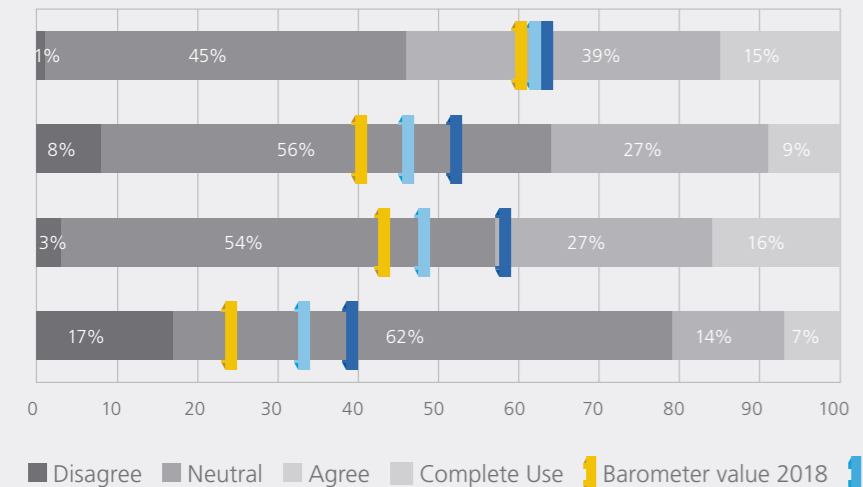
New applications and functions can be quickly integrated into critical applications, depending on the end user requirements.

We use a software platform to integrate our partners in the supply chain into our systems (for IT, production).

Our IT architecture is becoming more complex due to Industry 4.0, e.g. by point-to-point connections of applications.

In our company, there is a clearly defined roadmap of how our IT architecture should look in the future with Industry 4.0 (e.g. integration or replacement of legacy systems).

## IT Integration Data Analysis



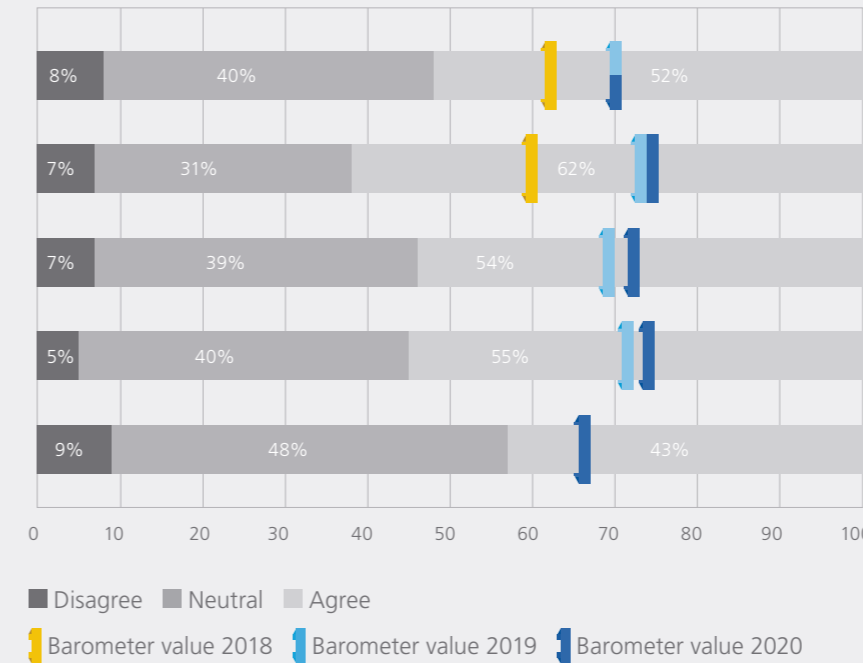
Continuous processing and management of data (high level of availability, up-to-date, consistent), e.g. in a data lake or data warehouse.

Skills and competencies of staff for advanced data analysis methods e.g. artificial intelligence, data mining, machine learning).

Technical infrastructure for advanced data analysis (e.g. in-memory databases, distributed file system, GPU server, Hadoop, Spark).

Partially and fully automated decisions in business processes through artificial intelligence or machine learning.

## IT Integration IT Security



Access to operating data and machine data is clearly regulated by a standardized identity and access management system.

Our company has defined guidelines regarding the security and usage of machine data.

The IT security officers have a special say in important decisions.

The use of our own or third-party Industry 4.0 applications takes into account recognized security guidelines (e.g. end-to-end encryption, ISO 27001).

Our company has sufficient equipment and expertise to prevent cyber attacks (through service providers, where appropriate).





# Smart Factory Program

The following case study is based on a project carried out by MHP at an international energy and automation technology group. The Smart Factory Program is designed to help customers digitalize their global production network.

## Initial situation and challenges

As part of a global digitalization initiative by an international energy and automation technology group, a pilot plant was selected as a subject for a comprehensive Smart Factory assessment. The assessment was made in order to determine the level of digitalization readiness, to identify potentials, and to leverage these potentials in a targeted manner in coordination with the group's headquarters. The Smart Factory Assessment procedure and successful digitalization initiatives in the pilot plant are to be incorporated into an overall concept that will serve as international guidance for other group locations.

## Methodology

A bottom-up approach was initially applied by identifying the current production processes, IT system landscape, and product portfolio by means of structured process inspections and workshops. This was

supplemented by a top-down approach involving meetings with the pilot plant management to select the relevant departments for the Smart Factory Program and to define the most important KPIs for the evaluation of digitalization use cases. The bottom-up analysis of the location and the top-down definition of the basic parameters and targets served as a basis for completing the individual steps of the Smart Factory Program at the pilot plant.

The first stage involved identifying the current challenges of the selected departments for the Smart Factory Program (Planning, Production, Quality, Maintenance, and Production Logistics) and their present maturity level of digitalization, together with the relevant function holders. In addition, department-specific targets were developed and presented visually. A standardized template was used to define detailed use cases on the basis of the challenges, the individual targets, and suggestions from the MHP use case catalog. Dependencies between the use cases were identified and situated on a strategic roadmap with clear spheres of activity. The use cases were then prioritized and assessed on the basis of their potential. Internal and external implementation partners were identified for the prioritized use cases, and the implementation projects were evaluated on the basis of business case calculations. First projects with a positive business case were initiated in consultation

with the group headquarters. Existing digitalization projects were also taken into account and expanded to include additional use cases. As a result, the pilot plant was able to play a pioneering role in the group's Smart Factory journey, and is now in a future-proof position and ready for the years to come.

## Results and outlook

The efforts toward digitalization undertaken by the pilot plant to date were jointly evaluated, structured, and further developed over the period of a few weeks. Several workshops were held together with the customer for the purpose of developing a clearly defined Smart Factory Roadmap based on customer-specific challenges and individual targets. In addition, in-house and out-of-house solutions that would ensure rapid and long-term mitigation of the challenges for the customer were evaluated. Both short-term savings potentials (over a period of up to one year) and longer-term potentials (over the next five years) could be identified as part of the project. Measures were set up within the project as well as experts and implementation partners were directly involved with a view to ensuring the lasting success of the project.



### 3.3 Strategy & Objectives Cluster

#### Interest in being a technological frontrunner and introducing new business models has waned

As was the case last year, disruptive targets such as the development of new business models (64 per cent) or the development of new market and customer segments (65 per cent) score highly across all industries, but optimization targets (which are more evolutionary in nature) are prioritized more heavily. Particularly in large companies and in the automotive industry, the primary aim is to use Industry 4.0 solutions to increase profitability (84 per cent) and product quality (77 per cent).

Both of these developments can be regarded as consequences of the coronavirus crisis. Due to the unpredictable course of the pandemic and the associated planning uncertainties, the likelihood increases that large-scale and long-term initiatives will be put on hold for the time being. A look at entrepreneurial orientation reinforces this assumption. Particularly in the non-automotive sectors (+16 per cent), the executive management team does not place much value on the role of a technology frontrunner.

#### Reference industries are leading the way in the field of cross-departmental cooperation

Further differences between the automotive sector and the reference industries can be observed in cross-departmental cooperation. Cooperation of this kind is more apparent in the reference industries. This is particularly apparent from the extent to which the agenda is set jointly by the business departments and the IT department (+5 per cent). In addition, there is a higher level of consensus between business and IT departments in the reference industries

about the role of IT throughout the company (+9 per cent). Closer coordination by means of regular workshops, jointly defined strategies and target images can be a successful way of breaking down internal silos within the company.

#### CIOs can strengthen cross-departmental competencies

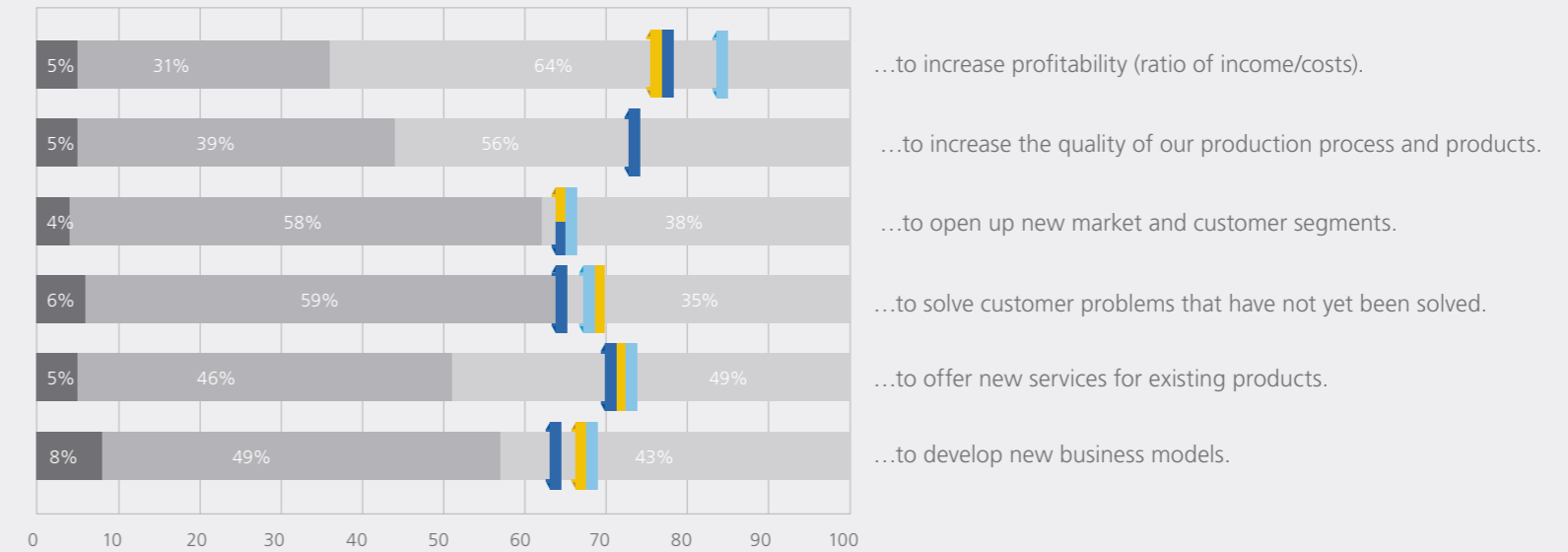
This is another way in which the inclusion of a CIO in the executive management team can prove to be an advantage. On the one hand, business departments in companies whose executive management team includes a CIO have a significantly better understanding of the added value of IT for process and product optimization (+11 per cent). On the other hand, employees in these companies also have more training opportunities available to them to expand their technical skills. In turn, the knowledge they gain in the process can have a positive impact on workforce innovativeness.

In addition, the very same companies are also more focused on developing new business models (+10 per cent) and services for their own products (+7 per cent), and on resolving customer issues that have remained unresolved to date (+10 per cent), which is evidence of a greater willingness to innovate yet contradicts the general trend.

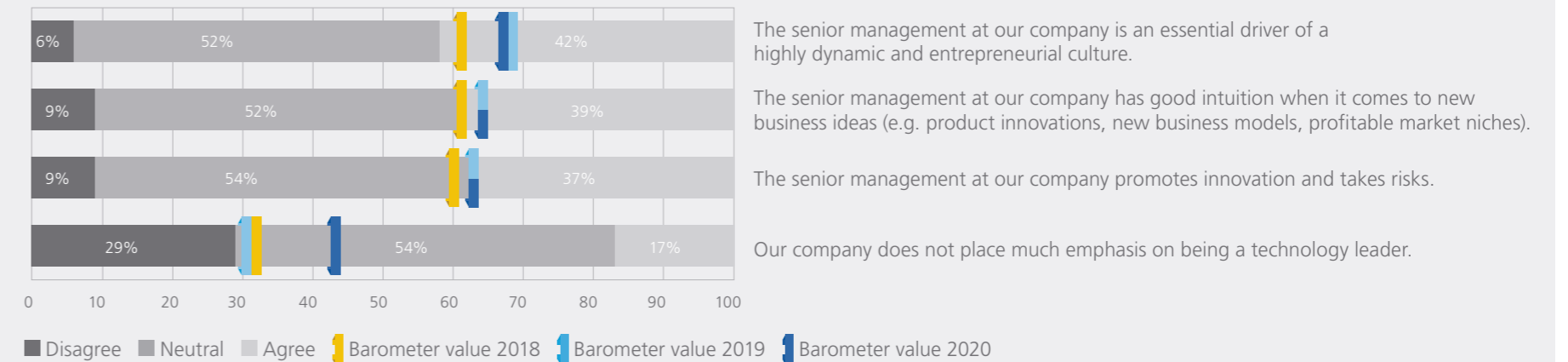
In fact, 53 per cent of respondents state that the CIO is not a member of the company's executive management team. Even though the CIO is often the only representative on the executive management team – particularly in low-tech sectors – with in-depth expertise on the different dimensions of the digital transition. With this expertise at executive management level, companies can recognize the opportunities of digitalization at an early stage, gaining a lead over other companies that can evolve into a lasting competitive edge in the years to come.

### Strategy and Objectives Strategic Industry 4.0 Focus

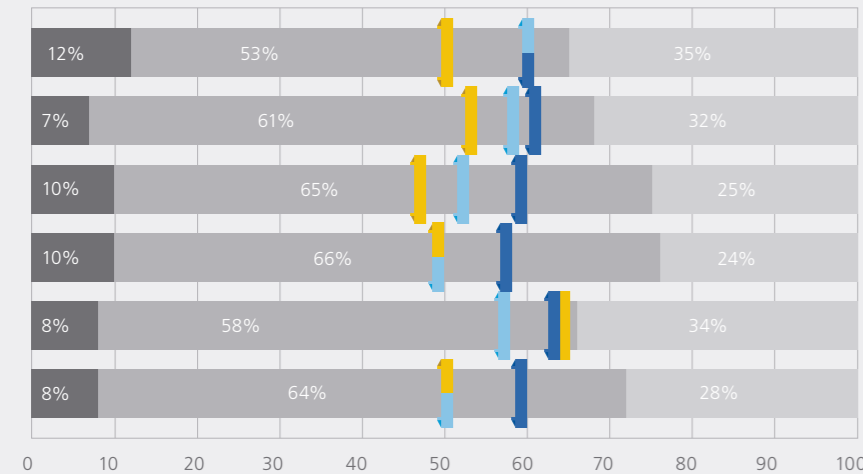
With Industry 4.0, our company is primarily aiming...



### Strategy and Objectives Entrepreneurial Orientation



## Strategy and Objectives Cross-Departmental Cooperation



There are regular meetings in which the IT department and other specialist departments (e.g. logistics, production, quality assurance, research and development, marketing) exchange knowledge about the business environment.

At our company, all functional areas involved in a decision are willing to exchange information.

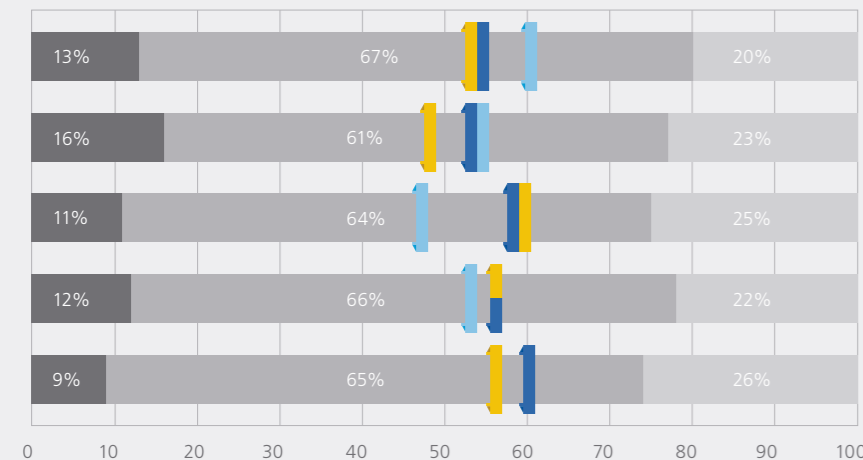
The IT department and other specialist departments at our company have a common agenda.

The IT department and other specialist departments have a common understanding of the role of IT at our company.

Employees in our IT department have a good understanding of the operational processes in the specialist departments.

Employees in our specialist departments have a good understanding of the IT systems used in the company.

## Strategy and Objectives Technological Intelligence



All specialist departments are looking for innovative technologies and companies in the Industry 4.0 environment, including outside our industry (e.g. purchase/participation, technology partnership).

Our specialist departments do not engage enough with the use of new digital technologies in the Industry 4.0 environment.

Our specialist departments quickly understand how we can use IT to improve processes and products.

Our specialist departments often exchange ideas with external partners (e.g. suppliers, customers, consultants, universities) about new and alternative technologies in the Industry 4.0 environment.

Our specialist departments offer employees the opportunity to expand their technical skills with respect to Industry 4.0 through (external) training and further education measures.

■ Disagree ■ Neutral ■ Agree ■ Barometer value 2018 ■ Barometer value 2019 ■ Barometer value 2020

” To successfully master the digital transformation, digitalization competencies must be established in the executive management. Our Industry 4.0 Barometer shows that the companies with a higher level of maturity have exactly these competencies in their executive management. However, this is not yet the case for many companies, especially DAX groups. “

**Tom Huber**

Head of Operations Performance & Strategy bei MHP

## 3.4 Drivers & Barriers Cluster

### The war for talent is decelerating

Compared to last year, companies across all industries have less difficulties in finding qualified employees. The slowing down of the war for talent (-10 per cent) may on the one hand suggest that universities and colleges are now focusing on educating digitalization experts for industry. On the other hand, it can be concluded that management is increasingly creating new positions for digitization projects. In IT departments in particular (-10 per cent), the level of concern about finding suitable talent seems less pronounced than in business departments.

When asked about specific drivers for Industry 4.0 in their own company, respondents were additionally able to provide answers of their own. In fact, many respondents stated that new employees and young students were a driving force behind Industry 4.0. Other key drivers from the perspective of respondents include competitive pressure and cost/process optimization, which confirms the results of previous surveys.

### Coronavirus pandemic and day-to-day business slow down the automotive sector

In a cross-sector comparison, it is noteworthy that companies in the automotive sector perceive both day-to-day business (+14 per cent) and the coronavirus pandemic (+11 per cent) as significantly greater barriers to the introduction of Industry 4.0 technologies than the reference industries. One reason for this might be the wider transformation which the automotive sector is currently undergoing, driven by the development of new drive technologies and

mobility concepts. The strategic and organizational changes resulting from this transformation, the challenges possessed by the coronavirus pandemic, and the sheer amount of work involved in day-to-day business – particularly when viewed in combination – left little space for additional innovation projects.

The challenges associated with the IT landscape are also rated as more substantial by the automotive industry. Historical IT systems (+11 per cent) and data silos (+11 per cent) appear to be particularly acute challenges in the automotive sector, slowing the rollout of innovative solutions. Another barrier that is being identified by more and more car manufacturers and suppliers is the absence of a positive financial return (+9 per cent) on previous pilot projects. Despite differences between sectors, obsolete system landscapes (-4 per cent) and data silos (-5 per cent) are generally less likely to pose a barrier to Industry 4.0. In particular, exchange of data with partners along the value chain (-11 per cent) is rated better by respondents than last year. Consequently, the conditions for cross-company optimization solutions with high scaling potential appear to be gradually improving.

### Opinions differ between business departments and IT departments

Areas of disagreements can be identified between respondents from IT departments and those from business departments. For example, IT employees rate data exchange along the supply chain better (+7 per cent) than their counterparts in the business departments. High investment costs are perceived as a particular challenge by the business departments (+12 per cent). A simple explanation for this might be that digitalization projects are financed from the budget of the respective business departments.

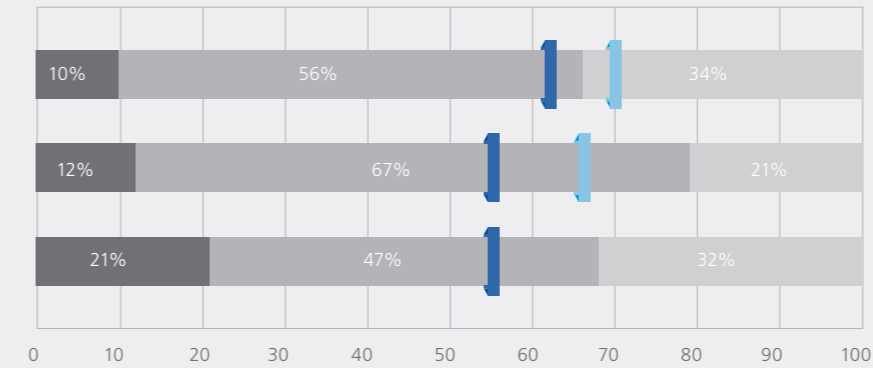
Business departments also perceive less pressure to change (-11 per cent) than IT departments. At the same time, the changes associated with Industry 4.0 are perceived as more complex by business departments (+7 per cent). A CIO can act as a troubleshooter

Companies with a CIO in the executive management team perform better across all categories. These companies find it easier to cope with the day-to-day business (-14 per cent), worry less about the loss of internal company data to competitors (-8 per cent), and perceive the challenges involved in measuring the success of Industry 4.0 technologies (-10 per cent) less difficult.

Once again, the CIO's digitization expertise emerges as a key to success. In the first place, this expertise can contribute to identifying the potential and added value of innovative solutions. In the second place, the added value of innovative solutions and technologies can be better quantified by reexamining and realigning conservative ROI calculations. In addition, a CIO with executive-level decision-making power can drive forward promising digitalization projects more effectively.

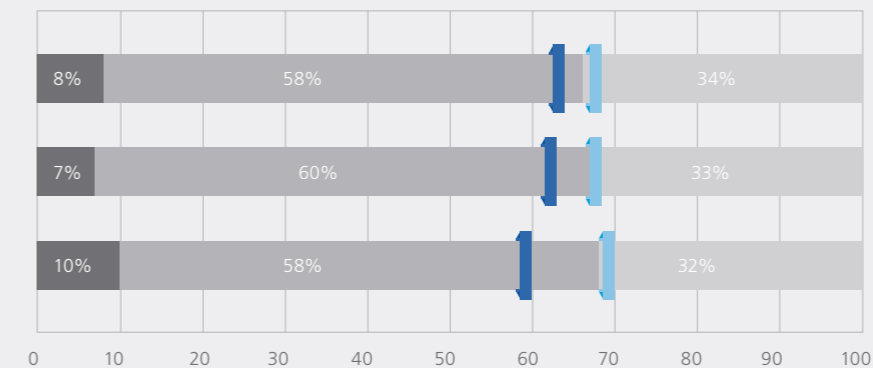
## Drivers and Barriers Resources

The introduction of Industry 4.0 technologies is delayed in our company...



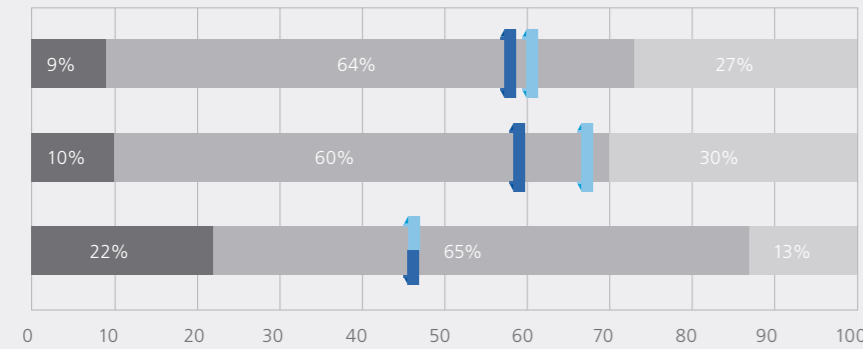
## Drivers and Barriers Requirements

The introduction of Industry 4.0 technologies is delayed in our company...



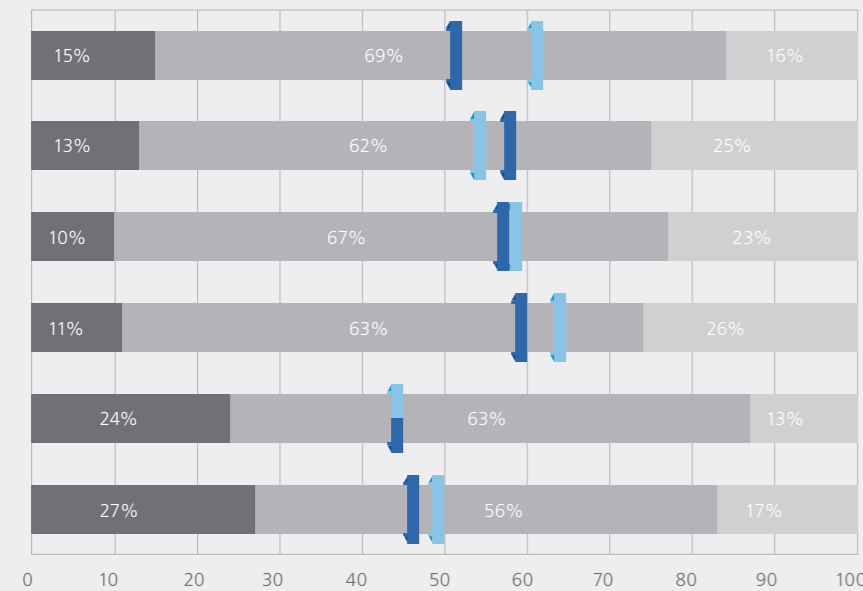
■ Disagree ■ Neutral ■ Agree | Barometer value 2018 | Barometer value 2019 | Barometer value 2020

### Drivers and Barriers Cost-Effectiveness



The introduction of Industry 4.0 technologies is delayed in our company...  
 ...because the investment costs are too high.  
 ...because it is difficult to accurately measure the effect of investing in Industry 4.0 technologies.  
 ...because pilot projects have not achieved the expected economic success.

### Drivers and Barriers Change Management



The introduction of Industry 4.0 technologies is delayed in our company...  
 ...because processes and responsibilities for the introduction are not clearly defined.  
 ...because nobody feels any pressure to change.  
 ...because the necessary changes are perceived by employees as too new and complex.  
 ... because not all the divisions involved are pulling together.  
 ...because there is a fear of losing control of production processes.  
 ...because of concerns that competitors and suppliers could gain access to important internal company data.

■ Disagree ■ Neutral ■ Agree ■ Barometer value 2018 ■ Barometer value 2019 ■ Barometer value 2020

“Our top management has a strong understanding that successful digitalization is crucial to our future success, and that helps us a lot. We see the digitalization as a huge opportunity rather than a threat. This mindset is much more important than the CIO’s level of responsibility.”

**Thomas Wölker**  
 Head of Integrated Business Solutions (IBS) und CIO bei REHAU

# 5G-Industry Campus Europe

The following case study presents the 5G-Industry Campus Europe, which is an international research infrastructure in Aachen.

## 5G-Industry Campus Europe in a nutshell

The 5G-Industry Campus Europe (5G-ICE) is a research infrastructure for the validation of 5G in production. It is located on the Melaten Campus of RWTH Aachen University, Germany. The objective of 5G-ICE is to establish a research infrastructure to implement industry-relevant 5G applications in production through pre-competitive research and development projects.

Three factors contribute to the uniqueness of 5G-ICE: a complete 5G infrastructure, comprehensive production equipment, and the production research expertise of the research institutes involved in the project – the Fraunhofer Institute for Production Technology (IPT), the Machine Tool Laboratory (WZL) at RWTH Aachen, and the Research Institute for Rationalization e.V. at RWTH Aachen. Ericsson was selected as the 5G network supplier. The IT Center at RWTH Aachen is responsible for networking the individual locations. The Federal Ministry of Transport and Digital Infrastructure (BMVI) provides funding for 5G-ICE, making

it one of the Federal Government's 5G model regions. In seven pre-competitive start-up projects on the 5G-ICE, the project partners are investigating specific advantages of 5G in industry-relevant applications – from 5G sensor technology for monitoring and controlling highly complex manufacturing processes, to mobile robotics and logistics, as well as cross-site production chains. The 5G-ICE is therefore the only location in Europe that takes a holistic view of 5G in the context of production. For this purpose, the 5G-ICE will be equipped with the very latest mobile communications equipment at an early stage. The partners of the 5G-ICE work in an application-oriented manner with real use cases and thus perform important pioneering work for the establishment of 5G in the manufacturing industry.

## 5G: advantages and potential applications

The new 5G mobile communications standard convinces with its short latency of up to one millisecond, high data rates of up to 10 Gbps, and the option of operating numerous devices simultaneously in tightly defined radio cells. In addition, the 5G technology is particularly well suited for use in networked, adaptive production plants with extensive measurement and control technology.

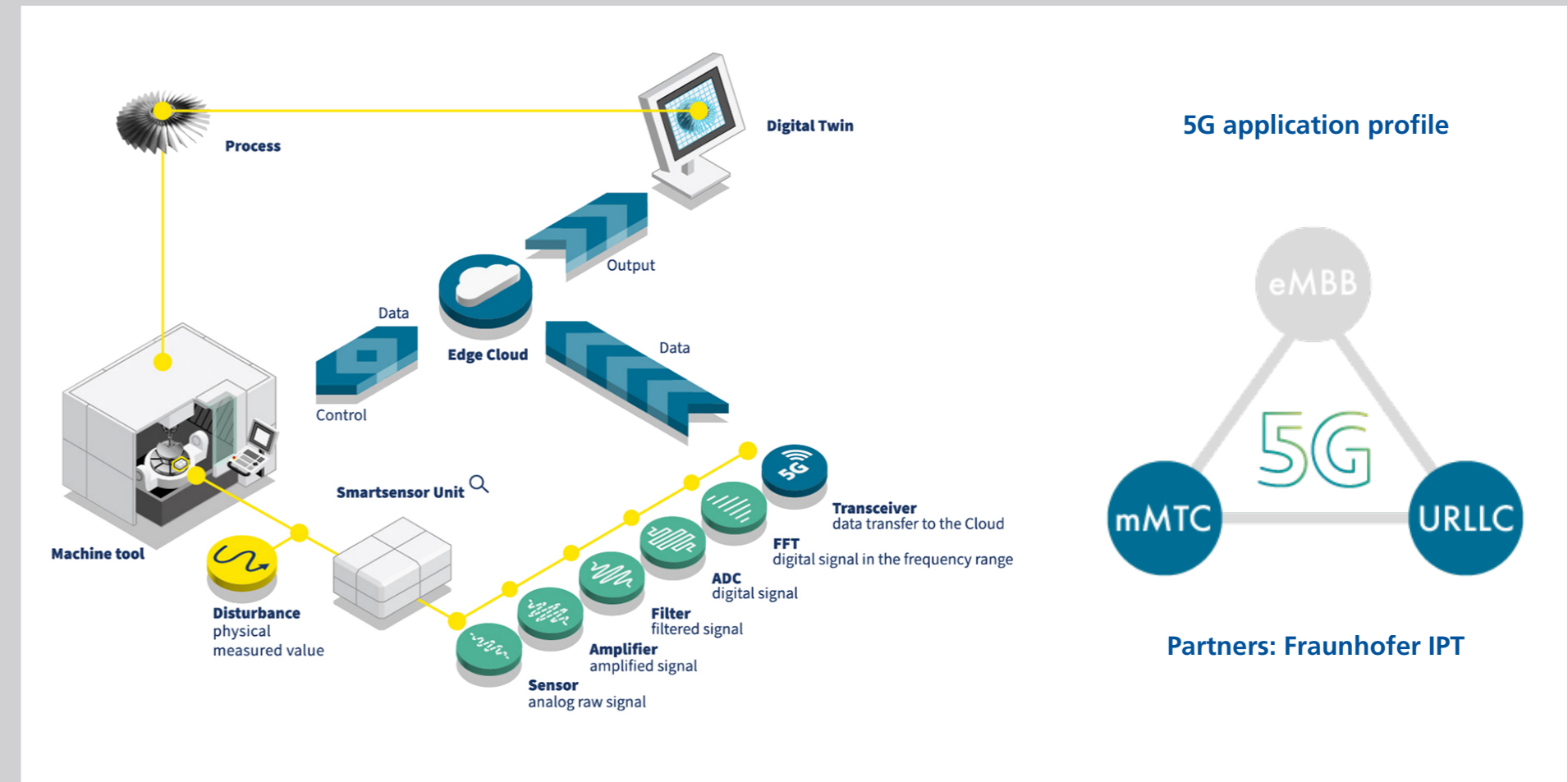
The large variety of machines and applications at Fraunhofer IPT offers the opportunity to use and test the 5G technology in a wide variety of applications. This can serve as a basis for developing solutions along the entire value chain. Possible applications range from mobile robots, smart sensors, process monitoring, and data management through to applications along the entire supply chain.

## Introduction to Use Cases

### Introduction to Use Case 1: 5G-Multisensor

The first industrial use case relates to the implementation of a control system. It already enables the monitoring of process stability for the milling of complex components such as BLSKs ("Blade Integrated Disk") in the turbomachinery sector using a wireless acceleration sensor.

Thanks to the 5G technology, sensor connections – which are wireless for the first time – are used extensively for data analysis while the process is still running, enabling adaptive control of the production processes with short response times. The 5G-Multisensor Platform (MSP) extends this approach to accommodate different modular sensors simultaneously such as acceleration sensors, temperature sensors, or



strain gages. The platform has microcontrollers for signal pre-processing and data packaging, as well as transmission via 5G modem.

The MSP can be used variably for process or machine monitoring, and can be configured remotely. In the future, components, workpiece carriers, or pallets will

also be localized using the MSP, while the MSP passes through production with the component and continuously transfers process data. 5G is well-suited to this approach thanks to its low latencies and high level of reliability compared to Bluetooth and WLAN. This means that MSP can be used throughout production and even in machines for real-time transmission.

As a further advantage, the data can be used company-wide on the intranet via IP connections or processed very quickly in edge cloud systems and fed back into production.

“With a total of 7,000 m<sup>2</sup> of fully equipped machine halls and outdoor space covering 1 km<sup>2</sup>, the 5G-Industry Campus Europe is the largest interlinked 5G research network for production in Europe. This allows many different issues relating to future production to be researched in an application-oriented way. Companies are invited to use the 5G-ICE facilities to evaluate the benefits of 5G for their own production. The 5G-Industry Campus Europe constitutes an important input to the design of the 5G ecosystem for data-driven production.”

Dipl.-Phys. Niels König

# 5G INDUSTRY CAMPUS EUROPE



## Introduction to Use Case 2: 5G-AE Sensor

The machining process can be monitored continuously with acoustic emission sensors in order to detect tool breakages or tool wear at an early stage. The advantage of wireless sensors is that they can very easily be affixed directly to workpieces.

The sensor scans acoustic emissions at 1 MHz, calculates the frequency spectrum via the FPGA (Field Programmable Gate Array), and transmits it via 5G at a

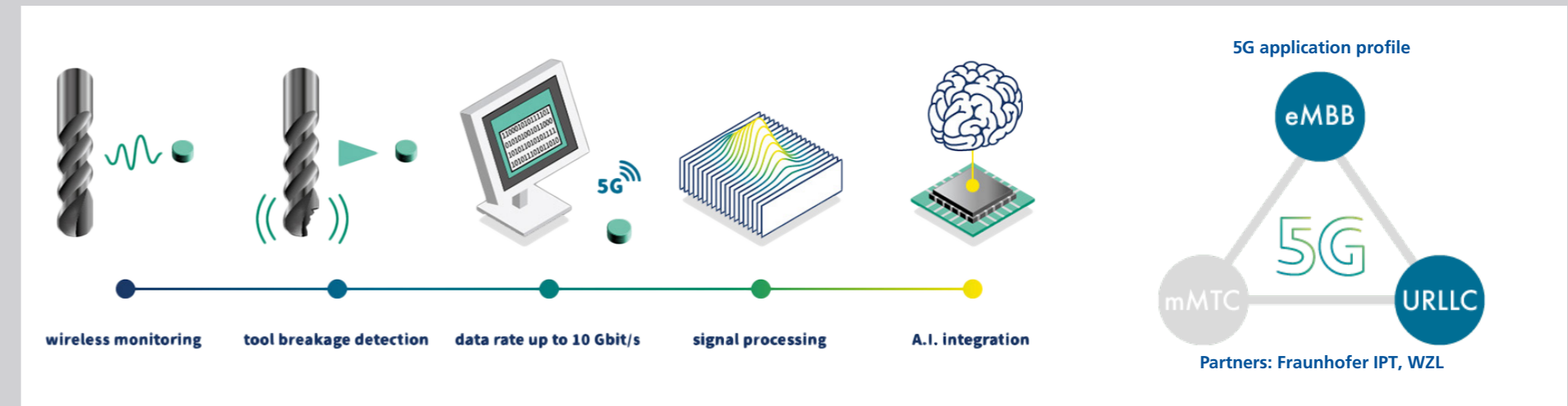
data rate of over 12 Mbps. The frequency spectrum can then be analyzed for breakages of tools or cutting edges.

The low latency of 5G allows direct responses for process control purposes. In addition, AI-based approaches allow an assessment to be made of tool wear, enabling optimization of tool life and hence, the economic efficiency can be optimized.

## Contact for the 5G-Industry Campus Europe

Dipl.-Phys. Niels König is Head of the Department of Production Metrology at Fraunhofer IPT. He is responsible for all 5G activities at the Institute, and represents the IPT in the 5G-ACIA (Alliance for Connected Industries and Automation). This role also involves coordinating the 5G-Industry Campus Europe.

**Dipl.-Phys. Niels König**  
 Coordinator 5G-Industry Campus Europe  
[Niels.Koenig@ipt.fraunhofer.de](mailto:Niels.Koenig@ipt.fraunhofer.de)



### 3.5 5G

#### Use of 5G still in the early stages, but of vital importance for the future

The new 5G mobile communications standard has attracted a lot of media attention, and is already being advertised as an industry milestone. Shorter latencies and higher data transfer rates mean that the technology offers enormous potential for the future digitalization of production and logistics.

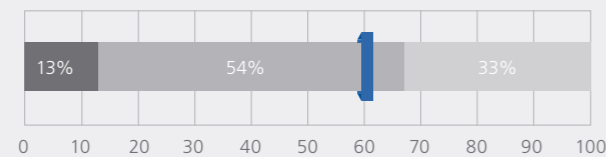
The survey results back up the media reports about 5G technology, since respondents (60 per cent) regard it as highly significant for the further advancement of a company's Industry 4.0 maturity. The impact of 5G is rated more highly (+10 per cent) among technology frontrunners (top 20 companies in the Technology cluster) than among technology latecomers (last 20 companies in the Technology cluster).

Generally speaking, however, it is apparent that 5G is being used beyond the test phase by just one in seven respondents (14 per cent). In particular, small and medium-sized enterprises lag behind large enterprises in terms of 5G use (-13 per cent). Almost half of all SMEs (46 on average) are not using 5G at all yet. This can be justified by the fact that 5G expansion is only profitable on a large scale, and perhaps even only across multiple sites.

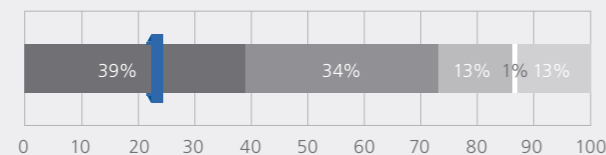
#### 5G used primarily for the networking of direct value creation

As far as the different applications of 5G are concerned, an increased focus is being placed on the networking of production plants and the implementation of real-time communications between machines (M2M communication). 5G is also an enabling technology for autonomous transport vehicles and systems.

#### Focus Topics for 2020 5G



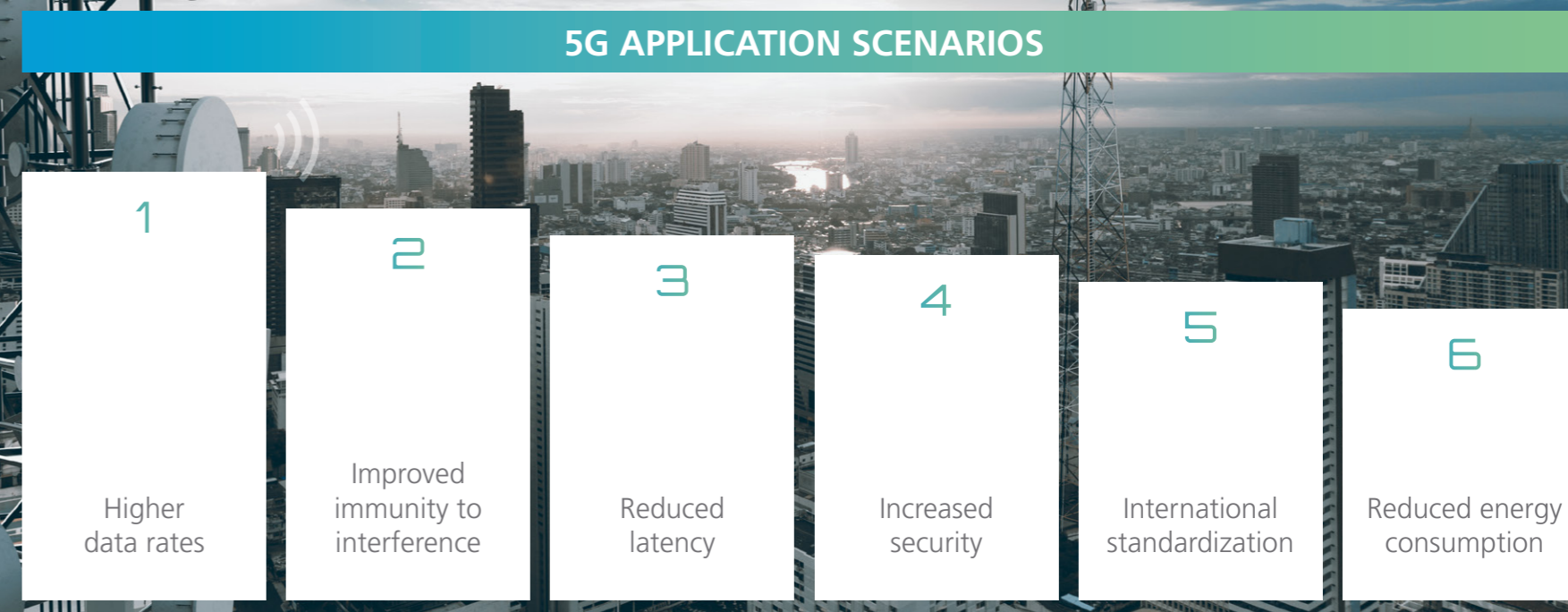
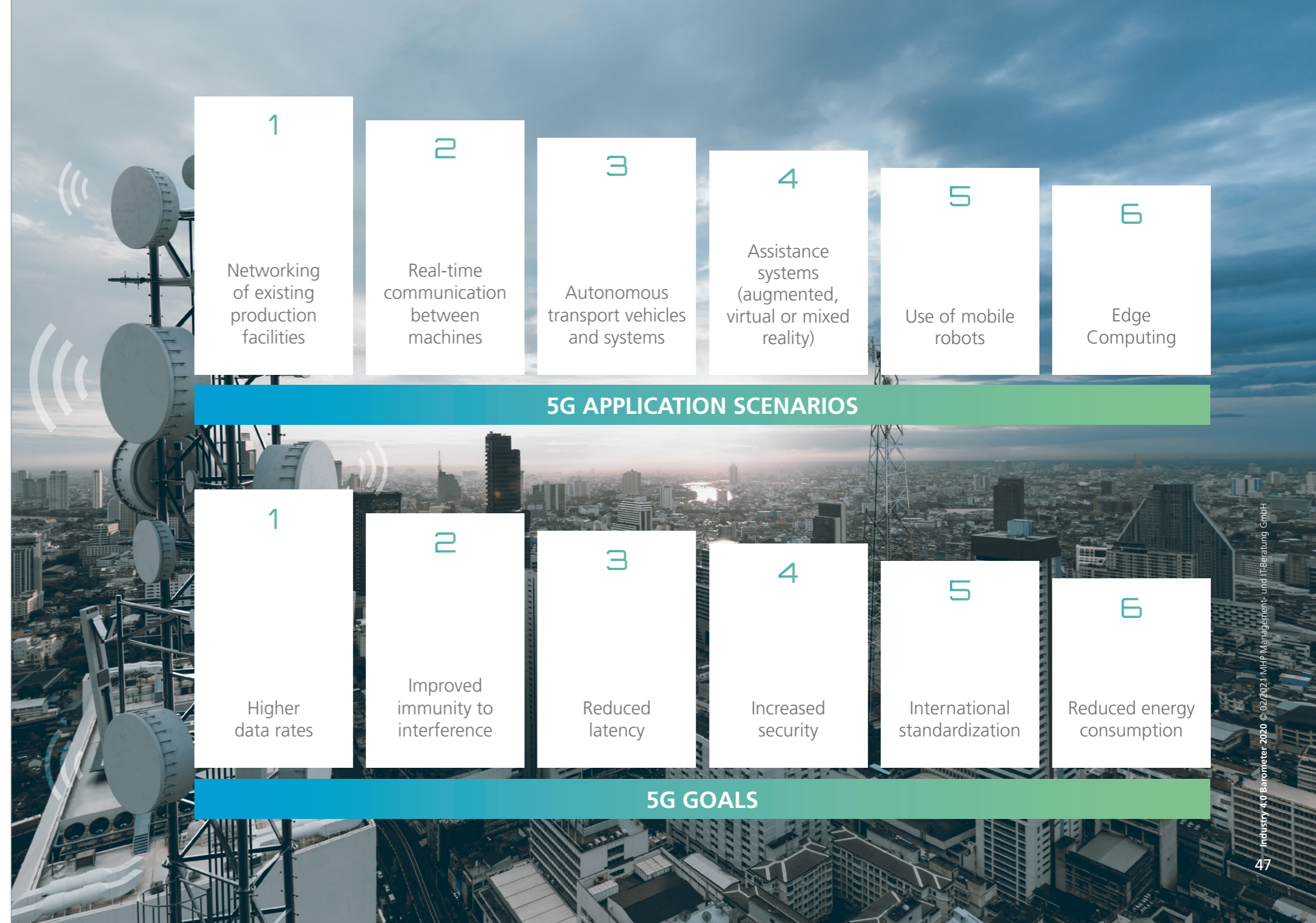
How important do you think 5G is for the further development of Industry 4.0 technologies and applications in your company?



How advanced is your company in terms of using 5G?

Assessments of 5G-related goals also focus on the optimization of production and logistics processes that directly create added value. Higher transfer rates, improved stability and shorter latencies appear to be more important than reduced energy demand or alignment with international standards, for example. This prioritization demonstrates that the key metrics of time, cost, and quality are critical to

the success of 5G technology. It follows that respondents attribute less significance to supporting factors that do not contribute directly to performance.







**CLOUD SERVICES APPLICATION SCENARIOS**



**CLOUD SERVICES GOALS**

### 3.6 Cloud Services

#### Cloud services on the rise across all industries

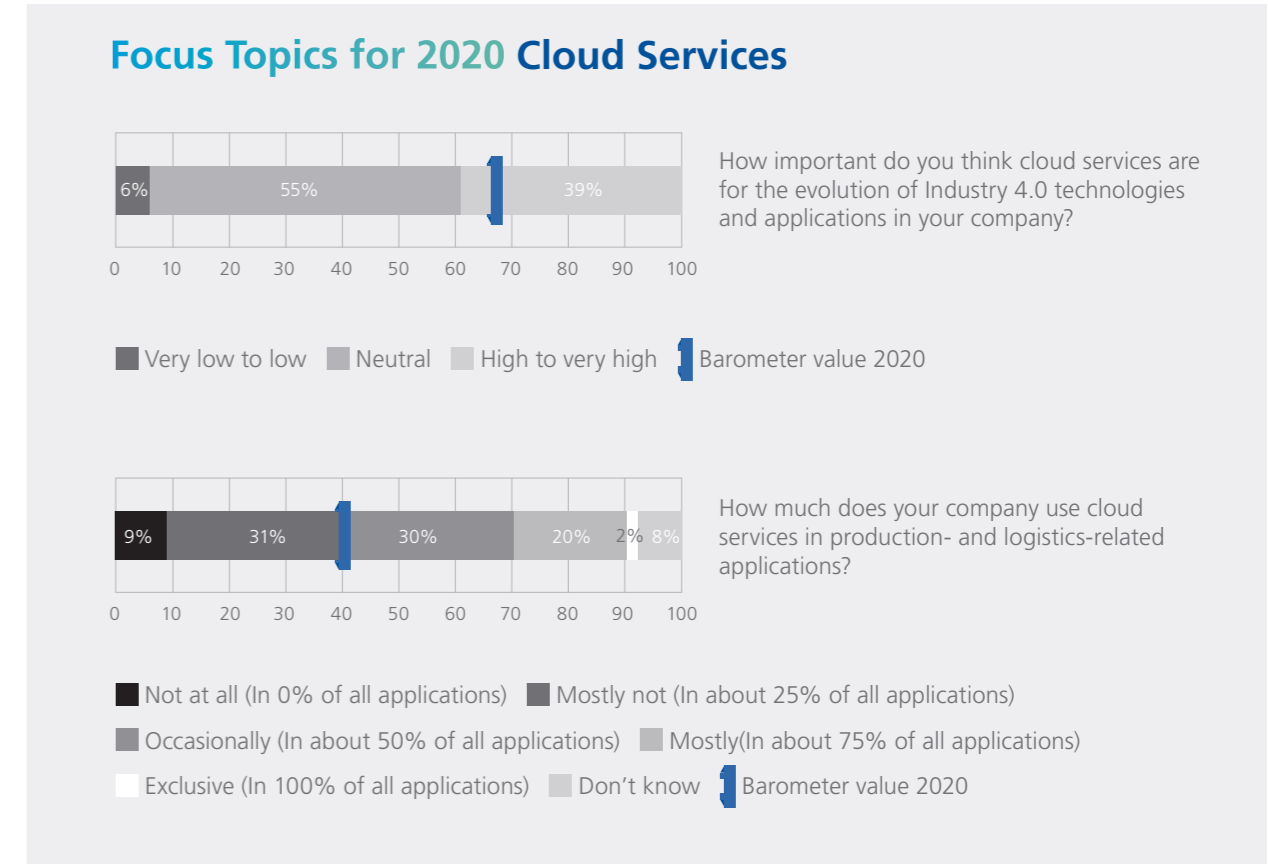
Cloud services are seen as catalysts and enablers of Industry 4.0 solutions. They have been an integral part of the digitization strategy of forward-looking companies for some time now. One of the best examples of this phenomenon is the cooperation established between German automotive manufacturers and the leading cloud providers. Examples include BMW with Microsoft Azure and Volkswagen with Amazon Web Services (AWS) – with enormously ambitious and innovative production applications being developed in industrial clouds in both cases.

The Industry 4.0 Barometer also reveals that progress is being made in respect of the transition from on-premise solutions to the cloud. The participants believe that cloud services are even more relevant to the evolution of Industry 4.0 solutions than 5G technology (+7 per cent). Flexible and highly scalable cloud services are rated as important for the advancement of digitalization in particular by large companies (73 per cent) and automotive companies (75 per cent).

#### Cloud services could still be deployed more widely

Yet as it is the case with 5G technology, the use of cloud services is lagging significantly behind expectations. The majority of respondents (70 per cent) state that their companies only use cloud services in 50 per cent or less of applications relating to production and logistics.

Interestingly, however, very small and small companies have a higher barometer score (+5 per cent) for the use of cloud services than medium and large companies. On the one hand, this might be the result of more streamlined



IT landscapes. On the other hand, however, it might also be explained by the disproportionate number of start-ups among smaller companies.

Direct value creation as a new focus for cloud services  
The main application scenarios for cloud services are the automation and networking of production and production-related logistics. This priority area covers a broad spectrum of applications, ranging from individual production plants to multi-site production processes. Activities that have only

an indirect influence on value creation are of secondary importance, however.

As might be expected given the prioritization of use cases, the goals for cloud services are also oriented toward value creation. The aims not only include increasing performance, efficiency, and availability, but also flexibility and scalability. Operational excellence is therefore a clear focus when using cloud services.

# Expert Interview

**Constantin Gonzalez**  
Amazon Web Services

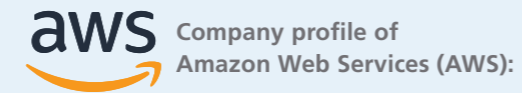


**Dirk Ramhorst**  
Wacker Chemie



## Short vita of Constantin Gonzalez (AWS)

**Constantin Gonzalez** is Principal Solutions Architect at Amazon Web Services (AWS). He advises a large number of customers from a range of different industrial sectors on their IT architecture and cloud computing.



Amazon Web Services is the world's most comprehensive and broadly adopted cloud platform. AWS offers millions of customers around the world access to over 175 services in fields such as data processing, data storage, databases, networks, analytics, robotics, machine learning, artificial intelligence, Internet of Things, mobile applications, security, hybrid environments, and virtual reality and augmented reality, as well as the development, deployment, and management of applications. AWS Cloud spans 77 availability zones within 24 regions.

## Short vita of Dirk Ramhorst (Wacker Chemie):

**Dirk Ramhorst** is Chief Information Officer (CIO) and Chief Digitalization Officer (CDO) at Wacker Chemie. Back in 2013, Dirk Ramhorst became the first CDO of a DAX-listed company while he was working at BASF; he subsequently moved to the role of CIO/CDO at Wacker Chemie.



Wacker Chemie is a globally active company with state-of-the-art specialty chemical products found in countless everyday items, ranging from cosmetic powders to solar cells. Its product portfolio in the silicone, polymer, life sciences, and polysilicon markets consists of over 3,200 products supplied to more than 100 countries.

The interview with **Constantin Gonzalez** (AWS) and **Dirk Ramhorst** (Wacker Chemie) took place on November 5, 2020 and was moderated by Prof. **Johann Kranz** (LMU Munich) and **Dr. Katharina Hölck** (MHP).

## Johann Kranz (LMU Munich):

How is the work you do on a daily basis shaped by issues and questions relating to Industry 4.0?

## Constantin Gonzales (AWS):

As Principal Solutions Architect at AWS, I deal with a number of different Industry 4.0 topics every day. Our work at AWS includes investigating how data can be moved into data lakes and how added value can be generated from these lakes. This includes explaining to our customers the different analytical methods they can use to gain insights from their data. Moreover, it includes research into how these insights can be used to bring concrete added value back to the shop floor. This could be, for example, intelligent and automated process solutions in the factory that can make decisions locally using machine learning from the cloud, or simply by improving planning and supply chain management processes.

## Dirk Ramhorst (Wacker Chemie):

The cloud is an important driver of change at Wacker. We launched the Cloud Transition program a few years back, which pursues a Cloud First rather than a Cloud Only strategy. Edge computing is particularly important at our production sites, since it allows us to guarantee operational continuity even in the absence of an Internet connection. Wacker is currently in the midst of a restructuring process that began even before the coronavirus pandemic. The topic of digitalization is an important lever for getting through these times; not only in the manufacturing environment, but also in other areas such as human resources and purchasing. Even when I introduced the issue of digitalization at Wacker, I talked about data-driven innovation,

because ultimately it is all about data. Interestingly, this focus already existed 30 years ago. Back then, data processing was the term commonly used to refer to an IT organization. Now we have come full circle, because in many places the focus is again shifting back to data. Our process load is typically very data-driven, so artificial intelligence is the most important tool that we have in our toolbox.

## Katharina Hölck (MHP):

Mr. Gonzalez, where are you now and where are you heading in terms of Industry 4.0?

## Constantin Gonzales:

AWS sees itself as a service provider offering its customers many different IT components. Cloud computing today involves much more than just virtual machines and storage. Our portfolio of over 175 services includes lots of IT components that companies would previously have had to develop themselves, with much greater effort. That is why a lot of our customers ask what we want to build in future, and the honest answer is that we just do not know. We cannot predict the future. That's why we flip the question and ask our customers what they have in mind and what they still missing. Over 90 per cent of our service modules are tailored to customer feedback. I always explain to my customers that they will not beat the competition by installing databases more rapidly, but by differentiating themselves through process and industry know-how, design skills, or their user experience. Our job at AWS is to help our customers put this expertise into practice as quickly as possible, by automating and therefore eliminating all the "housekeeping jobs" that previously had to be done by the IT team.

## Katharina Hölck:

Mr. Ramhorst, what challenges is Wacker facing in connection with Industry 4.0, and what goals has it set in this area?

## Dirk Ramhorst:

Those of us working in the process industry face a particular challenge. From the perspective of Industry 4.0, our assets have very long lifetimes of up to 40 years or more. At the time, few people were paying much attention to the topic of sensor technology [laughs]. One year ago we launched the Digital Backbone Production project, which has a planned lifetime of around 10 years. With this, we hope to both automate and digitalize our systems. Once again, the vision that Mr. Gonzales has just described comes into play. On the one hand, we want a clear overview of the current status of our plant, but on the other hand – and even more importantly – we also want to be able to predict potential bottlenecks at an early stage. Since we are working in the chemical industry, it is particularly vital to avoid unexpected and costly failures. A chemical factory cannot simply be understood as the sum of multiple individual production plants, since there are manifold interrelationships between all these different plants. For example, one chemical reaction might generate heat which is dissipated as steam and used as a catalyst in another plant. This means that optimization is a highly complex task, not least because the volatility of raw material prices must also be taken into account. We want our forecasts to be as accurate as possible in future, even if we still have a long way to go before we reach this goal. The second major issue is to create transparency about the quality of our products, so that we know the speed at which they have been stirred or mixed, for example. This has become increasingly important to our customers. The third topic is artificial intelligence. **How can we use historical data from past experimental setups to simulate the future? In order to do so, we need artificial intelligence and high-performance computing to lay the groundwork so that we can take the final step in the test tube. That allows us to achieve results much faster. These methods are also being applied in the field of biology at present, particularly in connection with coronavirus research.**

**Johann Kranz:**

Based on what you've said, Mr. Gonzalez, you act as the provider of modular services, while your customers are the primary source of domain knowledge. Is this division of roles set in stone? Might it be the case that AWS is offering more and more application expertise?

**Constantin Gonzales:**

Domain knowledge is not binary. There is no clear separation between domain knowledge and pure IT knowledge. Instead, it is a spectrum with many shades of grey. By implication, this means that IT teams now have to understand how the business or production actually works. Conversely, however, those involved on the business side are also having to become more familiar with IT. Perhaps not to the extent of learning how to install an SAP system, but they must understand the options opened up to them by IoT or machine learning, and how they can combine them into a solution that will subsequently prove helpful during operations or in their factory. Our approach is based on the symbiosis between domain knowledge and IT knowledge. There are certain best practices or architectural patterns that have proven successfully for many of our customers and that can benefit other customers or specific industries.

**Katharina Hölck:**

How do your customers use these best practices and architectural patterns?

**Constantin Gonzales:**

The beauty of cloud computing is that nothing is set in stone. The old model of IT involved very long, isolated, and inflexible analysis phases followed by the creation of IT. As a result, everything was set in stone for years. Things are different with the cloud. Everything that is built in the cloud can be changed, adapted, and improved immediately. It takes time to embed a new way of think-

ing. However, since we live in a world shaped on the one hand by old machines and sites, and on the other hand by the expectation that IT-related change involves spending three months jumping through procurement hoops before the first server appears. **That is why I always recommend our customers to pair digitalization projects with a change management program. Once our customers have internalized how quickly they can achieve their goals using cloud solutions, the flood-gates are opened and a huge amount of creativity is unleashed from everyone involved.**

**Johann Kranz:**

Mr. Ramhorst, do you still have work ahead of you to convince Wacker about the added value of digitalization?

**Dirk Ramhorst:**

Reasonably less, because people have accepted the principle of added value as such. We can use this as a basis for progressing with our next task, which is ensuring that things are implemented rapidly. We are reorganizing IT and attempting to organize and align it much more closely with the business, for example through process-oriented practices that build on basic principles such as Safe 5.0, Scrum, or DevOps. This must then be mapped in the matrix. Process-related practices are located in the verticals, while cross-cutting issues such as data analytics are located in the horizontals. In this respect, the fundamental aim is to scale these issues and translate power into performance as quickly as possible.

**Katharina Hölck:**

AWS has set up the Industrial Cloud and the Digital Production Platform together with Volkswagen. What added value could this Industrial Cloud deliver for other industries – in this instance primarily for the chemical industry and a customer like Wacker?

**Constantin Gonzales:**

The Digital Production Platform is a great example of how our customers can build a domain-specific solution with our building blocks. This means that Volkswagen's suppliers – and there are over 1,500 of them – now have the option of working together in the Volkswagen Industrial Cloud ecosystem and optimizing the value chain beyond the boundaries of a single company. Coordination of this kind, across multiple industries and between multiple participants, requires just such a solution. In my opinion, the concept of creating an ecosystem of companies that collaborate with each other and thus create the potential to enable cross-company optimizations is universal, and can therefore also be observed in the chemical industry.

**Johann Kranz:**

Has there been a shift in attitude to Industry 4.0 at Wacker?

**Dirk Ramhorst:**

Yes. For the first two years, we were heavily focused on ideation. We traveled to Silicon Valley, for example. We wanted to plunge into the culture of start-ups and to see all the various innovations for ourselves. We tried lots of different things. Some of them were clearly not yet mature enough to be used in an industrial context, and therefore they disappeared. A chemical process is not a trivial matter, and it demands a certain level of reliability. For more than a year, our main focus has been on execution, or in other words scalability. We are less interested in inventing new things. We finally have the budget and the resources we need, and now we need to concentrate on placing our game pieces on the squares where we will have the greatest ROI.

**Johann Kranz:**

Mr. Gonzalez, which Industry 4.0-related trends have you observed at AWS?

**Constantin Gonzales:**

I have observed that the industry is doing a lot more on its own rather than waiting for someone to come along and sell them a ready-made Industry 4.0 solution. One of my colleagues was recently asked whether we have a Smart Factory standard. If you've waited until there is a ready-made smart factory standard, you cannot innovate a lot. Fortunately, we have already learned a lot from the field of software development. It is sufficient to agree on a small number of standards such as JSON, HTTP, or MQTT in the IoT domain that enable interoperability between components. I personally believe that the cloud is the largest revolution in IT for almost 20 years. Looking 20 years back, IT operations have been outsourced to a large extent. Back then, everyone believed that IT did not contribute much in terms of value. People didn't understand that IT could be a value driver. Instead, they thought that it should be streamlined down to the bone. Now I'm seeing exactly the opposite with my customers. This renewed interest fits in very well with Germany as an industrial location – a mindset where people say, "we're building things and inventing things ourselves again."

**Dirk Ramhorst:**

I'd like to follow on from what Mr. Gonzalez said by touching on the topic of coopetition instead of competition. **If you examine the factors that contribute to the success of Silicon Valley, it's not simply the innovativeness of their university graduates – it's the entire ecosystem that represents the key to success. I believe that we need to move away from silos and think much more in terms of ecosystems. We need to do a lot more to join up the dots to harness the enormous potential that is latent in Germany, which has essentially emerged from small and medium-sized enterprises.** Cooperation must be stepped up between established companies and start-ups. This DNA is embedded deep in Germany's corporate landscape, and

we simply need to strengthen it and bring it to the fore again. If we did so, I genuinely believe that we would have no reason to shy away from competitors such as the USA and China.

**Katharina Hölck:**

Mr. Ramhorst, Mr. Gonzalez, our warm thanks for this fascinating discussion.





# 4 Recommended Actions

## 1 Build up digitalization expertise in the executive management team

A digital transformation will only succeed if the members of the company's executive management team understand the long-term added value of Industry 4.0 and drive forward its digitalization. It follows that they must be alerted to the groundbreaking potential of digitalization. Executive management teams also need a certain appetite for risk taking to drive forward the use of innovative solutions and exploit their sustainable optimization potential to the utmost. A CIO role is the perfect solution.

## 2 Scale innovative solutions to the maximum and leverage synergies!

Industry 4.0 calls for holistic thinking and end-to-end solutions. Many initiatives are doomed by conservative profitability analyses, since optimization potentials can often only be leveraged at the global scaling stage. In addition, the focus should be on promising use cases with a high scaling potential instead of the small-scale use of trend technologies whose integration may tie up too much capacity.

## 3 Create space and capacity for the digital transformation

Innovative projects must not be stalled by the sheer scale of work involved in day-to-day business. The introduction of innovative Industry 4.0 solutions is a highly complex task that involves not only technological challenges, but also organizational and cultural change within the company. It follows that adequate resources are required for long-term success. New and motivated specialists can lend fresh momentum in this connection. A forward-looking strategy for the further development of day-to-day business should also be developed to increase the responsiveness and flexibility of the organization.

## 4 Break down monoliths and increase data availability

Historical data silos must be broken up to enable the exchange of data across departments and companies as well as to create and exploit new optimization potentials. Increased use of loosely coupled systems, e.g. through microservices, promotes the disappearance of rigid monoliths. Reducing system dependencies increases the agility and flexibility of the IT infrastructure.

## 5 Structure, analyze, and derive profit from data

High-performance and efficient data management is a key foundation for the successful introduction of innovative and complex technologies. Architectures such as data lakes provide targeted support for the processing of unstructured data volumes and formats. Expanding the use of in-memory technologies can also accelerate the real-time processing of structured enterprise data.

## 6 Push modular and flexible IT architectures and streamline system landscapes

Any redundancies and inefficiencies in system landscapes must be pinpointed in order to identify and shut down outdated and obsolete systems. The resources freed up as a result should be used to build a flexible and highly scalable infrastructure to enable the rapid integration of partners both inside and outside the organization. The use of standardized platforms can also provide an additional boost to flexibility and scalability. At the same time, high-performance cyber security services should be used to provide targeted protection for individual IT architecture components.

## 7 Promote cross-departmental collaboration

Successful digital transformation enables companies to significantly increase their flexibility and responsiveness, helping them to remain competitive over the long term in volatile markets with dynamic and complex customer requirements. Cooperation between teams from all departments and shared contributions by these teams to the success of the digitalization projects constitute vital factors in the successful implementation of innovative solutions and the effective networking of plants, systems, and processes.

## 8 Build cross-industry partnerships and benefit from the pooling of skills

Alongside continuous product and process optimization, further development of the service portfolio can lend an added competitive edge. Cross-industry collaboration with technology and service partners provides companies with access to unique expertise that can serve as the basis for disruptive innovation. By developing new business models and distribution channels, companies can look forward to a time when they evolve beyond the boundaries of their original industries, placing themselves on a firm footing for the future.



## Conclusion and outlook

The Industry 4.0 Barometer 2020 points to positive developments in the industrial sector in German-speaking countries. Once again, it is apparent that technological progress is the key driving force behind the further development of individual business units, particularly IT. Improvements to IT infrastructures can also be observed, although there is still a great potential for optimization in both IT architectures and data availability.

Particularly for companies competing on the global stage, flexibility and innovativeness remain key success factors during turbulent times when the environment constantly

throws up new challenges. Close cooperation between business units within a single organization and the expansion of partnerships with innovative companies – including cross-industry projects – are a highly valuable tool in the fight to secure sustainable competitiveness.

Both the survey results and the statements by the interviewees indicate that the digital transformation is only just starting to gather pace. The observation is backed up by the fact that companies are still hesitant to deploy innovative technologies and services. The future digital transition holds countless innovations in store, but will

also throw up many new challenges. Both are intriguing proposals, making the next Industry 4.0 Barometer all the more eagerly awaited.

We would like to take this opportunity to thank all those who responded to the Industry 4.0 Barometer 2020 survey and our partners who feature in the interviews and case studies.



[The cloud is] the largest revolution in IT for almost 20 years. [...] People didn't understand that IT could be a value driver. Instead, they thought that it should be streamlined down to the bone. [...] This renewed interest fits in very well with Germany as an industrial location – a mindset where people say, “we're building things and inventing things ourselves again.”

**Constantin Gonzales**

Principal Solutions Architect bei Amazon Web Service



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**Welcome to the Future.** MHP is a leading international management and IT consultancy. We develop pioneering mobility and manufacturing solutions for multinational corporations, mid-sized companies and disruptive start-ups. As a premium business and technology partner, we are shaping tomorrow's digital future, today.

Our consulting approach is unique, combining holistic IT and tech knowledge with deep expertise in management. This makes MHP the ideal partner for a successful digital transformation. As digitalization experts, we deliver innovative strategies on the basis of strong analysis. These turn your change processes into sustained success.

Over 3,000 employees are driving digital progress in 20 locations worldwide, for over 300 clients. We display excellence at every level. **MHP: DRIVEN BY EXCELLENCE**

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