Digital Product Development 2025

Agile, Collaborative, AI Driven and Customer Centric

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Welcome to Digital Product Development 2025!

Product development and engineering departments across the globe need to master three fundamental challenges:

- Developing innovative, connected, customer-centric and personalised products and solutions
- Driving efficiency and digitisation of core product development and engineering processes
- Integrating their departments into an agile and integrated partner ecosystem

In today's world of rapid technological innovations, customers demand products and integrated solutions that are always up-to-date, complete with the latest designs and technologies. That shortens established product life-cycles and drives demand, not just for frequent product updates and incremental improvements but also for complete makeovers and breakthrough technology innovation. For industrial customers, "traditional" products often need to be digitally enhanced in a whole range of ways, including the addition of apps, human-machine interfaces, remote access and surveillance, predictive maintenance, self-learning adaptive parameter configuration, virtual assistance services, and other digital services that can be integrated seamlessly into existing and evolving full solution ecosystems.

In addition, customers are increasingly demanding personalised products and services that are tailored to their specific requirements. That creates challenges for developers and manufacturers who need to establish a modular product strategy that can be individually tailored to the specific features, designs, services and integrated solutions that customers require. Without digitised product development processes, engineering changes become too costly and time-consuming. Customers expect their orders to be fulfilled instantly – with same-day delivery now the new norm. In some industries, just-in-time delivery has already shifted to just-in-sequence delivery where suppliers need to deliver their parts or components within a very short window in the right sequence.

All of these trends are dramatically increasing the challenges for product development so companies are looking to increase the efficiency and output of their product development function while keeping costs under control. The answer lies in enhancing product development with digital tools, new agile development methodologies and automated processes. Digital Champions are already deploying key technologies including web-based, next generation product development techniques, data analytics and AI-based solution design, integrated product lifecycle management (PLM) systems and agile development techniques. And leading companies are using digitally-enabled tools to better capture customer needs and design products and integrated solutions that are individualised for specific customers.

Most importantly, companies leading digital product development are integrating their activities with key partners and becoming leaders of an integrated development ecosystem, which provides customers with integrated complete solutions, rather than individual products and services. Effective co-creation tools, common standards and simultaneous access to joint product development platforms then become part of an integrated ecosystem.

In this report we will take a closer look at how digital product development drives performance and helps companies to better meet individual customer expectations. We also describe what the most successful companies – the Digital Champions in the product development area – are doing differently and how that is impacting their results. Our research provides insights into which tools and processes are most effective and how to achieve the right mix for your company.

We also show you how digital tools are already being implemented in six profiled companies, from leading multinational companies like Electrolux, KION Group and Knorr-Bremse, to best-in-class middle-market players like BHS Corrugated and Krone, and innovative start-up e.GO Mobile. All of these companies are pioneering digital product development.

Our goal is to offer you practical steps to transform your company into a digital leader in product development and to integrate digital product development into your company's broader digitisation agenda.

Dr Reinhard Geissbauer
Partner and Head of
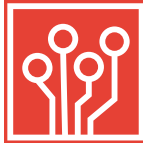Global Digital Operations
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Digital product development is expected to:

increase **efficiency** +19%

reduce **time-to-market** −17%

reduce **production costs** −13%

over the next five years

To support companies in achieving a more customer-centric, effective and efficient development of next generation products and services, this report looks at what we call "digital product development" – by which we mean the use of the right digital tools, supported by data analytics, winning partnerships, processes and organisation and governance structures. Based on data from a survey of 200 companies and additional in-depth interviews, we identified a number of key findings that provide insights into how companies can use digital product development to gain competitive advantage.

1 Digital product development drives performance

Digital product development is expected to increase efficiency by 19%, reduce time-to-market by 17% and facilitate the reduction of production costs by 13% over the next five years.
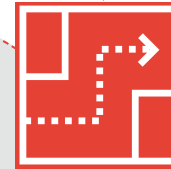
7 Vision: product development is part of an agile, integrated ecosystem

Companies need to become part of an integrated partner ecosystem that focuses on internal and external co-creation with agile and digitised development processes and methods with a clear customer focus.

2 Customer focus is key

Digital Champions have a much greater customer focus in product development and are using data and analytics to gain insights into how to create value for customers. They are also using customer analytics to develop individually-tailored products.

6 Cybersecurity is a must-have

Nearly three-quarters of companies (71%) do not yet have a mature enough approach to mitigate the cyber risks inherent in data-intensive development processes. Significant investments in cyber security and sensitive data protection are required.

3 New (digital) products drive competitiveness

Digital Champions are significantly ahead in generating revenue from new products and services – more than a fifth of champions (29%) earn more than 30% of revenues from new products within two years of introduction – and are also expecting far greater benefits from personalisation. 14% of champions also generate more than 30% of revenue from fully digital products and services.

5 Digital tools, methodologies and processes boost effectiveness

Digital Champions have introduced effective tools, methodologies and underlying processes that include fully-integrated PLM, digital twins of products and processes, real time co-creation with partners, and agile development principles. You don't necessarily need to spend more on product development to get better performance.

4 Data analytics and artificial intelligence (AI) are the new backbone of digital product development

41% of all companies are using data analytics and AI in product development to optimise processes and quality and to better design and validate new products and services. Digital Champions are using data analytics and AI more extensively to achieve better Design for X performance and customer-centric design.

1 Digital product development drives performance
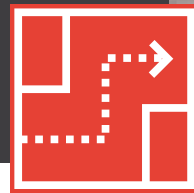
On average, the over 200 companies interviewed for this survey expect their investments in digital product development to increase efficiency and performance in product development by 19% over the next five years. That alone would be a strong argument to further digitise the product development function, but it's only one part of the picture. Companies are also expecting to reduce time-to-market for new products and services by 17%, a metric that will become ever more important as product lifecycles continue to shorten. And digital improvements in product development will also go beyond R&D and reduce overall production and operations costs by 13% over the next five years as well.

Strong commitment pays off

Our results show that strong commitment pays off in better performance. When we looked at the top 10% of companies who are already leading in digital product development – what we call the digital product development champions, or simply Digital Champions – these companies expect significantly greater benefits. Digital Champions anticipate an efficiency and output increase of 31% over the next five years, paired with a 28% reduction in time-to-market and a 20% reduction in production and operations costs. That is two to four times more than the Digital Novices in product development – the bottom 26% of companies in the survey – who only expect improvements of between 6 and 9% in each of these performance metrics. In Figure 1 we show some of the key drivers for each of these benefits which we explore in more detail later in this report.

Spending smarter, not more

Does spending more automatically correlate to better performance? Not necessarily. On average, our Digital Champions do spend a higher percentage of their overall revenue on product development. But nearly two-thirds of Digital Champions (61%) still achieve notably stronger development performance while spending less than 4% of revenues on R&D. That's lower than the cross-industry average spend of the top 1000 companies tracked in the annual PwC's Strategy& *Global Innovation Survey* (4.5% in both 2017 and 2018), and echoes the findings of that research which has consistently seen only a small amount of overlap between the top ten innovators and the ten biggest R&D spenders each year.

Spending varied by industry as companies in sectors producing more complex products, like automotive and machinery, invested a greater percentage of revenues in product development. To generate the most value and accelerate product development, no matter what your industry sector, it is vital to set clear priorities and find the right mix of digital tools and digitised and simultaneous processes.

Fig. 1   Benefits of investing in digital product development technologies and "Digital Champion" solutions

2019–2023	Digital Novices	Digital Champions	Overall		
Product development efficiency increase	+9%	+31%	+19%	✓ Customer-centric portfolio management ✓ Tech innovations, eg, twins, simulation and data analytics	✓ Digital product development strategy and implementation roadmap
Time-to-market reduction	–6%	–28%	–17%	✓ Frontloading with focus on modular solutions ✓ Fast and flexible through co-creation and agile	✓ Digital product development experts and dedicated training programmes
Production cost reduction	–6%	–20%	–13%	✓ Value based focused product design including DfX ✓ Fully horizontally-integrated PLM system	

What overall benefits do you expect of your investments in digital product development over the next 5 years? (for each of these metrics, cumulatively)

Note: Figures shown are averages.

e.GO Mobile

Photo: e.GO Mobile

Start Innovating: Significantly improving product development performance by pioneering changes to organisational structures, processes and culture

Founded in 2015 by Prof. Dr. Günther Schuh, e.GO Mobile AG is developing electric vehicles and implementing mobility products and services.

An innovation must satisfy a demand to become successful in the market. Therefore e.GO Mobile AG focuses on the needs of the customers and co-creates products and services with them in an agile environment. Hence, e.GO is about to begin series production on the e.GO Life (a medium-range fully electric car), and is partnering with ZF via a joint venture to develop and produce the e.GO Mover (an electric, connected and in the future fully automated bus). To this end, to develop creative ideas and solutions e.GO needs to create an innovation environment. Thus, e.GO implements agile methods throughout the whole network to keep the pace in the whole organisation. Deeply rooted in a transdisciplinary open innovation network, e.GO is spreading innovation culture excellence.

e.GO is also pioneering significant changes to development structures, processes and culture in comparison to traditional approaches. For example, e.GO developed the e.GO Life using multiple agile transdisciplinary core teams. Taking this innovation approach, the company also successfully shortened vehicle development time by years, and is applying this agile innovation strategy successfully to a wide range of other products and services.

Ultimately this way of working was only made possible through the use of:
1. Tailored tools for development structures and processes
2. Human capital and an innovation culture supported by a deep integration of agile methods and fields of co-creation
3. A trust-based open innovation network

Agile methodologies and an open innovation framework are the backbone of e.GO's success. Hence, e.GO has been embracing the differentiating capabilities of its suppliers to develop products and services within a co-operation network. Enriching this kind of innovation network by integrating valuable partners has been critical for e.GO. This includes assimilating the strengths of everyone in the network, eg, from Tier 1 automotive suppliers like ZF and Bosch, to manifold other start-ups and organisations, as well as with academia and local government. To this end, e.GO builds innovation networks of strong independent actors with complementary differentiating capabilities, who can work together to share value with the overall activities – this way "everyone leverages and each participant ends up with a bigger slice of a larger pie". The partnerships in the ecosystem around e.GO depend on the company's ability to foster a strongly collaborative culture with an emphasis on trust, driven by a strong research and innovation department. For example, these collaborations are synthesised into a local open innovation initiative, the Living Lab Mobility Aachen, which forms an ecosystem that brings together many local partners in the field of mobility.

Agile processes supported by the right digital tools for information exchange and reference are a critical part of the company's virtual infrastructure. Similar to the agile methodologies of software industry, e.GO works with releases of its vehicles instead of using classic project and development approaches which yield design freezes. This enables e.GO to respond to shorter product lifecycles and customer requirements to constantly improve their products and services. As an outstanding example, e.GO already presents early prototypes to customers in several e.GO pop-up stores that close the customer iteration loop. Finally, to achieve this holistic customer and partner orientation, all stakeholders are invited to live an agile mindset together with e.GO Mobile AG.

2 Customer focus is key

Data analytics and AI help drive insights into customers

Customer requirements have always been integral to the product development process and the vast majority of companies say they are working closely together with customers to develop products and services (89% overall). But just how are they doing it? Our research found that Digital Champions are more likely to be using data analytics and AI tools in order to analyse customer data, with the goal of optimising new or existing products and services. Nearly three-quarters (73%) of Digital Champions already do this, compared to just 31% of Digital Novices (see Figure 2).

Data collected for analytical purposes might include consumer characteristics, data from online configurators, product usage patterns, field quality information and service data or information on product performance and condition along the product lifecycle. For example, leading companies continuously monitor field performance and collect user feedback through connected devices so they can provide better and more personalised services and continually improve and upgrade current products. Prescriptive analytics techniques make it possible to understand, and optimally address customer preferences based on behaviour. In this way, they enrich traditional

market research and surveys by providing real-time customer insights. Companies use this improved understanding of their customers and products to drive enhancements to their next generation products and services – they therefore truly design for value.

Companies that successfully use data analytics and AI in this way can optimise product design by tailoring changes to the exact needs of customers – whether that means simplifying product functionality, improving durability, enhancing the user interface, or even facilitating options for product return or recycling at the end of the product life.

Customer analytics and social listening

Around two-fifths of our survey respondents say they are currently using AI-based customer analytics and social listening. These solutions draw on social media, websites, search engines and macroeconomic parameters and apply big data technologies and advanced analytical techniques such as natural language processing (NLP), complex event processing (CEP) and deep learning, in order to gain even deeper insights into customers, helping companies understand not just what customers are looking for and how they are using products today, but also to better predict what they may want in the future. Digital Champions are more likely to be using such tools comprehensively today (18% vs 6% overall). From an industry perspective, consumer goods companies are, not surprisingly, the biggest proponents – around half already use them.

Many companies recognise the power of these techniques. Companies at all stages of digital product development maturity expect to markedly increase their use of customer analytics and social listening technologies over the next three years, but Digital Champions will widen their lead when it comes to using social listening: three-quarters expect to do so, compared to around half of Digital Novices (see Figure 2).

Fig. 2 **Digital Champions have a much greater customer focus in product development and use data and analytics to gain insights**

Companies are increasingly using customer analytics and social listening to get to know their clients

Digital Novices: 51% (27% + 24%)
Digital Champions: 75% (36% +39%)

Today / In 3 years

Customer data/customer input is used to optimise new and existing products and services

Digital Novices: 31%
Digital Champions: 73%

Share of personalised products is expected to increase significantly

Digital Novices: 2%
Digital Champions: 26%

Generating more value for customers through personalisation

Tailoring products to a customer's specific requirements is one of the most powerful ways to meet customer needs and to achieve a higher profit margin. This type of personalisation can be difficult to achieve, though, particularly as many companies are looking to cut costs by reducing complexity. Cost-effective personalisation begins in the early development phase – a modular product and systems strategy as well as the right product architecture facilitates a high level of personalisation while minimising the complexity of products. The result is

a combination of predefined modules and a reasonable amount of customer-specific engineering, which results in high-margin, customer-tailored products and solutions.

Achieving this level of customer-centricity requires close collaboration with suppliers, for example by using digital tools to develop unique BOMs. And it's also important to make the most of direct interactions with each individual customer, during the sales process, at the time of sale, when installing or servicing products, and beyond (see Figure 3).

When companies are successful in their quest to personalise products, it can increase both customer loyalty and profitability. That's why it's another key benefit of digital product development – and one that Digital Champions in particular intend to make the most of. They expect to increase their share of personalised products by 26% over the next five years, more than twice as much as the sample overall – and 13 times as much as Digital Novices (see Figure 2).

Fig. 3   Digital product development is helping companies become more fully customer-centric

- **Circular economy** and product return at end of life
- **Continual product upgrades** and releases
- **Continuous monitoring** of field performance, user patterns and user feedback
- **Customers**
- Proactive, **customised and tailored offerings** based on customer/ consumer insights
- Personalised products and services based on collaborative, **1:1 interactions**
- Unique, simulated and **proven BOM** that is transferred even to suppliers
- **Full tracking** of chain of custody across product development, manufacturing and SC as well as PLM twin

73%
of **Digital Champions** already use customer data to optimise products and services

26%
of **Digital Champions** expect personalised products to make up more of their portfolio over the next five years

3 New (digital) products drive competitiveness

29%
of **Digital Champions** generate more than

30%
of their revenues from products and services that are less than two years old

Champions innovate and digitise their product portfolios

Industrial companies need to get much more effective at developing the new products and services that meet their customers' requirements, which often means including up-to-date new technologies that drive additional value. Yet fewer than half of the companies surveyed say they currently earn more than 10% of revenues from new products and services, defined as products or services that have been in the market less than two years. And just 5% of companies overall get more than 30% of revenues from new products and services.

Digital Champions are doing much better. Their average revenue from new products and services makes up more than a fifth of total revenues (see Figure 4). And 29% of Digital Champions generate more than 30% of their revenues from newly-introduced products and services That's a stark contrast with Digital Novices. Not a single one told us they are generating that much revenue from an up-to-date, customer-centred portfolio. On average, they earn just 8% of revenues from new products and services.

Fig. 4 **Companies with more mature digital product development have product and service portfolios which are newer and more innovative, and which include digital and personalised services**

Digital Champions generate 20%+ of their revenue with new products and services that are less than 2 years old

Digital Champions	22%
Digital Innovators	13%
Digital Followers	8%
Digital Novices	8%

Digital Champions drive development and revenue of digital products and services (in percent of total revenue)

Digital Champions	10%
Digital Innovators	5%
Digital Followers	4%
Digital Novices	5%

Digital Champions bet on personalised products and services – share to increase by 26%

Digital Champions	26%
Digital Innovators	18%
Digital Followers	8%
Digital Novices	2%

14%
of **Digital Champions** earn more than
30%
of their revenues from fully-digital products and services

Expanding digital business models and integrated solutions

Digital product development also paves the way for the development of digital products and digital services. Digital products generally build on the traditional base offering, which can be "digitised" by adding digital layers around it; eg, IIoT/connectivity or data-driven machine optimisation (eg, to improve quality). Fully-digitised products go beyond enhancements to make these features integral to the product. The next step is digitally-enabled, data-driven digital services that enhance the physical product. These support customers along their journey (both before and after they consume the product).

Digital products and services offer a whole range of benefits to companies that develop them successfully. In addition to creating new sources of revenue, they can also help companies weather demand cycles better, by creating ongoing revenue streams. The most advanced companies strive to offer fully-integrated, complete digital solutions to their customers, which consist of a mix of their own products and offerings from value chain partners.

While many companies already aspire to these new business models, our research suggests that relatively few are already generating revenues from them. Overall, companies earned just 8% of their revenues from fully-digital products and services in 2018, which go beyond simple enhancements to fully integrate digital functionality, or provide a fully-digital service. And while many of our Digital Champions also still generate a relatively small portion of revenues from digital services, 14% say they earned more than 30% of their revenue from digital services in 2018.

Krone Commercial Vehicles Group

Photo: Krone Commercial Vehicles Group

Striking the right balance between customisation and efficiency

Krone is a leading European manufacturer of agricultural machinery and trailers. Krone Commercial Vehicles Group, boasting a turnover of around 1.6 billion USD, produces all-round trailers as well as trailers for special transportation requirements like refrigerated, dry or fresh goods transport. Services such as telematics and maintenance are an integral part of the offering.

The family-owned company recently went through several mergers and acquisitions to build a foundation on which Krone aims to achieve further international, sustainable and profitable growth in an increasingly competitive environment. As a result, Krone has enlarged its internal network and entered several new markets with individual requirements. The truck and trailer industry is traditionally a highly-customised market. In 2015, to ensure profitable growth, the company started changing the complete business model from purely customised engineer-to-order production to a modular strategy, which allows the manufacture of customised products in a cost-efficient and scalable configure-to-order production.

The challenge was to implement a well-balanced modular strategy and underlying configuration management. The solution needed to be able to produce 60,000+ trailers per year based on a broad variety of customer requirements and, at the same time, increase cost efficiency and shorten time-to-market. To establish best-in-class configuration management and realise the benefits involved, Krone started a large-scale project in 2017, aiming for a complete rollout in early 2020.

The core deliverable of this project is a new parameterised modular strategy, which is translated into a knowledge base. This knowledge base contains order-independent knowledge that makes it possible for Krone to process and manufacture orders without any manual data input. The knowledge base is split into a sales model (customer perspective), design model (technology and development perspective) and factory model (production perspective) which can be seamlessly enhanced with new variants.

Based on customer requirements like length, height, transportation weight, goods to be transported and further individual criteria, the configurator will combine the correct parameterised modules and create the bills of materials, corresponding material requirements, work plans, even production sequences automatically. More then 100-plus millions of variants can be created this way already. The upside of this knowledge base is that it can continuously evolve without increased effort from resources.

Krone restructured the complete product development process by emphasising the development of modules that can be automatically adjusted, eg, depending on the height of the trailer, the back door can have dozens of different sizes, without taking individual elements into account. Parallel to this restructuring, all operation processes were also streamlined to be able to produce high-quality master data, ie, construction, production and sales data, upfront. This means the product development and engineering teams, including quality control, need to focus on creating the knowledge base content and simulation measures like model tests, integration tests and consistency and regression tests for variants that have not yet been physically built.

To reach the ambitious goal of eliminating the need for trade-offs between a high level of product customisation and production efficiency, Krone is collaborating on its journey with two very innovative companies, CONFIGIT, a configuration technology provider, and denkbares GmbH, a knowledge technology provider.

4 Data analytics and artificial intelligence (AI) are the new backbone of digital product development

Our previous research has already shown how vital data analytics and AI are for companies undergoing digital transformation. It suggests that many companies are already using data to streamline supply chains and enhance manufacturing operations. Data analytics and AI have been impacting product development too – 41% of companies say they are using data analytics and AI within their product development processes, focusing mainly on process and quality optimisation and validation of products and services. But there's still a long way to go. While 41% of companies use data analytics, just 5% use it comprehensively.

A deeper dive into our data revealed that those companies that do use data analytics comprehensively are achieving significant improvements in overall time-to-market, especially during the concept and specification and design and development phases.

The use of data analytics and AI is one area where the leaders really stand out – 18% of Digital Champions say they use data analytics/AI comprehensively. Digital Champions are also more likely to also be applying data analytics and AI applications more broadly across their enterprise (see Figure 5). These applications may include the usage of Hadoop- and Spark-based system architectures, scalable cloud platforms and powerful analytics and AI algorithms, such as random forest decision trees, deep neural networks or ensemble models, often based on open source Python libraries such as Tensorflow.

Companies achieving excellence in data analytics focus their attention not just on the algorithms used for analysis but also on the underlying data models and architecture that make this analysis possible and efficient. It's critical to develop a scalable data platform with fully-integrated, end-to-end data models that reach across the full product lifecycle. This makes it possible for companies to collaborate directly with suppliers and customers, whether it be to tailor individual BOMs for personalised products, incorporate feedback into the design process, or track and trace products across their lifecycle and develop a robust chain of custody.

Fig. 5   Digital Champions use data and analytics and AI more broadly

Usage of data and analytics and AI in product development

Don't know/ prefer not to say
1%

Not used
58%

Overall sample

Partly used
36%

Comprehensive usage
5%

Purpose of data and analytics and AI

Usage of data for process and quality optimisation in production and in field
- **100%** (Digital Champions)
- **75%** (Digital Novices)

Usage of data for validation of products and services
- **91%** (Digital Champions)
- **69%** (Digital Novices)

Usage of customer data/customer input in order to optimise new aswell and existing products and services
- **73%** (Digital Champions)
- **31%** (Digital Novices)

Usage of data to optimise/ensure DfX
- **68%** (Digital Champions)
- **25%** (Digital Novices)

■ Digital Champions   ■ Digital Novices

To what extent do you use data and analytics and artificial intelligence within product development? For what purposes do you use data and analytics and artificial intelligence?

Reducing product costs and adding product value through DfX

We've already noted that one of the benefits companies expect from digital product development is a reduction of production costs. That makes sense, since it is commonly held that 80% of production costs are defined during the product development process. But our research suggests that many companies are still overlooking some significant opportunities. By using DfX – design for cost, design for manufacturing, design for value, etc. – companies can achieve a dramatic reduction in costs, particularly when they draw on data analytics and AI to drive these efforts forward. More than two-thirds of our Digital Champions are already taking advantage of these techniques, compared to just a quarter of Digital Novices.

BHS Corrugated

Photo: BHS Corrugated

The digital twin behind your corrugated board box

BHS Corrugated, the world's largest provider of solutions for the corrugated industry, has been developing, manufacturing and installing corrugators, all over the world, for more than 50 years.

Over the past 50 years, BHS Corrugated has gained competitive advantage through its innovations in products and services. Today, the company is investing significantly in the development of digital products and services and has built strong in-house analytics capabilities.

By implementing its iCorr® platform, BHS Corrugated streams up to 1 MBit of data per second from its corrugators in the field. This enables developers to assess new solutions and to quickly diagnose and troubleshoot issues. Over 130 companies have already signed up and the system is proving particularly valuable for resolving and preventing disruptions. Many issues that would have required several weeks of on-site analysis can now be addressed much more quickly, remotely. The product insights BHS Corrugated gains from its analyses also help the company continually enhance and improve its current and next generation products and services.

With a goal of further improving the production output of its customers, BHS Corrugated is now developing a digital twin of each corrugator produced, which can be used for the entire product lifecycle. To fully achieve this, BHS Corrugated has a clear roadmap. It's a long journey to image a corrugator accurately in the digital world and keep it up-to-date over the entire lifecycle of the corrugator, an average of 20 years. Getting there requires the right processes, systems, technology and, most importantly, people. Integrated teams of digital analysts and technical experts have to work closely together to establish which parameters are important for an individual corrugator, depending on the specific inputs, outputs

and factory environment and what the customer wants to measure. Often it is also necessary to partner with key suppliers and establish an integrated network to exchange data along the value chain to keep track of the more than 100,000 parts that make a corrugator.

By linking together data collected from across the entire value chain as well as during the operation of the corrugator at the customer's site, it is possible to improve productivity across interconnected processes. For example, BHS Corrugated plans to analyse all settings on the corrugator and the way these settings influence the quality and productivity of the whole plant. Such improvements can best be achieved by using a fully established digital twin of each individual machine.

BHS Corrugated's transformation of its products, services and development process requires a team effort and the company is actively reaching out to its workforce and offering voluntary seminars on the company's digitalisation efforts. The response has been very enthusiastic. Many employees – generally 140–160 each month – attend in their own time. BHS Corrugated is also actively educating its service workforce who will be critical in ensuring that data continue to be collected accurately as corrugators are assembled, installed and serviced in the future. For example, each spare part will need to be carefully tracked and reflected in the digital twin.

The company is co-creating externally too – for example, by working closely with suppliers to collect and analyse data together and by participating in joint research projects.

Moving to the next level with AI

Data analytics can be further enhanced by using AI-powered solutions in a whole range of ways that are just beginning to be explored. Innovation in AI, driven mainly by the leading software and internet companies and research institutes, is progressing rapidly, making virtual assistants, self-learning and autonomous systems, as well as intelligent robotic process automation, easily accessible for traditional manufacturers. AI could potentially process data received by digital twins in the field, automatically identify new usage patterns or suboptimal configurations and translate these into new design specifications, for example. For large companies, it could also help with planning and monitoring projects and optimally allocating resources to them by drawing on information around past projects. In the pharmaceuticals industry, AI is already being used by at least 15 companies for drug discovery, with applications that sift through patient data or scan proteins or chemical compounds for possible pharmaceutical application.[1]

PwC's global AI study, *Sizing the Prize*, reported that 45% of total economic gains generated from AI by 2030 will come from product enhancements, stimulating consumer demand. This is because AI will drive greater product variety, with increased personalisation, attractiveness and affordability over time. The study expects up to a 26% boost in GDP from AI for local economies by 2030.

In PwC's *22nd Annual Global CEO Survey*, 85% of CEOs agree that AI will significantly change the way they do business in the next five years. That's a striking number. In fact, nearly two-thirds of global CEOs see it as bigger than the internet. However, resolving the information and talent gaps that CEOs face is a critical barrier to successfully exploiting the promise of AI.

In Germany, the federal government released its artificial intelligence strategy at the end of 2018, with the stated ambition of becoming a world leader in AI. Germany has pledged to back up the strategy with three billion Euros in investment. The need is there: PwC's recent study (in German) on artificial intelligence in enterprises showed that most companies still have a long way to go when it comes to AI. Just 4% of the 500 companies surveyed are already using AI, 2% have implemented AI systems, 17% are planning or testing uses for AI, and 28% see AI as relevant but haven't yet planned any concrete use cases. That's despite the fact that there are already many functioning applications available that can drive increased efficiency. Particularly concerning is the finding that that 48% of survey respondents believe that AI is not relevant for their company.

For further discussion of the way AI is impacting digital operations, please also see PwC's Strategy& *Global Digital Operations Survey 2018*.

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[1] Cf. Financial Times (online), "Pharma companies put faith in AI for breakthroughs", November 20, 2018, www.ft.com/content/e450a688-ddfb-11e8-b173-ebef6ab1374a.

5 Digital tools, methodologies and processes boost effectiveness

The companies we surveyed have already begun digitising product development. Most are using at least a few key tools to some extent, and the majority of Digital Champions are already using most tools. Looking ahead three years, there's a major jump in usage for every single tool we examined – between half and three-quarters of survey respondents expect to use each of them in coming years, and the numbers are even higher for Digital Champions (see Figure 6). Clearly, most players have understood the importance of using the latest tools and technologies to stay competitive. Many of them will become "table stakes".

Tools fostering co-creation stand out as the tools currently getting the broadest uptake, with nearly two-thirds of companies using them already. And around half of companies already use product portfolio management, process simulation and digital prototyping. Far fewer companies are using agile product development methods, digital twins, or PLM software, although interest in all of these is growing. Digital Champions are noticeably ahead in implementing these technologies, with more than 60% using all three.

Fig. 6   Companies are already using a wide range of tools. Trend: upwards.

Overall Sample

Digital Champions

Technology	Today	In 3 years	Total	Today (DC)	In 3 years (DC)	Total (DC)
Co-creation	64%	+12%	**76%**	71%	+4%	**75%**
Process simulation	50%	+24%	**74%**	82%	+14%	**96%**
Product portfolio management	52%	+21%	**73%**	75%	+21%	**96%**
Data analytics and AI[1]	41%	+30%	**71%**	79%	+21%	**100%**
Digital prototyping	51%	+16%	**67%**	68%	+18%	**86%**
Social listening	41%	+26%	**67%**	36%	+39%	**75%**
Agile development	34%	+26%	**60%**	68%	+21%	**89%**
Digital twin[1]	33%	+25%	**58%**	61%	+19%	**80%**
Product lifecycle management (PLM)	29%	+23%	**52%**	61%	+10%	**71%**

■ Today   ■ In 3 years   ■ Today   ■ In 3 years

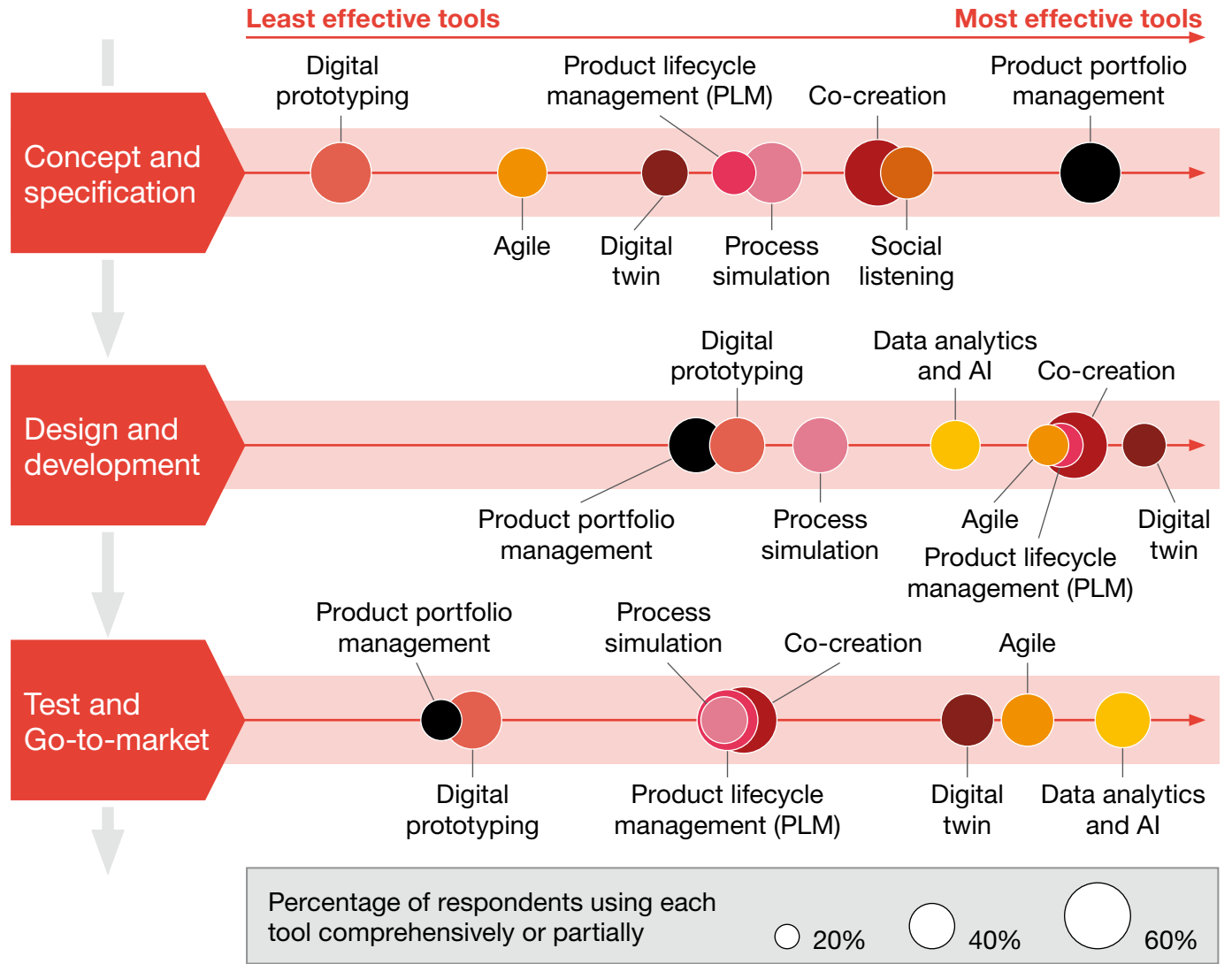To what extent do you use the following technologies today? Partial or comprehensive usage shown.

[1] Percentage increases for data analytics & AI and digital twins are extrapolated from data in our PwC Strategy& *Global Digital Operations Study 2018*.

It is vital to make sure your investments are the right ones

We've assessed the effectiveness of each tool during the three phases of the product development process to help companies decide which digital solutions will enhance their product development the most (see Figure 7).

Fig. 7 Effectiveness of digital product development tools and methodologies

Least effective tools → Most effective tools

Concept and specification

Digital prototyping · Product lifecycle management (PLM) · Co-creation · Product portfolio management

Agile · Digital twin · Process simulation · Social listening

Design and development

Digital prototyping · Data analytics and AI · Co-creation

Product portfolio management · Process simulation · Agile · Product lifecycle management (PLM) · Digital twin

Test and Go-to-market

Product portfolio management · Process simulation · Co-creation · Agile

Digital prototyping · Product lifecycle management (PLM) · Digital twin · Data analytics and AI

Percentage of respondents using each tool comprehensively or partially   ◯ 20%   ◯ 40%   ◯ 60%

To what extent do you use the following technologies today?

Note: Effectiveness reflects a mix of success factors; analysis PwC.

Developing products fast and flexibly throughout the development process

Co-creation – developing products together with suppliers, customers, or even using open innovation – is essential for future success. It allows companies to broaden their range of capabilities and fills in any capability gaps they may have, without going through the time- and cost-intensive process of building these internally. Further, it allows companies to focus and invest in their differentiating capabilities, those capabilities that truly make the difference compared to the competitors.

So it's a positive sign to see many companies putting co-creation and the underlying tools high on their list of investment areas. These are already proving to be effective, especially in the concept and specification and design and development phases (see Figure 7).

Co-creation doesn't only mean working with external parties; it's also important to co-create across functions within your own enterprise. That's something many companies are already doing; 73% tell us that they now develop products cross-functionally and sequentially.

Far fewer take the next step, though, and develop cross-functionally and in parallel. Parallel, cross-functional design makes it possible to get the most out of co-creation, which is why we believe it can be significantly enhanced by using agile development methods. Agile tools score at or near the top of our effectiveness ranking in both of the last two stages of development (see Figure 7). By adding agile tools and methodologies to product development processes, companies can shorten development time and cost significantly.

The use of agile tools and methodologies is one area where we see very significant differences between novices, the sample overall, and our Digital Champions. Just 39% of Digital Novices expect to use agile tools in three years. That increases to 60% across the sample as a whole and to 89% for Digital Champions.

61%
of **Digital Champions** currently use fully-integrated PLM systems, compared to just

12%
of **Digital Novices**

Enhancing product portfolios and lifecycles

Our research suggests that one of the most effective types of tool for the concept and specification phase of design is product portfolio management (PPM). These tools, and the underlying processes they support, help companies to focus on the right balance within the product portfolio. By understanding the key value drivers of current and future products, companies can ensure that scarce resources (eg, people, available investment) in product development and even beyond are available when needed and focused on the right priorities.

The companies we surveyed recognise this potential – 73% have already implemented PPM tools or plan to do so over the next three years. That number jumps to 96% for our Digital Champions. To get the most benefit from PPM, it's critical to make sure that strategists and product managers are working closely together with engineers and designers, so they can make the most informed decisions with regard to the product portfolio.

It's also vital to have the right tools to manage the full lifecycle of each product within the portfolio. Product lifecycle management has been around a long time, but today's state-of-the-art, end-to-end PLM solutions, paired with the right set of processes, enable the digital, fully integrated management of an (individual) product along the entire product lifecycle. These systems start with ideation and end with the end of product life – including all of the processes in between, from process and resource management to concept development and product definition, to product design, assurance and releases, through to performance and servicing. And they make it possible for companies to understand how their product development process impacts production and service activities.

However, relatively few companies have reached advanced stages of maturity in their PLM systems. Fully-integrated PLM systems go beyond cross-functional, integrated systems to connect through to the entire enterprise architecture, including CRM, ERP and MES, driving real-time track and trace and in the most advanced stage also enable co-creation with external partners on a common platform.

Such systems are very ambitious and reflect more fundamental changes to the enterprise, so it's not surprising that fully-integrated PLM systems rank at the bottom of the list of digital product development tools currently in use across the sample as a whole. There's a strong relationship between digital product development maturity and use of fully-integrated PLMs. While 61% of Digital Champions use them today, just 12% of Digital Novices do so.

Electrolux

Photo: Electrolux

Seamlessly connecting engineers around the world to create great consumer experiences at Electrolux

Electrolux is a leading global appliance company that places the consumer at the heart of everything they do. Through their brands, including Electrolux, AEG and Frigidaire, the company sells more than 60 million household and professional products around the world.

Developing products that meet customer needs in each of Electrolux's more than 150 markets isn't easy. A decade ago, the company met that challenge by using a wide range of diverse product development tools around the world. Today, Electrolux is achieving greater efficiency in product development through its global implementation of one comprehensive PLM tool across the company. Engineers in all of Electrolux's locations can now easily share information relevant to the development of products, from technical documentation, to specifications, article acceptance, engineering changes, and more, so they can drive great consumer experiences more quickly.

This technical backbone helps Electrolux to get the most out of the company's implementation of a modular product architecture. Global modular platforms are helping the company spread successful launches from one market to another, with adaptations to local preferences. Local engineers in each country can easily access digital twins of Electrolux's product masters and translate these into specific models which are tailored to the requirements of each individual market. In addition to mirroring all of the information about the product's physical characteristics, these twins also include any software that has been integrated into the product, the results of any lab testing, etc., so that there is one "single source of truth" about a particular product category. Suppliers can be connected via the platform too, so that they receive the latest information about any engineering changes immediately and are always up-to-date.

Electrolux estimates that its global modular platforms can reduce the time from product development for a market for a new product by 20–30% and that the investment cost decreases by 15–20%. It sees modular designs as enabling flexibility, by allowing designers and engineers to customise products using a limited number of standard components, and also increasing economies of scale in the sourcing of components.

Electrolux is currently working on taking these capabilities one step further. In addition to the existing digital twin for the product master, the company is now prototyping a system capable of using a "configurator" approach, which would create a robust digital twin that can automatically replicate every individual SKU. This super twin can thus produce an "overloaded" or "150%" BOM, which reflects all possible product variations and can be directly fed into material requirements planning.

Because these product twins use the same PLM backbone as Electrolux's digital twins of its manufacturing sites, based on Teamcenter and Technomatics from Siemens, they can connect seamlessly with the digital twins being developed of the Electrolux factories which will produce the respective products. Electrolux has worked with closely with Siemens and is even an early adopter of some applications in the Siemens portfolio, such as the Line Designer 3D modelling tools. All of the resources for optimising production created in Line Designer can be saved in Teamcenter, so they are available for users all around the world. This tight integration increases efficiency in both product development and production, helping the company save costs, while enhancing its responsiveness to local markets.
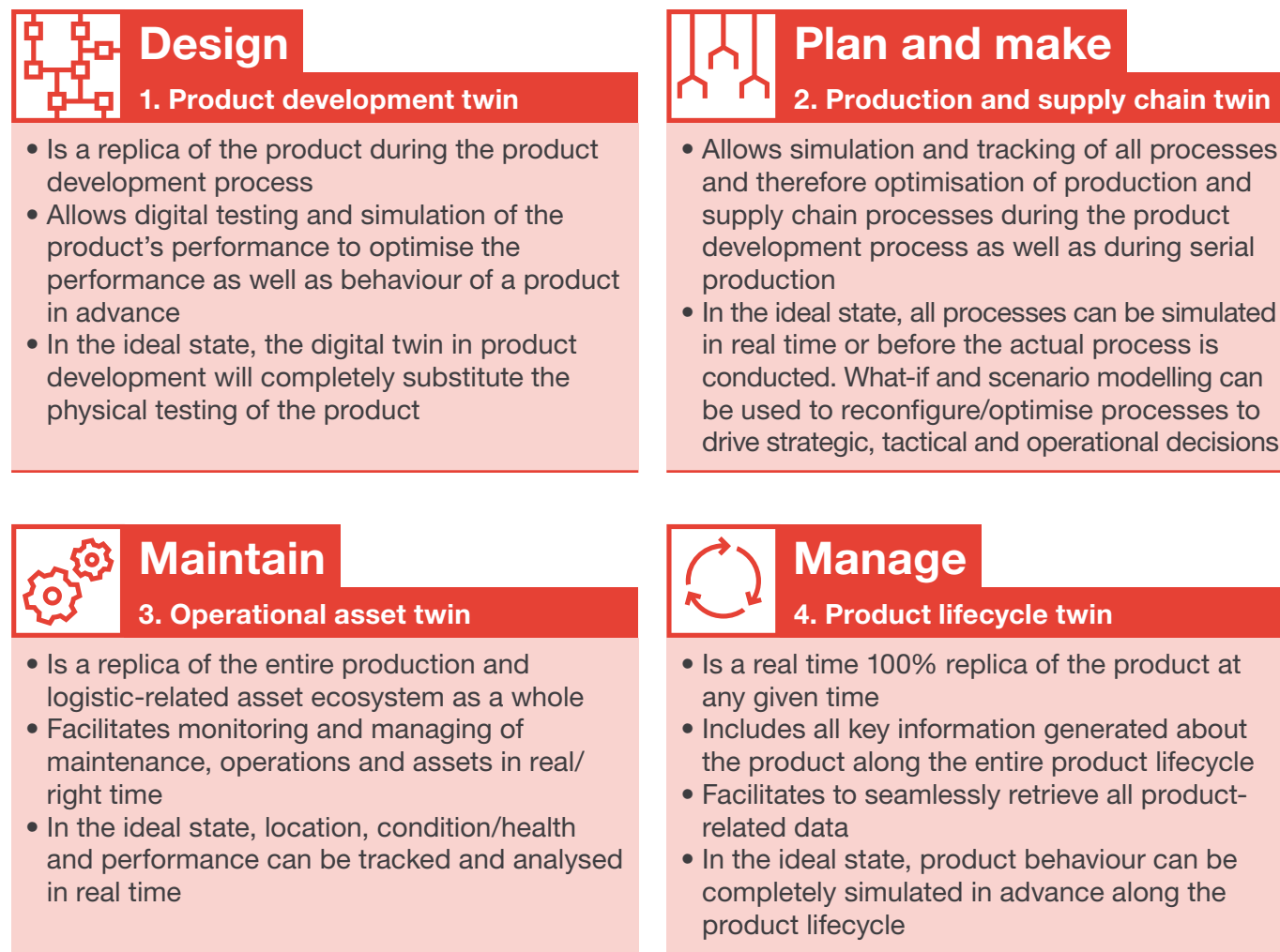
Using digital twins to accelerate product development and improve all the processes which follow

The term "digital twin" is used in a whole range of different applications across the entire operations spectrum, from product development to supply chain, logistics, manufacturing and service. To clarify which types of applications we mean, we named and categorised the digital twins based on their primary area of application (see Figure 8):
- Product development twin – to simulate product performance from end-to-end and therefore substitute any physical testing
- Production and supply chain twin – to simulate supply chain processes and therefore understand and improve the outcome before the physical process happens
- Operational asset twin – to monitor and steer the entire asset ecosystem
- Product lifecycle twin – to have full visibility and traceability and understand, simulate and optimise the product, as well as user behaviour, along the entire product lifecycle

In product development, digital twins stand out as the most effective tool during the design and development phase and are useful tools for both concept and specification and testing and go-to-market (see Figure 7). However, as mentioned previously, the benefits of a digital twin go far beyond the product development process.

Fig. 8   Types and uses of Digital Twins

Design
1. Product development twin
- Is a replica of the product during the product development process
- Allows digital testing and simulation of the product's performance to optimise the performance as well as behaviour of a product in advance
- In the ideal state, the digital twin in product development will completely substitute the physical testing of the product

Plan and make
2. Production and supply chain twin
- Allows simulation and tracking of all processes and therefore optimisation of production and supply chain processes during the product development process as well as during serial production
- In the ideal state, all processes can be simulated in real time or before the actual process is conducted. What-if and scenario modelling can be used to reconfigure/optimise processes to drive strategic, tactical and operational decisions

Maintain
3. Operational asset twin
- Is a replica of the entire production and logistic-related asset ecosystem as a whole
- Facilitates monitoring and managing of maintenance, operations and assets in real/right time
- In the ideal state, location, condition/health and performance can be tracked and analysed in real time

Manage
4. Product lifecycle twin
- Is a real time 100% replica of the product at any given time
- Includes all key information generated about the product along the entire product lifecycle
- Facilitates to seamlessly retrieve all product-related data
- In the ideal state, product behaviour can be completely simulated in advance along the product lifecycle

74%

of automotive companies are already using digital twins for product development.

Around half the companies we surveyed already have a digital twin in place (see Figure 9). The product development twin and product lifecycle twin are the most directly relevant for product development. However, the benefits of the product lifecycle twin go far beyond product development. For example, it enables end-to-end traceability which is becoming more and more important for regulatory purposes. This type of twin will make it possible for companies to provide better service to their customers and/or to offer new services, etc.

Production and supply chain twins that provide virtual versions of production and the supply chain can also help during the product development phase as they make it easier for companies to build efficiencies in both areas into product design (see DfX). Many companies are starting this journey, or planning to do so, with process simulation in selected areas (not as a whole); around half use process simulation now and nearly three-quarters plan to do so in three years (see Figure 6).

Some companies are also developing operational asset twins to facilitate management and steering of the entire asset ecosystem.
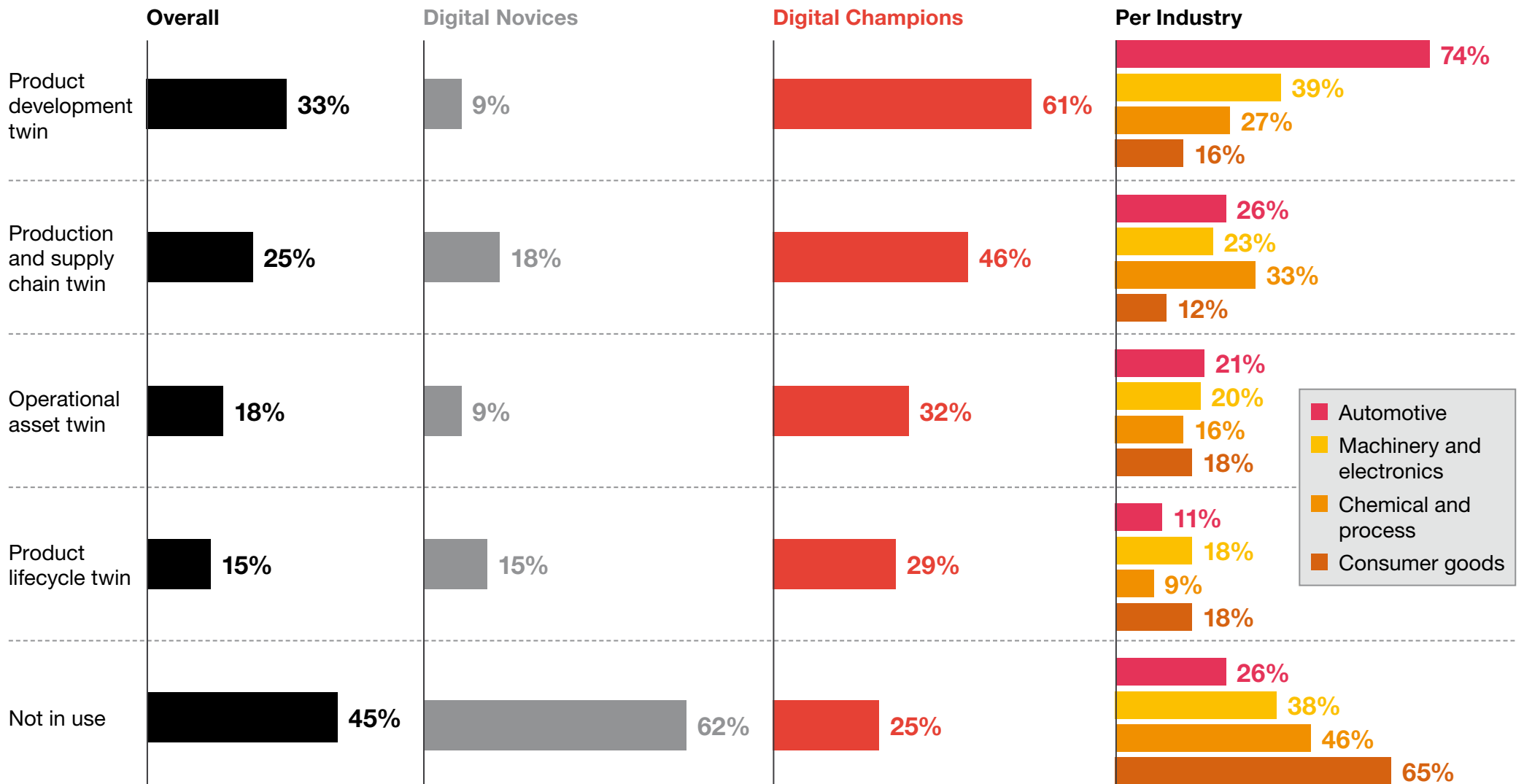
Across the sample overall, companies are most likely to use digital twins in product development; fewer companies are using them to optimise production and supply chain processes.

Less than one-fifth of the companies have an operational asset twin or a product lifecycle twin up and running (see Figure 9). That's because the use of digital twins in product development doesn't require companies to capture end-to-end data from the shop floor or field and is therefore much easier to implement, especially for companies that have already been investing in their 3D and simulation capabilities for several years. Around half of companies – and more than two-thirds of Digital Champions – already use digital prototyping in more limited ways, for example to test products virtually and dramatically reduce the number of field tests needed (see Figure 6).

Since a product lifecycle twin requires the integration of all stakeholders along the entire product lifecycle, as well as an advanced connection to products in the field, it can be very challenging for companies to implement.

Overall, we see enormous potential for broader uptake of digital twins and Digital Champions are already recognising this: not only do 61% use digital twins for product development, 46% say their companies use them within production, and nearly one-third use them for asset management (32%) and across the product lifecycle (29%). Digital Novices, in stark contrast, are lagging in this area. The use of digital twins varies by industry; generally, the more complex the product (eg, vehicles, machinery), the more likely companies are to use digital twins for product development (see Figure 9).

Fig. 9   Digital Champions and automotive companies are using digital twins significantly more than their peers

	Overall	Digital Novices	Digital Champions	Per Industry
Product development twin	33%	9%	61%	Automotive 74% / Machinery and electronics 39% / Chemical and process 27% / Consumer goods 16%
Production and supply chain twin	25%	18%	46%	Automotive 26% / Machinery and electronics 23% / Chemical and process 33% / Consumer goods 12%
Operational asset twin	18%	9%	32%	Automotive 21% / Machinery and electronics 20% / Chemical and process 16% / Consumer goods 18%
Product lifecycle twin	15%	15%	29%	Automotive 11% / Machinery and electronics 18% / Chemical and process 9% / Consumer goods 18%
Not in use	45%	62%	25%	Automotive 26% / Machinery and electronics 38% / Chemical and process 46% / Consumer goods 65%

Legend:
- Automotive
- Machinery and electronics
- Chemical and process
- Consumer goods

In which areas are "digital twins" already used within your company? Multiple answers possible.

Knorr-Bremse

Photo: Knorr-Bremse

Knorr-Bremse's technical calculations team is driving greater efficiency in product development and testing

Every day, more than 1,000,000,000 people around the world rely on systems from Knorr-Bremse. The company is a world leader in rail systems and offers products and services across the entire lifecycle of the train.

At Knorr-Bremse Systeme für Schienenfahrzeuge GmbH, the rail systems division of Knorr-Bremse Group, a highly-skilled team of experts in the technical calculations department is achieving as much with their computer simulations as a test centre. Knorr-Bremse uses virtual tests to simulate exactly what happens on test rigs at the company's Munich Development Centre, with one major difference: their computer analysis uses a digital twin.

Knorr-Bremse sees virtual testing as integral to validating products faster and more cheaply. By optimising products, Knorr-Bremse can ensure lighter components and thus save costs. The most important task of the simulations is to guarantee that products are capable of meeting the stringent requirements expected of them – for decades to come. The technical calculations team does this by simulating loads tailored for individual customers and use cases. For example, there is a huge difference between a train journey from one German city to another and one in Kazakhstan.

Brake discs, compressors and load-bearing structures are subjected to "torture", using sophisticated software to simulate heat, cold, airflows and, above all, structural integrity and vibrations. The high loads on a train in motion impact everything – from doors and HVAC systems to power converters and braking systems – so Knorr-Bremse created its own company procedure to calculate vibrations for each use case. Experts at all facilities use the same models for their calculations.

The company's simulation experts collaborate closely with the real testing conducted on the test rigs. Virtual testing can significantly reduce the number of tests a product is required to undergo on a test rig. But Knorr-Bremse also uses hardware testing to ensure that its virtual models simulate reality precisely and that its digital twins really are twins. By validating the approach in this way, it is possible to minimise the amount of hardware testing for individual product releases.

This relatively new trend also brings tangible benefits for the OEM, which uses it to support key customers like OEMs of high speed trains. Knorr-Bremse regularly provides computer simulations for many of the systems it supplies. And in some cases the collaboration goes a step further. Knorr-Bremse can provide customers with an "encapsulated" version of its in-house digital twins so they can simulate all systems throughout an entire train. This means the OEM is able to reproduce a virtual train with all systems running and in so doing save a considerable amount of time and money. When a new train is put on the rails for initial testing, OEMs can be confident that by and large everything already works – eliminating the need for extensive measurement runs.

Knorr-Bremse is seeing a rapidly-growing demand for this approach – and significant opportunities. The company's expert knowledge in this area helps it to support customers and exploit savings potential.

6 Cybersecurity is a must-have

We've shown how important data and analytics and AI are to companies implementing digital product development strategies. Co-creation, including working with external partners, suppliers and customers, is also at the top of companies' agendas. But whenever sensitive data are collected, analysed or exchanged externally, the communication channels can potentially be compromised and intellectual property or other sensitive, private information leaked. Do organisations know at all times which information is sensitive or relevant for regulatory purposes, how it is used, by whom and in which context? The honest answer to this question is almost always no.

Without knowing what data the organisation has, where they are stored and how they are being used, it is difficult to make the claim that the digital assets and data systems have been implemented with a data protection by design principle at the core.

In a structured environment such as a database, companies generally have a fairly good idea what data are available and how they are used. Once information is in any way transported from a controlled environment, for example through sharing with external partners, companies often lose control of the information and who is accessing it for what purpose.

Very few companies have mature programmes in place to mitigate cyber risk
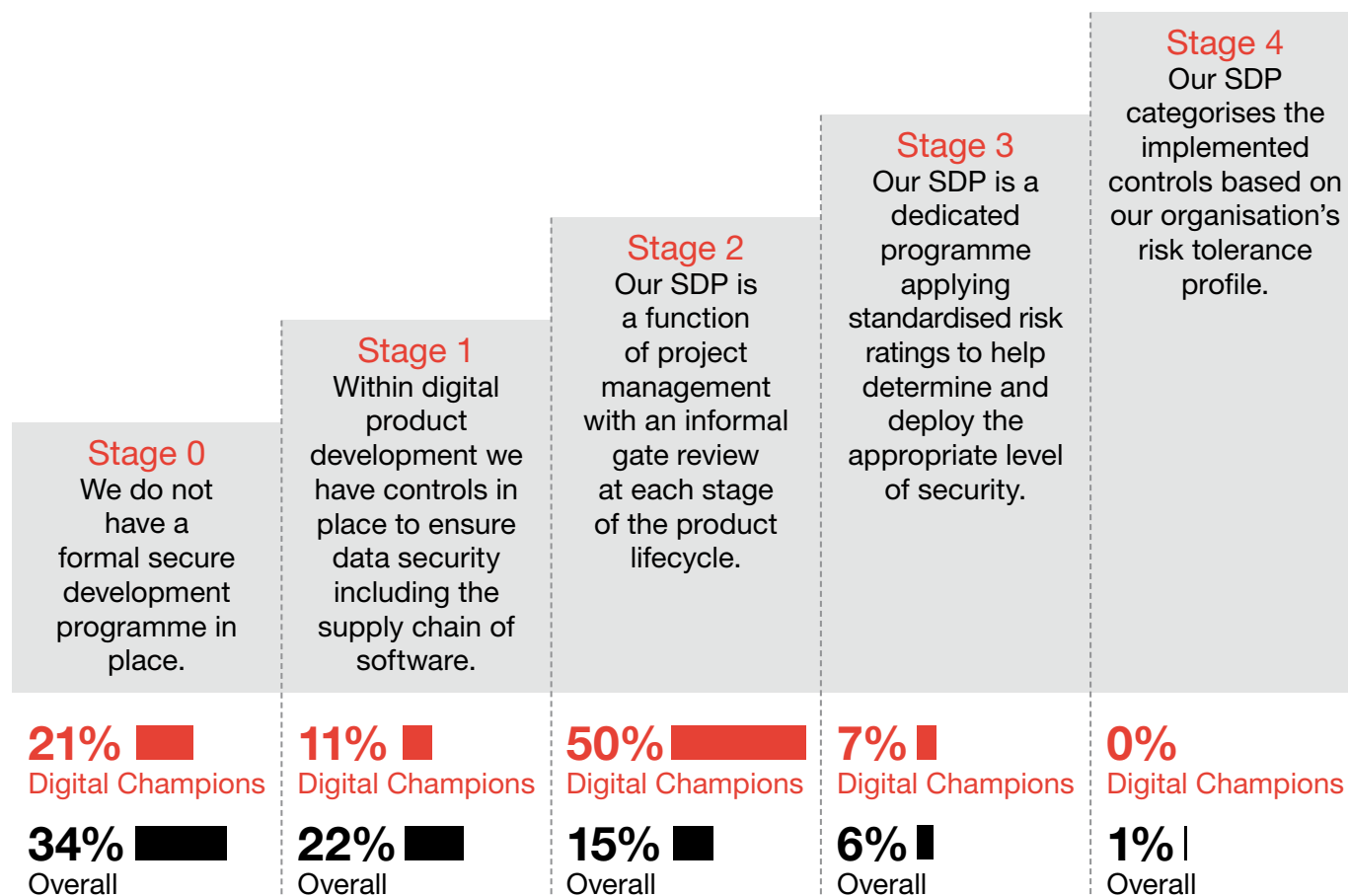
Our research suggests that companies still need to ramp up their cybersecurity efforts. Overall, a third of companies don't yet have any formal secure development programme (SDP) in place, and only a very small minority have a mature approach to mitigate the cyber risks inherent in data-intensive development processes.

Digital Champions are more likely to have a programme for cybersecurity in place, and their programmes are somewhat more comprehensive – around half say they embed their secure development programme within project management with an information gate review at each stage of the product lifecycle, compared to just 8% of novices who do this (see Figure 10).

Even Digital Champions are mostly not yet turning their initiatives to ensure secure development into a dedicated programme that applies risk ratings to deploy the appropriate level of security, or that goes a step further and implements controls based on their specific organisation's tolerance for risk. That's a missed opportunity because, by categorising risk into areas like enterprise impact, function safety, privacy and connectivity/access, companies can allocate their resources most efficiently.

Corporations should take active measures to analyse, classify, protect and track their digital assets and sensitive data. It's critical to keep the focus on the information that is truly important, regardless of where it is stored and used.

Fig. 10 Very few companies are fully addressing cyber risks

Stage 0
We do not have a formal secure development programme in place.

Stage 1
Within digital product development we have controls in place to ensure data security including the supply chain of software.

Stage 2
Our SDP is a function of project management with an informal gate review at each stage of the product lifecycle.

Stage 3
Our SDP is a dedicated programme applying standardised risk ratings to help determine and deploy the appropriate level of security.

Stage 4
Our SDP categorises the implemented controls based on our organisation's risk tolerance profile.

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
21% Digital Champions	**11%** Digital Champions	**50%** Digital Champions	**7%** Digital Champions	**0%** Digital Champions
34% Overall	**22%** Overall	**15%** Overall	**6%** Overall	**1%** Overall

To what extent have you implemented a secure development programme which governs the flow of data through the digital production development lifecycle?

Note: Don't know/prefer not to say not shown.

71%

of companies overall do not have a mature approach to mitigate cyber risks inherent in data-intensive development processes.

Worries about hacked vehicles spurring greater efforts in automotive as cars get more connected

Of the industries we surveyed, automotive companies were the most mature – 21% treat the SDP as a dedicated programme with a risk-based focus and differentiated security levels. That's not surprising given the increasingly wide range of possible vulnerabilities within connected vehicles. Wireless communications, onboard diagnostic interfaces, embedded computers on local vehicle networks, brought-in device communication (eg, driver's mobile phone), vehicle to vehicle, vehicle to infrastructure, and vehicle to grid communications, sensors, cameras and microphones – all of these are potential areas for attack and, as vehicles get more connected, those interfaces are also getting increasingly more complex.

That's why many in the industry are taking a holistic cybersecurity approach that starts with secure vehicle design and also includes secure engineering processes, testing, production and operation. The ISO/SAE is even developing a new cybersecurity engineering standard for road vehicles.

7 Vision: product development is part of an agile, integrated ecosystem

61%
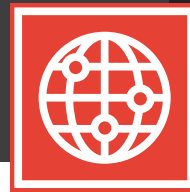
of **Digital Champions** have digitised their product development process

68%

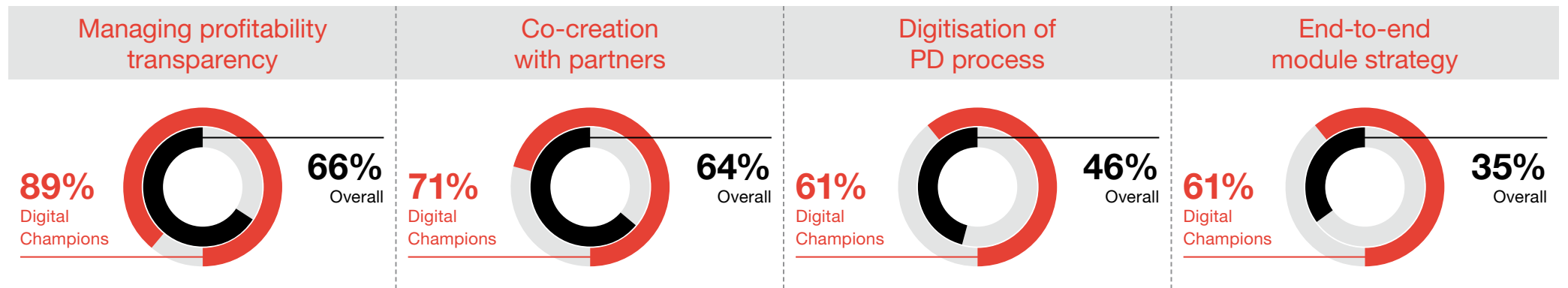of **Digital Champions** are already using tools for agile development

We asked companies how their product development has changed over the past five years. The results show that most companies have the basics in place but have yet to make more transformational changes.

Most companies also say they are digitising their product development process to at least some extent and we've already discussed in detail some of the specific tools and methods they are using most effectively. Many companies have come a long way towards gaining real transparency around what their product development costs and how it contributes to profitability (see Figure 11). Awareness of co-creation is also already high. Back in 2016, 42% of survey respondents reported that their product development and engineering had a high level of digitisation. These results suggest that they've made substantial progress since then, particularly around the basics.

It is essential to note here that Digital Champions already understand the power of the full range of available technologies and underlying processes – the vast majority of Digital Champions will use data and analytics in five years and almost all will perform process simulation and rigorous product portfolio management. Moreover, they put a strong emphasis on tools that enable and foster agile ways of working, while novices are considerably lagging behind in this area.

Still, most companies are only just beginning to make more transformational changes, like implementing an end-to-end module strategy or moving beyond the isolated application of tools and consistently using agile development methods.

Managing profitability transparency	Co-creation with partners	Digitisation of PD process	End-to-end module strategy

89% Digital Champions — **66%** Overall

71% Digital Champions — **64%** Overall

61% Digital Champions — **46%** Overall

61% Digital Champions — **35%** Overall

How has your product development process changed today compared to 5 years ago?
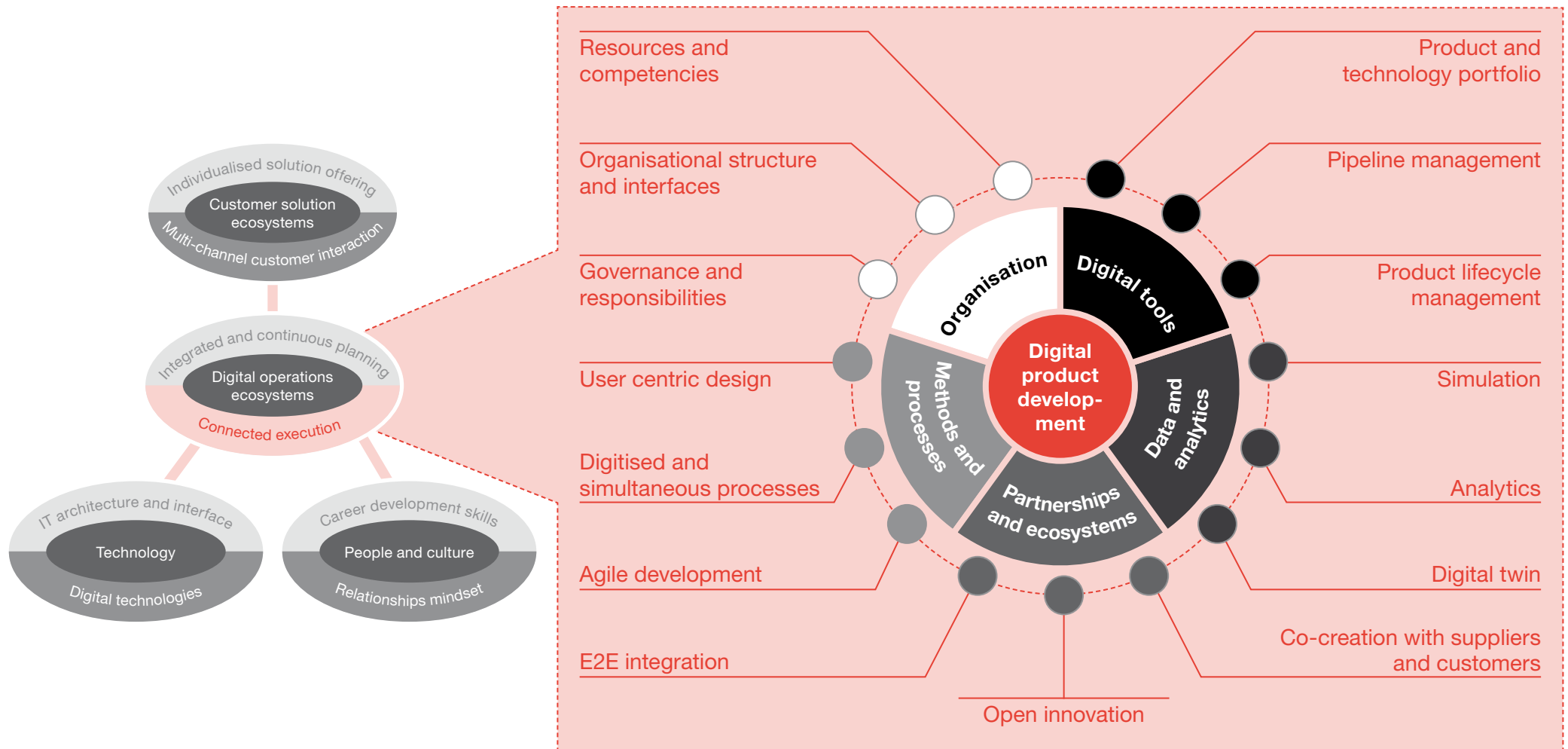
Moving towards an integrated ecosystem approach

In earlier research, we've looked at the importance of taking an ecosystem approach to digital operations. PwC's Strategy& *Global Digital Operations Study 2018* showed how industry leaders are building integrated operations ecosystems to deliver end-to-end customer solutions. It took a broad, holistic look at all aspects of digital operations. We found that leading companies, or Digital Champions, excelled at managing and integrating four critical ecosystems – customer solutions, operations, technology and people – each of which represents an array of partners, suppliers, products and services, employees, third-party advisors, factories, outsourcing arrangements, technology and customers.

The operations ecosystem layer itself is made up of five interconnected layers, one of which is the digital product development ecosystem (the others are procurement 4.0, smart manufacturing, connected supply chain and aftersales services). Companies taking an ecosystem approach to drive digital product development take care to balance a range of factors, including digital tools, data and analytics, partnerships, methods and processes, and organisation (see Figure 12). The Digital Champions in product development we identified in this study are already stronger than their peers in many of these areas.

The digital product development ecosystem has many touchpoints with other connected ecosystems, for example the use of customer analytics feeds directly into the customer solution ecosystem, and the technology and people ecosystems provide the IT infrastructure and human skills necessary for execution. A shift to agile product development is likely to require close interaction with the people ecosystem as it impacts motivation, behaviour, career opportunities, etc.

In the final section of this report, we explore in more detail the steps companies can take to develop their digital product development ecosystem.

Fig. 12 The digital product development ecosystem, one of five interconnected layers of the digital operations ecosystem

Individualised solution offering
Customer solution ecosystems
Multi-channel customer interaction

Integrated and continuous planning
Digital operations ecosystems
Connected execution

IT architecture and interface
Technology
Digital technologies

Career development skills
People and culture
Relationships mindset

Resources and competencies

Organisational structure and interfaces

Governance and responsibilities

User centric design

Digitised and simultaneous processes

Agile development

E2E integration

Organisation

Digital tools

Digital product development

Data and analytics

Methods and processes

Partnerships and ecosystems

Product and technology portfolio

Pipeline management

Product lifecycle management

Simulation

Analytics

Digital twin

Co-creation with suppliers and customers

Open innovation

Sources: Digital Product Development Study 2025 – Agile, Collaborative, AI Driven and Customer Centric, PwC's Strategy& *Global Digital Operations Study 2018*, PwC analysis.

KION Group

Photo: KION Group

KION Group: Digital product development through a digital campus

The KION Group is a global leader in industrial trucks, related services and supply chain solutions. Across more than 100 countries worldwide, the KION Group designs, builds and supports logistics solutions that optimise material and information flow within factories, warehouses and distribution centres.

In early 2018 the KION Group opened the KION digital campus in Frankfurt, Germany, as a creative hub for new digital business models, solutions and ways of working. The digital campus is KION's latest initiative on its way to becoming an integrated digital solution and service provider.

Since spring 2018, campus strategists, UX designers, data scientists and developers have been co-creating new digital products and services and implementing them in the shortest possible time, moving away from conventional product development processes. The campus space in Frankfurt's House of Logistics and Mobility is tailored entirely to the needs of dynamic cross-functional teams: open rooms and mobile workplaces provide a start-up atmosphere but, most importantly, state-of-the-art technical equipment provides the right test bed for leading digital solutions.

KION combines methods such as design thinking and agile application development with modern digital technologies. As diverse as the approaches are, they all serve the same goal: to develop sustainable digital solutions that offer real benefits for their users. The company is placing customers at the centre of everything they do and exploring different ways to provide the best possible value.

Data analytics is an integral part of the product development process used at the digital campus. For example, campus data scientists have worked with product managers and engineers to analyse large amounts of product configuration data in order to gain transparency over sales and cost drivers of specific product variants. They are also going a step further and using modern big data and advanced analytics technologies to predict operating costs for leased products, taking into account variant characteristics and environmental impacts.

At the digital campus teams are challenged to come up with a prototype in less than a week. This provides an important reality check. Many ideas look logical on paper but, once a prototype has been built, it becomes possible to really identify any weaknesses in a concept.

The first solutions developed in the digital campus include a chatbot app for service technicians, which increases process efficiency and also improves the acquisition of data about failures and their root causes – an important input for product optimisation. Another solution is an application for data-driven fleet optimisation, which enables a completely new business model for KION.

KION's digital campus is accelerating the digital transformation of the entire group. In addition to developing directly applicable new customer solutions and forward-looking new business models, KION's employees are learning new ways of working that will help them in their increasingly digital working lives.

Blueprint for becoming a digital product development champion

Investing in digital product development has significant benefits and should be an essential part of your company's overall digital operations strategy. Setting the right focus is key in order to invest smartly in the right digital product development strategies, processes and tools.

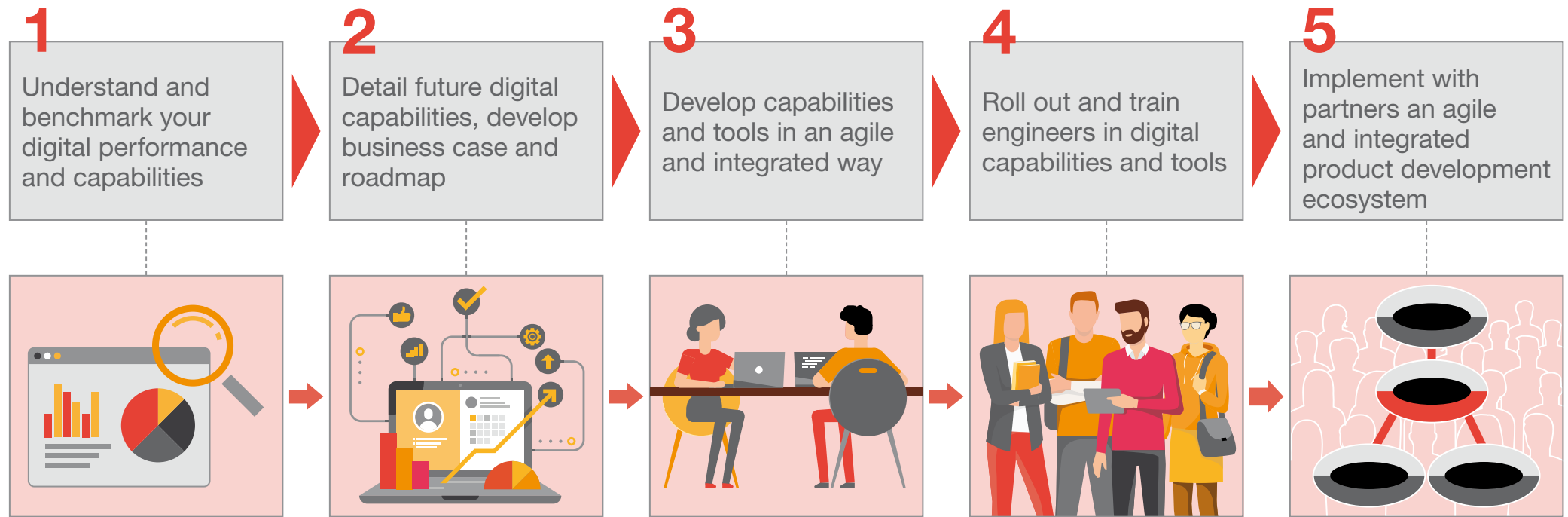## 1. Understand and benchmark digital performance and capabilities

Your first step should be gaining a comprehensive understanding of your current performance in product development and engineering. How does your company perform compared to your competitors within each of the key capabilities, and based on product development KPIs?

In addition, you need to assess your current digital product development capabilities (including differentiating capabilities) and pain points/challenges when it comes to digital performance. Which capabilities are must-haves (so-called table stakes) and which capabilities truly differentiate your company from your competitors? For example, do you have a stronger understanding of your customers, or do you already use AI to gain better customer insights?

Finally, you need to assess your current pain points around
• Digital tools
• Data and analytics
• Partnerships
• Digital methods and processes
• Existing R&D organisation

Fig. 13 Blueprint for becoming a digital champion in product development

1	2	3	4	5
Understand and benchmark your digital performance and capabilities	Detail future digital capabilities, develop business case and roadmap	Develop capabilities and tools in an agile and integrated way	Roll out and train engineers in digital capabilities and tools	Implement with partners an agile and integrated product development ecosystem

2. Detail future capabilities, priorities and business case

Once you understand where you stand with digital capabilities, you need to detail which digital capabilities you need to build or enhance to ensure sustainable performance.

Key focus areas should be defined by carefully looking at your differentiating capabilities, your performance compared to your competitors and overall, and your pain points as a whole. Digital capabilities might include data analytics and AI, agile development methodologies or implementing digital co-creation tools.

To prioritise your focus areas and to ensure that you have clear targets during the implementation phase, it's essential to develop a detailed business case for each focus area.

A robust cost benefits analysis will then help you to prioritise the focus areas and to omit "trendy" technologies with limited benefit or strategic value.

3. Develop capabilities and tools in an agile and integrated way

During the next phase of your digital journey your company needs to develop and implement digital solutions, from capabilities to tools and methodologies, in an agile way. Start with the focus area that has the highest priority, then develop and implement the solutions incrementally until you have reached your targets. Set yourself two-week sprint goals that provide you with continual results and checkpoints so you can change your development focus to achieve more benefits or fail fast if the value of a solution cannot be achieved. Lo-fi prototypes that demonstrate a solution to users, scrum sessions and other tools can support your company in rapid and successful solution development. A certain degree of flexibility within your targets should be allowed as long as the solutions continue to meet your key business requirements.

4. Roll out and train engineers in digital capabilities and tools

Once you have started implementing new capabilities and incremental solutions, it is also critical to set up a digital communication programme that informs and educates your engineers about the digital changes and new ways of working. You will need to offer digital training courses, both online and face-to-face, to train your employees as data scientists, digital design engineers or digital PLM managers. An in-house digital training academy – paired with outside training providers – enables a smooth digital transformation of your R&D and engineering department.

A challenging but realistic rollout plan needs to include your entire regional and global R&D and engineering organisation in a step-by-step approach.

5. Implement with partners an agile and integrated product development ecosystem

As a final step towards becoming a digital champion in product development, your company needs to integrate its product development activities with those of key development, product and service partners and lead an integrated development ecosystem. Through co-creation and joint product offerings with partners your company will be able to offer customers fully integrated, complete solutions rather than individual products and services. Effective co-creation tools, common standards and simultaneous access to joint product development platforms will become part of this integrated digital ecosystem.
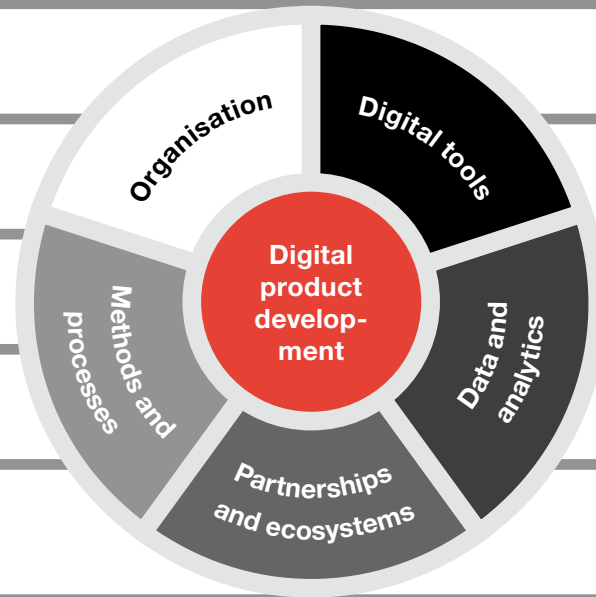
Digital transformation is never easy but for most companies it is essential to stay competitive. To help your transformation run more smoothly, we recommend that you involve your key stakeholders/influencers throughout the entire process to ensure their buy-in.

All of these steps will help your company to move from traditional product development to a truly digital product development, drawing on the strengths of digital tools, data analytics, agile processes, and other key methodologies (see Figure 14) – making your company agile, collaborative, AI-driven and customer-centric.

Fig. 14   Moving from traditional to digital product development

From …

… to:

From	To
Long product lifecycle	Short product lifecycle
Product maturity reached during production ramp-up	Simulation/prototyping enhances pre-launch maturity
W and V waterfall-based releases of entire systems	Agile with continual releases
Customer interaction from 1:n	Individual, personalised interactions and products
Siloed data models	One E2E product data network along the lifecycle
Sequential development and design	Ecosystem approach, parallel development and collaboration
Product and service improvements based on field performance surveys and warranty/service information	Continuous product and service improvements through constant monitoring and prescriptive analytics
Post-launch cost savings and manufacturability improvement initiatives	Pre-launch cost savings and manufacturability improvements

Organisation · Digital tools · Data and analytics · Partnerships and ecosystems · Methods and processes

Digital product development

About the survey

This report *Digital Product Development 2025 – Agile, Collaborative, AI Driven and Customer Centric* is based on quantitative research consisting of interviews conducted by a leading market research firm and by PwC in December 2018 and January 2019 with 200 executives from industrial companies in central and northern Europe. These quantitative results were supplemented by our editorial team's in-depth interviews with executives from leading companies in January and February 2019 and the in-depth knowledge of our authors.

Quantitative survey participants were decision makers with responsibility for product development. Companies of all sizes and in a range of product-focused industries were surveyed (automotive, chemicals and process industry, machinery and electronics, consumer goods). Charts generally exclude responses of "don't know/prefer not to say" and results may be rounded.

Following a similar methodology to that used in PwC's Strategy& *Global Digital Operations Study 2018*, we developed an index that ranks companies by digital product development maturity. Our index took into account the revenues that companies earned from new products and from digital products and services, the extent of their use of data analytics and other technological tools for product development, and their expected benefits from digitisation, including reduction in time-to-market, increased efficiency, reduction of production cost, and increased share of personalised products. We grouped the companies into one of four categories: Digital Novices (26.5%), Digital Followers (32%), Digital Innovators (31.5%),

and Digital Champions (10%), based on their scores in this index. The use of these terms in this report refers specifically to the interviewed companies' level of maturity in product development, as distinct from the broader use of the term in the previous study.

We grouped the companies into one of four categories:

26.5%
Digital Novices

32%
Digital Followers

31.5%
Digital Innovators

10%
Digital Champions

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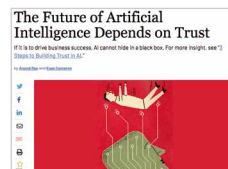
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About us
Our clients face diverse challenges, strive to put new ideas into practice and seek expert advice. They turn to us for comprehensive support and practical solutions that deliver maximum value. Whether for a global player, a family business or a public institution, we leverage all of our assets: experience, industry knowledge, high standards of quality, commitment to innovation and the resources of our expert network in 158 countries. Building a trusting and cooperative relationship with our clients is particularly important to us – the better we know and understand our clients' needs, the more effectively we can support them.

PwC. More than 11,000 dedicated people at 21 locations. €2.2 billion in turnover. The leading auditing and consulting firm in Germany.

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