

# Digital business models in plant engineering and construction in an international comparison



## A benchmarking study of PwC and VDMA

in cooperation with



Large Industrial Plant  
Manufacturers' Group

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## Executive summary

Pressure on the EPC<sup>1</sup> industry has increased noticeably in recent years. Stagnation and in some cases a decline in market share have been the consequences of this development. Nevertheless, the VDMA's large-scale plant manufacturers were able to record 2018 their first increase in orders after five years. However, the experts are reluctant to rate this development as a turnaround. Digitalisation<sup>2</sup> seems to be the way out for German EPCs<sup>3</sup> with its promise of releasing hitherto hidden potential for efficiency gains. So far-reaching changes are imminent for the EPC industry.

The aim of this study is to formulate the most promising digital business models and benchmark German industry against international peers.

To be successful, however, business models need to meet customer needs. This study is also designed around this principle. A customer-centric model (see Figure 1) was used and initially more than ten expert interviews were conducted with large owner organisations as well

as digitalisation experts. These findings were translated into a questionnaire addressed to both German and international EPCs. The aim was to evaluate the extent to which the German and international EPCs met the identified customer requirements. Overall, there were five major customer requirements (see Figure 2).

Surprisingly, perhaps, digitalisation has not led to new customer requirements. Digitalisation should instead be viewed as an enabler which promises to meet these requirements in a novel form. Customers demand increased visibility at business process level throughout the project lifecycle (A). This represents a departure from the previous classic EPC industry, which is characterised by lump sum turnkey contracts. The trend towards greater customisation is also affecting the EPC industry. Owners are being forced to accede to their end customers' demands for personalisation (for example for personalised products). This requirement is then passed on to the EPCs (B).



Figure 1. Customer-centric approach taken in the course of the study

Source: PwC

1 EPC is short for engineering, procurement and construction.  
 2 Digitalisation describes the use of digital technologies to create new revenue and value-producing opportunities; it is the process towards a digital business model.  
 3 German EPCs describes the EPCs that have their headquarters in Germany.

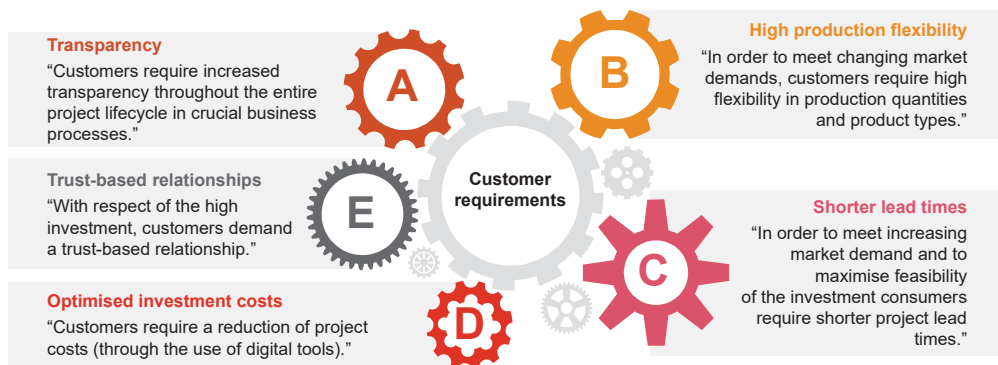


Figure 2. Five major customer requirements identified among German and international EPCs

Source: PwC

The demand for shorter project lead times (C), reduction in total costs (D) and trust-based customer relationships (E) have long been an inherent part of the EPC industry. Many initiatives in recent years have been aimed at reducing time and costs. Often, it seems that there are solid technical reasons why processes cannot be shortened, but here new approaches are necessary. A key focus should be on non-value-adding processes. For example, the process of project development, sales and tendering often takes one and a half years or more. Almost no value is

being generated during this period. Customised advisory activities and new contract models may suggest controversial new approaches. Customers clearly say they are not willing to pay a premium for digital tools. However, 40% of German EPCs believe that their customers are willing to pay a premium for the use of digital tools.

Today, 40% of German EPCs say they have only partially initiated the digital transformation. In the future, German EPCs are aiming to make significant investments in this field. The key

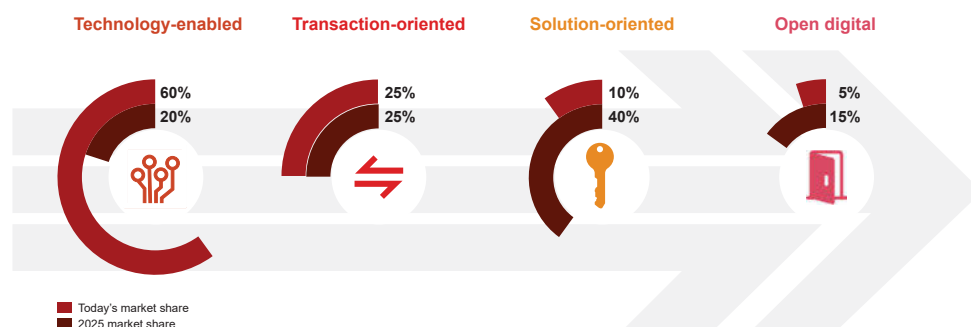


Figure 3. Market share of the four archetypes today and in 2025

Source: PwC

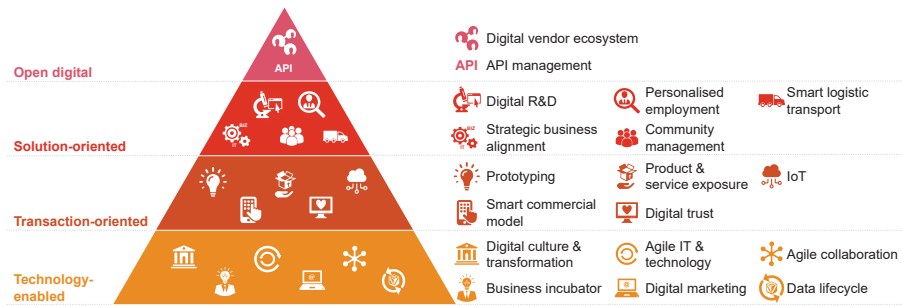


Figure 4. The four archetypes and their capabilities

Source: PwC

question is what form these investments should take. German EPCs plan to build many of the required capabilities organically. The international competition, on the other hand, takes an opposite approach. They are trying to have as many external partners as possible. They also try to apply more innovative and cooperative development approaches (e.g. open-source and open-innovation). Thus they are able to react faster on trends, develop and place new products and services much faster on the market. Unlike the German EPCs they do not have any constraints on the use of open-source and open-innovation approaches that may endanger the protection of their critical know how.

What do these trends mean for the business models of the German EPCs? To answer this question, the study has relied heavily on one of the best-known frameworks for digital business models (the so-called d.quarks model) and adapted it to the specific needs of the EPC industry. This classifies business models based on four archetypes: technology-enabled, transaction-oriented, solution-oriented and open digital. Each archetype is based on specific capabilities that are needed to realise the potential of each business model. In general, the level of digital capability increases from archetype to archetype, i.e., there is a development from the digitally supported product (archetype 1 “Technology-enabled”) to the open

EPC ecosystem (archetype 4 “Open digital”). The chart (see Figure 3) shows that the EPC industry is facing a “game changer”.

Based on the survey and numerous expert interviews this study demonstrates that German EPCs will be forced to progressively transform their businesses from a digital-enabled product (“Technology-enabled”) to a digitally open service business, as the market potential for the technology-enabled archetype will drop from 60% to 20%. Additionally, it is expected that enormous pressure is being put on the adequate margins in the services business. The suppliers have the expertise and data inherent in the individual technical components (machines, for example) and thus fulfil the potential for new competition. Customers are increasingly keen on evaluating their own operational data systematically.

This challenging situation raises the question for EPCs: how can they, as an organisation, perform this change quickly and sustainably? The answer lies in their digital capabilities, depending on the archetype the organisations wants to achieve. We developed 18 EPC-specific capabilities required to realise the potential of each archetype in the ecosystem of 2025 (see Figure 4).

These capabilities were analysed with regard to their relevance to the characteristics of German EPCs and to their international competition by performing a benchmark. As the benchmark

shows, the picture on skill levels varies (see Figure 5). International EPCs have a slight lead in technology-enabled capabilities.

A key driver of digitalisation is change management, in order to take employees on the journey of digital transformation (see Figure 5). It is surprising that neither German nor international EPCs have recognised the significance of this requirement and have not acted accordingly yet. For example, in representative surveys at industry meetings, only 5% (international EPCs) and 20% (German EPCs) of companies had a strategy for cultural transformation.<sup>4</sup>

In applying agile forms of collaboration (such as agile project management, open source and open innovation) and creating a business incubator, international companies are one step ahead of the German EPCs. This is why agile project

management is regularly used by international EPCs. Representative examples of this are use cases for agile project management by American EPCs and open innovation at a Chinese steel company (see Chapter “Digital business models”). For German EPCs, these applications remain the exception rather than the rule.

Within the range of “Transaction-oriented” archetype, German EPCs are also on average just behind their international competitors. However, German EPCs are (still) leading in one substantial



**“Culture is #1 driver for digital transformation; technology is just the enabler.”**

*Giovanni Bavestrelli, TENOVA*

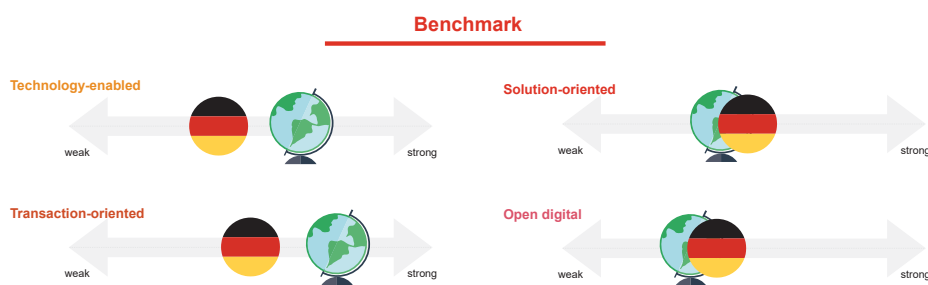


Figure 5. Benchmark of all required capabilities

Source: PwC

<sup>4</sup> Cf. 6th Engineering Summit – Annual Networking Event organized by the VDMA



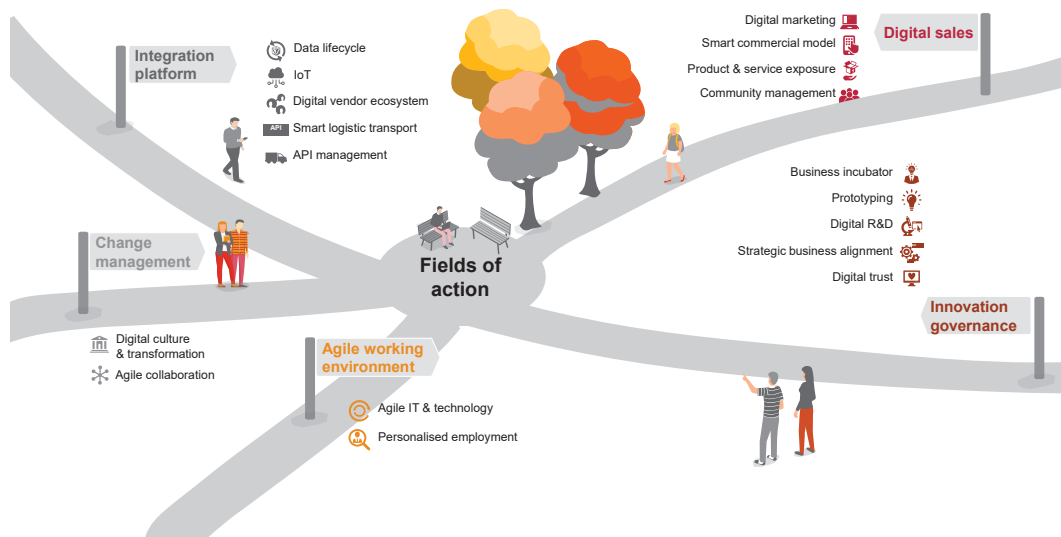


Figure 6. Blueprint to digital success

Source: PwC

area: they can transform a trust-based customer relationship into one that fits the digital age. For example, in terms of digital trust, there is already more awareness on the importance of cyber security officers, with new job profiles already in place or planned within the organisation or the project.

With regard to the “Solution-oriented” archetype, the situation is very similar. German companies are behind the competition on strategic harmonisation and integration of external partners into digital R&D. A good example is the use case of Baosteel which takes the open innovation approach to controlling its R&D process with multiple external partners.<sup>5</sup>

Within the range of the “Open digital” archetype, German and international EPCs are on a par. Today, several integration platforms partially meet the requirements of a digital EPC landscape.

In summary, German EPCs have made remarkable efforts, built up many capabilities and have shown competitive advantages in various fields of action (e.g. cyber security). However, German EPCs have potential for optimisation in the

following five areas, “Change Management”, “Integration platform”, “Digital sales”, “Agile working environment” and “Innovation governance” (see Figure 6) in order to even better exploit the opportunities offered by the digital transformation.

These five fields for actions are based on the previously described capabilities. In addition, for German EPCs, it is important to develop a roadmap for building up these capabilities and to prioritise market and industry specifics based on the specific business model. A “one size fits all” approach will fail, hence an individual roadmap to digital business models must be developed based on the steps outlined in Figure 7.

For EPCs, the first task would be to define the target archetype, i. e. to get a detailed picture of the customer landscape and its likely development by 2025 (step 1). This could be followed by a capability assessment. The required capabilities depend on the defined archetype. These skills are compared with the existing capabilities (step 2). The final step is to close the gaps. The companies are asked to decide to which extent the “missing capabilities” can be built up internally and which skills require external input (step 3). This three steps agile approach must be repeated at defined time intervals (for example annually) to allow the company to respond to any changes.

5 Cf. [http://www.baosteel.com/group\\_en/contents/2887/40017.html](http://www.baosteel.com/group_en/contents/2887/40017.html)

The study results can be summarised as follows:

- Digitization is the enabler to meet well-known (e.g. shorter lead times) and new customer requirements (in particular transparency) in an efficient and sustainable way
- Providing increased transparency in all business process at the interface to the customer and in the supply chain via an integration platform is the key to sustainable success
- The EPC market is undergoing drastic and disrupting changes with shifting market potential
- Companies that fail to make that leap from technology to digital & data-driven service in an open EPC ecosystem will find it difficult to position themselves on the market in 2025
- The impact of change management is systematically underestimated and can lead to a failure of digital transformation on both international and German EPC side
- Expanding the strengths of cyber security and digital trust is key for German EPCs and forms a key competitive advantage
- German EPCs continue to build the digital capabilities they need internally, but there is still considerable potential to accelerate project execution and improve the cost position
- German EPCs have made remarkable efforts with first success stories; it is important now to accelerate the further development through the application of the agile “three-step approach“

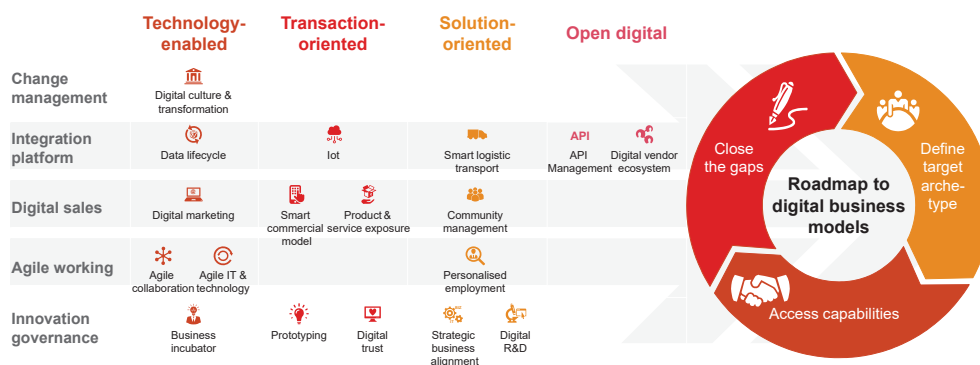


Figure 7. Roadmap to digital business models

Source: PwC

## Background and objectives of the study

### Background

This study looks at large industrial plant manufacturers, defined by the VDMA Large Industrial Plant Manufacturers' Group (AGAB) as companies with the capacity to manufacture customer-specific industrial plants worth at least €25 million once or several times a year based on an extensive knowledge of process engineering. AGAB members received new orders of around €18 billion per year in the last couple of years and have a world market share of around 15%.<sup>6</sup> They employ 54,000 highly qualified experts in Germany as well as another 100,000 at international locations and, with around 75% of products sourced from external suppliers, have a significant knock-on effect on medium-sized machine and plant construction.

Around 150,000 additional jobs in supplying industries depend on the projects of VDMA large industrial plant engineering companies.

Large industrial plant manufacturers operate in an increasingly demanding and difficult market environment with a global economy that is volatile, uncertain, complex and ambiguous (the so-called VUCA world). As evidenced by the EPC capability study<sup>7</sup> in 2017, the EPC sector is currently a buyer's market. At the same time, competitors are steadily developing and increasing the pressure on German EPCs. Chinese competitors have not only replaced Korean EPCs as cost leaders but are also pushing for more sophisticated solutions through massive R&D investment.<sup>8</sup>

	2014	2015	2016	2017	2018	Change 2018/2017
<b>Order intake (total)</b>	19.6	19.5	18.9	17.8	18.3	3.0%
Domestic orders	3.7	2.6	3.7	3.8	3.5	-7.0%
Foreign orders	15.9	16.9	15.2	14.0	14.8	5.7%
Thereof						
Eastern Europe and CIS	4.1	2.2	1.8	1.8	4.3	138%
Industrialized states	4.3	4.2	4.1	4.5	4.1	-7.4%
Asia-Pacific region	3.7	2.0	2.2	3.5	2.2	-37.4%
Near and Middle East	1.8	2.4	1.8	1.4	2.1	51.0%
Rest of the world	2.0	6.1	5.4	2.9	2.2	25.3%
<b>Sales</b>	20.3	20.5	22.8	21.2	18.6	-12.4%
<b>Export share (in %)</b>	81.0	86.6	80.7	78.9	81.0	
<b>Customer countries</b>	119	115	110	112	111	
<b>Employees in Germany</b>	61,000	58,800	57,600	55,900	54,100	-3.3%

Figure 8.  
Large industrial plant manufacturing in figures  
(in billion euros)

Source: VDMA Large Industrial Plant Manufacturers' Group

6 Cf. VDMA, Status Report 2017/18

7 Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

8 Cf. <http://www.chinadaily.com.cn/a/201901/02/WS5c2c2fc5a310d91214052117.html>

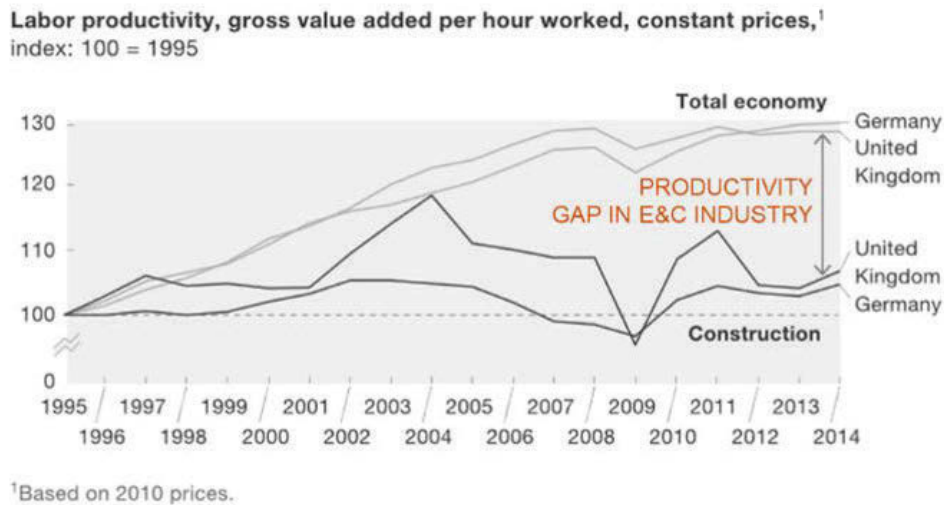


Figure 9. Productivity gap in the E&C industry

Source: Organisation for Economic Co-operation and Development

The VDMA status report states that competitive pressure will continue to increase for German EPCs in the coming years and China will become the strongest competitor.<sup>9</sup>

Market share is declining and revenues stagnating in some areas (see Figure 8). This is the outlook for the next few years. Nevertheless, the EPC industry is facing profound changes in the near future. Adjustments are therefore urgently needed. Digitalisation is understood as being the key enabler for increasing efficiency. The yearly OECD report gives a clear indication of efficiency improvements of the different industries over the past years. Unfortunately, the plant engineering and construction sector is not shown separately. Therefore, we have chosen the construction industry as reference for the following reason. The construction industry has the lowest efficiency gains according to a recent OECD report. Even though the EPC business is not equivalent to the construction business, the both industries are united in one point. The individual planning and execution of a (time and cost intensive) project is the core of both business models.

Digitalisation is seen as the enabler to close that productivity gap in the engineering and construction industry. Digital transformation promises to improve the EPC ecosystem dramatically and is therefore still a top priority on management

boards’ agendas around the globe. EPC companies are finding it challenging to maintain their market position. Today, only a few EPC companies and new disruptive market players are able to adjust their new business models. These are the so-called leading EPCs.

### Objectives of the study

The study has the following five objectives:

- Evaluate and gain a clear understanding of customer requirements today and in 2025
- Benchmark and identify the EPC company with the most promising digital business model(s) (“archetypes”, see Chapter “Digital business models” for details) in the year 2025
- Forecast the market potential of the four different digital business model archetypes
- Define EPC 2025 and the capabilities needed to meet the customer requirements and exploit the changing market potential
- Make detailed recommendations for EPCs for the different business model archetypes and provide a roadmap that needs to be adjusted by the EPCs in order to improve their competitive position

9 Cf. VDMA, Status Report 2017/18



Figure 10. Customer-centric approach taken in the course of the study

Source: PwC

## Approach

A customer-centric approach is the recipe for success in digitalisation. We therefore follow this approach in this study, as shown in Figure 10.

The following core principles form the basis for the approach:

- The study is a joint collaboration between the VDMA and PwC
- The customer-centric approach (ten steps in total)
- The study started in July 2018 and be completed by May 2019
- The focus industries are
  - Cement
  - Chemicals
  - Energy
  - Metals
- Hybrid approach of a quantitative and qualitative analysis

The following sub-headings refer to the ten steps shown in the chart (see Figure 10).

### Steps 1 and 2 – Understand your customers’ requirements

As described in the Background section (p. 10/11), the first goal of the study is to evaluate current and future customer needs. The intention was to systematically record these in order to verify the extent to which these criteria are met by German and international EPCs (see Figure 11 and refer to steps 3–5). The following steps were necessary to achieve this goal:

- Identify globally active owners in the four defined core industries
- Conduct ten expert interviews with globally active owners, academic institutions and new market players
- Derive and define core customer requirements from these interviews

**Steps 3 to 5 – Conduct and evaluate the quantitative analysis**

In order to benchmark German EPCs with their global competitors, we conducted a quantitative analysis:

- 25 German EPCs participated, representing market coverage of 75% (based on revenues)
- 32 expert interviews conducted; Figure 13 lists a small selection of the companies and institutions that have participated in the study
- A total of 20 international participants were interviewed in eight countries (see Figure 12) in order to reflect the global character of the EPC industry
- Focus points and trends with regard to strengths and optimisation potential in terms of fulfilling customer requirements were identified
- Preliminary benchmark results were derived as a basis for further validation in expert interviews and workshop sessions

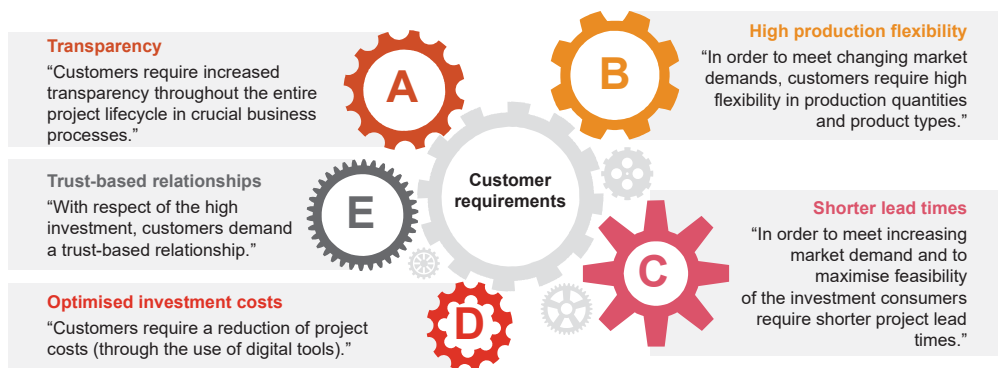


Figure 11. Customer requirements

Source: PwC



Figure 12. International study respondents

Source: PwC

**Steps 6 and 7 – Validate focus subjects by expert interviews and workshops**

Preliminary results were discussed and further validated by the following sessions:

- Expert interviews with EPCs
- German EPCs (ten interviews)
- International EPCs (five interviews)
- VDMA Industrie 4.0 working group
- Engineering Summit in Wiesbaden, Germany (2018)
- Sulphur 2018 + Sulphuric Acid Conference, Gothenburg, Sweden (2018)
- Workshop sessions with the AGAB management board

The validations were important for providing an in-depth analysis of the identified focus points and deriving areas for actions for German EPCs.



Figure 13. A small selection of the interviewed experts from the total participants of the study (sorted in alphabetical order)

Source: PwC

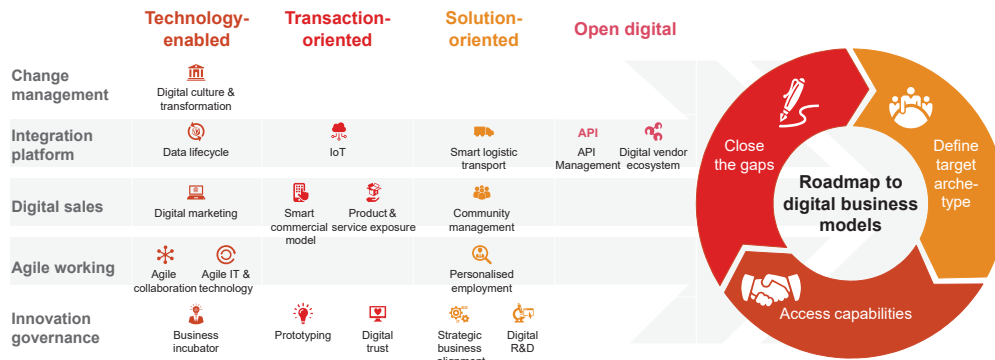


Figure 14. Roadmap to digital business models

Source: PwC

**Steps 8 to 10 – Finalise study and give recommendations**

The study findings show how customer requirements can be transferred to digital business models:

- Systematic and structured presentation using a recognised framework
- Selection of a recognised framework (d.quarks) and tailored it to the needs of the EPC industry
- Development of four archetypes and forecast of market potential across these archetypes
- Assignment of capabilities required for each archetype
- Definition of each capability, its relevance and benchmarking against international competitors
- Aggregation of capabilities into five clusters for recommendations
- Development of a tailor-made roadmap to success for German EPCs (see Figure 14) to each archetype, assessment of capabilities and closing of gaps



## Industry profiles

Different industries have different business model requirements. In order to reflect these requirements, the four core industries of this study, i. e. cement, energy, steel and chemicals are explained in more detail below. These industry profiles are essential tools for evaluating the quantitative and qualitative analyses and developing recommendations. The profiles will follow the same structure. There is a short summary (bullet points) at the beginning of each industry. These bullet points and the detailed explanation include the “Definition & business model characteristics”, the “Market development and competitive landscape” and “Outlook & entry points for digitalisation”.

### Cement industry

- The cement industry is a local business, that requires a secure supply chain on a long-term basis
- Highly competitive market led to several consolidation and puts German EPCs under high efficiency pressure
- Research and development is a promising key to success; digitization helps to create a smoother research and development process by including internal and external stakeholder

#### Definition & business model characteristics of the cement industry

Cement production is predominantly a local business, as cement is a heavy product that can only be transported economically over short distances by land. Cement plants are typically located within a radius of a few 100 kilometres of sales markets. International trade in cement is only profitable if water transport is used and most export locations are therefore close to waterways.

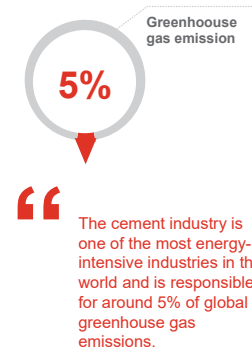


Figure 15. Greenhouse gas emission Source: PwC

The regional market situation is crucial to investment in the cement industry. Capacities are expanded when demand for cement exceeds local production capacity and imports are not an option. In the long term, capacity development therefore follows underlying consumption. Cement production is highly capital-intensive with long repayment terms. In addition, investment in the cement industry is usually irreversible since the plant cannot be used to produce alternative products. The cement industry therefore needs a secure long-term supply of raw materials.

The cement industry is one of the most energy-intensive industries in the world and is responsible for around 5% of global greenhouse gas emissions (see Figure 15). The industry is therefore more dependent than other industries on competitive energy policy framework conditions. The EU’s plans to further reduce greenhouse gas emissions and the number of emission certificates available are putting cement manufacturers under increased pressure to switch to more environmentally friendly production. If they fail to do so domestic cement supply could be replaced by cheap imports, especially in Europe, if transport rates fall and production costs are low overseas.

### Cement market development & competitive landscape

As a result of the global financial crisis in 2008, the cement market suffered several years of weakness characterised by declining prices and falling demand. However, this trend has now been reversed. In 2018, global cement consumption (excluding China) grew by 3.3% (including China: -0.2%) to approximately 1.8 billion tonnes (4.0 billion tonnes including China). This increase is primarily attributable to infrastructure investments in North America, the economic recovery in Europe and the revival of demand for cement in Asia (+5.1%) and Eastern Europe (+3.6%). In Africa, cement consumption rose by just under 2% in 2018, and there are also signs of growth in the Middle East. Consumption is expected to increase there with annual growth in capacity of 2.3% between 2018 and 2023.

In China, on the other hand, which accounts for more than half of global cement demand, consumption has been falling for years. A decline of 2.8% was recorded in 2018. A continuation of this trend is likely due to shrinking public construction investments. According to estimates by the US consulting firm CW Research, capacities of around 400 million tonnes per year will be shut

down in China by 2023. Against this backdrop, the international expansion of Chinese plant manufacturers and cement plant operators is likely to accelerate further.

The growth markets of the cement industry are in emerging economies, where the drivers are often infrastructure projects and urbanisation. As an important supplier to the construction industry, the cement industry benefits particularly from this development. In 2018, the Asia-Pacific region accounted for more than 75% of global cement consumption, of which China accounted for approximately 70% (see Figure 16). In Asia, India, Indonesia and Vietnam in particular offer good prospects for the cement industry. However, catch-up processes are also taking place in the Middle East, Eastern Europe and Africa. In Africa, this development is supported by strong Chinese commitment, which includes both cement production and the construction of industrial plants. By contrast, consumption in the industrialised countries has been stagnating for years. In Germany, for example, cement consumption in 2000 was still around 35 million tonnes. In the meantime, this figure has fallen to 27 million tonnes. The lack of demographic dynamism and declining public spending are the main reasons for this.

Since the financial crisis, the cement industry has undergone a fundamental transformation. Many companies were forced to initiate consolidation measures due to falling demand and high overcapacities. In recent years, there have been a number of mergers between important market participants as a result. A prominent example is the merger of the Swiss company Holcim and the French company Lafarge. The German market leader HeidelbergCement and Italcementi merged in 2016.



Figure 16.  
Cement consumption  
in the Asia-Pacific region

Source: PwC



Figure 17.  
Market shares in cement  
production in 2018

Source: PwC

Development in China is spectacular. The government is actively promoting the formation of large groups which are likely to assume market leadership in a number of sectors. As part of this strategy, the Chinese companies CNBM and SINOMA merged in 2017 to form a national champion, both active in the production of building materials and in engineering. It is too early to predict the consequences of this vertical concentration step for the cement market and plant construction. However, experts expect the market to become more dynamic and international competition to intensify.

The acquisitions of the recent past have led to a stronger concentration on the cement market. Whereas at the turn of the millennium the five

largest companies were responsible for around a quarter of global cement production, the four largest suppliers now account for over 30% of global production (see Figure 17, excluding China). Despite this development, the market remains highly fragmented. Global groups with their own plants on different continents continue to be an exception. LafargeHolcim is the only supplier with more than 10% of the world's production capacity. In principle, such foreign commitments enable companies to hedge against economic risks through geographical diversification and to stabilise domestic cement production.

Many strategic realignments took place in parallel with this market consolidation. Companies that previously produced only cement established vertical structures. They diversified their range and also produced finished products (e.g. concrete, ready-mix mortar). Some products (e.g. plasterboard, insulation systems) and activities (e.g. logistics, engineering) from outside the industry were added to the portfolio. This contributed to the consolidation of sales and acted as a buffer against competing companies or imports. Most of the world's leading cement manufacturers are now international conglomerates with a wide range of shareholdings.

## Outlook

In order to save energy – and thus costs – and to comply with ambitious emission limits, the cement industry is continuously increasing the efficiency of its plants. In addition to process improvements, companies are exploiting the substitution potential of alternative fuels, which make a significant contribution to reducing CO<sub>2</sub> emissions. In 2016, 65% of the fuel energy in the industry was already covered by alternative fuels – more than twice as much as in 2000. In addition, the vision of a carbon dioxide-free cement production will be subjected to a reality check in Sweden where plans to construct a pilot plant powered by renewable electricity are being developed. However, it will be years before this technology is ready for the market.

The factors determining demand for cement include global population growth, global income development, urbanisation and – as a consequence of this – the growth of the construction industry. These drivers remain intact and should ensure growth in cement demand in the coming years, especially in the markets in Asia, Africa and Eastern Europe.

According to estimates by CR Research, global cement consumption will increase by 2% in 2018, with a slight decline in China offsetting growth of 3.3% in the rest of the world.

By 2023, growth is expected to accelerate to 3.6% per year (see Figure 18, excluding China) and global consumption will then be around 2.1 billion tonnes (excluding China). Further declines in consumption can be expected for China. In addition to weaker construction activity in the public sector, this is mainly due to strict environmental protection regulations that limit the expansion of the cement industry.

The medium-term prospects for cement plant manufacturers are promising. Africa is currently one of the industry's most important sales markets. Chinese suppliers are established there and have commissioned several standard plants in recent years. European plant manufacturers are currently demonstrating their competence in demanding turnkey projects, for example in North Africa, South America and the Middle East. There are only a few new projects on the market in the industrialised countries. Market potential arises primarily from the modernisation of existing plants and provision of services.

In the past, new developments in cement plant construction focused on optimising machine and process technology. Today, compliance with environmental protection laws plays a key role. In order to remain market leaders, the VDMA's large industrial plant manufacturers are therefore focusing their research and development activities on reducing climate-relevant gases, developing new cement types and replacing fossil fuels with renewable fuels. In order to master the complex production processes, it is also necessary to use modern software solutions and digital applications.

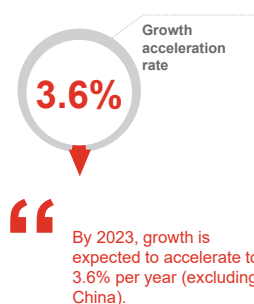


Figure 18.  
Growth rate in the cement industry 2019 – 2023

Source: PwC

## Chemistry industry

- In speciality chemicals, chemicals for special applications are produced to customer specifications and in relatively small batches
- Market volume rose to €4.4 trillion in 2017, growth markets are emerging countries; China is the world's largest chemical nation, accounting for around 36% of global sales
- Digitalisation enables leaps in efficiency

### Definition & business model characteristics of the chemistry industry

The chemical industry is largely globalised and can be divided into two segments: basic and speciality chemicals.

The basic chemicals industry manufactures products that are used as starting materials for other industrial products. These are mostly chemically simple substances produced in large-scale plants. Basic chemicals form the basis for mass products such as plastics and fertilisers as well as for special products such as adhesives. The production price for basic chemicals is lower than for downstream products due to economies of scale and depends heavily on raw material and energy prices.

In speciality chemicals, chemicals for special applications are produced to customer specifications and in relatively small batches. Typical speciality chemicals are additives such as flame retardants, light stabilisers and food additives. The main characteristics of speciality chemicals are high expenditure on research and development and high manufacturing costs compared with basic chemicals. In speciality chemicals, large-scale plants are rarely used. The small volumes are usually produced in discontinuous production processes on special-purpose machines or modular plants.

### Chemistry market development & competitive landscape

The chemical industry is one of the largest industries in the world. It is an important supplier of inputs, for example for the plastics industry, the food industry, mechanical engineering and the building materials industry. In 2017, the industry's worldwide turnover amounted to around €4.4 trillion, which is roughly equivalent to Japan's GDP. The growth rate of the chemical industry in recent years has been impressive. Since 2010, production has increased in a range of 3% to 5% per year. In 2018, the chemical-pharmaceutical industry grew by 4%.

China is the world's largest chemical market, accounting for around 36% of global sales (2017). This is followed by the USA (15%) and Japan (4.4%). In Europe, the German chemical-pharmaceutical industry generates a quarter of chemical sales and is by far the number one. With sales of €196 billion and around 453,000 employees, it is one of the most important industries in Germany.

Triggered by the economic rise of China and other emerging markets, world market shares in the chemical industry have fundamentally shifted since the turn of the millennium. The growth poles are in markets with rapidly increasing demand for chemicals and in countries with low energy and raw material costs – and no longer in the industrialised countries. Asia in particular is becoming increasingly important in the international chemicals business. This region now accounts for 57% of the chemical industry's sales (see Figure 19).

China increased its share of sales in the chemical industry from 10% in 2004 to over 35% in 2018. In the same period, the share of the EU shrank from 32% to 16%, that of the USA from 22% to 15% and that of Germany from 9% to a good 4%.

However, thanks to its strength in trade and its innovative capacity, Germany can benefit from growth in other regions through exports and direct investments.

The regional shift in the markets will continue. Especially in basic chemicals, European companies will continue to lose competitiveness due to high energy costs. The main beneficiaries are regions rich in raw materials with low energy prices such as the Middle East, the CIS and North Africa. In recent years, extensive investments have been made there to strengthen local value creation and create jobs. These programs will be continued, for example in Russia, where chemical production is to be increased by 20% by 2020. To this end, major projects with a volume of €80 billion are being planned or are already being implemented.

The USA plays a special role. Traditionally, US chemistry concentrates on the manufacture of pharmaceuticals and speciality chemicals. Thanks to the shale gas boom, which has given the country a comparative advantage in oil and gas production, investments in US basic chemicals have risen again. The construction of several fertiliser factories and plants for the production of propylene and methanol are evidence of this upturn.

In the past, many chemical companies had a product portfolio that covered the entire value chain from raw material extraction to the manufacture of pharmaceuticals. With the increasing demands of customers and the globalisation of many businesses, there was a trend towards specialisation with the large corporations reorganising and splitting up in order to use their resources in a more focused manner. Integrated conglomerates are now an exception.

In the course of this development, which began in the 1990s and continues to this day, the production of speciality and fine chemicals has steadily increased in importance. Today, pharmaceuticals and speciality chemicals are the most important market segment. In Germany, for example, this sector accounts for almost 50% of total chemical production.

Since applications in fine chemicals are innovation-driven and tailored to individual customer requirements, in-depth product and process knowledge is required to manufacture them. A high R&D quota is therefore a characteristic of the industry and distinguishes it from basic chemicals. Europe, North America and Japan continue to maintain their market leadership in this segment, although manufacturers from Asia, especially China, are rapidly catching up.



Figure 19.  
Share of sales in the  
chemistry industry

Source: PwC

The chemical industry consists of various segments that follow different strategic patterns. The fragmentation of the industry sector is illustrated by a comparison of the sales share of the ten largest companies in an industry with their total industry sales: the top 10 in the chemical industry represent just 15% of their total sales (see Figure 20). The petroleum industry (67%), the automotive industry (60%) and the pharmaceutical industry (51%) have much higher levels of concentration. This is primarily due to the fact that various niches have formed within the chemical industry that pursue different competitive strategies, such as cost or quality leadership.

#### Outlook

Price pressure is increasing in the chemical industry and customer requirements, in particular the high production flexibility (see Chapter “Customer requirements”) are becoming more and more demanding. In order to hold their own in this environment, chemical companies have to strengthen their competitiveness. The development of new business models, the closing of material cycles and investments in climate protection technologies are important in this context. In addition, the use of digital technologies is becoming increasingly prominent in the chemical industry. The majority of companies see clear added value in digitalisation and, according to a study by PwC, expect the degree of digitalisation to rise from 21% (2015) to 77% by 2020.

The starting points for achieving this target value are the collection and analysis of big data available in companies, which can be used to further optimise and automate production processes. In addition, the industry is vigorously driving forward developments in predictive maintenance, networked logistics and the application of virtual reality concepts.

The chemical industry is heavily dependent on general economic developments, as chemical products are used as inputs in many branches of industry. In this respect, the weaker global economic outlook is dampening the industry’s expectations for 2019. The German Chemical Industry Association nevertheless believes that domestic growth is possible and expects production in the chemical and pharmaceutical industries to rise by 1.5% in 2019. Looking at global markets, demand for chemicals is expected to weaken. For example, the European Chemical Industry Council expects moderate growth in Europe of 0.5% at best. The USA is bucking this trend: with the shale gas boom and the commissioning of numerous large-scale plants, the American Chemical Industry Council expects US chemical production to increase by 3.6% in 2019.

The changes in the chemical industry markets are also reflected in new orders in the plant engineering sector. The industrialised countries, apart from the United States, are tending to lose importance, while the emerging markets are becoming more important, especially in turnkey business. The industry is responding to this development by expanding local branches in growth markets. Companies are also strengthening their service business in order to meet the requirements of customers in core markets.



Figure 20.  
Market shares in the  
chemistry industry

Source: PwC

## Energy industry

- The framework conditions on the global energy market have changed fundamentally; decentralisation and CO<sub>2</sub> neutrality are the main requirements
- Power-to-X-technology opens up further perspectives for German EPCs
- Industry pushes network expansion and digitalisation is asked to be the enabler for a close networking of producers and consumers

### Definition & business model characteristics of the energy sector

The framework conditions on the global energy market have changed fundamentally since the turn of the millennium. In many countries, the energy industry is increasingly focusing on CO<sub>2</sub> neutrality and decentralisation. The main triggers for this change were resistance to nuclear energy and growing awareness of the dramatic consequences of climate change. These developments have been reflected in numerous political decisions. In Germany, for example, there were agreements to phase out nuclear energy (2011) and coal-fired power generation (2019), in China rules were passed to promote electro mobility, and at the global level the international community agreed at the UN Climate Conference in Paris in 2015 to limit global warming to 1.5 degrees Celsius compared with pre-industrial levels. Ultimately, any energy policy is now taking place against the background of climate change and the goal of reducing global greenhouse gas emissions.

### Energy market development & competitive landscape

These agreements have contributed to the fact that the share of fossil energies in global electricity generation has fallen since the 1973 oil crisis from 75% to 65% (2017), while renewable energies (excluding hydropower) have been able to multiply their share.

However, fossil fuels continue to form the backbone of the world's electricity and energy supply. While the share of coal in the global electricity mix remained almost constant between 1973 and 2018 at around 40%, the weight of crude oil fell significantly and currently stands at around 4%. Natural gas, on the other hand, which is less harmful to the climate, has gained in importance and accounted for 22% of the electricity generated worldwide in 2018. This was ultimately due to the creation of a global market for natural gas, which can be transported as LNG over long distances by tankers.

What is surprising is that, despite a variety of legislative activities and financial incentives, the share of renewable energies (with hydropower) in global electricity production has hardly risen since 1973. While the share was 22% in 1973, it was only slightly higher in 2017 at 24%. One reason for this is the relatively slow pace of hydropower expansion, which lags behind the growth in general electricity consumption. In some countries, such as Germany, the share of hydropower in electricity production is even declining, and for ecological and social reasons there is strong resistance to large dam projects in developing countries.

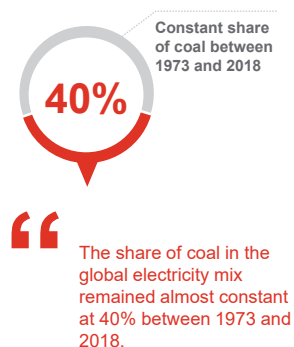


Figure 21.  
Electricity mix between  
1973 and 2018

Source: PwC



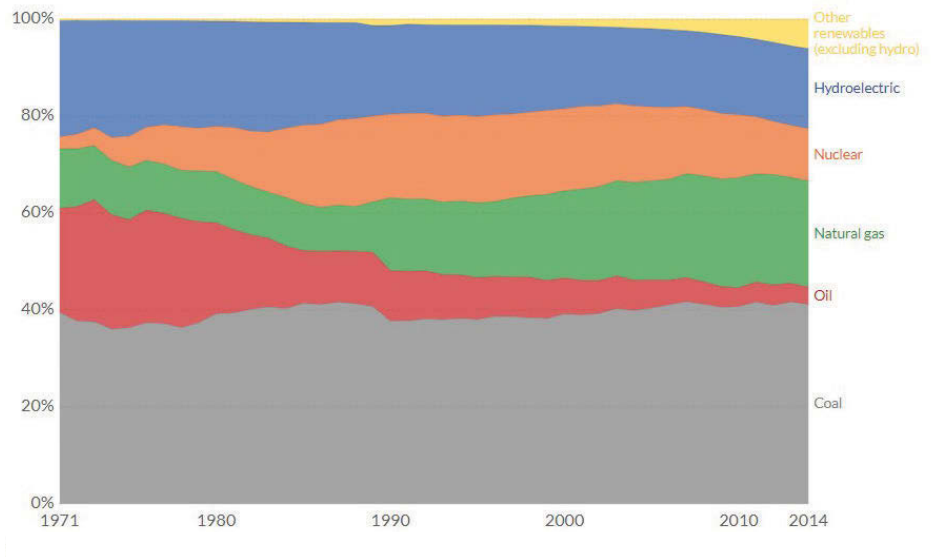


Figure 22. Global electricity production by energy source 1971 to 2014

Source: International Energy Agency (IEA) via The World Bank

The fact that the share of renewable energies in the global electricity mix has nevertheless increased since the turn of the millennium depends exclusively on the strong growth of alternative sources such as wind and solar energy.

Overall, the global capacity of plants for the production of electricity from renewable sources more than doubled between 2008 and 2017 to 2,179 gigawatts (GW). The largest increases were achieved with wind power with 400 GW and solar energy with 375 GW. While growth in hydropower was even higher than in wind and solar power until 2010, the picture has changed since then in favour of wind and in 2017 above all in favour of solar energy. The capacity of wind power plants more than quadrupled to 514 GW by 2017 compared to 2008. At 391 GW, the global generation capacity of solar plants in 2017 was 26 times as high as in 2008.

In many countries, the energy industry is increasingly focusing on CO2 neutrality and decentralisation. Already today, the share of decentralized gas and steam turbines as well as wind power and photovoltaic plants in the annual global expansion of power plants is more than 50% and is expected to rise to over 60% by 2030.

Solar and wind energy are much more volatile than coal, oil and gas. The new technologies are thus changing the traditional distribution of roles in the energy system. In the past, only a few large power plants transported electricity to consumers via distribution networks. Today, millions of small and medium-sized renewable energy plants generate electricity at all grid levels. Their expansion takes place above all at locations with a lot of wind or many hours of sunshine, thus enabling plant operators to keep their generation costs low. Whether electricity can be purchased locally only plays a secondary role in investment decisions.

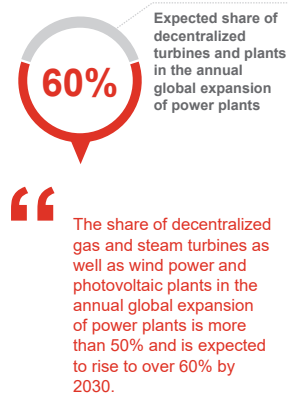


Figure 23. Share of global power plant expansion

Source: PwC

With the shift towards decentralised forms of energy generation, the demands placed on electricity grids are changing fundamentally. Transmission capacities are increasingly being used to absorb regional surpluses and transport them to areas with excess demand, especially in countries with a high proportion of volatile wind and solar energy. This requires the expansion of energy infrastructures, in some cases even across national borders. Particularly in Europe, the establishment of an internal market for electricity and gas is leading to an increasing need for transport.

The establishment of electricity storage facilities is also gaining in importance in the current market environment. Storage facilities can, for example, take up electricity during windy times, which they feed into the grid during periods of calm. Traditionally, pumped storage power plants have taken on this task. Power-to-X-technology opens up further perspectives. With its help, renewable energies and CO<sub>2</sub> recycling can be combined. VDMA members already operate such innovative energy storage systems in Germany, which can convert excess electricity from wind power plants into hydrogen by means of electrolysis. The industry is also working on the further development of large battery storage systems and compressed air storage systems, in which excess electricity is used to press air into underground salt domes, which, if needed, flows through a turbine to generate electricity.

Energy generation from fossil sources will continue to be necessary in order to reliably supply the growing world population with electricity. However, the global market development is currently clearly following the efforts to reduce CO<sub>2</sub> emissions through regulatory interventions. This development has led to a decline in orders for thermal power plants. Coal-fired power plants are still being built in China, South and Southeast Asia and Africa. But particularly in Europe, there is hardly any new construction of such plants. This development also affects demand for gas-fired power plants, which is reflected in high overcapacities and a fall in prices for large gas turbines.

Suppliers of fossil-fired power plants have to deal with these market changes. Capacity adjustments have become unavoidable in view of falling demand and continued price erosion. Nevertheless, the current market environment also offers opportunities. The age of power plant fleets and stricter emission limits require investments in the modernization and environmental adaptation of existing plants. This will increase sales in services and retrofitting. In addition, there are still markets in need of expansion, particularly in the emerging markets, both for new power plants and for grid infrastructure. European power plant construction must therefore strengthen its market position through technology advancement. In addition, the digitalisation of engineering, purchasing and manufacturing processes enables faster and more cost-effective production while at the same time increasing the reliability and quality of the products.

### Outlook

Digitalisation is also revolutionizing the energy sector. Finally, the conversion of power generation to a small-scale, volatile system dominated by solar and wind energy is only possible through close networking of producers and consumers. In addition, digitalisation and the processing of big data make the use of electricity and heat more intelligent and flexible. In the future, electricity can be traded in real time and energy demand can be flexibly adapted according to customer's requirements. Central business models will build on this approach. This includes the macro-control of a large number of producers and consumers, but also the micro-optimization of single-family houses, for example when using heating systems or electricity storage systems. The central value-adding elements of the new energy ecosystem are no longer the mere sale of kilowatt hours, but the networking of market participants and customer-specific offers of electricity and heat.

Global demand for energy will continue to rise in the coming years. However, developments differ from country to country. While the industrialized countries are tending to reduce their energy consumption, demand in many emerging markets, especially in Asia and Africa, will continue to rise until the middle of the century. Electricity consumption is also set to grow. In addition to the digitization of many areas of life, the electrification of traffic and buildings is an important driver. By the middle of the century, electricity consumption could be responsible for 30% of global energy demand; today it is a good 20%.

Renewable sources are already dominating the expansion of power plant capacity. By 2030, the International Energy Agency (IEA) estimates that they will account for just under 50% of global electricity production; by 2040 this figure could rise to over 60%. At the same time, the importance of fossil resources in electricity production is declining. For instance, the share of coal in the global power generation mix is expected to fall from currently just under 40% to less than 15% by 2050.

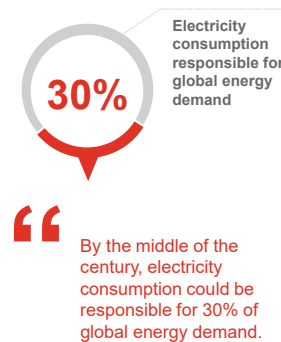


Figure 24.  
Electricity consumption and energy demand

Source: PwC

## Steel industry

- Steel is a heavy product that is predominantly locally produced and used
- The steel industry continues to suffer from overcapacity and there is urgent need to pull production facilities out of the market
- Industry relies on digitalisation to gain efficiency on short-term and develop new revenue streams on a long-term basis

### Definition & business model characteristics of the steel industry

The steel production can be divided into two segments: Conventional steel and stainless/special steel. Conventional steel is mainly used in the construction industry as well as in shipbuilding and is mainly produced in developing and emerging countries. By contrast, many manufacturers in industrialised countries are focusing on the production of stainless and special steels and have increased their research budgets respectively.

Steel is a heavy product that is predominantly locally used. Only just under 30% of global production is traded internationally (see Figure 25). This share only increases when the steel used in further processing is included – for example for



Figure 25.  
International trade in  
the steel industry

Source: PwC

cars, machinery and defence technology. Due to increasing protectionist tendencies, this will change little in the short term. However, Chinese exports to the EU could rise and put renewed pressure on what are currently adequate prices.

### Steel market development & competitive landscape

According to the World Steel Association (WSA), a total of 1.81 billion tons of crude steel were produced worldwide in 2018, just under 5% more than in 2017 (1.69 billion tons). Despite this growth, the steel industry continues to suffer from overcapacity and there is urgent need to pull production facilities out of the market. China began the first steps towards consolidation in 2017 and continued this course in 2018 in the context of plans to contain the rampant environmental pollution and to make the economy more environmentally sustainable.

Despite lower global economic growth, the WSA expects global demand for steel to rise by 1.4% in 2019. Depending on developments in China, demand could even increase by 2%. The association expects steel demand to continue to grow in the coming years. The automotive, construction, packaging and rail industries want to expand the role of steel as a versatile material and drive this development.

China increased steel output by 6.6% to 928 million tonnes in 2018. India and Japan follow on the list of the largest steel nations with slightly more than 100 million tonnes each. Crude steel production in Europe stagnated at the previous year's level in 2018, which can be seen as a success given the good business performance in 2017. Steel production in the USA increased by 6.2%. Measures to foreclose the market to imports, particularly from China, led to a significant rise in prices there.

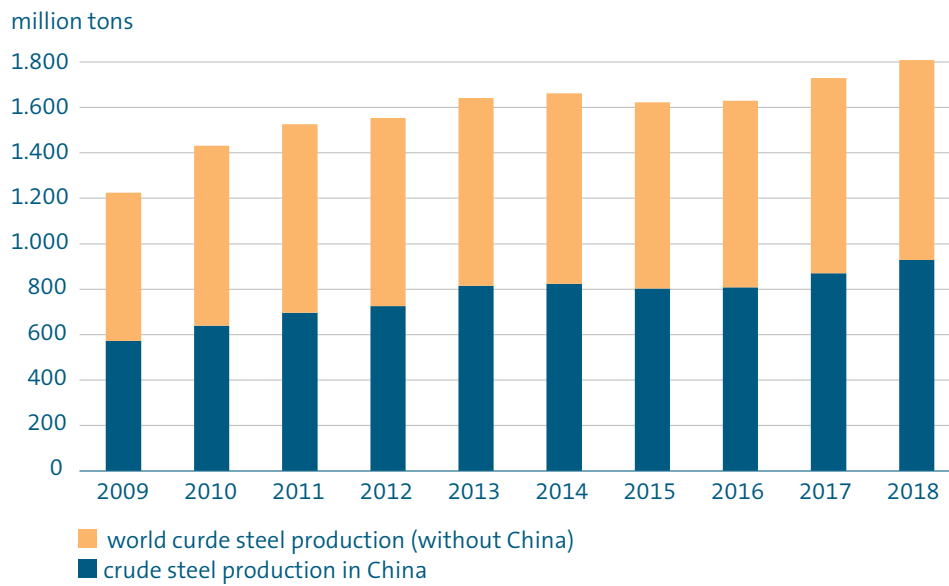


Figure 26. World crude steel production 2009 – 2018

Source: VDMA Status Report 2018/2019

The leading steel manufacturing companies mainly come from Asia. Five of the ten largest companies alone come from China, two from Japan and one from South Korea. The ten largest manufacturers together produced 434 million tons of steel in 2017. That was 26% of global output. The degree of concentration in the steel industry has thus increased but remains relatively low compared with other industries. The trigger for this development is the massive market and price pressure that the industry is countering by building up large units. At the same time, there are still national champions who concentrate on the production of special steels and thus meet the particular requirements of local markets.

In the steel industry, the traditional core markets in Europe, North America and Japan are steadily becoming less important. In 2007, a good third of the world's steel was still produced in the so-called triad, compared with only 23% in 2017. In addition to high wage and energy costs, this was primarily due to structural changes in demand. While the markets in the industrialised countries are saturated, many emerging markets still have to catch up. A meaningful indicator of this is per capita steel consumption, which is often under 100 kg in developing and emerging countries versus typical values of between 300 and 500 kg in industrialised countries.

In the past, development in China was spectacular, where more than half of world production is now smelted. In addition, India, South Korea, Taiwan and Turkey recorded significant increases in production. The future markets are Indonesia, Vietnam and Malaysia. The climate policy of many industrialised countries could accelerate these market shifts.

As an energy-intensive industry, the steel industry depends on a fair operating environment. In a competitive market environment, however, there is a limit to how much rising energy and emission prices can be passed on to customers. In the EU, plans to reduce greenhouse gas emissions by 2.2% per year from 2021 and to reduce the volume of emission certificates available could in particular lead to further relocations of steel plants.

The automotive industry is a trendsetter in this area and is pushing ahead with lightweight body construction as part of the expansion of electromobility. Steel competes with materials such as aluminium and carbon, but is able to maintain its position, especially in the high-volume segment. This is due both to technological advances and to the higher quality and lower costs of steel compared with the alternatives mentioned.

### Outlook

The industry is working on improving its CO<sub>2</sub> footprint. In Sweden, a test plant is currently being built which will use hydrogen instead of coal and coke to produce the steel. On an industrial scale, the technology should be ready by 2035.

Today, digitalisation enables the steel industry to optimise processes, save materials and reduce costs – both in the retail, production and maintenance of equipment sectors and in joint research with customers. There is great potential especially in interaction with leading industries such as automotive or mechanical engineering. For example, development times can be shortened if specifications for new steels are sent to customers as early as the development phase, so that they can test their suitability in parallel. Many customers are already shortening their product cycles with digital offers. According to estimates by the consulting firm IW Consult, the degree of digitalisation in the steel industry is around 10%, which is in the middle of all sectors. Recently, various efforts have been made to increase this rate. One in seven companies in the industry invested more than 6% of its sales in digital transformation in 2017, and by 2022 the figure is set to rise to one third.

The construction of steel mills and rolling mills accompanies the steel industry on this path. A keyword here is the “learning steelworks”, which independently optimises and controls itself – based on human knowledge, physical connections and mathematical models. This enables performance parameters such as output, quality and throughput time to be improved. One of the well-known implementation concepts is the Big River Steel plant in the USA.<sup>10</sup>

The regional production shifts in the steel industry are also reflected in new orders in the smelter and rolling mill construction sector. While sales in the industrialised countries are falling, the markets in Asia and South America are becoming more important. The BRIC countries – China, India, Russia and Brazil – are the most important customer groups worldwide. The industry is responding to these changes by strengthening local branches and adapting its product portfolio to the needs of new markets. But there are also structural shifts. While the boom years were characterised by new construction projects, modernisation is now the focus of the market. In this context, many customers are concerned with improving the cost and energy efficiency of their plants. In addition to hardware, plant manufacturers also provide essential services and consulting.

Due to high market volatility, the availability and different qualities of raw materials are increasingly influencing the profitability of plants in the metallurgical industry. Plants and processes that allow customers to flexibly switch between different production processes and raw materials are having an increasing influence on purchasing decisions.

<sup>10</sup> Cf. <https://businessfacilities.com/2018/07/big-river-steel-expanding-osceola-arkansas-flex-mill/>

## Customer requirements

Customer orientation is nothing new. However, digitalisation leads to two changes in customer orientation. On the one hand, the EPC business is provided with new tools and technologies to better meet the known customer requirements. On the other hand, digitalisation leads to completely new customer requirements. Both types of customer requirements need to be covered by the EPC.

A customer-centric approach is the recipe for success today and even more in the year 2025. We therefore conducted a total of ten expert interviews with relevant clients while developing this study. The goal was to identify and bundle customer requirements in 2025.

From the customer's point of view, the five most important requirements are "Transparency", "High production flexibility", "Shorter lead times", "Optimised investment costs" and "Trust-based relationships" (see Figure 27).

The chart shows both "new" and "known" customer requirements, with the first two customer requirements (transparency and high production flexibility) classed as "new" requirements.

The "transparency" requirement is mainly driven by the B2C sector. For example, orders placed with an internet store such as Amazon can be routinely tracked, leading customers to ask why this is possible for a €10 order but not for an investment running into several hundreds of millions of euros.

The "High production flexibility" requirement is driven by the end customer. The end customer requests greater customisation and the owner passes this on to the EPC. There are many examples for this development, such as the trend towards personalised medicine or made-to-measure clothing.

The three customer requirements classed as "known" (see C–E in Figure 27) are not further explained here but will be presented in more detail in the individual sections.

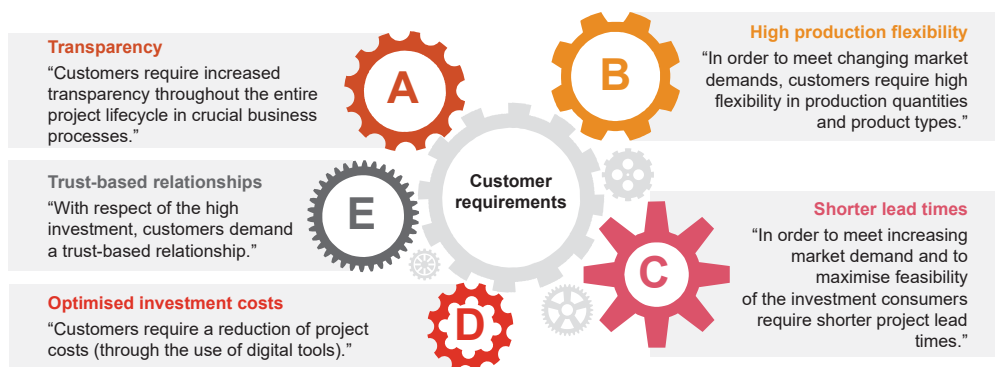


Figure 27. The five most relevant customer requirements in 2025

Source: PwC



“  
**Transparency will not only define success, it will be a do-or-die decision for every EPC.**  
 Dr. Markus Reifferscheid, SMS Group

## Greater transparency

### Relevance and background

The customer requirement for greater transparency is mainly based on customers’ pain points and lessons learnt from past EPC projects:

- Lack of transparency during project initiation and execution with limited information provided by the contractor
- Scoping processes at the project development and tender stage takes too long, especially in lump-sum turnkey projects
- In most cases information is mainly provided retrospectively, limiting potential for responding to it

Customers are therefore asking for increased transparency along the entire project lifecycle in crucial business processes. Owners want to shift from believing what EPCs report to a transparent daily monitoring system with an in-depth database. How this greater transparency can be provided and to what extent German companies already meet this requirement will be examined below.



“  
**Today is believing, tomorrow is monitoring on a day to day basis.**  
 Industry expert

### Results of the quantitative analysis

From a customer perspective, providing an integration platform confers the greatest benefits. An integration platform is generally defined as a holistic data model that

- spans the entire project lifecycle, i.e., from the early bidding phase to operations and dismantling, if applicable
- allows communication in various configurations (machine-machine, machine-human etc.)
- includes the entire supply chain
- involves customers at crucial business process levels and allows their involvement in crucial decisions

In addition, the following features for the integration platform were rated as important in the expert interview sessions:

- Customising interface management
- Use as a communication platform
- Forming the basis for data and analytics including prediction
- Managing the asset throughout the entire lifecycle from the early planning stages to dismantling
- Serving as a “safe environment” for data sharing and communication



**Integration platform as USP in future EPC business**

Most German EPC companies agree with customers that providing an integration platform is a must-have for tomorrow’s value proposition and success. 77% of German EPCs think an integration platform is necessary (see Figure 28). But they disagree over who should provide it. 50% plan to develop an individual project delivery platform, whereas 28% would prefer an industry-wide platform (see Figure 29). Proponents of an industry-wide platform cite the time and costs involved: individual companies are unlikely to be able to bear the cost of these investments on their own. However, any platform would also need to be closely geared to the individual needs of customers and EPCs, something an industry-wide platform could not afford.

Further disagreement exists over the phase of the project lifecycle most likely to benefit from the integration platform. Analysis of the survey reveals unanimous agreement that plant operation benefits from transparency (e.g. application of smart sensors for monitoring). However, expert interviews with owners suggest it is the engineering phase where transparency currently falls short of what is needed.



Figure 28. Necessity of an integration platform Source: PwC



Figure 29. EPC reaction to the customer requirement for greater transparency Source: PwC

The expert interviews show that integration platforms are not a vision of the future but are already in use or being developed. At the customers’ request, companies are already working into a tool/integration platform of the customer. Many companies are already launching measures for developing and implementing an integration platform.

Although no industry-wide integration platform exists so far, some companies have already started to implement an integration platform in their own company or supply chain. They are using their experience of this kind of platform as a basis for recommendations to the customers. The integration platform will not only change the way of collaboration, it will also have a significant impact on revenue streams, both direct and indirect.

All direct revenue streams are revenues generated by the use or provision of the platform. Microservices between different integration platforms are referred to as indirect revenues. A microservice is a non-monolithic structure in which a number of services are loosely coupled together. This means that a microservice can be created quickly using nothing more than a shell script or other technology. Microservices are also changing the way services and software are designed. This model creates a total lifecycle culture, where developers focus not just on functionality but also on how to make the service compatible with real-world conditions and much

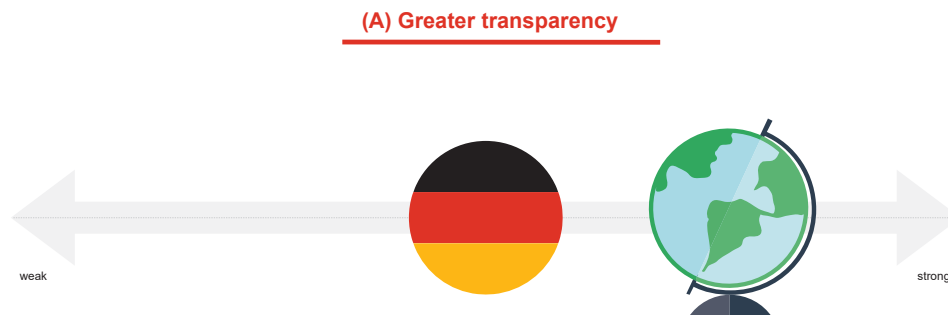


Figure 30. Benchmark of the customer requirement for 'Greater transparency'

Source: PwC

easier to support. That's the technical explanation, but what sort of microservices are on offer for the EPC industry?

For example, owners might upload their digital twins on one or multiple integration platforms. Microservices might, for example, upload plant data and information stored in various platforms into one "digital headquarter". Additionally, predictive maintenance systems could report vulnerabilities and initiate maintenance across platforms. However, there is one major obstacle to creating an integration platform with all its benefits.

EPCs are facing customers' request for full transparency along the entire project/product life-cycle. However, not all customers are currently willing to provide themselves the same level of transparency, i. e., the required operational data. The customers argue that they fear to lose the crucial expertise of their business model. One consequence of their reluctance is that predictive maintenance cannot be fully utilised.

One question that is frequently discussed relates to whether it is efficient to provide the customer with full transparency, and what level of transparency would be the most efficient solution for both sides? Providing more transparency could simply throw up more questions from customers who may not have full knowledge of the entire EPC process.

These then need to be answered, resulting in a good deal of time spent (wasted) not just on answering the questions but also on explaining the EPC process in (more) detail.

#### Benchmarking

International competitors have a slight advantage when it comes to providing an integration platform. This is mainly driven, as explained in detail below, by their different approach towards providing the integration platform (see Figure 30).

Both international and German EPCs view integration platforms as the USP of tomorrow for the EPC industry. The figure is higher for international EPCs (+5%). German EPCs have a different approach from international EPCs on how integration platforms are made available. German EPCs tend to develop integration platforms and capabilities organically. International EPCs leverage digital offerings faster through partnerships as part of a continuing trend towards greater cross-industry cooperation.<sup>11</sup> This is especially true for EPCs from China, Japan and Spain, where they plan to rely on an industry standard (not yet on the market) when it comes to IoT platforms.

<sup>11</sup> Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

## High production flexibility

### Relevance and background

The customer requirement for high production flexibility is mainly driven by expectations from their customers, i.e., from the end customers and can be summarised as follows:

- In order to meet changing market demands, end customers require high flexibility in terms of production quantities and product types
- End customers demand increasingly individualised products at smaller quantity rates (batch size of 1)
- Customers need to change production type with shorter conversion times to fulfil the end customers' changing product demand (e.g. personalised pharmaceuticals)
- Customers require ongoing customised advice during acquisition and plant operation to develop the best plant configuration and automation

### Results of the quantitative analysis

The (end) customers want even greater individualisation of plant design and products. At the same time, various standardisation-based cost reduction programmes have been a feature of the German EPC industry in recent years. Many German EPCs also expect there to be greater standardisation in the future. It would be reasonable to ask whether these two approaches are in conflict with each other. The reason why these do not conflict and the extent to which German EPCs fulfil these requirements is the focus of the following section.

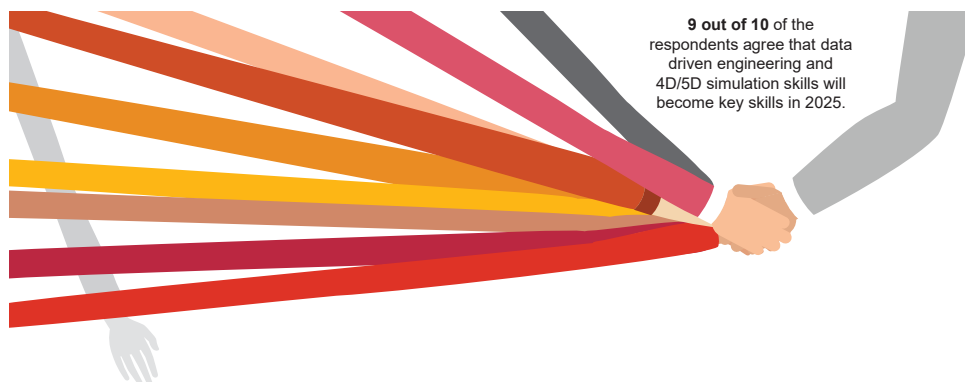


Figure 31. Data driven engineering – Key skill in 2025

Source: PwC



**Standardization has conflicting forces; you need to standardize the core (e.g. sub-systems) but adjust to customer's specific demands.**

*Giovanni Bavestrelli, TENOVA*

### Data engineering/analytics and automation

Nine out of ten German EPCs agree that data-driven engineering and 4D/5D simulation will be key in 2025 (see Figure 31). Simulation of processes and flows of goods to increase the output and the quality of the plant is and was a differentiator of the German EPCs. The owners resoundingly confirmed this in the survey and also expect German EPCs to focus on this strength. In the future, owners expect the EPC to create simulations that include data from the early project development phase, the manufacturing process, subsequent operations, and dismantling through a digital twin. A frequent comment during the expert interviews was that too little data from the supply chain is made available in many cases. Data sovereignty too often lies with the suppliers. This will allow suppliers to gain a strategic advantage in the future. This danger is already recognised today. For example, 67% of German EPCs believe that today's suppliers could become their biggest competitors. It should be noted, however, that this is still a vision of the future based on a lack of capabilities in the integration of different subsystems. The model for achieving data sovereignty by the EPC companies, despite its significant supply chain, is the automotive industry.

This is due to the market power of the automobile manufacturers. The oil and gas industry is developing initial approaches to standardisation through the Capital Facility Information Hand-over Specification initiative. Therefore, it is not surprising that there are some (academic) voices who argue for a national competence centre for the EPC business. Sharing all data could be an asset that increases market power.

A German competence centre for EPCs could be based on the following five pillars:

- Overview of trends and market overviews
- Think tank for innovation in the EPC industry
- Establishment of an academic community including a trade journal
- In-house academic education and training
- Research and funding coordination



**A national competence center is crucial for German EPCs to master digital transformation.**

*Dr. Michael Krenz, FAU Nürnberg-Erlangen*

### Standardisation and modularisation

The expected increase in standardisation is evident in two forms. On the one hand, German EPCs, in contrast to today, expect to offer “plants from catalogue” (standardisation level > 75%) by 2025. An important consideration here, as the expert interviews show are the two main directions of standardisation. The aim is to standardise and modularise the core and the subsystems as far as possible. However, this is limited by individual customers’ requests. Although aggregate results show the opposite tendency overall, there are increasing concerns at individual company level that digitalisation will put an end to the standardisation and modularisation programmes that are widespread in the German EPC landscape. Specifically, standardised hardware is being supplemented by customized software. For smaller systems in particular, individual colour mixtures, fertilisers and pharmaceuticals can be produced in this way.

### Consulting Services

55% state that consulting services are key activities for increasing the service industry, whereas the top priority will be simulation services (see Figure 32). Consulting services thus provide a vehicle for meeting the specific customer requirements. Many German EPCs regard customers as continuing to be unwilling to cooperate in an open and transparent manner (see customer requirement for “Transparency”). A basic requirement on the EPC side is the flexibility to adapt service offerings to customer needs so the EPC can adapt to the digital maturity of the client. 60% of the German EPCs rate their offerings as mostly flexible enough to respond to the different digital maturity levels of their clients.

### Benchmarking

As a result of this, German EPCs fulfil this customer requirement more comprehensively than their international competitors. The benchmarking reflects the focus on data engineering, standardisation/modularisation and consulting services (see Figure 33).



Figure 32.  
Anticipated increase in  
the service business

Source: PwC

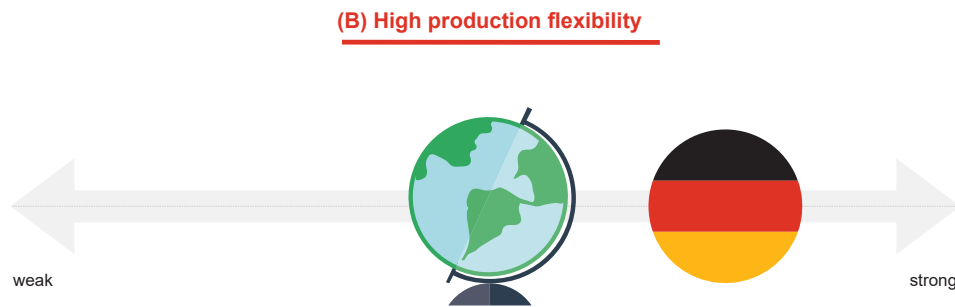


Figure 33. Benchmark of the customer requirement for 'Higher production flexibility'

Source: PwC

#### **Data engineering/analytics and automation**

International competitors are clearly lagging behind in this area. Through various investments and innovations, the international competitors are trying to catch up here, but are still behind their German competitors.

#### **Standardisation and modularisation**

60% of the international EPCs plan to have plant configurators in 2025. This puts the international EPCs just ahead of the German EPCs (56%). It should be noted that international EPCs, unlike their German counterparts, do not plan to increase the standardisation share. This can be explained by the fact that even international EPCs have recognised the limits of standardisation even if standard solutions continue to be part of their value proposition.

#### **Consulting services**

In the field of consulting services German EPCs build up these capabilities internally. Thus, the share of strategic partnerships with international competitors is about six times greater than that of German competitors. German and international EPCs give similar ratings for their current EPC offerings (see Figure 33).

## Shorter lead times

### Relevance and background

An inherent requirement of the EPC is to shorten project duration. There is still increasing pressure to shorten project lead times.<sup>12</sup> EPCs recently tried to shorten project duration through technical and technological improvements and innovations. Hence, from a technical and technology standpoint the maximum has almost been reached in certain industries (e.g. chemicals). Therefore, the focus needs to be adjusted, i.e., it will be on the optimisation of non-value adding processes and the construction period. The essential points here are:

- In order to meet increasing market demand and to maximise feasibility of the investment consumers require shorter project lead times
- Shorter lead times lead directly to a better investment case
- Non value-adding processes along the project lifecycle need to be cut (e.g. long lasting request for proposal and tender processes)
- Project delivery has to be improved not only during development phase but also during construction

### Results of the quantitative analysis

In particular, the quantitative analysis will provide answers as to how German EPCs can meet the requirements for reducing non-value adding processes and optimising construction. Furthermore, it will explain cooperative contract models, construction and enhanced partnerships as well as agile and collaborative methods. At first the process of project development and bidding is explained.

In most cases, project development and assignment on the customer side follows the classic procedure. Based on internal studies and feasibility studies, the call for tenders is marketed to suitable EPCs. This is followed by time-consuming evaluation and negotiation with just a few EPCs. This process normally takes up to one and a half years, often more. However, no value is created for the customer throughout the process. One thing is clear: the earlier the customer can utilise the plant commercially, the better the business case. This means that shorter project durations can also justify higher CAPEX. There are two essential ways of shortening project duration. Firstly, through technical optimisation and secondly through improving the management processes during project execution (for example through consulting services and more cooperative contract models). Since technical and technological optimisations continue to be possible, but are also difficult to realise, it is appropriate to implement previously unused optimisations in project development and management.

12 Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

**Cooperative contract models**

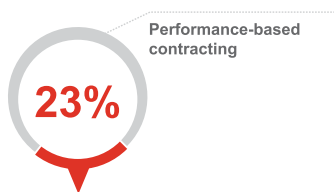
The German EPCs are still very cautious when using novel contract models. For example, performance-based contracting (23%), subscription (28%) and pay-per-use (29%) are used reluctantly (see Figure 34). The reluctance to use performance-based contracting is largely due to the following reasons.

- High investment volume (up-front) combined with an even higher risk profile than in classic EPC projects. Very long maturities make calculation and cost-effectiveness of projects difficult
- Implementation of a different business model that impacts the EPC’s structure and process organisation



“  
**Projects increasingly fail during the construction phase as a result of a shortage of qualified personnel. Therefore, increased modularisation is a must.**

*Dr. Joachim Thiel, BASF*



“  
 Only 23% of German EPCs state that they were also using performance-based contracting.

**Construction**

Even in times of digitalisation, construction remains important. In the context of the EPC study<sup>13</sup>, it was pointed out that German EPCs have structural disadvantages versus their international competitors. Many of the international competitors originally come from the construction business. Owners are also very much aware of the frequent difficulties that arise in the worldwide projects (see quote). Possibilities for improvement result in particular from higher standardisation and prefabrication levels and prior visualisation of the building.

Figure 34. Performance-based contracting

Source: PwC

13 Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.



**Enhanced partnerships/agile and collaborative methods**

The search for suitable cooperation partners is a major driver for reduction of lead times in the EPC industry.<sup>14</sup> Digitalisation helps to make cooperation more efficient. Highest priority is given to tool and data base integration (see Figure 35). There is still restraint in the biggest obstacle to long-term partnerships, know-how protection. Only 60% say digitalisation can help. In addition, the focus of long-term partnerships is also changing. Priority is given to the search for partners in the field of digital twins as well as parts and supply management.

90% of German EPCs see the greatest need for partnerships in the field of digital twin (see Figure 36). Partnerships German EPCs want to participate from the experience that especially construction and engineering companies made in this field. They argued that these companies are needed for providing required references, have cost advantages and the technical expertise already available. This allows German EPCs to bid for BIM projects.



Figure 35. Priority of digital tool application Source: PwC



Figure 36. Fields for partnerships Source: PwC

The approach to searching for cooperation partners is changing. Agile forms of collaboration are deeply rooted in day-to-day business in other areas (such as IT). The benefits of higher efficiency and shorter implementation times have been demonstrated. The transfer to the EPC industry is thus promising. Nevertheless, there is clear reluctance from German EPCs. Only 31% are willing to use open source and only 43% to use open innovation. The main reason for this was the IP protection offered by companies that have not previously worked with open source and open innovation, as in other areas. Companies that are increasingly using open source and open innovation did not cite IP protection as an inhibitor. Rather, the advantages of these new forms of collaboration were also emphasised here. No longer having to build up the skills required internally over the long term and drawing on in-depth experience in specialist areas such as AI, regularly scored highest in responses.

**Benchmarking**

The benchmarking shows international EPCs are rather more able to fulfil the requirement for shorter lead times than their German competitors. The decisive factors in particular are strengths in the area of construction and the use of agile working methods in partnerships (see Figure 37).

14 Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

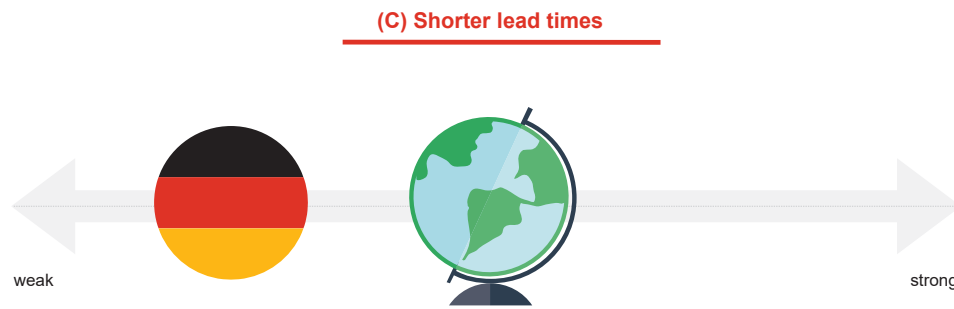


Figure 37. Benchmark of the customer requirement for 'Shorter lead times'

Source: PwC

**Cooperative contract models**

International competitors in general are similarly reluctant to use new and cooperative contract models (American EPCs are more open). 40% of the international respondents see performance-based contracting as priority for being tomorrow’s prioritised contract model. Cost plus fee contracts and unit price contracts are common practice, especially in the USA. Collaborative approaches, such as alliance contracting (please refer to the capability “Smart commercial model” in Chapter “Digital business models”) are state of the art for projects in Australia.

example for the enhancement through partnerships. The construction company Rhomberg pursues a combined BIM and open innovation approach. Rhomberg’s product library is available to companies that also share their product library and knowledge.<sup>15</sup> Asian competitors in particular can shorten their project lead times through their extensive use of open innovation and open source. However, it is also true that this approach is easier for these companies as their USP, unlike their German counterparts, is not technological knowledge.

**Construction**

International competitors can increase their advantages in the construction industry. On the one hand there are multiple examples of high pre-fabrication and integrated supply chains (e.g. the US-based construction company Kattera). On the other hand, international competitors have more experience of using the digital twin. This applies in particular to competitors from countries where Building Information Modeling (BIM) is legally required for public tenders (e.g. USA).

**Enhanced partnerships/agile and collaborative methods**

International competitors gain significant advantages from entering into partnerships and using agile and collaborative methods. Experts have identified successful use cases from different industries that should be taken as a leading



**The wildlife (ant colony) shows us every day how well self-organizing systems can work.**

*Industry expert*

15 Cf. <https://rhomborg-sersa.com/en/home/>

## Optimised investment cost

### Relevance and background

The customer requirement for optimised investment cost is the second customer requirement inherent in the EPC industry. Customers' price sensitivity is increasingly reaching new heights, with no end currently in sight. In particular, competitors from best-cost countries are increasing price pressure on a buyer's market. Thus, in addition to new business models and forms of revenue recognition, the target for digitalisation will also be to reduce direct project costs from an owner's perspective and can be summarised as follows:

- Customers expect a reduction in project costs (through the use of digital tools, e.g. AI, VR/AR)
- Customers will remain price sensitive, especially in commodity product businesses, in a highly competitive market environment
- Low risk appetite and financing constraints prevent customers from investing in new production facilities
- Customers are starting to consider OPEX in investment case decisions

### Results of the quantitative analysis

The possibilities of optimising the investment cost are shown in three parts, i.e. "Investment in digital tools and technologies", "Owners' willingness to pay a premium for the use of digital tools" and "Cost saving potential".

### Investment in digital tools and technologies

This quantitative analysis will focus on the extent to which cost reductions are achieved by the use of digital tools and technologies in order to optimise the owner's total investment costs. 60% of German EPCs are currently relatively reluctant to invest in the digital transformation (see Figure 38). 40% of respondents had launched a few measures to trigger the digital transformation, while 20% have not launched any measures.

A change in investment behaviour is expected by 2025. 96% of German EPCs plan to significantly increase their company's investment budget for digital tools and technologies up to 2025. At higher values, the focus of investments is important.



Figure 38.  
Digital transformation  
investment

Source: PwC

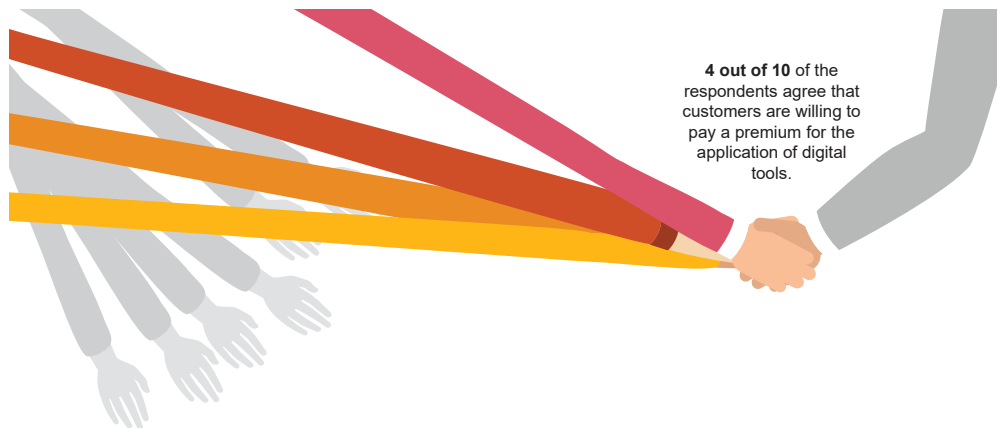


Figure 39. Additional costs for the application of digital tools and technologies

Source: PwC

**Owners' willingness to pay a premium for the use of digital tools**

A frequently discussed question is whether customers are willing to pay a premium for using digital tools. The clear response from customers is that they are not. German EPCs, however, were far from unanimous in their responses. Four out of ten of the respondents agree that customers are willing to pay a premium for the use of digital tools (see Figure 39). Self-assessments and third-party assessments are clearly far from convergent, which could result in service and product ranges that fail to meet customer requirements.

**Cost saving potential**

80% of German EPCs rate AI, VR/AR, cloud and IoT as the top priority when it comes to cost improvements by digital tools, whilst 3D printing and blockchain score lowest (see Figure 40). It has been pointed out, however, that while 3D printing does not always directly reduce direct costs, it still provides great added value. Thus, 3D printing is used for the production of temporary spare parts, in particular if this can prevent plant shut-down. Challenges are certification in 3D printing and the use in chemical processes.

Benefits differ for each tool depending on the project phase. The greatest benefit is expected at the phases of engineering, procurement and logistics. Various use cases and future solutions were identified in the expert interviews. AI can be weak (based on the human thinking structure, e.g. control function) or strong (autonomous creation of, for example, P&IDs). These aspects are explained in more detail below.



***Owners are not willing to pay a premium for the use of digital tools and technologies.***

Industry expert



Figure 40.  
Digital tools

Source: PwC

AI can generally add value to all business processes. An essential feature of critical business processes is the “four-eye principle”. AI can act as a second pair of eyes here, providing a complete, real-time review function that speeds up the release procedure and the quality of the release process (this idea is still at the development stage). In addition, AI can help with predictive analysis (troubleshooting). Smart goggles are often used in VR so operators can identify and improve processes at an early stage. This also improves the customer experience by allowing customers to visualise the plant earlier than before.

### Benchmarking

The benchmark shows that international competitors are maintaining their cost advantages and leadership (Chinese competitors). German EPCs generally expect a greater cost-saving potential. However, it is clear that the international competitors will in the future rely more on other technologies such as robotics as well as expected potential savings at other project phases of the lifecycle. What these are in detail and how they will be used is discussed below.

### Investment in digital tools and technologies

To date, international competitors have invested more in digital transformation than their German competitors. For example, 80% of international EPCs have already made significant investments. Partly as a result of this advantage, future investment behaviour is likely to be far more moderate. Thus, 20% of international EPCs said they did not want to invest more in the future than they do today.

**Owners' willingness to pay a premium for the use of digital tools**

40% of international competitors say that their customers are willing to pay for the use of digital tools. There is agreement between the German and international EPCs. Nevertheless, both are failing to meet the expectations of clients not willing to pay such a premium.

**Cost saving potential**

Generally, the international EPCs are more cautious on the cost saving potential than the German EPCs. In addition, the focus of tools and technologies and their use differ depending on the project phase. German EPCs see huge potential in IoT (priority 1), robotics (priority 2) and artificial intelligence (priority 3). International EPCs see the biggest potential in sales and tendering (priority 1) as well as construction/procurement and logistics (both priority 2). One potential use case combines robotics and construction. The so-called robotics pre-fabrication system allows a prefabricated structure to be automatically dismantled and rebuilt to a new design.<sup>16</sup>

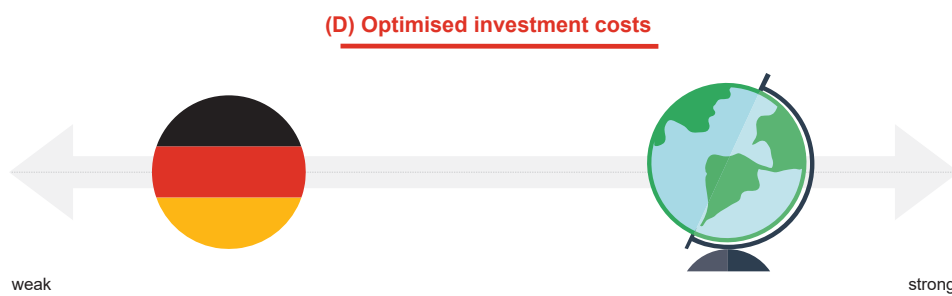


Figure 41. Benchmark of the customer requirement for 'Optimised investment costs'

Source: PwC

16 Cf. Kasperzyk, Kim and Brilakis, Automated re-prefabrication system for buildings using robotics, 2017.

## Trust-based relationships

### Relevance and background

The EPC industry is a people business. This applies internally in relation to the EPC's personnel but additionally and in particular to the relationship between owner and contractor. This trust-based, personal relationship was the main feature in the past decades but one the owners expect to apply in the next decades as well. The following statements are made on the main drivers of a trust-based relationship between EPC and owner:

- With respect to high investment, customers demand a trust-based relationship
- Personal contact will remain the major channel especially when it comes to building trust
- Efficiency improvements can be achieved by automation of repetitive processes only (in particular during the sales, execution and operations phase)

- Customers require a contact person for individual inquiries
- Customers need reliability and want to speak on a long-term basis with the same technically skilled personnel

### Results of the quantitative analysis

The quantitative analysis reveals the extent to which German EPCs are able to meet the five major customer concerns (see Chapter 'Customer requirements').

German EPCs also consider personal contact to be a success factor. Thus, eight out of ten agree that personal contact will be the key for a trust-based relationship and main sales channel. Meeting this customer requirement for the same and technically well-trained contact person in the long term is much more difficult for the EPCs. Owners want to know the key people they are investing in. If EPCs are unable to retain (key) people on a long-term basis it is quite difficult to build trust-based relationships as owners need to continuously get to know new people and contact persons.



Figure 42. Key to a trust-based relationship

Source: PwC



Figure 43. Source: PwC  
Company's attractiveness

Thus, 40% state that their company is not attractive enough to retain key people on a long-term basis (see Figure 43). They also have only a vague notion of who their key personnel will be in future. There is a wide range of opinions on this. On the one hand, the IT-expert and the data engineer or still the process engineer on the other hand? However, there was agreement on two points. First, it is impossible to make confident predictions and these predictions can vary widely between industries and customers. Second, the requirement profiles are changing significantly. In the future, well-trained process engineers will have to supplement their skill set with digital and data-based capabilities, with interface knowledge as a priority. There are many reasons and starting points for improving attractiveness. Still too many EPCs do not focus to any great extent on work-life balance, social wages and company shares.

We now come to the question of a good customer relationship. Who wants to be a customer in the EPC industry in 2025? Will there be a

strong external impetus that disrupts the EPC industry? The German EPCs expect to see less radical but still significant changes, to which they must respond. Thus, 33% see new customer groups (for example from the finance and IT sector) as prospective future clients, in view of the current low interest rates. Increased use of digital tools and work practices is also expected to reduce project risks and make them more predictable. This should increase bankability and relevance for investors.

As mentioned before, personal contact remains for both the customer and the EPC the main communication and sales channel in 2025. The question, however, is whether it applies to all business processes. The answer is both yes and no, depending on the customer benefit. In recurring processes with repeated and immediate solutions (e.g. operations), chatbots and avatars may be helpful at the project development and definition stage.

This is already happening with some German EPCs. Thus, 39% see that with the use of remote operation capabilities and (remote) predictive maintenance services they will expand their service portfolio by 2025. Again, there is a general trend that German EPCs are developing these capabilities organically rather than adding them externally.

### Benchmarking

The benchmarking shows that German EPCs are able to build more trust-based relationships with their customers than their international competitors do. It can be summarised as follows: German EPCs will strengthen their trust-based personal contacts while international EPCs will strengthen their digital-based communication channels (see Figure 44).



**(E) Trust-based relationships**

Figure 44. Benchmark of the customer requirement for a 'Trust-based relationship'

Source: PwC

**Personal contact and digital-based communication**

International competitors also see the necessity to build on personal relationship for specific issues, especially during project development. However, international competitors do not have the trust-based relationships that German EPCs have. In order to close that gap, the international competitors are trying to invest heavily in digital communication, e.g. platform forums (such as TripAdvisor), while automated support (e.g. chatbot) and self-service were rated as not important.

**Attractiveness to key people**

40% of the international EPCs do not rate their company as attractive enough to retain key people on a long-term basis. This puts them close to their German competitors (43%). Although the result is comparable, the approaches to increasing retention are different. International competitors try to keep key people loyal in the long term through a high basic salary and a clearly defined career path. Performance-related bonuses or bonuses based on the company's public image are in third and fourth place. It is worth recalling here that public image, the work environment and work-life balance came first for German EPCs.

A more in-depth assessment of right or wrong approaches is not possible here due to the high diversity of cultural, personal and legal operating environments involved. Overall, the results show that international EPCs are also faced with the great challenge of retaining their key personnel in the long term; the approaches to solving them are simply different.

**Competitive situation and owners in 2025**

Most international competitors (over 60%) expect new competitors from the IT sector to be the biggest change in the competitive situation in 2025. They believe that IT knowledge will be a differentiator in 2025 and help for example to set up and maintain an integration platform. They expect that IT companies will partner with or acquire companies with a strong technical background and capabilities.

International competitors are more cautious when it comes to shifts in the customers' structure. Most do not expect an increase in customers from the banking and insurance sector since they do not expect EPC projects to be sufficiently financially attractive, even though digitalisation will have a positive impact on the risk profile of EPC projects.

## Digital business models

This chapter looks at how customer needs correlate with the various archetypes of digital business models. To do so in a traceable and objective manner we have used one of the most renowned frameworks in the field of digital business model development, the so-called d.quarks framework. The d.quarks framework offers a holistic and comprehensive framework for digital transformation with industrial testing. The framework has been applied across industries and numerous projects. The capabilities provided by the d.quarks framework describe elementary skills that a company must organize, procure and develop in order to realize digital business models. They offer an orientation aid which is particularly tangible and scalable. Minor adjustments were made to accommodate the highly specific EPC environment. In order to determine the mandatory capabilities, a determined catalogue of criteria was applied to map the characteristics. These characteristics were inter alia the interdisciplinary, internationality, high technological complexity, high project volume involved etc.

By applying these criteria, we ranked all capabilities shown in the d.quarks framework. Capabilities as e.g. infrastructure management, which do not fit the EPC environment, have fallen through the grid. Overall, the framework now consists of 4 typical business models, the so-called archetypes. The archetypes are “Technology-enabled”, “Transaction-oriented”, “Solution-oriented” and “Open-digital”. First of all, we describe the four archetypes and then go on to describe general principles for the application of the framework (see Figure 45):

Companies under the first archetype “Technology enabled” start to expand the physical product by using new technologies and data to add new digital services. In the “Transaction-oriented” archetype, various products/devices automatically perform transactions (e.g. smart contracts). In the next archetype “Solution oriented”, companies start to use digital customer profiles to gain more knowledge about the customer. This is to adopt the customer’s perspective and deliver

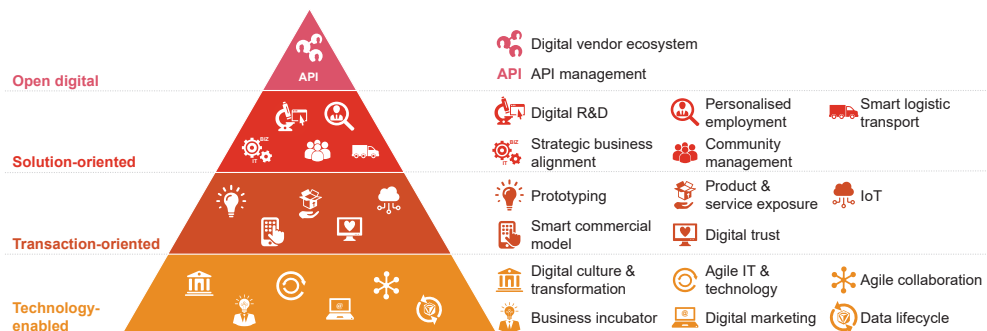


Figure 45. Overview of the four archetypes with their capabilities

Source: PwC

personalised offerings and integrated end-to-end solutions in one comprehensive customer experience. The fourth and final archetype is “Open digital”. Companies start to build a complete digital ecosystem at this stage for third parties, suppliers, partners and customers.<sup>17</sup>

The application of the framework follows the following basic principles:

- The four archetypes are not mutually exclusive, i.e., a company can also deal with different products/divisions in different digital business model archetypes.
- Not all business model archetypes need to be reached consecutively, i.e., it is possible to “jump” from archetype I “Technology-enabled” to archetype III “Solution-oriented”.
- However, all the capabilities of the previous business model must be in place to successfully go one step higher.

## Market share of archetypes today and in 2025

### Basis for calculation

The development of market potential (see Figure 47) is calculated using objective, comprehensible and transparent parameters. It predicts the shift from today to the year 2025. Due to the exponential growth in the age of digitalisation, this period of six years represents a long time. There are a number of factors influencing market potential, so there is some inherent blurring, as in any forecast of the future. To minimise this, market potential was calculated in two steps. In the first step, guidelines were formulated, which were specified in the second step and thus made the calculation possible.

Market potential was calculated based on the following guidelines:

- Identification of the overall target market on the basis of the VDMA status report (see Figure 46)
- Division of this market into private and public clients
- New orders for German EPCs from Germany and abroad, based on the VDMA status report 2017 (see Figure 46)
- These country shares were retained for the market share calculation in 2025 in order to have a valid basis for comparison

The guidelines were supplemented by the following specific parameters:

- Subdivision of key criteria for public and private clients
- Obligatory regulations on the use of BIM<sup>18</sup> were used for contracting authorities
- Digitalisation programs and strategies were used for private clients
- A large-scale study on the introduction and use of BIM shows that penetration across the entire supply chain increases in line with the rollout of mandatory BIM.<sup>19</sup>
- We apply the same logic to private client organisations with great market power as the private sector is expected to follow the public sectors on obligatory BIM regulations (for details see below)

17 Cf. PwC, d.quarks, The Path to Digital Business, 2016.

18 BIM short for Building Information Modeling

19 Cf. [http://www.bauinfoconsult.de/presse/pressemitteilungen/2017/bim-stau\\_am\\_bau\\_die\\_unternehmen\\_scheuen\\_noch\\_den\\_aufwand\\_einer\\_umstellung/2699](http://www.bauinfoconsult.de/presse/pressemitteilungen/2017/bim-stau_am_bau_die_unternehmen_scheuen_noch_den_aufwand_einer_umstellung/2699)

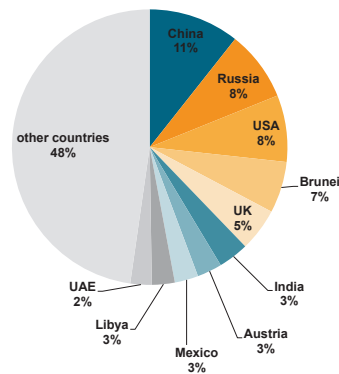


Figure 46.  
Foreign incoming orders per country in large industrial plant manufacturing (2017)

Source: VDMA Large Industrial Plant Manufacturers' Group

- Five degrees of severity represent the legal introduction of BIM (public procurers) or of digitalisation strategies (private EPCs) from 2017 to 2025
- As severity increases, the market potential shifts from archetype 1 to archetype 4

The following parameters apply for public clients.

According to the list of new orders from the VDMA status report 2017/18, the introduction of BIM was examined in each of the countries listed and its (planned) introduction date noted. Assignment to the individual archetypes was based on the maturity logic. The trend is for BIM to be introduced generally. This is also evident in the largest sales markets. For example, BIM was introduced in Russia in 2017. In China, it will be announced for the year 2020. Africa is the only area which is cautious about the introduction of BIM.

The following parameters apply for private clients.

Different digitalisation programs and strategies of large clients with corresponding market power were taken into account for private clients. Annual financial statements and management reports, strategy papers and internal PwC

network and expert knowledge were the basis of information gathering. For German clients, for example, we looked at the digitalisation strategy of Bayer and BASF. In an international comparison, we looked inter alia at the owner company Vedanta.

## Results

The predicted shift in the market shares of each digital business model by 2025 can be illustrated by the chart below (see Figure 47). In this chart, the outer circle represents today's market share per archetype and the inner dark circle the market share in 2025. The overall market, as explained in the introduction, has been calculated on the basis of the VDMA status report 2018/2019.

The chart clearly shows a shift to the right, from the "Technology-enabled" to the two archetypes "Solution-oriented" and "Open digital". Only 20% of the market in 2025 will make business models equivalent to the first "Technology-enabled" archetype. The shift in the market is particularly evident in the increase in the market share of the business models of the third and fourth archetype "Solution-oriented" and "Open digital". Business models under these archetypes will lead the market in 2025 and companies that deal only with the technology-enabled business model will not be able to survive long in 2025.

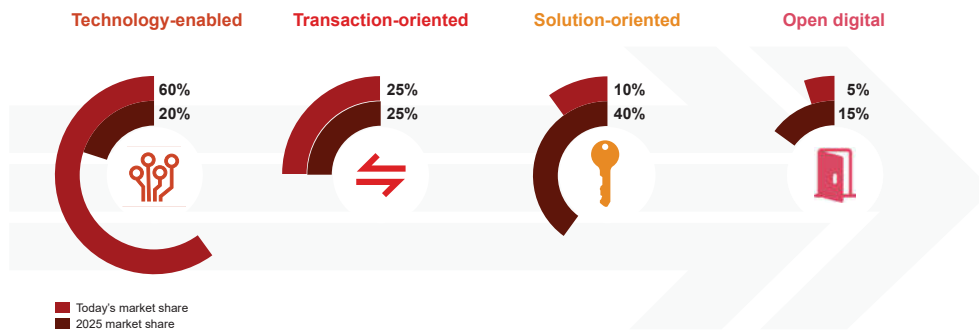


Figure 47. Market share of the four archetypes today and in 2025

Source: PwC

### Cement industry

The cement industry is a local business that requires a secure supply chain on a long-term basis. It is a highly competitive market that led to several consolidation and puts German EPCs under high efficiency pressure. Therefore, digitalisation is the key enabler to lever efficiency potentials today and in 2025. Therefore, German EPCs need to focus on the archetype “Technology enabled”. They need to build up those capabilities in a short-term in order to resist the competitive pressure. In addition, German EPCs are asked to build up or expand the capabilities regarding the smart logistics transport and vendor eco-system in order to align global sourcing with the local requirements (e.g. localization rates) and lever the needed efficiency potentials.

### Chemistry industry

The chemical industry is largely globalised and can be divided into two segments, i.e. basic and speciality chemicals. The basic chemicals are used as starting materials for other industrial products and are therefore produced in large-scale plants. Speciality chemicals are produced to customer specifications and in relatively small batches. The trend towards individualized chemical products (e.g. pharmaceuticals) is significant. To better meet this end-customers’ requirements, owners are heavily investing in digitalizing their existing production assets. German EPCs need to correspond to this trend by investing in end-to-end solutions (archetype “Solution-oriented”) in a first step and to open digital environment (archetype “Open digital”) in a second step as the owner’s expectation is clear. They want to include new production facilities in their digital twin. From a capability perspective, German EPCs will need to focus on “Digital R&D” and “API management”.

**Energy industry**

Specifically for the energy market, resulting in an expected shift to the archetypes III (solution-oriented) and IV (open digital) as framework conditions on the global energy market have changed fundamentally. Establishing decentralized energy supply and CO2 neutrality as the main requirements. Therefore, the industry pushes network expansion and power-to-X-technologies. Due to the continuous decentralisation, digitization is the key enabler to allow a close harmonization of energy producers and end-consumers. This fact has a huge effect on tomorrow's market share. End-to-end solutions in a first step and an open-digital network of producers and consumers are expected to be fundamental at least in 2025. Assigning a particular importance to the acquisition of the capabilities of digital trust, IoT, community management as well as the API management for EPCs of the energy sector.

**Steel industry**

Steel is a heavy product that is predominantly locally produced and used. The steel industry continues to suffer from overcapacity and there is urgent need to pull production facilities out of the market. Greenfield projects are rather the exception. Digitization is also understood to mainly improve the efficiency for both greenfield and brownfield projects. In this regard the term of a learning steel work is frequently used. A learning steel market optimises and controls itself – based on human knowledge, physical connections and mathematical models. This enables performance parameters such as output, quality and throughput time to be improved. Today, the focus of EPCs is to realize the needed efficiency improvements. Due to the increasing production flexibility and more individualized products EPCs will tomorrow be asked to offer more end-to-end solutions and processes (archetype “Solution-oriented”). The capabilities “IoT” and “Smart commercial model” are of particular interest for the German EPCs.

## Technology-enabled

Companies in this archetype start to expand the physical product by using new technologies and data to add new digital services. Today, the highest market potential in this archetype is for customers with a low level of digital maturity. Today's market potential amounts to 60% of total market volume (see section on "Market share of archetypes today and in 2025" within this chapter).

To reach the archetype "Technology-enabled", companies need to have the following six capabilities: "Digital culture & transformation", "Business incubator", "Agile IT & technology", "Digital marketing", "Agile collaboration" and "Data lifecycle".



**Culture is #1 driver for digital transformation; technology is just the enabler.**

Giovanni Bavestrelli, TENOVA

### 1. Digital culture & transformation

#### Background

The first-time use of new technologies and tools (such as BIM) reveals the importance of digital culture. The most frequent reason for not reaching the goals set was/is a lack of change management<sup>20</sup>. This supports the statement that it is culture that drives the digital transformation and not technology. But why exactly is culture so important? Culture provides the guideline for employees on how to behave and act. A culture should support the overall strategy and corporate aim. Every successful transformation needs a culture that supports the change. A clear correlation was identified between the intensity of the corporate culture and financial performance.<sup>21</sup>

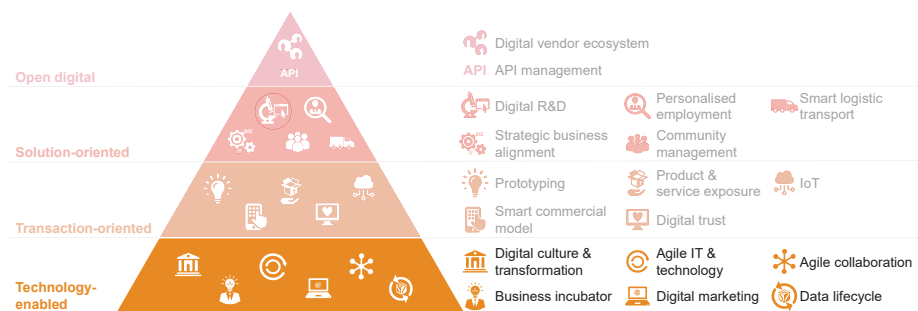


Figure 48. The archetype 'Technology-enabled' with the corresponding capabilities

Source: PwC

20 Cf. BCG, Getting Smart About Change Management, 2017.

21 Cf. Hemerling, Kilmann, Danoesastro, Stutts and Ahern, It's Not a Digital Transformation Without a Digital Culture, 2018.

A digital culture offers future benefits, i.e., digital talents are attracted by a culture that they can identify with, which helps to retain key people on a long term basis (see Chapter “Customer requirements”, section “Trust-based relationships”). In addition, a digital organisation is characterised by performing core operations through the utilisation of digital tools and technologies.

**Definition**

Digital culture transformation means change, to which companies and employees need to be open. All employees need to acquire the capability of handling digital technologies, apps and end devices. For change to be successful, all employees need to (actively) participate in the change journey.

**Results of the quantitative analysis**

**Change Management strategy**

At the Engineering Summit 2018 in Wiesbaden we asked about the implementation status of two strategies, i.e., one for digital transformation and one for change management. The survey shows a clear picture: most participants have



Figure 49. Capability of a digital culture & transformation Source: PwC



Figure 50. Error tolerance among EPCs Source: PwC

not realised the importance of a change management strategy. Only 17% stated that they had implemented a change management strategy (see Figure 49), while over 54% stated that they had a digital transformation strategy in place.

The quantitative survey drilled down from that high-level question to look at innovation culture and error tolerance, which are both crucial parts of a digital culture.

**Innovation culture**

In the area of innovation culture, there is a significant difference between the actual state and the target picture in 2025. For example, 56% of respondents said that as a corporation they do not currently provide enough room for innovation. On the other hand, all respondents said that the most important driver for the digital transformation is the innovation culture.

**Error tolerance**

There was a very clear tendency in terms of error tolerance. 80% of the German EPCs agreed that an improved error tolerance will be an accelerator for the digital transformation within their company (see Figure 50). However, improved error tolerance also relates to the customer relationship. The communication of errors and the general fault tolerance are issues, which also have to be communicated with the customer in the future, especially when it comes to more collaborative contracting models.



### Benchmarking

#### Change management strategy

The survey results at the Ammonia and Sulphur Conference 2018 in Gothenburg show that even international EPCs have not yet discovered the need for a change management strategy. Thus, only 5% of respondents had a strategy in place. A sub-finding here might be that both international and German EPCs are lagging behind with regard to including employees in the transformation process (see Figure 51).

#### Innovation culture

Innovations are at the centre of development in the EPC industry. The international EPCs also see the innovation culture as the driver of digital transformation. However, this target image is incompatible with the current characteristics of

the EPCs. 60% say that they do not have enough freedom to innovate. They face the same challenges as the German EPCs. Concrete starting points for improving the innovation culture are found in other abilities, such as incubator and prototyping.

#### Error tolerance

80% of the international EPCs (the same percentage as the German EPCs) agreed that an improved error tolerance will be an accelerator for the digital transformation. Fault tolerance tends to be culturally anchored in different countries. Thus, the principle of trial and error is part of the cultural identity of the US and its EPCs. In other cultures, especially in Asia, it will be much more difficult to integrate the principle of fault tolerance into daily working processes.

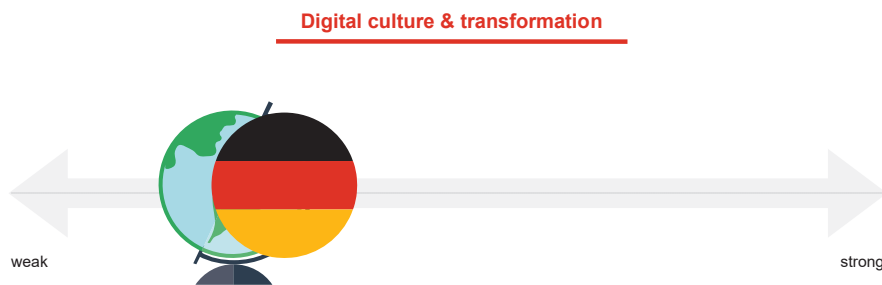


Figure 51. Benchmark of the capability 'Digital culture & transformation'

Source: PwC



**An accelerator is key to kick-off the digitalisation process within a company.**

*Julien Brunel, Linde AG*

## 2. Business incubator

### Background

Over the past years, the EPC industry has evolved into a buyer's market, creating a highly competitive environment for German EPCs. German EPCs are facing high pressure on their top and bottom line; hence they still maintain the technological leadership.<sup>22</sup> Innovations are key to maintaining this technological leadership and defend or increase their market share. The environment for innovations is becoming tougher, as a) there are highly mature technologies (e.g. in the chemical industry) and b) the time to market for innovations needs to be shortened to optimise customers' investment cases. Incubators have already proven their worth in addressing both requirements, in the EPC industry as well as in other industries.

### Definition

The term incubator describes a company's own innovation centre. An incubator offers a place where new innovative business ideas can quickly be implemented and securely evolve to a mature stage. Incubators are not measured by hard business cases and do not require revenue targets.

Moreover, incubators create a space for employees to collaborate, to innovate and to create.<sup>23</sup> This adds an essential factor: experimentation. Results and innovative approaches can only be achieved through experimentation and lessons learned.<sup>24</sup>

### Results of the quantitative analysis

The quantitative analysis shows that German EPCs have differing views on the need for a business incubator. 61% rated the business incubator as necessary for accelerating the digital transformation (see Figure 52). The analysis shows that larger businesses tend to see incubators as important: 100% of all companies with a turnover of more than €600 million agreed that a business incubator was needed. This does not appear to be sector-dependent. There are many advantages of an incubator. For example, incubators are often the official and visible starting point of the digital transformation as they provide the opportunity to develop new business ideas in a secure environment. However, the participants stated that incubators are only the starting point and digital activities need to be incorporated into the company after a certain time.

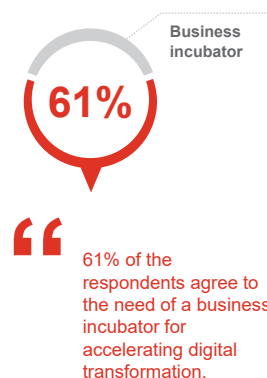


Figure 52. Capability of a business incubator

Source: PwC

22 Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

23 Cf. Newman, Three Ways Change And Innovation Drives Digital Transformation, 2018.

24 Cf. Newman, Secret To Digital Transformation Success: Fail Fast To Innovate Faster, 2017.

**Benchmarking**

The international comparison revealed that in comparison to the German EPC's international EPC's are, in terms of an innovation environment, better positioned. International EPCs uniformly agreed on the necessity of a business incubator for accelerating digital transformation progresses (see Figure 53).

Nevertheless, German EPC's are on the right track, as the qualitative analysis revealed. Almost all experts interviewed stated that an innovation environment has already been implemented in the company's structure.

German SMEs are particularly cautious about setting up innovation environments (e.g. business incubators)

Even though the benchmark puts German EPCs behind their international competitors, there are already some positive examples within the German EPCs. The following use case represent one of them (see Figure 54).

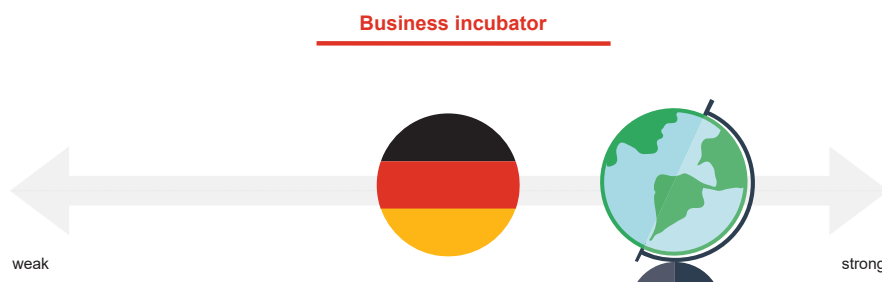


Figure 53. Benchmark of the capability 'Business incubator'

Source: PwC

Business incubator with  THE LINDE GROUP 

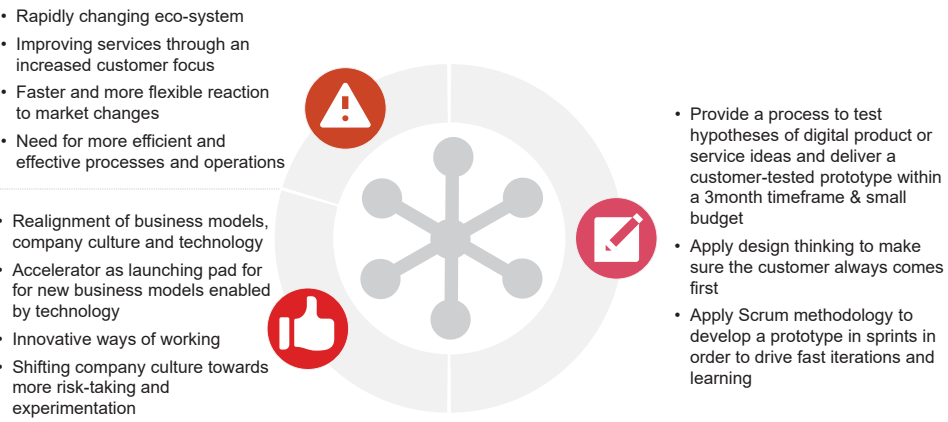


Figure 54. Use-Case for the capability of 'Business incubator'

Source: PwC

3. Agile IT and technology

Background

New IT solutions and promising technologies are coming to market at increasingly short time intervals. The range of possibilities is huge. The pressure to find the right IT solutions and the most promising technology is high. For EPC, the forces of increasing customer demand and the growing buyer market are at work. Expensive, lengthy and only partially successful software

launches, often following the traditional waterfall methodology, represent an economic risk for the EPC. Moreover, the former clear separation of IT and business projects no longer applies. This means that IT knowledge and interface knowledge is more necessary than ever.

Definition

Faster IT solutions through agile and collaborative methods. The agile aspects need to be linked to the traditional waterfall-like methods.

Agile IT and technology refers to a group of software development methodologies based on iterative development, where requirements and solutions evolve through collaboration between self-organising cross-functional teams. This applies to both the implementation of a new IT solution (e.g. a software) and the implementation of new technologies (e.g. IoT, VR/AR, AI etc.).



Figure 55. Capability of an agile IT & technology

Source: PwC



Figure 56. Benchmark of the capability 'Agile IT and technology'

Source: PwC

#### Results of the quantitative analysis

68% of respondents rate agile methods as (very) important capabilities that are needed for a successful EPC business in 2025 (see Figure 55). The agile methods include collaboration (with a focus on agile collaboration) and the introduction of IT solutions and technologies (the focus of this chapter). In addition, 94% of respondents said advanced IT capabilities are expected from graduates in 2025. In the expert interviews it was pointed out that these capabilities refer to a basic understanding. It was argued that in future it is expected to understand neural networks, but not to build them.

#### Benchmarking

Overall, a homogeneous picture emerges (see Figure 56). The strengths of international EPCs lie in the integration and use of agile IT methods. 80% of respondents say that they require advanced IT capabilities from graduates.

#### 4. Digital marketing

##### Background

The ongoing digitalisation and evolution of technologies are changing how consumers behave, how markets evolve, and how companies (including their supply chain) interact with their customers. Probably the most popular example is the fact that customers are increasingly asking for a continuous user experience. By offering many channels and a tailor-made digital marketing strategy, companies, particularly in other industries (e.g. retail) are already attempting to respond to these developments.<sup>25</sup> A recent study shows that digital marketing maturity can decrease expenditure by up to 30% and offer an increase in revenues by 20%.<sup>26</sup>

##### Definition

The terms “omni-channel and digital marketing” can be described as the development and expansion of existing sales channels by aiming for a holistic customer experience/journey along all sales channels, offline as well as online (e.g. via web shops). Digital marketing incorporates the examination and evaluation of how products and contents reach the customer and the routes involved.

##### Results of the quantitative analysis

The quantitative analysis revealed that three quarters of respondents rated their current sales channels as only partly suitable for accommodating the revenue streams in 2025. The reasons given were the new customer groups, changing customer requirements and the new possibilities of digitalisation. However, further survey questions revealed a contradiction when it comes to the importance of digitalisation and digital sales channels. Only 13% stated that digital sales channels, such as web shops and plant configurators, are the most relevant channels for EPC business in 2025 (see Figure 57).



Figure 57.  
Capability of digital marketing

Source: PwC

25 Cf. Mirsch, Lehrer and Jung, Channel Integration Towards Omnichannel Management: A Literature Review, 2016; 20th Pacific Asia Conference on Information Systems (PACIS) 2016, Chiayi, Taiwan.

26 Cf. BCG, Mastering Digital Marketing Maturity, 2018.

This low importance underlines the complexity and investment volume of such types of projects. Despite this small percentage, there are already positive examples in Germany and abroad (see use case). Here, too, the trend is apparent that SMEs are more cautious in this regard than larger companies.

Both international and German EPCs are reluctant to exploit digital sales channels. However, this benchmarking result should be qualified in the light of the customer requirement for personal contact, which is the most important sales channel today and tomorrow from the customer's point of view.

### Benchmarking

The benchmark shows that both German and international EPCs share the same perspective in terms of today's sales channels and the revenue streams in 2025 (see Figure 58). These suggests that German and international EPCs are not yet properly prepared for the change in revenue streams by 2025.



Figure 58. Benchmark of the capability 'Digital marketing'

Source: PwC



“  
**T shaped model is a way to ensure interdisciplinary collaboration and knowledge transfer.**

*Kurt Herzog, Primetals*

**5. Agile collaboration**

**Background**

In an ever more globalised, faster acting and digitalised environment, companies’ procedures and organisational structures need to adapt to respond to these changes. Project teams are spread around the globe and data needs to be shared constantly. Customers are still increasing their requirements and demanding, for example, ever shorter project lead times (see Chapter “Customer requirements”, section “Shorter lead times”). Technical improvements are often neither easy to implement nor feasible.

**Definition**

Agile collaboration in this section means a collaboration that is multidisciplinary, foregoes hierarchies and based on knowledge sharing. The collaboration needs to be available ad hoc, anytime and anywhere, regardless of geographical borders.

**Results of the quantitative analysis**

The quantitative analysis is based on three dimensions, i.e., multidisciplinary team set up, working across hierarchy levels and the use of agile project management.

**Multidisciplinary**

The complexity of major projects makes multidisciplinary essential. Examining interface competence and thinking outside the box of one’s own discipline are key success factors in the EPC industry. In this respect, it is rather surprising to see that 39% of respondents do not agree that their project teams are sufficiently heterogeneous. Just 34% stated that they had self-organised small teams developing deliverables independently and across hierarchies.

**Hierarchy levels**

83% of the German EPCs expect flat hierarchies to become a success factor for accelerating the digital transformation. A distinction was made on this in the expert interviews, however: although designing hierarchy levels is a good first step, what really matters is how they are implemented in the day-to-day business. An underlying change management system (please refer to the “Digital culture and transformation” capability) is supportive here.



Figure 59. Diversity of project team Source: PwC



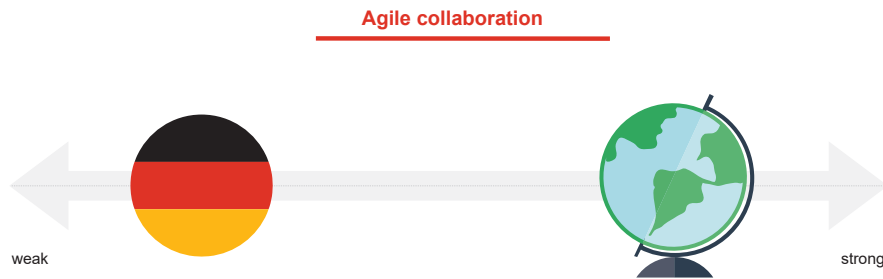


Figure 60. Benchmark of the capability 'Agile collaboration'

Source: PwC

### Agile project management

Agile project management has not yet gained widespread acceptance in the EPC industry. 6% and 37% consider these abilities to be very important or important respectively. The reason for this restraint is explained in the expert interviews as follows. The deliverables or plant outputs to be fulfilled are clearly defined, but in practice agile methods require and reinforce cross-functional collaboration. Thus, the requirements of the EPC industry are promoting initial efforts and concrete use cases that reflect the growing importance of agile project management. Some examples of applying agile methods in EPC projects were presented at the Engineering Summit 2018 in Wiesbaden by the leading global engineering companies Alstom, Air Liquide and Outotec.

### Benchmarking

International EPCs have a significant advantage in agile collaboration (see Figure 60). This advantage is evident across all three subcategories. We look at the basis for this in detail below.

### Multidisciplinarity

80% of the international EPCs state that their teams are mostly heterogeneous and cross hierarchies. Collaboration is frequently, but not necessarily, supported by processes and clear governance.

### Hierarchy levels

Only 60% believe that flat hierarchies accelerate the digital transformation. Since previous types of project cooperation already function across hierarchy levels, flatter hierarchy levels are only seen as adding value in certain circumstances.

**Agile project management**

International competitors rate agile project management as one of the top priority capabilities that will be needed in 2025. They have already implemented agile project management in their day-to-day operations, partly due to their extensive partnerships with IT companies and start-ups. The following use case underlines this statement.

It represents an example from a different industry, i.e. the banking sector. The banking sector is typically not the first association when it comes to agile project management. In addition, the use case of Rabobank illustrates perfectly how consequent and disruptive other sectors apply agile project management. Therefore, we have chosen that particular example to provide German EPCs with illustrative material that shows the consequences the increasing competition and further digitalisation can have (see Figure 61).

Agile collaboration with  

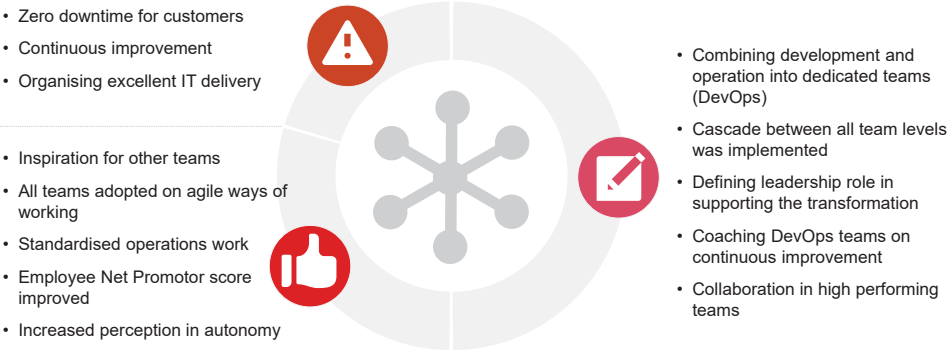


Figure 61. Use-Case for the capability of 'Agile collaboration'

Source: PwC

## 6. Data lifecycle

### Background

In the terms of digitalisation, digital products and services lie at the heart of knowledge, i. e., data. Each EPC project is unique. EPCs often try to accommodate this with a customised and individual data structure. Individual contractual requirements sometimes prohibit sharing the same data structure across EPC projects within a company.

### Definition

Data lifecycle management is a policy-based approach to managing the flow of an information system's data throughout its lifecycle: from creation and initial storage to the time when it becomes obsolete and is deleted.<sup>27</sup>

### Results of the quantitative analysis

#### Data engineering

94% of German EPCs see data engineering as a capability that will be required in 2025.

#### Analysing operational data

56% plan to develop internal capabilities for analysing operational data. German EPCs are currently hampered by limited data.

#### Tool and data base integration

At the expert interviews it was pointed out that data mining will become more relevant in the future. Data mining examines large pre-existing databases in order to generate new information.

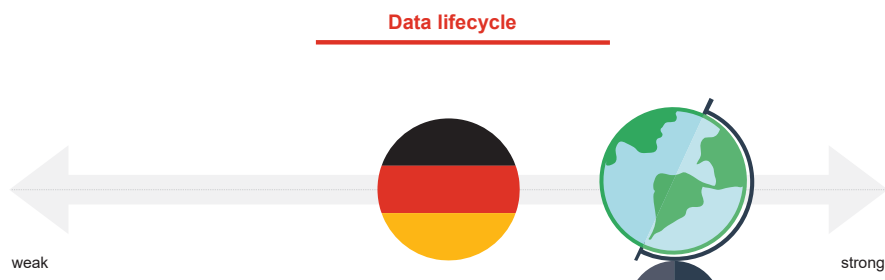


Figure 62. Benchmark of the capability 'Data lifecycle'

Source: PwC

<sup>27</sup> Cf. <https://aec-business.com/construction-life-cycle-management-necessary-business-strategy/>.

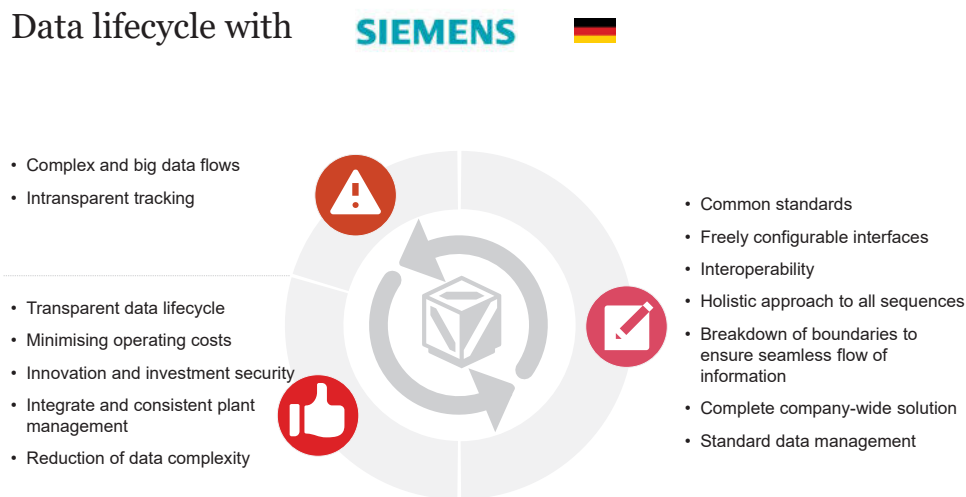


Figure 63. Use-Case for the capability 'Data lifecycle'

Source: PwC

**Benchmarking****Data engineering**

100% of international EPCs think data engineering is a capability that will be required in 2025.

**Analysing operational data**

56% plan to develop capabilities for analysing operational data organically. German EPCs are currently hampered by limited data.

**Tool and data base integration**

At the expert interviews it was pointed out that data mining will become more relevant in the future. Data mining examines large pre-existing databases in order to generate new information. German EPCs are lagging behind on collecting of data to power their service business (see Figure 62).

Even though the benchmark puts German EPCs behind their international competitors, there are already some positive examples within the German EPCs. The following use case represent one of them (see Figure 63).

## Transaction-oriented

Companies in this archetype start to expand the physical product by using new technologies and data to add new digital services. Its market potential, today and in 2025, amounts to 25% (see section “Market share of archetypes today and in 2025” in this chapter).

To reach the archetype “Transaction-oriented” (see Figure 64), companies need to additionally have the following six capabilities: “Prototyping”, “Smart commercial model”, “Product & service exposure”, Digital trust” and “Internet of Things (IoT)”.

## 7. Prototyping

### Background

Innovations must meet customer requirements and achieve market readiness in ever shorter cycles. The commercial pressure on innovations to make a significant value contribution is increasing at the same rate. In an increasingly interconnected world, it is also necessary to consider the growing number of interfaces and actors in development. Customers are increasingly demanding to be involved in innovation development. Creating a customer journey starts at this early stage.

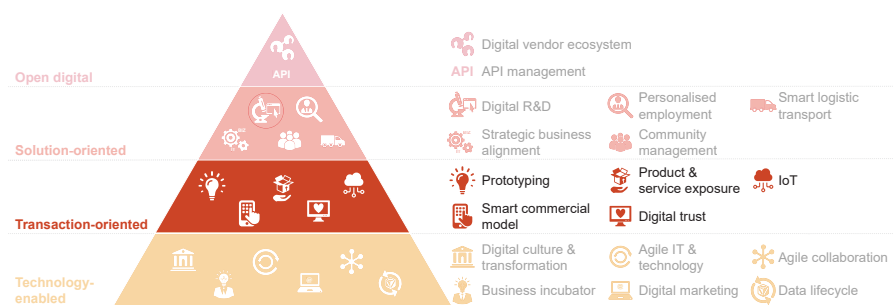


Figure 64. The archetype ‘Transaction-oriented’ and the corresponding capabilities

Source: PwC

**Definition**

User- and customer-centric identification and development of new business ideas and business models. Feedback is acquired through prototypes in early development stages. The involvement of the different entities allows for early error detection and for the incorporation of different perspectives and knowledge, which is essential in the digital age.

**Results of the quantitative analysis**

The expert interviews revealed several strategies on how to initiate and steer incentives. The most common approach was the “pilot approach”. The logic of the “pilot approach” is that there is no innovation without a concrete customer and benefit to the customer. It was argued that

this approach minimises the risk for the EPC, increases the acceptance of that innovation within the EPC’s organisation and strengthens the customer relationship over the long term.

**Benchmarking**

Both, German and international EPCs are nearly on the same level of the digital capability “Prototyping” see (Figure 65). Nevertheless, different approaches were applied.

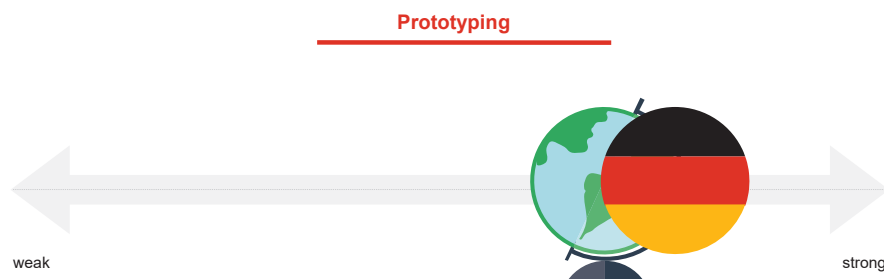


Figure 65. Benchmark of the capability 'Prototyping'

Source: PwC

### 8. Smart commercial model

#### Background

An earlier (EPC) study<sup>28</sup> already identified the optimisation potential of German EPCs in the area of contract and claim management. In the future, commercial and contract management will be even more crucial. As already pointed out, the trend is towards individual customer advice with individualised solutions for each customer. These technical solutions must be transferred to the economic and legal world.

#### Definition

A smart commercial model and contract management is the backbone for new products and services with new and diverse revenue streams that need to be highly customised to customer usage habits. The development and delivery of those (digital) services require effective contractual agreements with providers, partners, and customers along the entire project lifecycle.



“  
New sales channel will supplement but not replace the traditional ones.”

Dr. Hannes Storch, Outotec

#### Results of the quantitative analysis

The quantitative analysis revealed that both German (75%) and international EPCs (100%) are convinced that the EPC lump sum turnkey contract model will also be the top priority contract model of the future. This runs counter to owners' expectations. Clients expect individual and solution-oriented contract models and view lump sum turnkey contracts as a black box. The owners also feel they are likely to lose out in any case. If the project goes well, the EPC optimises and if it

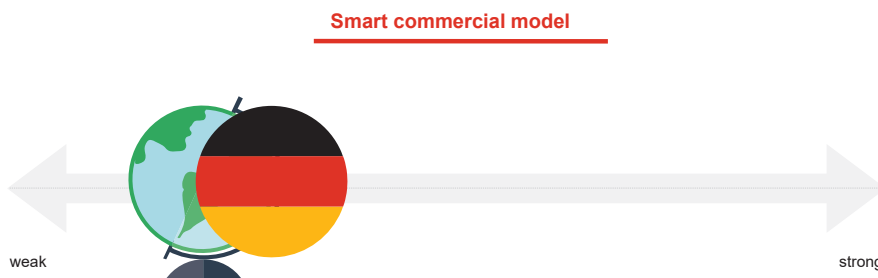


Figure 66. Benchmark of the capability 'Smart commercial model'

Source: PwC

28 PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

goes badly the client’s investment case deteriorates. Disruptive changes in the contract model are expected in the future. Some experts assume that smart contracts will be the contract model of the future, especially in the area of operations. A smart contract is a computer protocol designed to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart contracts allow credible transactions to be performed without third parties. These transactions are trackable and irreversible. The disruptive element here is that there will be no need to include a human interface since machines will perform activities automatically.

**Benchmarking**

Both the international and German EPCs underestimate the importance of changing contract models, e.g. smart contracts (see Figure 66). Both agreed in giving the highest score to lump sum turnkey projects for 2025, in other words the exact opposite of what customers are demanding.

The following use case describes an exemplary presentation and impressive implementation of the capability ‘Smart commercial model’ (see Figure 67). The Chamber of Digital Commerce is an association of innovators, operators, consultants and investors in the field of smart commercial models. It shows the importance of joining forces by jointly collaborating with partners that are in many other cases competitors.

Smart commercial model with



- Limited visibility due to siloed data
  - Various formats of captured data
  - Incompatibilities in data and blind spots in tracking goods
- 
- Reduce redundant actions
  - Simplification of complex multi-party systems delivery
  - Granular-level inventory and delivery tracking
  - Enhancement of tracing and verification to reduce risks



- Code defining actions and conditions of fulfilment
- Implementation of trusted oracles for validated registrations of an entity
- Registration and attestation of all actors, e.g. institutions, individuals, sensors, facilities and goods

Figure 67. Use-Case for the capability ‘Smart commercial model’

Source: PwC



## 9. Product and service exposure

### Background

For several years now, there has been a shift in the EPC industry to the service business. An earlier study explained this by one major fact, i.e., that the service business has a lower risk profile and can also achieve higher margins. And the pressure for high margins continues to increase. Against this background, a higher service share promises to be a recipe for success in the future as well. But it is not as simple as it sounds. The pressure on the service business of EPCs is expected to increase. This pressure is rising both on the supplier side and on the customer side. The suppliers have the expertise and data inherent in the individual technical components (machines, for example). The customers have corporate data and are trying to evaluate it even more systematically.



***The requirements for the user interface are to be so intuitive and self-exploratory that no experience is needed.***

*Prof. Dr. Mütze-Niewohner, RWTH*

### Definition

Digital products and services need to be increasingly provided on time and at lower cost and made more easily accessible.

### Results of the quantitative analysis

50% of the German EPCs plan to generate half of their turnover from services in 2025, a fivefold increase in the current number (see Figure 68). At the expert interviews, the reasons for the expansion of the share, the type of services and possible obstacles were discussed.



Figure 68.  
Capability of product and  
service exposure

Source: PwC

In contrast to the previous study<sup>29</sup>, the focus is no longer on minimising risks and maximising margins but on improving customer relations and experience. In addition, innovative types of service will be more important than traditional services (such as spare parts). The questionnaire asked what strategy would be used to develop and expand eight possible services. It is striking that German EPCs, with a few exceptions (for example, application of digital twins), focus on building up internal capabilities. This leads to delays in the German EPCs bringing new services to the market. Key lessons learnt by potential partners need to be acknowledged by the EPCs themselves.

**Benchmarking**

Benchmarking the capability of product and service exposure reveals a clear trend towards the growth of companies' share in service-oriented business. However, international EPCs seem to be less risk averse, as 57% indicated an expected share of service-oriented business of 75% in 2025 (see Figure 69).



Figure 69. Benchmark of the capability 'Product & service exposure'

Source: PwC

29 PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

## 10. Digital trust

### Background

A trust-based client relationship has always been a key success factor in the EPC industry.<sup>30</sup> This principle continues to apply in the digitalisation age. However, the components of trust-based cooperation are changing. Owners are focusing on digital products and services and data collection is essential to providing tailored digital services since it provides an insight into customers' working processes and challenges. However, the customer needs to consent to transparency before this data can be collected. This will ensure it can be collected in the future and allow further customer-centric improvement of products and services. EPCs need to focus on providing and communicating digital trust.<sup>31</sup> It is no longer enough to expect them simply to have trust and faith in the contractor. Customers demand digital trust and privacy for their data.



*Only a permanent, always up-to-date and future-oriented cyber security managed service can ensure a secure digital growth of the industry.*

*Klaus Glatz, Anderitz AG*

### Definition

Digital trust incorporates trustworthy and secure data processing, since connectivity of logistic and production is security-critical. It's all about trust, loyalty and long-term retention of customers.

### Results of the quantitative analysis

The analysis shows that German EPCs understand the upcoming need for increased data security and privacy. 94% of the German EPCs stated that these are crucial capabilities for the value proposition in 2025 (see Figure 70).



Figure 70. Capability of digital trust

Source: PwC

30 Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

31 Cf. BCG, Digital maturity is paying off, 2018.

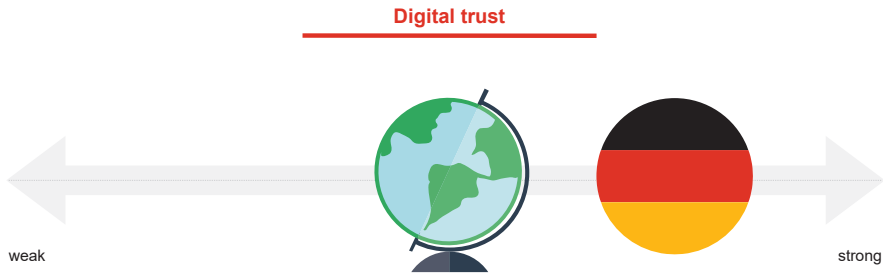


Figure 71. Benchmark of the capability 'Digital trust'

Source: PwC

At the expert interviews it was increasingly pointed out that it will not be long before the cyber security officer becomes an important part of the EPC project organisation. The driver is the customer requirement for increased transparency at the business process level (see Chapter "Customer requirements", section "Greater transparency"). This can only be guaranteed consistently if the cyber security office incorporates this into routine EPC project management processes.

**Benchmarking**

German EPCs overwhelmingly rated cyber security as a crucial part of future project implementation (see Figure 71). 80% of the international EPCs said that cyber security capabilities would be a crucial part in 2025. Nonetheless, there are individual use cases abroad that already rely successfully on cyber security (see Figure 72).

**Digital trust with**



- Impact of insecurity: hacking, unplanned shut downs & manipulation of safety systems
- The more digitalization and the use of new technologies progress, the more important it becomes
- Customers need a managed service instead of a singular product
- All assets are transparent and identified
- Cyber risks are evaluated and potential impacts are portrayed
- Active and continuous assessment of risks
- Actively assisting customers to meet the enormous challenges of managing cyber security



- Managed service with own products, services and solutions
- Risk assessment services, advanced risk monitoring, proprietary products
- Detailed assessment helps evaluate relevant threat scenarios
- Customers in most cases have no transparency, limited knowledge and not the necessary resources to meet the topic sufficiently
- Subject is still underestimated in many cases

Figure 72. Use-Case for the capability of 'Digital trust'

Source: PwC

## 11. Internet of Things (IoT)

### Background

Many of the digital products and services already mentioned and discussed within this study require a wealth of data and information that was previously unavailable in the real world. The IoT acts as an interface between the real and virtual worlds. It is the foundation for connecting physical products through sensors and actuators. Digital services are only made possible by creating communication between physical products. This requires the IoT platform to be strategically constructed and managed.

### Definition

The IoT is the foundation for connecting physical products through sensors and actuators. Digital services are only made possible by creating communication between physical products. This requires the IoT platform to be strategically constructed and managed.

### Results of the quantitative analysis

The survey results reflect the high importance of IoT for EPCs in 2025. The respondents unanimously rated the IoT as the most promising future value contributor in future project implementation and delivery. At the expert interviews, four main use cases for IoT in the EPC industry were developed. These are shown below; the last point shows how IoT can be used by suppliers to increase competitive pressure on EPCs:

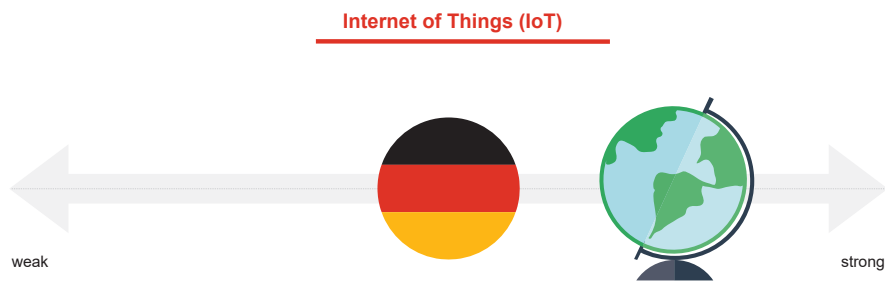


Figure 73. Benchmark of the capability 'Internet of Things'

Source: PwC

- Building an IoT construction cloud involves matching the algorithm to the data – machine learning projects for data collection – building access for the clients so they can view their plants
- Plant monitoring requires more data than just the data coming from the control system. Data flowing through the control system is also very expensive. Here, reducing the number of CAPEX-intensive IoT sensors could be useful for obtaining the information required for predictive maintenance
- IoT platforms are preparing for a time when large companies have suppliers and smaller steel companies that develop their own ecosystem
- On the other hand, IoT can also increase the pressure on the EPC. The sub-suppliers will also be able to rely on IoT and thus be able to use the data to expand their knowledge

#### **Benchmarking**

Putting these results into an international context, German EPCs are clearly lagging behind with regard to the anticipated benefits of connectivity through an IoT platform (see Figure 73). Their international peers place one-third more emphasis on know-how transfer across industries.

### Solution-oriented

Companies in this archetype are addressing customer needs holistically. They combine individual services and partners to form end-to-end solutions that meet customer needs based on aggregating customer data into digital profiles. Market potential will increase from 10% (today) to 40% in 2025. This 40% market share will represent the largest share in 2025. EPCs therefore need to pay special attention to build up the required capabilities.

To reach this archetype (see Figure 74), companies need to have the following five capabilities: “Digital R&D”, “Strategic business alignment”, “Personalised employment”, “Community management” and “Smart logistic transport”.



“  
From a scientific perspective ‘open innovation’ is correct, however, the mentality and data protection regulation may inhibit its added value.  
Dr. Michael Krenz, FAU Nürnberg-Erlangen

### 12. Digital R&D

#### Background

Innovations are key for German EPCs to maintain this technological leadership and defend or increase their market share. The incubator is the internal trigger for the digital transformation process and acts as a catalyst for innovations (see the “Business incubator” capability). In a more digitised world, interconnections and dependencies are increasing. This also applies to innovations. So digital R&D requires collaborative solutions that cross internal and external barriers.

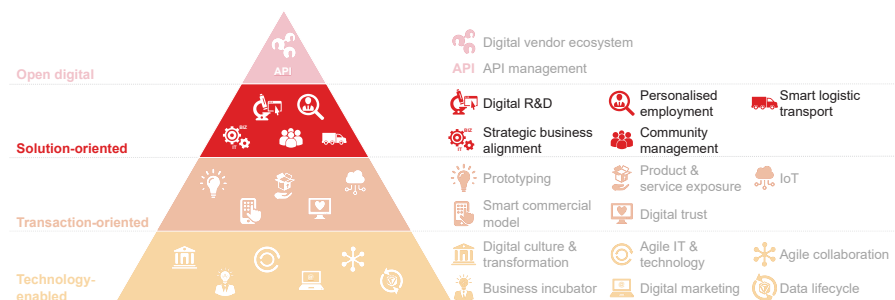


Figure 74. The archetype ‘Solution-oriented’ and the corresponding capabilities

Source: PwC

### Definition

It therefore includes additional stakeholders (e.g. end customers or extended research networks). User-centred and multidisciplinary aspects thus increase the effectiveness of R&D.

### Results of the quantitative analysis

40% of the German EPCs are willing to adopt the open innovation approach in R&D (see Figure 75). The major obstacle is IP protection (see Chapter “Customer requirements”, section “Shorter lead times”). However, German EPCs try to integrate as many external stakeholders as possible during the R&D process. This includes academic institutions and start-ups. A number of German EPCs have various programmes in place aimed at systematically integrating these external stakeholders. It is also clear that large corporations have an advantage over medium-sized companies due to their greater financial possibilities.



Figure 75.  
Open innovation approach in R&D

Source: PwC



**R&D in the digital age requires to integrate external partners such as scientific institutions.**

*Kurt Herzog, Primetals*

### Benchmarking

Asian EPCs in particular actively adopt the open innovation approach to the R&D process (see Figure 77). The Asian EPCs rate the reduction in time-to-market as the major benefit here. International EPCs from other regions are a little more reluctant than the Asian EPCs. The following use case describes impressively how ‘Digital R&D’ can be brought to business. We have chosen that use case because of two reasons. On the one hand Haier’s ultimate company Midea holds 95% of KUKA’s shares and on the other hand Chinese large-scale plant engineering companies are recently rated as top competitor by the AGAB members. It shall give indications how the important part of R&D and technological leadership can be further improved.



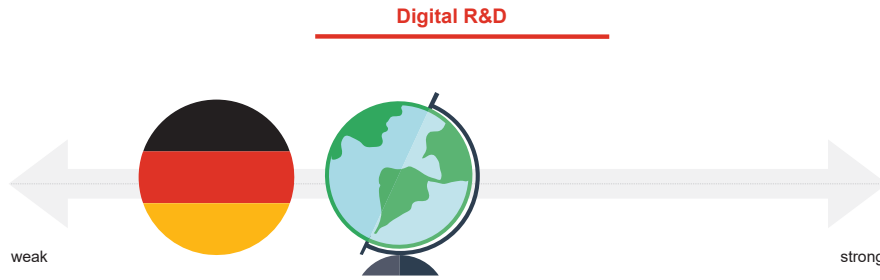


Figure 76. Benchmark of the capability 'Digital R&D'

Source: PwC

Digital R&D with

Haier



- Fast changing industry
- Long time to market
- Limitation in access

- Reduce redundant actions
- Simplification of complex multi-party systems delivery
- Granular-level inventory and delivery tracking
- Enhancement of tracing and verification to reduce risks



- Code defining actions and conditions of fulfilment
- Implementation of trusted oracles for validated registrations of an entity
- Registration and attestation of all actors, e.g. institutions, individuals, sensors, facilities and goods

Figure 77. Use-Case for the capability of "Digital R&D"

Source: PwC

### 13. Strategic business alignment

#### Background

One component is often lacking throughout the strategy creation and execution process. If consistently applied, it will dramatically enhance the progress of strategy creation, communication and execution. This critical component is alignment.<sup>32</sup>

Half of senior executives polled across companies feel that their company is not successfully implementing 50% of their strategies.<sup>33</sup> The lack of a clear transformation strategy was similarly cited by 35% of executives as a key barrier to achieving its full digital potential.

#### Definition

Therefore, the successful development of innovation, new business models and digital services requires a clear policy on how and when to align, escalate and decide on strategic alignment across all business units involved (inter alia R&D, business development and sales, technical and commercial departments).

#### Results of the quantitative analysis

The quantitative analysis revealed that collaboration between the different units and top-level support for new strategies and innovations are relevant here.

#### Collaboration between business units

75% of the German EPCs agree that the collaboration and alignment of overarching activities and strategies across business units and departments is in place. The expert interviews reveal that the difficulty is still how to implement those principles and guidelines into daily operations. The major success factors revealed at the expert interviews are clear governance and an open communication concept that support the “tone from the top”.

#### Top management support

There was general agreement on top management support for new strategies and innovations. 44% of German EPCs state that lack of top management support prevents these cross-department strategies from being implemented successfully (see Figure 78).



Figure 78.  
Capability of strategic  
business alignment

Source: PwC

32 Cf. [www.forbes.com/sites/larrymyler/2012/10/16/strategy-101-its-all-about-alignment/#15a701fe28cf](http://www.forbes.com/sites/larrymyler/2012/10/16/strategy-101-its-all-about-alignment/#15a701fe28cf).

33 Cf. <https://wiprodigital.com/news/new-survey-highlights-leadership-crisis-digital-transformation/>.

**Benchmarking**

Although the overall picture is balanced, there were nuanced differences between collaboration of business units and the “tone from the top” (see Figure 79).

**Collaboration between business units**

40% of the international EPCs rate their collaboration across business units as sufficient to align overarching activities and strategies. That puts them below their German competitors. This is rather surprising since they make greater use of collaborative working methods (agile project management; see “Agile collaboration” in the section “Technology-enabled”).

**Top management support**

80% of the international EPCs state that the top management supports strategic business alignment and dynamic team structures across business units. Cultural differences should also be taken into account. Thus, in Asian culture it is common practice to use strategies to enforce via hierarchical levels.



Figure 79. Benchmark of the capability ‘Strategic business alignment’

Source: PwC

## 14. Personalised employment

### Background

Over the past few years, engineers with an in-depth understanding of the technical (e.g. chemical) process have been the driving force for maintaining technological leadership and thus also the success of major plant engineering and construction in Germany.<sup>34</sup> Process engineers have been key positions in every German EPC. But will this be the same in future? The question cannot be answered with a clear yes or no. But what is certain is that digitalisation will create new digital requirements for success. Within digital companies, new roles/position profiles (cyber security, data scientist, new business manager) are becoming increasingly important or relevant. Companies need to offer good work-life balance with flexible working times and personal salary structures to increase their attractiveness as a digital employer.

### Definition

Within digital companies, new roles/position profiles (data scientist, new business manager) are becoming increasingly important or relevant. Companies need to offer good work-life balance with flexible working times and personal salary structures to increase their attractiveness as a digital employer.

### Results of the quantitative analysis

German EPCs mostly agree that cyber security and data engineering will be new roles within the EPC's organisation (for details see the "digital trust" capability).

As digitalisation spreads across all industries there will be a huge need of digital talents. Companies need to be attractive to recruit the most talented graduates. German EPCs, unlike their international competitors, tend to build the digital capabilities they need internally rather than build long-term strategic partnerships with digital companies from outside the engineering industry. All staff need to participate in the change process and be introduced to the topic of digitalisation. This results in the following requirements:

- A new mindset is required
- An innovation culture needs to be promoted
- Companies use the concept of incubator environments to support the innovation culture and innovation drive

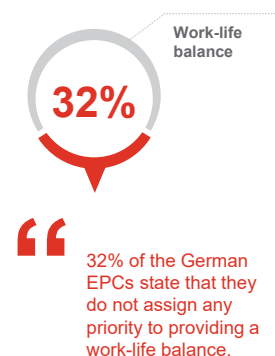


Figure 80. Capability of personalized employment

Source: PwC

34 Cf. PwC, EPC Capabilities of German Companies in Construction and in Mechanical and Plant Engineering Industries, 2017.

Three quarters indicated that they would not describe their organisation as sufficiently attractive for digital talents. As a result, there is a risk that German EPCs will not be able to step up to the challenge of the digital transformation due to the lack of adequate personnel.

To minimise that risk, German EPCs are taking different approaches. They said their top three priorities were public image/brand, working environment (e.g. flexible working) and work-life balance.

32% of German EPCs do not rate work-life balance as any priority for increasing their attractiveness to digital talents (see Figure 80). However, a current study of graduates and potential digital talents finds that they rate work-life balance as the number one priority.<sup>35</sup> German EPCs also find it difficult to retain their key resources over the long term.

Around 40% of respondents stated that they did not think their company was sufficiently able to retain key people on a long-term basis. To summarise: people and culture are the driver for the digital transformation. German EPCs are struggling with two crucial steps, firstly attracting digital talents and secondly retaining them on a long-term basis.

### Benchmarking

German and international EPCs are at the same level overall. However, closer examination of the individual results reveals significant differences (see Figure 81). German EPCs lead when it comes to identifying the skill profiles and roles a successful EPC will need in future. But international EPCs lead when it comes to being attractive to young digital talents and retaining key positions in the long term. So international competitors give top priority to a clear career development path for attracting digital talents.



Figure 81. Benchmark of the capability 'Personalised employment'

Source: PwC

<sup>35</sup> Cf. [www.appinio.com/de/blog/absolventen-befragung-studie-zu-jobsuche-und-bewerbung](http://www.appinio.com/de/blog/absolventen-befragung-studie-zu-jobsuche-und-bewerbung).



Figure 82. Benchmark of the capability ‘Community management’

Source: PwC

**15. Community management**

**Background**

Companies need to be customer-oriented to be successful. According to the results of this study, customer needs have changed and therefore the customer orientation needs to be adjusted. Communities are being established to deepen customer relationships.

**Definition**

These social network communities can be used to bring customers together with people who share the same interests. Customers can be included in the product development process and loyal customers can be rewarded through special offerings and exclusive information. Customers are increasingly gaining a digital identity based on their buying and online behaviour.

**Results of the quantitative analysis**

German EPCs have a significant strength in building trust-based and personal relationships. However, they are still reluctant to use digital sales channels. 13% say that these will be very important by 2025 (see Figure 83). On this basis, web shops and plant configurators can be offered, which can form the basis for rewards programmes. A few examples of these already exist in the German plant engineering industry.

**Benchmarking**

To place the community management capability into an international context, both international and German EPCs exhibit potential for setting up digital communities to foster customer relationships through, for example, special offerings and transparent development processes (see Figure 82).



Figure 83. Importance of digital sales channels Source: PwC

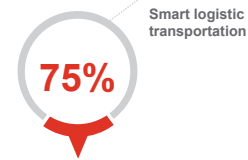
## 16. Smart transport logistics

### Background

Procurement and logistics for goods and services of a specific EPC project is typically the main cost and a significant risk driver, particularly in cases of delayed, defective, or non-quality-compliant delivery. In the future, the supply and logistics chain will remain critical to success. As the expert interview session with customers revealed: customers demand more transparency. They demand it throughout the project lifecycle and during procurement and logistics in particular. Amazon already offers real-time product tracking. So, why isn't this possible for the EPC industry?

### Definition

E2E logistics is becoming more intelligent and optimising the transport phase through the use of sensor technology and data analysis. Customers can get real-time information on the location and status of their products.



“ 75% of the German EPCs (totally) agree that standardised procurement and logistics tracking adds value.”

Figure 84. Importance of digital sales channels

Source: PwC

### Results of the quantitative analysis

75% of German EPCs (totally) agree that standardised procurement and logistics tracking adds value to the construction phase (see Figure 84).

### Benchmarking

Both international and German EPCs are on the right track on making the logistics phase smarter and ensuring greater transparency. 75% of the international EPCs (totally) agree that standardised procurement and logistics tracking add value, the same percentage as their German peers (see Figure 85).

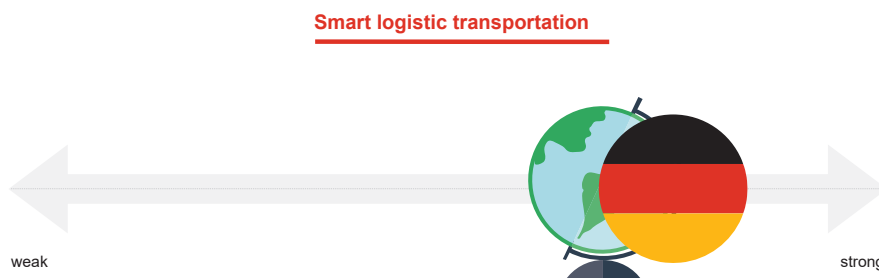


Figure 85. Benchmark of the capability 'Smart logistic transportation'

Source: PwC

### Open digital

Companies in this archetype are creating customer value together with the customer and all partners in the supply chain. Uniform interfaces in an open partner ecosystem allow many partners to offer their services directly as well as co-creating new, smart services and products.

This archetype requires companies to have the following two capabilities: “Digital vendor ecosystem” and “API management” (see Figure 86).



“Partnerships are a catalyst for new innovations; not all required capabilities can be developed internally.”  
Julien Brunel, Linde AG

### 17. Digital vendor ecosystem

#### Background

The importance of a digital vendor ecosystem for the success of an EPC project is described under the “Smart logistic transport” capability.

#### Definition

Within in a digital ecosystem, the purchasing processes between the various users are organised by one digital platform throughout the entire supply chain.

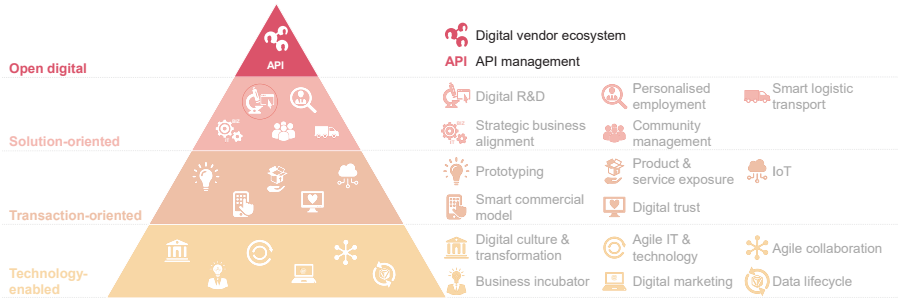


Figure 86. The archetype ‘Open digital’ with the corresponding capabilities

Source: PwC



**Results of the quantitative analysis**

84% of German EPCs see the need for a procurement platform (see Figure 87) (putting it in second place with respect to platforms required in the EPC industry). The procurement platform would include supplier selection and supplier integration and acts as the basis for any interaction with the supplier during project execution. As revealed during the expert interviews there are two challenges that need to be tackled in particular:

- Fragmented supply chains, leading to huge numbers of suppliers that need to be included on the platform. This means that either added value is required for each of the suppliers, or the market reach of the platform (like Amazon, for example) needs to be wide enough to “force” the suppliers to join the platform.
- Increasing pressure from the suppliers’ end to further expand the supply chain and enter the EPC industry.



Figure 87. Necessity of a procurement platform Source: PwC

**Benchmarking**

International and German EPCs have the same view on the importance of procurement platforms (see Figure 88). The local supply chain within the various home countries of the EPCs may facilitate supplier integration and thus make it easier to launch a procurement platform. In Korea, for example, the market power of the large EPCs (so-called Chaebols) is such that their requirements can be passed through directly into the supply chain. The same applies to Japan.



Figure 88. Benchmark of the capability ‘Digital vendor ecosystem’

Source: PwC



**Results of the quantitative analysis**

77% of the German EPCs rate the integration platform as a necessity for tomorrow's EPC business. Today, there are single German EPCs that are already in the development or implementation phase respectively (please refer to the specific use case at the end of this chapter). German EPCs will need to answer the following questions: 1. Do we, as a German EPC, can/want to transform to a platform provider? 2. Will the technical solution also be our tomorrow's unique selling point?

**Benchmarking**

Both international and German EPCs recognise the need for an integration platform to support their future value propositions (see Figure 89). Both are now in a development/implementation phase and have first use cases (please refer to Chapter "Blueprint to digital success").

There are already some positive examples within the German EPCs. The following use case represent one of them (see Figure 90).

**API Management with**



Figure 90. Use-Case for the capability of 'API Management'

Source: PwC

# Blueprint to digital success

This chapter focuses on the derivation of recommendations for actions. It should be noted that in terms of making statements about the future there is no one-size-fits-all solution. Implying that we are offering a framework which can be applied to different scenarios with deviating initial situations and available resources. By this we thrive to provide tailor-made recommendations that take the individual needs of German EPCs into account. The derivation of a digital strategy and roadmap depends on company, market and industry specifics, which must be taken into account. Furthermore, the following aspects of the blueprint for digital success do not mean that German EPCs have not yet become active in this area. Good approaches have already been noted

in many places. However, these must also be further expanded in order to remain competitive in a sustainable international context.

Our blueprint for digital success is based on the importance of customer requirements, competitive behavior and the shift in market potential within the four archetypes. From the total of 18 skills (see Chapter "Digital business models"), the five overarching thematic areas are developed and prioritized ("Change management", "Integration platform", "Innovation governance", "Agile working environment" and "Digital sales" (see Figure 91). These are explained in detail below and initial solutions are presented.

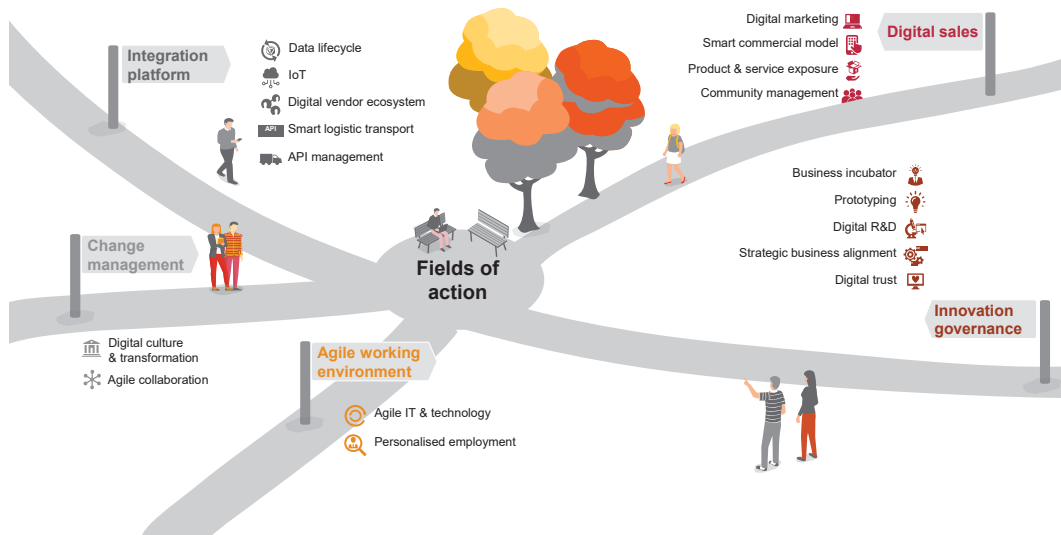


Figure 91. Blueprint to digital success

Source: PwC

## 1. Change management

A successful digital transformation is not a technology race. It is driven and decided on by people. It is not only the first (unsuccessful) BIM projects that show that new technologies and tools require a clear change management strategy with new ways of working and thinking (see Chapter “Digital business models”). These unsuccessful BIM projects are characterised by a failure to achieve the anticipated efficiency gains by partial digitalisation alone. These projects continued to be implemented with error-prone analogue methods.



***The long-term orientation of the top management creates the necessary trust within your organisation and is key for a successful digital transformation.***

Dr. Hannes Storch, Outotec

The global reluctance to introduce company-wide change management strategies can be viewed as an opportunity for German EPCs to gain a competitive advantage and strengthen their competitive position in the long term. The initial requirements for this can be summarised in three points:

- Implementation of a consistent change management strategy harmonised with the overall digital transformation strategy across all levels of the organisation with the clear support of top management. Depending on the size of the company, additional visibility and added value may be achieved by setting up an organisational unit to oversee the strategy.
- Maintaining momentum and dealing with disillusionment and setbacks (“break it until you make it”) must be actively managed. The euphoria is high when budgets and resources are available to tackle digital projects. However, the truth is that not every project is a success. Producing tangible successes and effects at the operational level and raising their profile across the company is important to ensure acceptance and motivation for long-term and exhausting digitalisation projects.
- Achieving fault tolerance and acceptance as an integral part of the corporate culture. Setting up a fault acceptance culture and putting it into practice both internally and customer-facing (especially in collaborative contract models) is a key success factor. It is essential to promote the fault tolerance policy in business processes across all hierarchical levels and in support of strong governance – leading by example.

## 2. Integration platform

Greater transparency to the customer and vertical integration of the supply chain is a USP in the future EPC business. An integration platform can do both. This is realised by German and international EPCs alike. The new teaching on platform economics shows that the winner takes it all. Therefore, German EPCs are under huge time pressure to provide customers with an integration platform.

However, German EPCs are already on a good way to develop integration platforms. Currently there are several German Integration platforms existing, inter alia Adamos, Axiom and Mindsphere, all with a clear focus on plant operation. This shows that German companies are on a good track. Not all EPCs have identified this potential already and further investments will be required. In general, there are various routes to an integration platform. The international competition is aiming for industry-wide cooperation. Hence, a marketable solution is not yet available. Common standards, development approaches and collaboration are a recipe for success. The oil and gas industry is developing initial approaches to standardisation through the CFIHOS initiative. It harmonises data structures and handover formats across all levels from the supplier, general



***The future is an ecosystem consisting out of multiple platforms and microservices.***

Dr. Jürgen Brandes, Siemens



***International standards are key to make integration platforms a success.***

Dr. Anne Bendzulla, Thyssenkrupp

contractor, operator and owner. As a result, efficiencies are raised at each level and regardless of the size of the company.

Customers expect the EPCs to provide a platform. Whether or not it is a proprietary platform is not critical. A two-part approach is therefore recommended for companies:

- Balancing the need to provide the customer with a proprietary platform based on a cost-benefit calculation
- Identification of potential cooperation partners at EPC level as well as EPC-independent companies or involving the science community

The added value of the platform is not just the ability to interact, but also the opportunity to provide a number of different microservices via this platform. Customers can be encouraged to participate through bonus systems and be tied to the platform and companies over the long term.

### 3. Digital sales and contract management

Future revenue streams will be significantly different from today's. There is wide agreement between owners and EPCs on this fact. Customers expect solutions tailored to their needs. This requires a more collaborative and advisory relationship including the use of customer data and more in-depth advice (see Chapter "Customer requirements"). These trends are seen in new contract models (pay-per-use and performance-based), new forms of customer retention (such as communities) and the requirement for shorter time-to-market for new and additional services.

For EPCs, this means breaking down old structures throughout the project lifecycle. Owners are under pressure to shorten non-value-added activities (see customer requirement for "Shorter lead times" in Chapter "Customer requirements"). This requires the following structural adjustments:

- Develop contract management capabilities with respect to more collaborative EPC contract models such as alliance contracting and new innovative contract models, especially in the area of operations ("smart contracts")
- Consider introducing loyalty programmes, especially for new service



***Flexible, individual and collaborative contractual solutions are necessary.***

*Dr. Joachim Thiel, BASF*

## 4. Agile working environment

Both, German and international EPCs stuck in the dilemma of facing the challenge to bind key personnel and providing customers trust-based relationships on a long-term basis. In addition, both consider themselves as not sufficiently attractive enough to compete in the war for digital talents. Additionally, new tools and technologies also require new capabilities, ways of working and thinking. There is generally a trend towards more collaborative working methods and changing or new job profiles provided by digitalisation. This trend is also evident within the EPC business. So far, agile working methods have been particularly successful in software development. However, the use cases of international competitors and non-sector companies show that they have also been successfully adopted in the EPC environment. Agile project management provides the greatest added value when the desired outcome is not finally designed yet. The scope of the EPC business is therefore limited. Today, German EPCs widely use agile project management during the design phase of an EPC project and for the development of new services and products. German EPCs need to initiate the following:



***The cooperation with the customer will change significantly. Today the customer is offered a 100% developed solution, which is adapted to his challenges. In future we will work in a collaborative way in an earlier stage of development to find the best customer-oriented solution.***

Dr. Anne Bendzulla, Thyssenkrupp

- Define scope of agile project management and define lighthouse projects
- Develop a target picture of future job profiles and needed skills in a typical EPC project (e.g. a project cyber security manager)
- Re-think the working environment to increase attractiveness for digital talents. Evaluate to which extent an optimization of the work-life balance is possible under the constraints of the EPC business



## 5. Innovation governance

Technical innovations will continue to be the most important driver for manifesting and expanding German EPCs' leading position on technology. Shorter innovation cycles and increasing pressure for innovation from international competitors, the supply chain and owners are all having an effect on German EPCs. Foreign EPCs, from Asia for example, are trying to close the technological gap by massive investments (up to 8% of turnover<sup>36</sup>).

Innovations generally involve a conflict between the freedom and creativity required to create novel products and clearly measurable and controllable success factors such as KPIs. Innovation governance that can combine both is the key to success. Again, as already stated, there is no "one size fits all" solution. However, the following criteria and boundary conditions are promising:

- Official and visible launch of digitalisation activities (for example through a business incubator)
- Customer focus! No innovation project without customer-specific benefits (customer-specific project)

- Involvement of internal and external partners from the beginning, i.e., at the research and development stage as well as development and formulation of the business strategy across all business units
- Creation of a clear concept for setting up and expanding data security, both in terms of structure and process organisation. In the long term, the post of e.g. project data security managers or BIM information managers will be a key part of large EPC projects
- Provide budgets, space and resources for discovering innovation

### Roadmap for the introduction of the recommendations 1-5

The roadmap (see Figure 92) shows that there are three steps to practical implementation in each company. The customer-centric approach will also determine where activities start. For EPCs, the first task is to obtain a detailed picture of the customer, market and competitive landscape (step 1). Accessing external data is recommended here (e.g. customer's business reports and strategy documents, general market information, planned BIM launches). It is also important to predict likely changes between now and 2025. This forecast will be used by the EPC to determine when to schedule expansion of the relevant capabilities.

36 Cf. <https://go.forrester.com/blogs/chinas-tech-market-will-grow-by-8-in-2018-and-9-in-2019/>

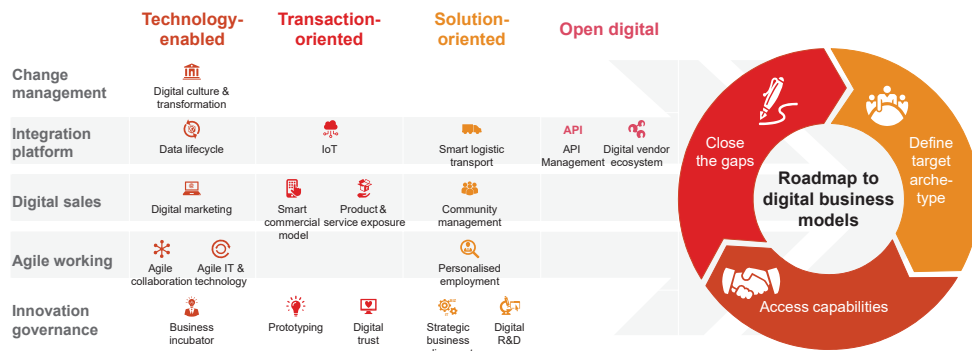


Figure 92. Roadmap to digital business models

Source: PwC

EPCs need to start by gaining a clear image of the capabilities required to achieve their target, systematically incorporating existing capabilities (step 2), both internal and external (partner). They then need to compare this target image with existing capabilities to identify the gaps that need to be closed (step 3). Once these fields of action are identified, the initial considerations below can act as a guideline for deciding whether to develop them internally or externally. This list is not exhaustive but provides an initial basis for internal discussion within the EPC companies:

- Strategic component
- Know-how criticality
- Availability on the market

In view of the volatility referred to earlier it is advisable to review this on an annual basis and make any adjustments required to the archetype implementation strategy.

This overview of the five recommendations for action shows that German EPCs are already having some visible measure of success. However, pressure from competitors and increasing customer expectations mean further measures are needed for German EPCs to retain their position as technological leaders with significant market shares in the long term. However, the long-term perspective must not obscure the need for German EPCs to act today. The essential requirements here are to see digitalisation as an opportunity and actively develop digital solutions.

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## List of abbreviations

AGAB	VDMA LARGE INDUSTRIAL PLANT MANUFACTURERS' GROUP
AI	ARTIFICIAL INTELLIGENCE
API	APPLICATION PROGRAMMING INTERFACE
AR	AUGMENTED REALITY
BIM	BUILDING INFORMATION MODELLING
BRIC	BRAZIL, RUSSIA, INDIA, CHINA
CAPEX	CAPITAL EXPENDITURE
CFIHOS	CAPITAL FACILITY INFORMATION HANDOVER SPECIFICATION
CIS	COMMONWEALTH OF INDEPENDENT STATES
CO <sub>2</sub>	CARBON DIOXIDE
CP&I	CAPITAL PROJECTS AND INFRASTRUCTURE
E.G.	FOR EXAMPLE
EPC	ENGINEERING PROCUREMENT AND CONSTRUCTION
ETC.	ET CETERA
EU	EUROPEAN UNION
GW	GIGAWATT
IEA	INTERNATIONAL ENERGY AGENCY
I.E.	ID EST
INTL.	INTERNATIONAL
IOT	INTERNET OF THINGS
IP	INTELLECTUAL PROPERTY
IT	INFORMATION TECHNOLOGY
KPI	KEY PERFORMANCE INDICATOR
LNG	LIQUEFIED NATURAL GAS
OECD	ORGANIZATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
OPEX	OPERATING EXPENSE
PWC	PRICEWATERHOUSECOOPERS GMBH WIRTSCHAFTSPRÜFUNGSGESELLSCHAFT
R&D	RESEARCH & DEVELOPMENT
RFP	REQUEST FOR PROPOSAL
SME	SMALL AND MEDIUM-SIZED ENTERPRISE
UN	UNITED NATIONS
USP	UNIQUE SELLING POINT
VDMA	GERMAN ENGINEERING FEDERATION
VR	VIRTUAL REALITY
VUCA	VOLATILITY, UNCERTAINTY, COMPLEXITY AND AMBIGUITY
WSA	WORLD STEEL ASSOCIATION

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## Disclaimer

This study does not claim to be complete. Furthermore, the particular features of the different sectors and products of the large industrial plant manufacturers, as well as their different applications, are to be considered. Therefore, a variety of other assessments on the issues raised in this study are possible.

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