



Time to bloom

A study on the digital transformation of the chemical industry



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Foreword



Vir Lakshman

Partner, Head of Chemicals &
Pharmaceuticals
KPMG in Germany

The chemical industry is in many respects subject to a different set of rules than most industries: capital intensity is high, dependency on raw materials is very pronounced, and processes are bound to the laws of chemicals. The advantages in efficiency offered by the latest technological equipment are not sufficient — the chemical industry must recognize that it too faces the new challenges associated with digitalization. After initial hesitation, most companies have come to accept changes to the culture and are beginning to recognize and seize the opportunities presented by this transformation. Chemical industry managers with an understanding of the natural sciences have discovered that digitalization can provide them with a tool for making their business more predictable and less dependent on chance.

Transformation is inevitable. This raises several questions: What are the issues and technologies that should most concern companies in the chemicals industry? What should be their objectives? We believe that, as an industry strongly oriented towards B2B, the most relevant technologies will be those that enable process optimizations and efficiency improvements. The

keywords here are digital production, simulation technology and fully autonomous logistics. The first step is to analyze the company's own position and identify the best individual strategy for the company. In an industry as capital-intensive as the chemical industry, platforms and collaborations are also relevant. Networking with customers and suppliers can decrease costs and increase efficiency.

Between April and May 2016, we interviewed a total of 75 CEOs, owners, managing directors and department heads from the chemical industry throughout Germany to ask for their assessment of the state of digital transformation in their company. We would like to take this opportunity to thank everyone who participated in the survey and our interview partners for their cooperation and their open feedback.

We are pleased to share with you the insights we gained from this study and hope you enjoy reading the results.



Sven Linden

Partner, Operations Consulting
KPMG in Germany

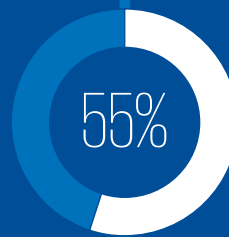
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Overview of results

The customer is increasingly at the center of the value-added network

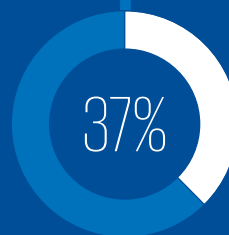
The chemical industry is moving closer to the customer. Therefore, companies should increasingly focus all processes on the customer and recognize potential in all dimensions of the business model. One important area is creating platforms for positioning additional digital services, i.e. for customers from the agricultural sector. Physical and virtual networks can be created around an agile company by consolidating internal and external processes.



55 percent of chemical companies cite increased customer proximity through digital network expansion and customer integration as one of their three highest priorities.

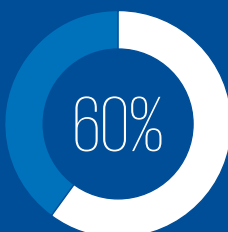
The entire organization must experience cultural transformation

Employees' skill profiles are changing — routine activities are being replaced by creative knowledge work. Top management must push through changes across the entire organization and involve employees at every level of the hierarchy. Work that is networked and flexible is becoming the new normal. Large chemical companies are already implementing ideas for virtual workplaces.



More than a third of companies see the need to catch up when it comes to acquiring skills for assessing technological potential. Three of the five largest obstacles to digital transformation are HR-related.

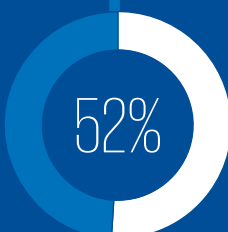
Familiarity with digital transformation is a predominant theme; however, 60 percent of chemical companies do not devote sufficient resources and competencies to digital transformation.



Chemical companies need a proactive approach to digital transformation

The chemical industry now understands this but remains somewhat conservative when it comes to digitalization. A transformation strategy is needed to proactively manage change. Sufficient resources need to be earmarked and many chemical companies are lagging behind in this respect. Leading companies are already taking advantage of digital transformation.

In most cases, chemical companies are already working on acquiring the relevant skill sets. 52 percent of chemical companies plan to proactively establish data and analytics in administration and product life cycle as a core competence over the coming decade.



New core competencies are crucial factors for success

Product and production knowledge alone are no longer sufficient. Companies require extensive knowledge of customer applications and new disruptive technological developments. Knowledge about the customer is becoming a core competence. The use of data and analytics is becoming mandatory. Leading companies have already used data and analytics to improve their processes and save on resources. The business environment is also becoming increasingly predictable.

Laying the foundation for success

Every company must have a clear understanding of its current and future position in the value creation network and a strategy developed around reaching that position. An ongoing comparison to assess the progress made in implementation creates clarity and opportunities for developing innovative positioning for the future.

Fertile soil for sustainable growth



1. Approaching transformation

75%

of chemical companies
describe themselves as
rather conservative.

60%

of chemical companies do not have
sufficient resources and skill sets for
digital transformation.

3%

— a small group of first movers and
pioneers — are already taking advantages
of the opportunities of digitalization.

“Digital transformation has become part of the C-level agenda and is one of the top priorities. An unqualified commitment on the part of management is a precondition for successful transformation. The optimal implementation can only be achieved within the team, when all business areas participate and there are clear roles and responsibilities across management and company functions.

The possibilities of disruptive technologies allow business models to be redefined in order to grow more quickly and profitably than the competition. This change is no longer an option but a question of design and safe implementation to avoid emerging a loser or underperformer: it must be planned, structured, and above all lived and led.”

Sven Linden,
Partner, KPMG

Transformation is the new normal

A drone that grows in a tank — through only chemical processes. This is not science fiction; these are the plans of the company BAE Systems. The so-called “Chempooter” produces molecules from complex substances and uses them to build objects. Unlike a 3D printer, the “Chempooter” does not work with physical processes. This example shows that even in the chemical industry, innovative ideas can disrupt traditional structures and turn the whole industry on its head.

The chemical industry is going its own way

Is the industry ready to take these steps? The results of the KPMG survey show that a majority of the companies surveyed describe themselves as rather conservative. This does not mean that chemical companies do not incorporate innovations.

The industry is seen as a pioneer in several areas. It follows its own business logic and introduces innovative solutions wherever it sees direct benefit.

The level of automation is particularly high in the area of basic chemicals. Facilities that produce several hundred thousand and up to millions of tons of product — phenol and acetone made from acumen, for example — are operated via high-performance monitoring and control technology. Where this technology is in use, no on-site personnel is required. That is how one international industrial gas company controls its air separation plants. Hydrogen production in Europe is also operated via ROC (Remote Operations Center).

Automation presents a major challenge in the areas of specialty and fine chemicals, where batch reactors with frequent product changes are often used. The knowledge and experience of the operating teams are still very important to the execution of these syntheses. At the same time, significant efforts are being made to lay the foundation for further automation using more complex process analysis technology (PAT). A conservative attitude has often proved successful in the chemical industry. Some chemical companies have the awareness, means and competencies for transformation but act cautiously and selectively. Compared with the chemical industry, the manufacturing industry is further advanced.

Fig. 1: Attitudes towards transformation compared with the manufacturing industry



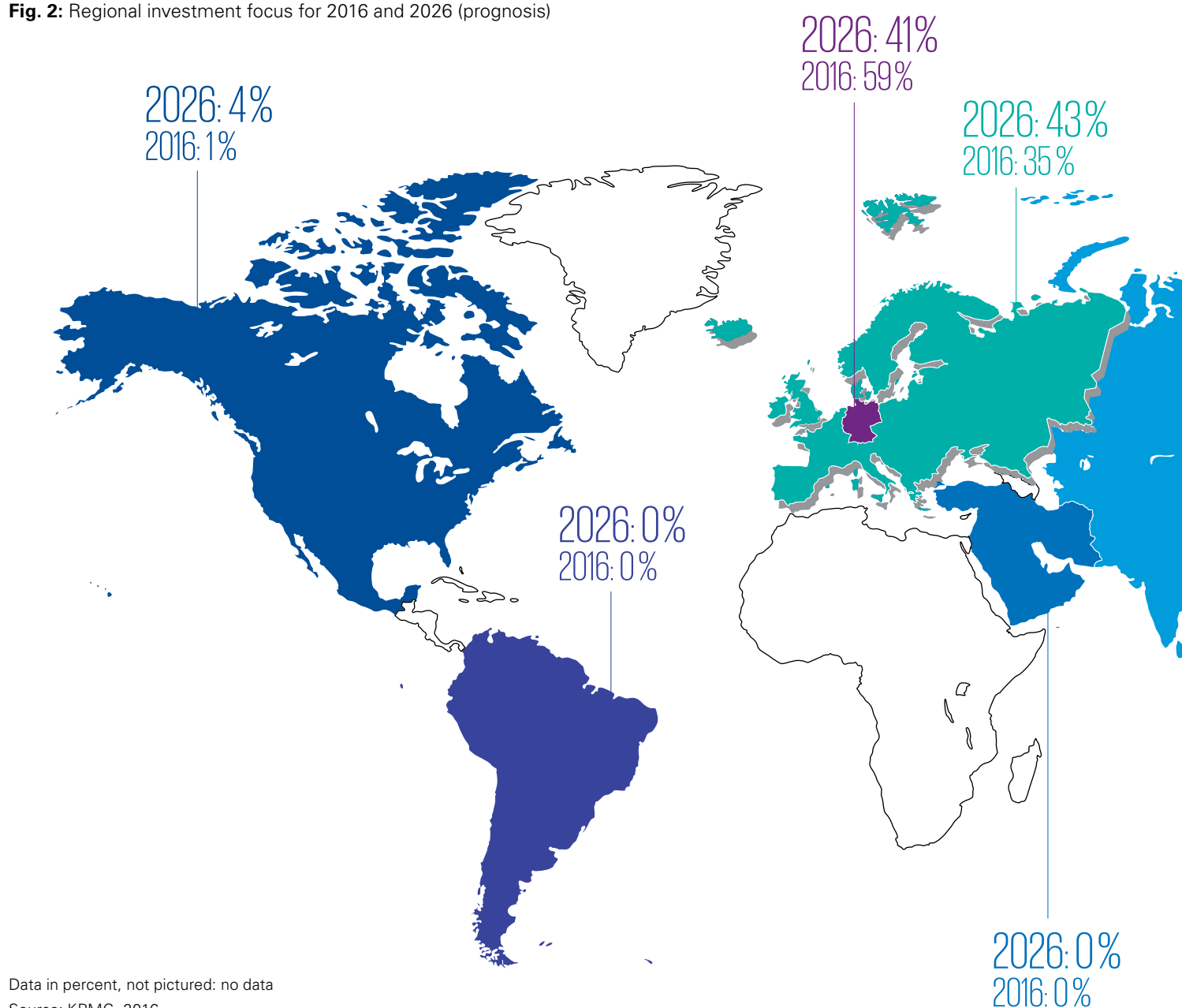
Data in percent, not pictured: no data
Source: KPMG, 2016

Focus on Europe

Conservative attitudes regarding digitalization are reflected in investment behavior. Europe has proven itself in the past as a location for specialty chemicals; qualified personnel are available. Geographical investment is thus likely to remain

focused on Germany and Europe; however, Germany's investment attractiveness seems to be losing some ground. On the whole, investment behavior is projected to remain focused on product portfolio over the next decade.

Fig. 2: Regional investment focus for 2016 and 2026 (prognosis)





"The major challenge for companies is not the purchase of machines and equipment but the reorganization of company processes. Companies have to prepare their employees for the tasks at hand. Training and education initiatives are becoming a significant cost factor. Add to that the conversion to modern and end-to-end company software."

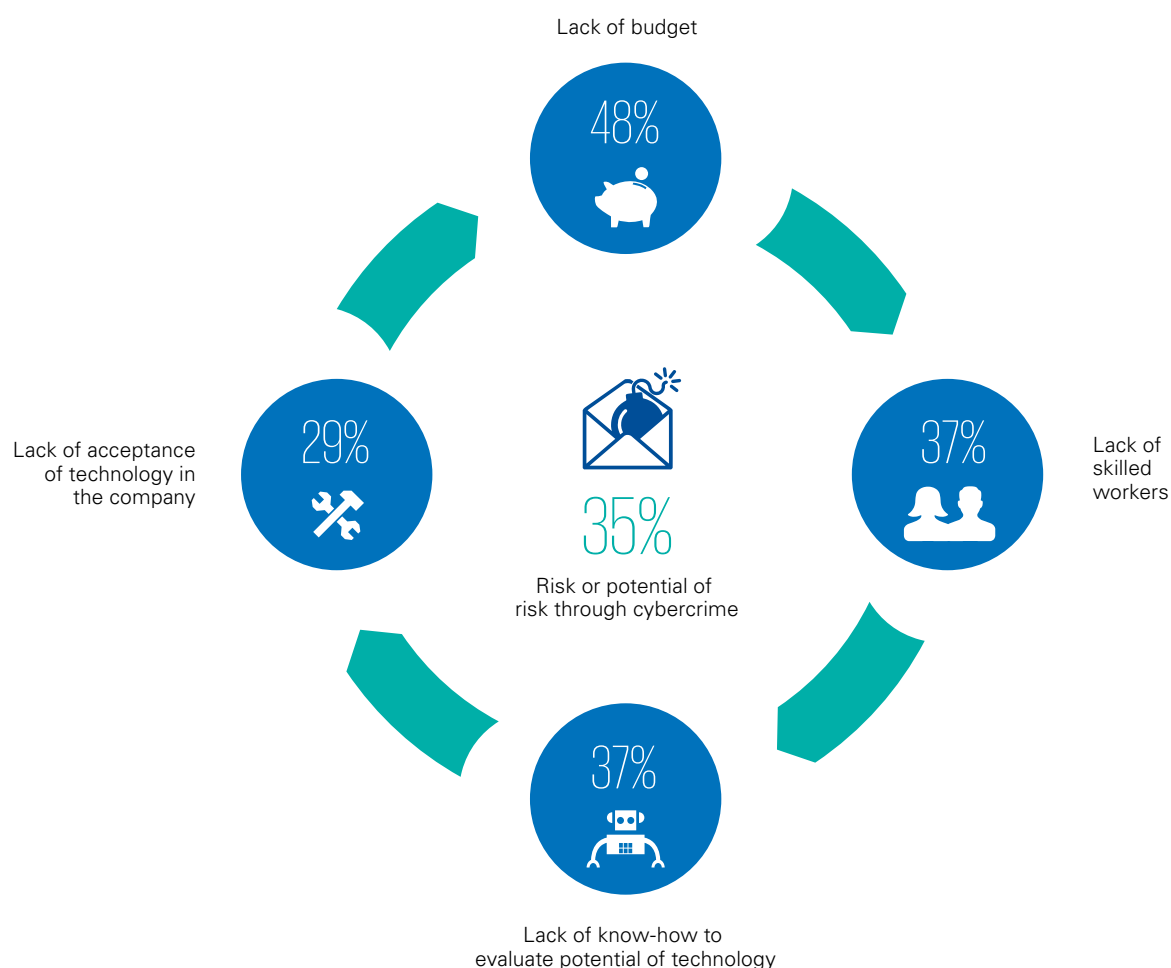
Ulrich Grillo,
President of the Federation of German
Industries (BDI)

Breaking the vicious cycle

Chemical companies not only lack money for advancing digital transformation but also, according to them, the know-how — this results in a vicious circle. One reason for the lack of

budget might be the lack of faith in digital transformation. The opportunities of leveraging high-potential, often expensive systems, thus often remain untapped.

Fig. 3: Substantial obstacles to digital transformation



Data in percent, three-part answer
Source: KPMG, 2016

Forward-looking approaches

A small group of visionary companies are emerging as first movers and are already significantly driving transformation in the industry. They are setting themselves apart from other companies by their ability to quickly anticipate trends. Their trend-setting success stories give the other players in the industry the opportunity to critically reassess their own positions and expand in the industry.

Industry example: Vision @ Evonik

370 researchers, experts, managers and mavericks (divided into technological scouts and the strategic innovation unit, Creavis) are working on innovation at Evonik. The Creavis Corporate Foresight Team, composed of chemists, biologists, physicists, engineers and additional experts where needed, is developing scenarios for the future and discussing new growth fields and areas for research for Evonik.

Source: Evonik Industries AG (www.creavis.de, 11/14/2016)

“The state has to create the proper conditions for the rapid expansion of IT infrastructure so that chemical companies can transform their vision into action.”

Dr. Matthias Blum,
German Chemical Industry Association (VCI)



Fostering ideal growing conditions

2. Creating ecosystems

73%

of chemical companies anticipate limited or no changes to their business models.

25%

plan to make major changes to their product and service portfolios as part of digital transformation.

13%

expect alternative yield models to become more important than classic sales over the course of the next decade.

“We anticipate the largest changes to our business model brought on by digitalization in the areas of sales, marketing and logistics. Kemper is focused on specialized trade. We take advantage of the opportunities provided by new media to improve basic and advanced training for our own employees, as well as processor training and specialized trade qualification. We are also following developments in the area of augmented reality in order to be able to incorporate important factual information on site. We are already working on an app that can apply the current state and its projection to various models. We have also developed a configurator that initially manages standard components on an electronic shopping list. Additional products are expected in the medium-term. We also anticipate that in approximately eight to ten years, changes in the ordering behavior of our customers will be immediately recognizable via the configurator. This will lead to the fast and flexible adaptation of logistics and production strategies because we are always focused on customer satisfaction. When it comes to individual orders, this will be possible even earlier by starting directly with production control.”

Holger Freyaldenhoven, Managing Director,
and Ingo Wolf, Head of Research and
Development, KEMPER SYSTEM
GmbH & Co. KG

Focus on the customer

Digitalization enables companies to provide individual (end) customer solutions and offers new services by adapting business models. For this to work, understanding the customer is essential.

A major automobile manufacturer currently offers its customers individual painting solutions. This in turn has an effect on the chemical industry as a supplier. Customers are calling for increasingly individualized products and services for standard prices and always flexible. This is not possible under traditional business models.

By deconstructing the business model into its dimensions and defining interfaces — a modularization of the business model in other words — individual parts can be adapted or replaced. The ability to remain flexible and agile in reacting to unexpected events is an increasingly decisive advantage for companies.

Individualized production

A medium-sized German specialty paint manufacturer set up a business area with individualized paint products. It allows DIYers to configure their own color from a palette of basic colors when ordering from the company's website. Saving the data ensures that exactly the same color mixture can be reproduced. A radio chip created individually for each order which contains all relevant information communicates directly with the embedded systems along the production line. The chip takes over additional production control by continuously exchanging current process information with the central server. This IT support enables the company to make its production more flexible and to produce a wide variety of paint products. Individualized production is thus just as possible as series production with economically comparable conditions.

Source: Federal Ministry of Education and Research,
“Industry 4.0,” October 2013

Recognizing potential in product and service portfolios

A quarter of chemical companies want to adapt their product and service portfolios as part of digital transformations. Opportunities are being recognized, with much upward potential still to be explored. Twice as many companies in the manufacturing industry are planning on adapting their portfolios.

'As of service' offers allow for individually optimized products to be offered for specific purposes. One example is the supply of clean water or the seamless manufacture of paper with excellent whiteness.

Industry example: Mobile Chemieanlagen @ Evonik

The EcoTrainer by Evonik is a complete mobile production plant on wheels in container format. It can be used at various locations and facilitates laboratory tests and process development, as well as subsequent industrial production in the same infrastructure.

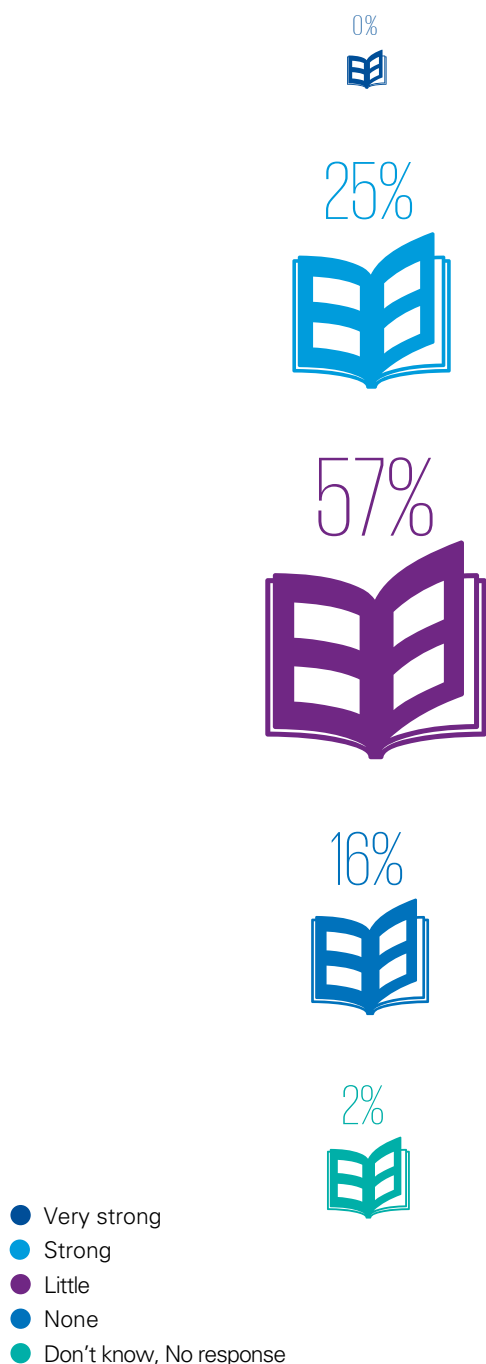
Source: Evonik Industries AG (product story no. 68, page 4, 12/22/2014)

Industry example: B2C @ Armacell

Since June 2016, in addition to apps and training sessions, Armacell provides access to information and service tools relevant to planning and tendering according to the plug and play principle by providing a USB stick in business card format. Access is via an individual landing page; specially prepared information is automatically updated.

Source: Armacell GmbH (press release, 6/1/2016)

Fig. 4: Adapting product and service portfolios



Data in percent
 Source: KPMG, 2016

Opening up alternative revenue models

A large section of the chemical industry still views classical sales as the most important source of revenue; in other words, maximum output at an attractive product price. Potential alternative revenue models are not recognized. Only a few first movers are currently implementing new revenue models.

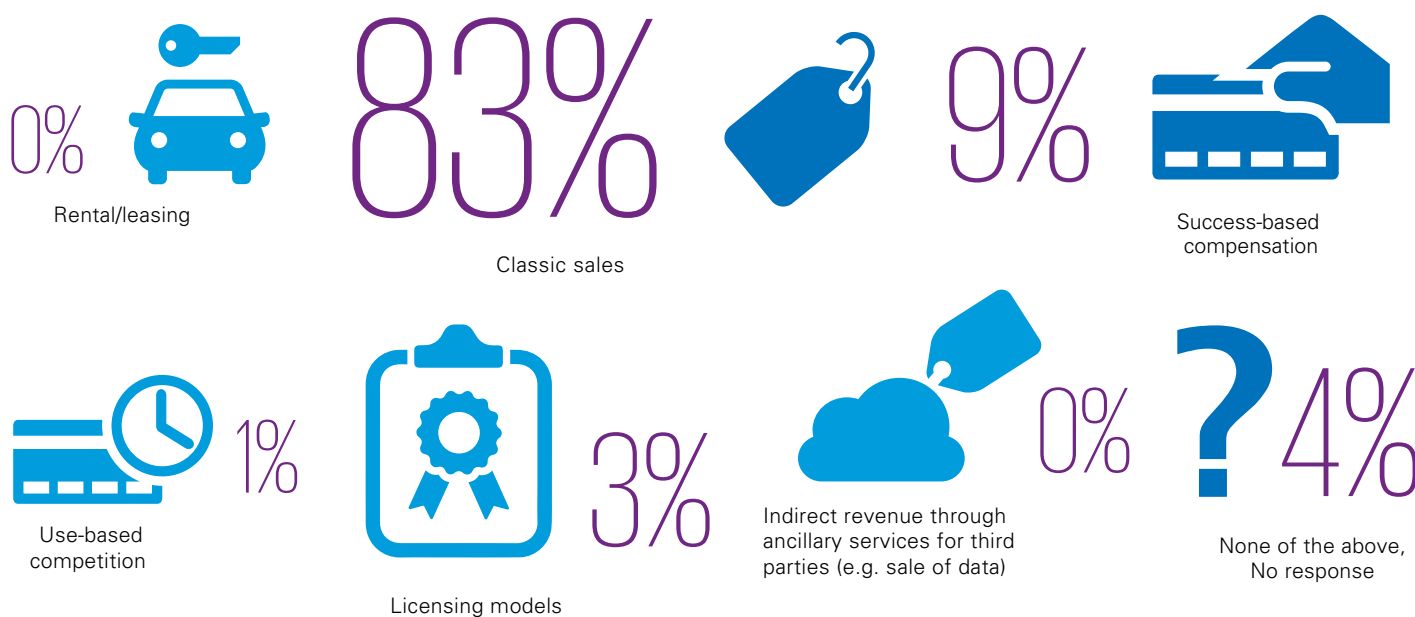
Replacing classic revenue models is a secondary priority in the manufacturing industry as well. 68 percent of survey participants from the manufacturing industry view classic sales as the most important source of revenue in the coming decade.

Industry example: Performance-based contracting @ BASF

Automotive paint producer BASF provides its customers with the option of CPU billing (cost per unit). With this form of performance-based contracting, automobile manufacturers no longer have to pay for quantities of used paint but only for perfectly coated vehicle bodies. In addition to paint coatings for system suppliers, BASF also offers numerous services in order to ensure the greatest possible impact on work results.

Source: BASF SE (BASF Coatings, Services)

Fig. 5: Which of the following areas will likely gain the most importance for your revenue model in the coming decade?

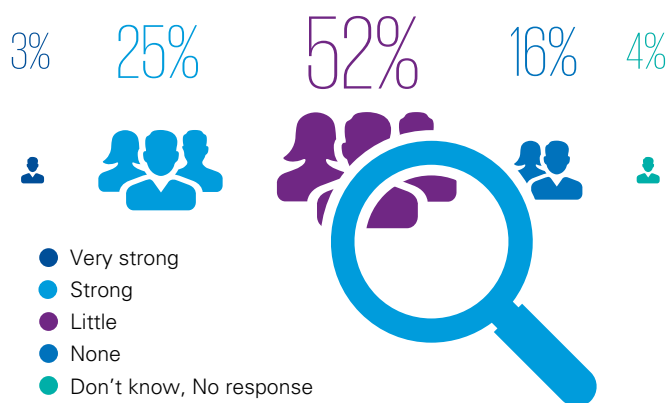


Data in percent
Source: KPMG, 2016

Attracting new customers

Chemical companies recognize in digital transformation the opportunity to tap into new target groups. For the chemical industry this means that, in the medium-term, companies should regularly review their role to ensure they are closer to the customer or re-defining their position as an intermediate supplier.

Fig. 6: To what extent does digital transformation enable your company to tap into new target groups?



Data in percent
Source: KPMG, 2016

"German industry is on the verge of a paradigm shift. The future will be focused on users and their needs and preferences rather than products. These will be collected on web-based platforms, personalized product service packages and smart services. Whoever can link data from objects, devices and machines with user data will determine the business. But the competition for the control over data and platforms has already begun. Speed and agility will determine this race."

Prof. Dr. Henning Kagermann,
President of acatech — the National
Academy of Science and Engineering

“Our tools, such as the digital farming tool, are primarily aimed at enabling our customers to optimize and digitize their own processes. This strengthens our relationship to the consumers of our products. The key here is networking.”

Tim Piepers,
Head of Architecture,
Bayer CropScience AG

23% of surveyed companies are making plans to conduct sales and purchases primarily using virtual platforms — software to software, automated cooperation, commerce without human intervention. 68 percent are planning on person-to-person interactions.

Not pictured: no data

Source: KPMG, 2016

Platforms as sales channels

Chemical companies can add profitable benefits to C-customers through digital platforms. One German chemical company has been using a B2B online shopping platform from a Chinese provider since July 2015 to make its products more available to small and medium-sized companies in China through new sales channels. Providers from online shopping platforms in the B2B area include Alibaba, Amazon, Wer liefert was, Europages and Marktplatz Mittelstand. Customers can easily compare products, services and costs, and providers have a direct overview of their competitors' offers.

But there are also risks: in several industries, when companies from outside of the industry wedge their way between providers and customers, the previous provider loses direct contact with the customer. Theoretically, anyone could offer products. Traditional factors such as customer loyalty to providers are fading into the background.

In several industries, platforms are already automated and do not require additional human intervention, and this will become increasingly important in the future.

Industry example: Digitalization in agriculture @ Bayer

In addition to agrochemicals, Bayer offers digital solutions for managing arable land. Using service platforms and apps, Bayer provides product information, weather data, topographical maps, etc. and provides support for decisions regarding growth stages and in identifying and treating diseases, pests and weeds. Strategic investments and long-term partnerships with other technology providers are part of digital farming activities. Bayer is additionally planning to develop applications and products based on satellite images from a space exploration company.

Source: Bayer AG
(www.digitalfarming.bayer.com, 11/14/2016)

Industry example: Cylinder management @ Linde

Linde in Australia is using the cylinder inventory tracking system ACCURA to bring its cylinder management closer to its customers. A cloud-based platform captures the movement, use and content of each gas cylinder in circulation in real time. It also provides customers with an overview of their gas inventory. According to company data, the platform registers when the contents of a customer's cylinder are low in order to facilitate the ordering of new supplies. One component of this development is the integration of smart valves, which are fully automated to communicate with the network regarding their location and levels. Cylinder inventories, filling quantities and consumption profile, which can be used in real time by both customers and Linde, can be the basis for both customer-internal process optimization and for better sales activity on the part of Linde.

Source: Linde AG (press release 4/19/2016)

Enabler platforms

Digital platforms in the chemical industry simplify customer management by opening up new sales channels. The ideal platform also makes it easier for customers to work more comfortably and cost-effectively. In this respect, chemical companies will become service providers.

By providing customers with tools and platforms oriented to their value chains and requirements, chemical companies can successfully integrate themselves into the end user's business over the long term. Improved connectivity with the end user increases customer proximity and customer loyalty.

"We are constantly working on introducing IT innovations. It is also important for us not to blindly pursue every hyped IT innovation. Instead, we are committed to understanding and targeting the specific needs of our customers, and thus creating added value for them. These are important criteria for both selecting and implementing digital solutions as well as for investment decisions."

Sandeep Sen,
Group CIO, Linde AG

"The boundaries between B2B and B2C have blurred. Our experience in the chemical industry show a marked trend towards stronger customer orientation in all areas. Innovative multichannel platforms, which are strongly geared towards customer requirements, and which provide the basis for a digital ecosystem, are probably one of the strongest manifestations of this trend."

Ashish Madan,
Partner, KPMG in Germany

Connecting partners, networking infrastructure

Integration of development partners

Networking is one of the most important elements for successful transformation. Chemical companies place a high priority on networking with customers. Partnerships with suppliers and universities also encourage innovation and acquisition of additional valuable data. Chemical companies can also position themselves through special ingredient branding for downstream products. Partners in development partnerships are faced with the challenge of protecting intellectual property. Systems and rules which enforce this protection must be developed if the ambitious goals of digitalization are not to be jeopardized.

The idea of open innovation already shapes several development partnerships. The ability to innovate increases both within the chemical industry and across multiple industries.

Industry example: Open Innovation @ Altana

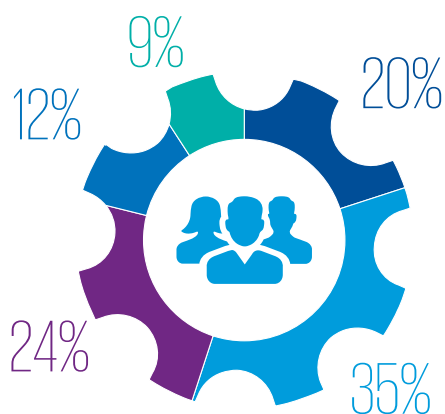
In addition to a company-internal innovation council which promotes a cross-sectoral efficient innovation process for the company, Altana is involved in external innovation networks regionally, nationally and internationally.

Altana's intention is to promote both industry-specific and cross-industry networks:

- Trend monitoring and discussion of new business ideas on life and work.
- Networking of science and industry for the efficient practical application of theoretical findings, ideas and know-how (including in industrial biotechnology and organic electronics).
- Entrepreneurial talent search and sponsorship.

Source: Altana AG (www.altana.de/innovation/altana-innovation-council, 11/14/2016)

Fig. 7: How do you plan to structure your development communities over the next decade?



- Temporary, project-based development communities
- Mostly temporary, project-based development communities
- Mostly permanent, fixed development communities
- Permanent, fixed development communities
- Don't Know, No Response

Data in percent
Source: KPMG, 2016

Industry example: Promotion of innovation @ Bayer/DuPont

Bayer and DuPont are using a common fund called Radicle to invest in technology start ups that are looking for new solutions for agrochemicals. The two companies are looking to use these investments to expand their classic product portfolio with additional services, such as data services. The US\$15 million investment volume is being paid into the fund along with contributions from three venture capital companies. These investments with cooperative partners are part of Bayer's 'digital farming' strategy.

Source: Bayer AG, E. I. du Pont de Nemours and Company (DuPont) (www.radiclellc.com, 11/14/2016)

"The increasing digitalization of all areas of a company offers many opportunities for new business models. The focus of all of the company's processes must be on the customer. By networking with everyone involved in value creation, companies can create ecosystems which integrate the customer into a long-term relationship. Companies that understand how to take advantage of such opportunities and quickly react to new challenges will likely be successful in the future."

Markus Deutsch,
Partner, KPMG in Germany

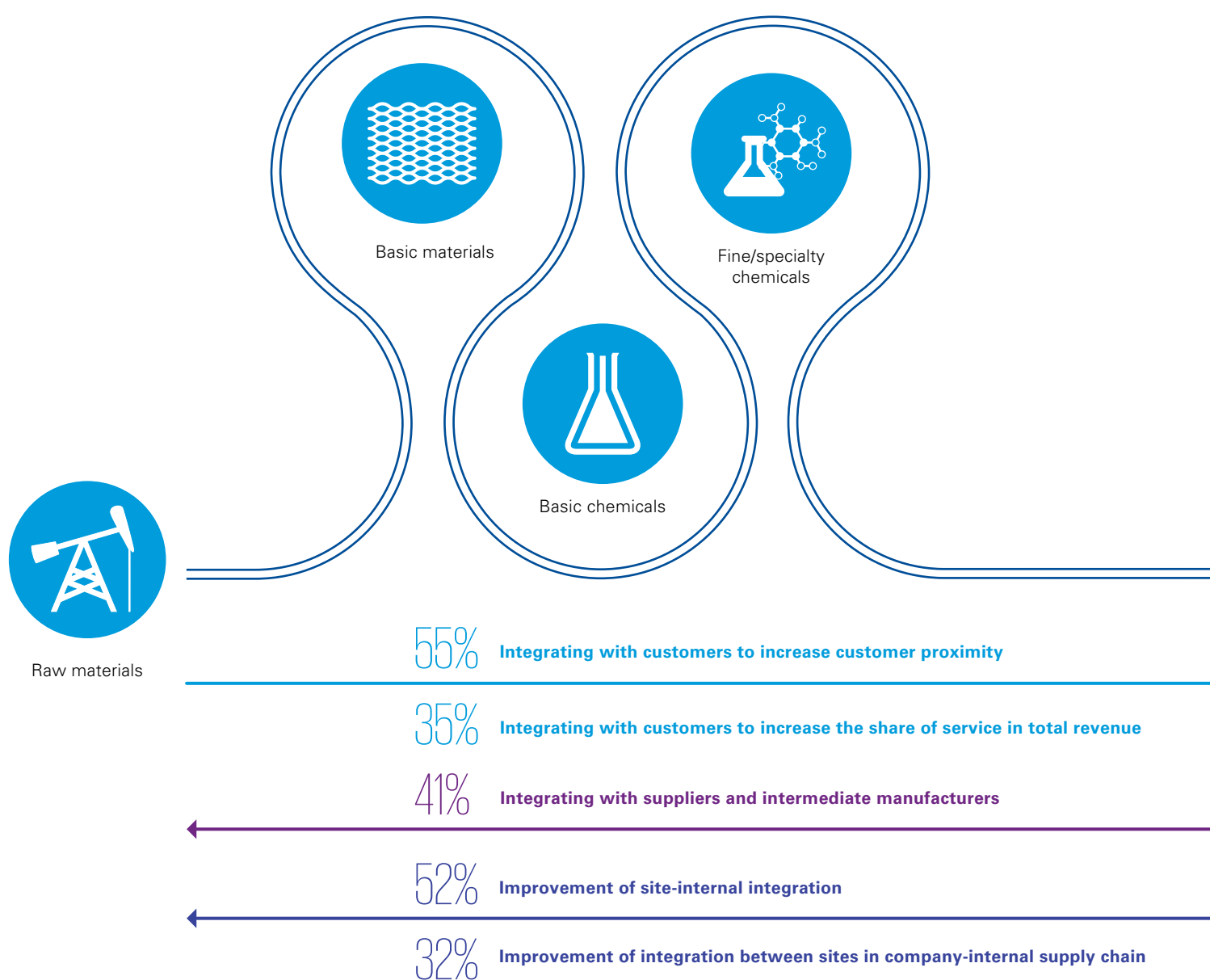
Creating a networked ecosystem

The boundaries between scientific disciplines and various technologies are disappearing. In the same way, the borders between different companies are becoming more fluid. For example, the automobile industry is increasingly pursuing innovations in areas like chemicals and software. The end result will be a comprehensive system, a so-called value creation network, a networked ecosystem.

Companies must identify connections along the value chain with other participants and develop powerful, standardized interfaces.

The focus of most companies should clearly be on networking in order to increase customer proximity. Site-internal networking also has a high priority in the chemical industry.

Fig. 8: The focus of digital networking along the value chain



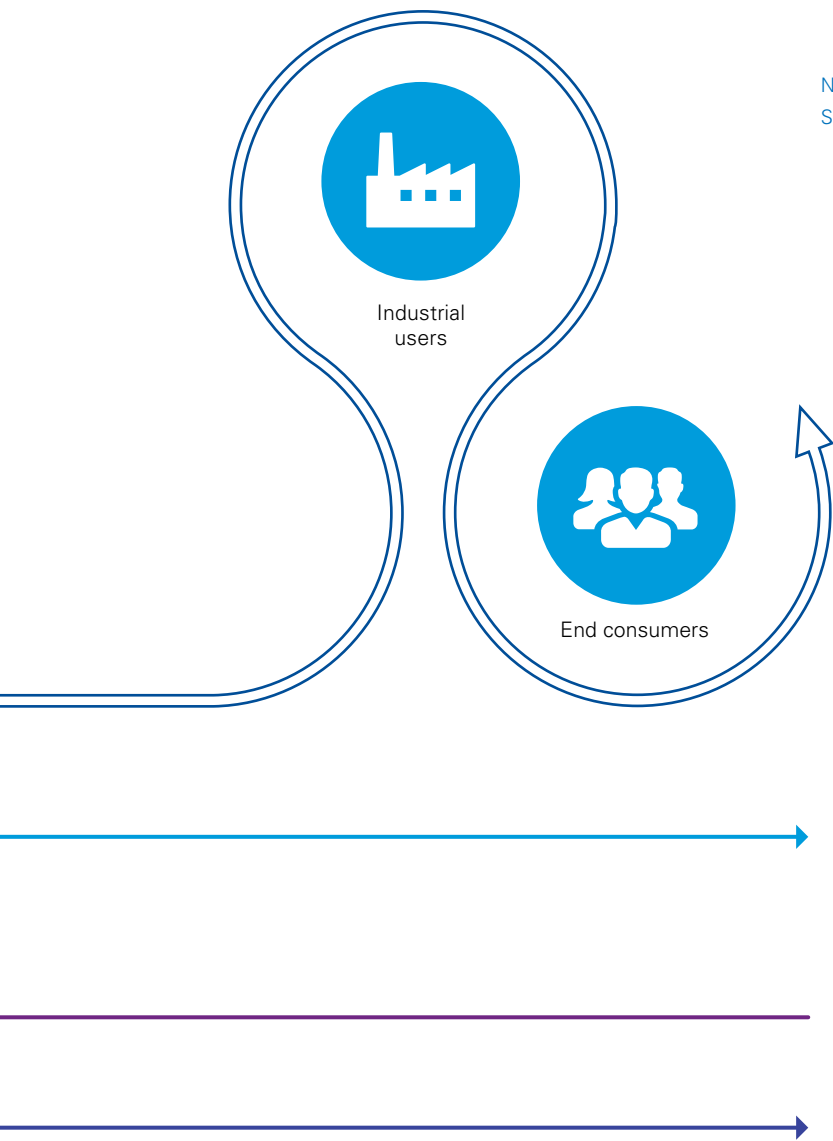
Data in percent, three-part answer
Source: KPMG, 2016

This allows the advantages of a physically connected location to be better coordinated and developed. Significantly fewer companies prioritize the possibility of closer connection with suppliers.

In order to create an ecosystem, they not only need the right strategy but also the right technologies and skills.

29% of surveyed companies anticipate extending their value chains; 15 percent are planning on shortening their value chains; 51 percent are not planning on changing their value chains over the next decade.

Not pictured: no data
Source: KPMG, 2016



Cultivate or perish



3. Mastering knowledge

>50%

of surveyed companies want to establish data and analytics as internal core competencies.

46%

are planning fully automated logistics across company boundaries over the next decade.

Using technologies

Technologies of the future

Plastic packaging made from algae, biodegradable? — International business groups are currently researching this topic. Whether it's algae or CO₂, alternative raw materials will be increasingly important in the future. Innovations are increasingly becoming a component of company strategy and philosophy.

The agendas of some chemical companies already include relevant topics such as fully automated logistics and the simulation of all business processes. Overall, however, a significant majority of surveyed companies does not consider any of the above-mentioned technologies to be relevant over the next decade — a significant contradiction.

The future will likely see new areas of innovation for the chemical industry such as robotics, additive manufacturing processes (3D printing), nanotechnology, genetic engineering, biotechnology and electromobility. In these areas, customer markets expect innovation for production, lightweight construction, safety and functionality.

Industry example: Simulation @ Work

With its project "Digital Plant," a major chemical company is pursuing the goal of creating a complete digital twin consisting of networked documents and a 3D model for every physical facility. This digital memory map spans the plant life cycle and helps in implementing new, digital processes using simulation technology. Digital process building blocks should then be tested in practice until the facility life cycle is integrated and the transformation has taken place. This is how the digital plant offers possible advantages with regard to alteration costs and on-time implementation.



Spotlight: nanotechnology ...

... and composites are defined as a combination of material science and materials technology in order to change the structure of materials at a molecular level. Future innovations will focus on the advantages conferred by their properties — including light weight, high strength, controllable light spectra and high chemical reactivity — compared with established materials.



Spotlight: Additive manufacturing processes ...

... will likely have a major impact on the chemical industry and its position in the industrial value chain in the medium-term. Classic 3D printing that works with physical processes will likely only play a role as process technology in the chemical industry in the long term — for example, when molecular 3D printing materials can be assembled to form chemical compounds on a molecular level using nanotechnology. However, chemical companies can already play an important role today as suppliers of printing materials.



Spotlight: Electric drives and energy storage media ...

... will turn the electromobility market into an important economic factor for Germany. Along with the automotive and supplier industries, the chemical industry will likely play a prominent role in the creation of a leading market. The central components of electromobility are batteries composed of specialty chemicals along with lightweight construction, which in turn requires composite materials in order to reduce weight.

Fig. 9: When will the following topics be relevant to your company?



Data in percent
Source: KPMG, 2016

● Already the case ● Later ● Don't know, no response
● In 10 years ● Never

“Digitalization and networking of industrial processes provide tools that — when used correctly — can create important market differentiation. For this purpose, the process steps and their associated technology must be mastered. If this results in a competitive advantage, companies should develop these elements into a key organizational capability and establish them as part of a digitalization strategy. This is the only way that relevant competencies can be designed, built and effectively implemented by qualified employees.”

Michael Bremicker,
Partner, KPMG in Germany

Building core competencies

Developing or purchasing core competencies

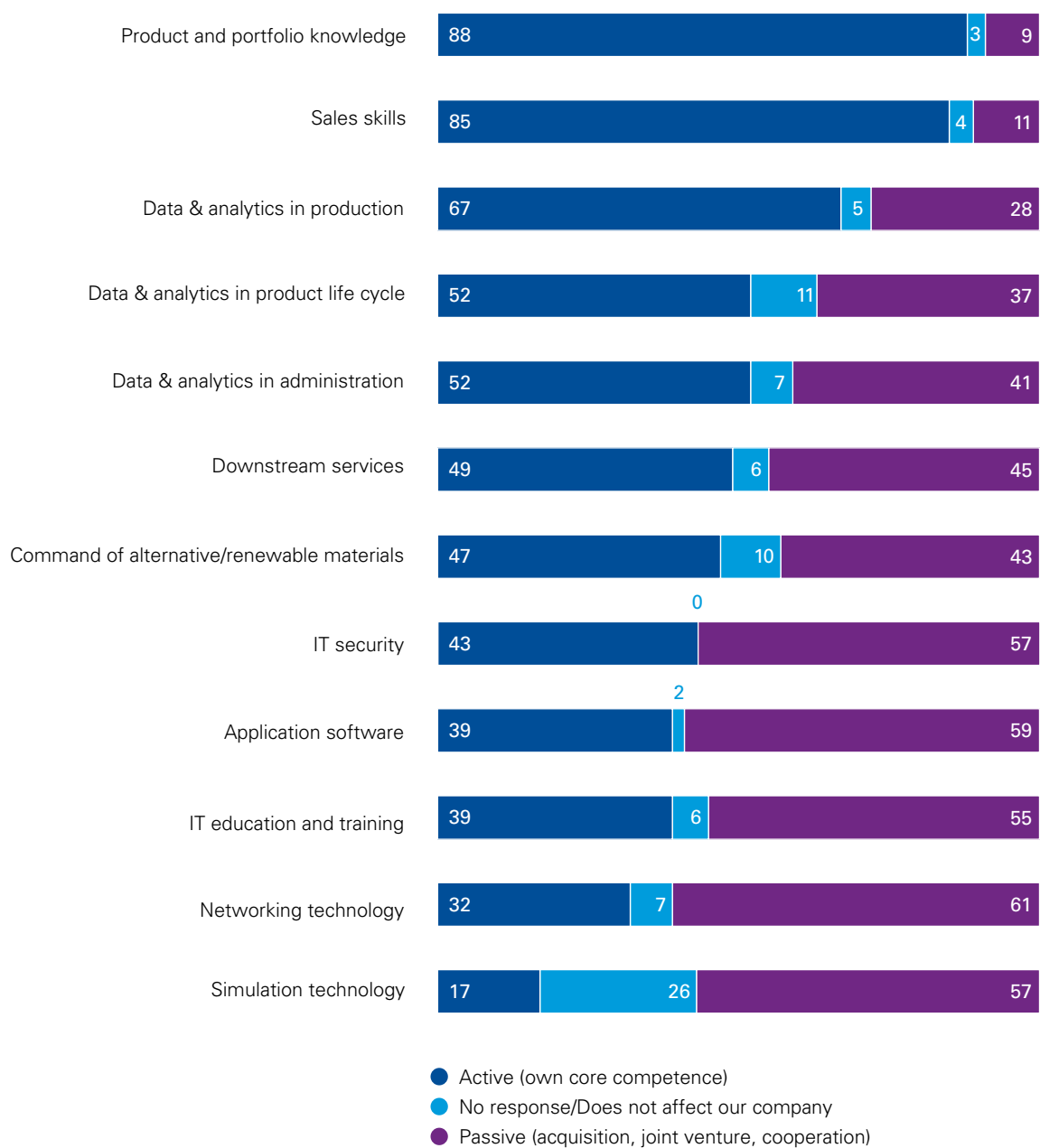
The company should consider the following at each of the defined interfaces in the value chain: what should we do ourselves, what should we source externally? For example, logistics and filling processes can be decoupled from the manufacturing process.

Most German chemical companies have already put time and resources into figuring out how to acquire the necessary skill sets. The most important are product and portfolio competencies as well as sales competence. Thereafter, new skills such as the efficient analysis of unstructured data (data and analytics) in production and administration follow.

There are several core competencies that the companies do not wish to actively pursue, which results in the risk of becoming dependent on third-party suppliers in crucial areas.

The varying levels of agreement within the areas suggests that some respondents fail to see connections between the above-mentioned areas of competencies: survey participants viewed product and portfolio competencies as important; however, many regarded simulation technology — that is, the ability to plan and simulate in virtual models (digital factory, digital twin) — as irrelevant.

Fig. 10: How do you intend to acquire core competencies in the following areas over the next ten years?



Data in percent
Source: KPMG, 2016

Big data — Big opportunities

Data analysis has previously been used primarily to react to past events. Analyzing data with regard to the future in order to predict when events might occur and what a company can do to prepare, is a new possibility.

Companies need to be aware of what data they currently possess. High data quality is also an important prerequisite for complex analysis. Available data also has to be managed and monitored; anyone in possession of a facility's data can, under the right conditions, reproduce the entire formulation. Administration and use can be controlled through intelligent data management.

Forward-looking data evaluation in the chemical industry has yet to become a common reality, though industries like the automobile industry and mechanical engineering are already a step ahead.

But at least the subject is starting to appear on the agenda: one major chemical company used analysis software to optimize the processes of a facility in the United States, which allowed them to save 36 million US dollars over 3 years. Another major chemical company reduced the error rate of its sales forecast from 40 percent to 10 percent by analyzing complex data sets.

The role of Chief Digital Officer (CDO) is becoming increasingly prominent with the development and implementation of digital company strategies. The goal of CDOs must be to generate measurable results. To this end, they oversee the merger of digital competencies within a company and its environment. This results in the creation of additional new positions, including that of data scientist, data analyst and data steward, who provide support to the CDO.¹

Fig. 11: The proactive development of in-house core competencies over the next decade in the area of data and analytics (see fig. 10).



Data in percent
Source: KPMG, 2016

¹ Source: KPMG International Cooperative, REACTION Magazine: 20th Edition, July 2016

Potential for the chemical industry

Intelligent production:

The real-time integration of data — from pumps or pressure gauges, for example — optimizes production, which increases margins and avoids waste. Problems in the production process can also be predicted and reaction times shortened.

Efficient pricing:

Instead of determining prices conventionally, current market information is included and used to continuously dynamically adapt prices. This is particularly important for a global industry like chemicals in order to offer optimal prices in all markets.

Quicker innovations:

Linking data from research, in-house laboratories and simulations reduces innovation cycles. In the development of polymers, suitable candidates are identified before the experimental phase using suitable properties such as melting point and molecular mass.

Source: KPMG International Cooperative, REACTION Magazine:
20th Edition, July 2016

“Today every company already uses a variety of data in its daily business. In our experience, however, the data’s efficiency is often rather lacking. Companies need a concept for using data to generate constant revenue growth, as well as gains in efficiency and innovation. This necessitates a clear strategy and structures to enable data to come together in an organized fashion, and to reinforce awareness that data is a resource, just like personnel, know-how, technology and capital.”

Oleg Brodski,
Partner, KPMG in Germany

"Cyber security is an integral part of the company's top management agenda. Cyber attacks, theft of data and other forms of digital economic crime are becoming increasingly sophisticated. Information security is not a purely technological concern or exclusively the realm of IT; in order to meet the external challenges of the future, a paradigm shift must take place throughout the company. In addition to company-specific technical solutions, it is crucial that every employee develop security awareness. Conscientious employees combined with tailor-made technology are the best protection."

Uwe Bernd-Striebeck,
Partner, KPMG in Germany

A question of security

Systems that are open for data exchange are often also open to cyber attacks. The proper handling of cyber security and attacks will be critical to an organization's sustainable success. A high level of awareness, sophisticated integrated networks and high data quality and security are key success factors.

An integrative cyber security concept brings together corporate executives, engineers and IT experts and covers the entire IT life cycle including analysis, planning, conception, implementation and monitoring. Successful companies initially integrate different IT and control systems in production, and then define access levels and interfaces.

43%

of surveyed companies wish to acquire their own core competencies in the area of IT security; 57 percent wish to acquire them passively.

100%

of chemical companies have already dealt with the subject of IT security.

Source: KPMG, 2016

Overcoming boundaries within companies



Source: KPMG International Cooperative, REACTION Magazine: 18th Edition, December 2015



Change
requires fresh
impulses

4. Designing the work environment

29%

of surveyed companies perceive a lack of technological acceptance within their own companies as one of the largest impediments to introducing new technology.

37%

More than one in three companies lacks the know-how to assess the potential of new technologies.

23%

of survey participants anticipate that complex knowledge and decision work will be replaced by artificial intelligence over the next decade.

Networking — life-long learning

Promoting acceptance — Organizing corporate culture

Three of the five largest obstacles to digital transformation are HR-related. That means that it is above all people who have to change. They have to accept and implement digital transformation — a cultural change is needed.

The commitment of employers, management and the workforce will be a decisive factor in digital transformation. Decision-makers are needed throughout the entire workforce to advance transformation.

Setting up the work environment

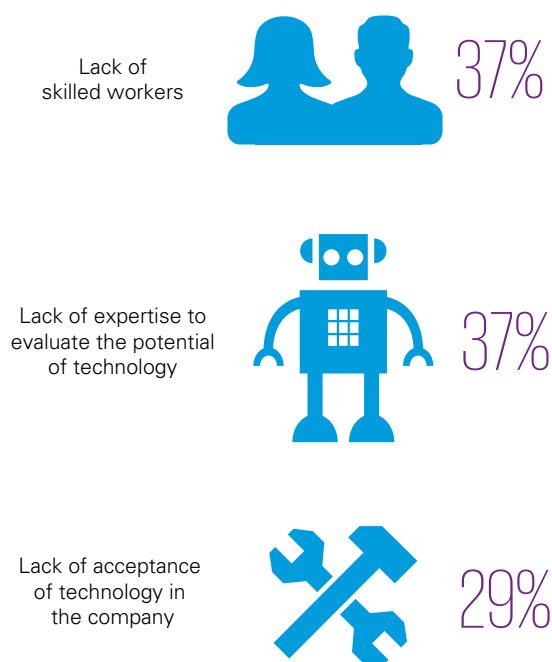
Today it remains uncertain whether digitalization will result in the loss or creation of jobs over the long term. The only thing that is certain is that most jobs will be fundamentally changed by digital transformation — from the office to the production site.



Spotlight: Virtual workplace

More adaptable models for working hours and the workplace are becoming increasingly important with respect to digitalization and the need to reconcile career and family. New technologies will be used to work more flexibly from places of residence. Virtual teams can be assembled for specific projects.

Fig. 12: The three most important HR-related impediments to digitalization



Data in percent, three-part answer
Source: KPMG, 2016

Industry example: Virtual workplace @ Merck

In 2015, Merck installed the digital work platform EVA (Expertise everywhere, Virtual teams, Access to information), replacing its intranet. 40,000 employees with access can use virtual spaces which model organizations, projects, topics, processes or locations to collaborate and exchange knowledge. EVA is intended to promote creative solutions and new methods at Merck, which enable work time and location to be determined freely.

Source: Merck KGaA, (press release, 11.6.2015)

28%

of surveyed companies expect robots to take over dangerous routine tasks from humans within the coming decade.

Source: KPMG, 2016

20%

of surveyed companies anticipate that complex knowledge and decision work will be replaced by artificial intelligence over the next decade. 3 percent of participants believe that this could happen today.

Source: KPMG, 2016



Spotlight: Robotics

The transformation of stationary industrial robots into autonomous mobile robots in particular will promote cooperation between man and machine. Robots can act as a “third arm” and perform tasks even in hazardous situations. In the medium-term, perceptually-driven, mobile robots will take over intralogistics in chemical complexes.

26%

of surveyed companies expect that VR and AR will become an integral part of the working world within the coming decade.

Source: KPMG, 2016



Spotlight: VR/AR

Virtual and augmented reality are becoming an increasingly integral part of the working world, for example in training and for performing tasks where every step can be displayed live.

A training scenario from the German Trade Association for Raw Materials and the Chemical Industry (Berufsgenossenschaft Rohstoffe und chemische Industrie — BG RCI) on filling flammable materials shows how safe training sessions can be carried out in the chemical industry. Virtual reality thus opens up entirely new possibilities for training instructors. Workspaces can be realistically modeled and certain processes can be demonstrated and trained without risk.



Spotlight: Creative assistants

Knowledge-based systems and artificial intelligence learn to recognize patterns in unstructured data. Using artificial neural networks (structures modeled on the brain) they can train themselves and become more intelligent over time — the machines are learning.

Knowledge-based systems can be used to determine the optimal control state for a production operation. Sensor data provides information on current states which a previously trained network can use to make predictions about potential future states. Image and pattern recognition from sensor data on materials can be used to make estimates on material states. This can also be done by comparing the simulations of optimally running production. In the future, knowledge-based systems and artificial intelligence will not only be able to provide support but also design processes creatively and independently.

Industry example: Work of the future @ Work

In order to realize the potential of Industry 4.0, a major chemical company installed an Industry 4.0 education pyramid for training its large staff for digital transformation. Since most companies view unmanned factories as unlikely in the next five to ten years, particular focus is being placed on intelligent assistance systems.

“The specialist public remains undecided as to whether additive production processes represent a disruptive technology, an important aspect of Industry 4.0 and/or just hype. In my view these are largely academic questions: the changes that are gaining momentum across all sectors are already apparent. Too little thought is given to training and education preparing people for these new technologies. Their use can only be economically viable with a change of thinking in marketing, design and production. The foundations for these changes must be laid now.”

Prof. Dr.-Ing. Burghilde Wieneke-Toutaoui,
Chairman of the VDI regional association
Berlin-Brandenburg, President of the
Technical University of Brandenburg

New qualification profiles

Trust in systems continues to increase. There are fewer standardized tasks, as tasks become increasingly digitally supported or entirely replaceable. Employees are being given more responsibility as their tasks increasingly entail planning or controlling.

New skill sets and job profiles will be needed, such as mathematicians for generating algorithms. At the same time, human intelligence and creativity will become increasingly relevant. A technology company defined 25 skill sets which are particularly crucial and must be more strongly communicated in the future. These include cloud computing, project management, media competence and robotics. Not all skills set will become increasingly more important; but they will be more pronounced.

For the chemical industry, the greatest challenges include moving beyond silo thinking and expanding qualifications. Only a process engineer who understands the possibilities and requirements of computer science can create the proper conditions for automation. The same applies to computer scientists.

Newly established markets also need new qualification profiles and material know-how for generative production.

Industry example: Future careers @ Dow

As part of the American equivalent of Industry 4.0 (Advanced Manufacturing Partnership 2.0), the Dow Chemical Company has been implementing a three-year training program at several locations in the United States since 2015. According to Dow, the program aims to qualify the next generation in the advanced manufacturing technology of tomorrow. Dow is working with several educational institutions with the intention of combining teaching and practical experience.

Source: The Dow Chemical Company (press release 10/06/2014)



Interview with Ralf Detmer, Workplace Strategy Manager for Bayer Business Services GmbH

How are you designing the eWorkplace of tomorrow?

In order to create the workplace of tomorrow, we've implemented the "one size fits all" approach. Our future goal is to create a user-oriented workplace while at the same time keeping costs stable and security standards high. To this end, we divided the workforce into groups and analyzed them accordingly: What tasks need to be accomplished? What do they need? Which applications do they need? That's why, for example, the R&D group has different requirements than other areas in the company with regard to collaboration with internal and external research groups and the related exchange of data. An additional approach takes age-specific requirements into account. We call this the "four generation topic." Different age groups have different requirements of their workplace. This applies to both the selection of tools and the need for mobility. Both are important factors in attracting new talent. Our goal is to support these various needs as best we can, without getting too far away from the standard. This approach aims to create transparency and acceptance. Technology should no longer create work; it should make life easier.

How do you consider new qualification profiles for employees?

Today there are new job profiles which did not even have a name 5 years ago, let alone any training. The user-oriented workplace of the future is not purely confined to technologies. We have to start asking questions about the qualification profiles of the future today: how will the workforce and job structure look in ten years? Where will we work? What will be required in the future? These questions can only be successfully answered when collaboration between HR, IT, Real Estate and other company functions is successful.

What do you consider to be the success factors for a successful transformation?

The main condition for transformation is innovation-oriented management. All strategic initiatives of this kind require the active support of management. Additional essential components are cultural transformation throughout the company and the proper communication. Software and technology are usually interchangeable and their implementation is largely professionalized. The willingness to make changes in a company remains a challenge. Everyone is needed here because more opportunities also mean more responsibility for every individual in a company.



Transformation needed to bloom

5. Seizing opportunities

Strategic positioning

Digitalization and Industry 4.0 open the door for several potential success models, all of which can be sustainably developed in parallel. Companies must consciously determine future positioning with respect to every target group and acquire the necessary core competencies. It is time to act. Four strategic positionings are listed below.



Networked company

These companies focus on individual process steps and/or activities such as R&D, manufacturing and/or distribution.

Networks are created on a project basis and are then dissolved after the projects are completed (long-term deliveries are relocated). The aim here is to identify high-margin product needs and offer appropriate solutions. The project portfolio is then managed decentrally.

The core skill sets lie not only in close cooperation within the Group, but also with customers and potentially with competitors from other categories. The open exchange of data, close customer contact and continuous development are key to this positioning.



Intangible pure player

This positioning places a strong, if not exclusive, focus on direct customer contact and identifying gaps in the service portfolio of other categories. This could also be expressed by companies being prepared to assume risks that others cannot or do not wish to assume (e.g. in niche markets).

The core competencies include the ability to create and operate the B2C and B2B platforms and networks (e.g. Amazon, Alibaba or Europages) — and of course collecting and evaluating relevant market data. In order to ensure a successful and above all structured implementation, these organizations are often centrally managed.



Value chain expert

The customers of value chain experts are among the largest companies in the world. They can offer and deliver a standardized product pallet at any time, in any quantity and anywhere in the world. Many products are also offered as services (e.g. automotive paints).

The core competence of these companies is their centrally controlled portfolio management. The competitive advantage offered here is both deep insight into global value chains and their end markets as well as correspondingly fast-reacting control mechanisms.



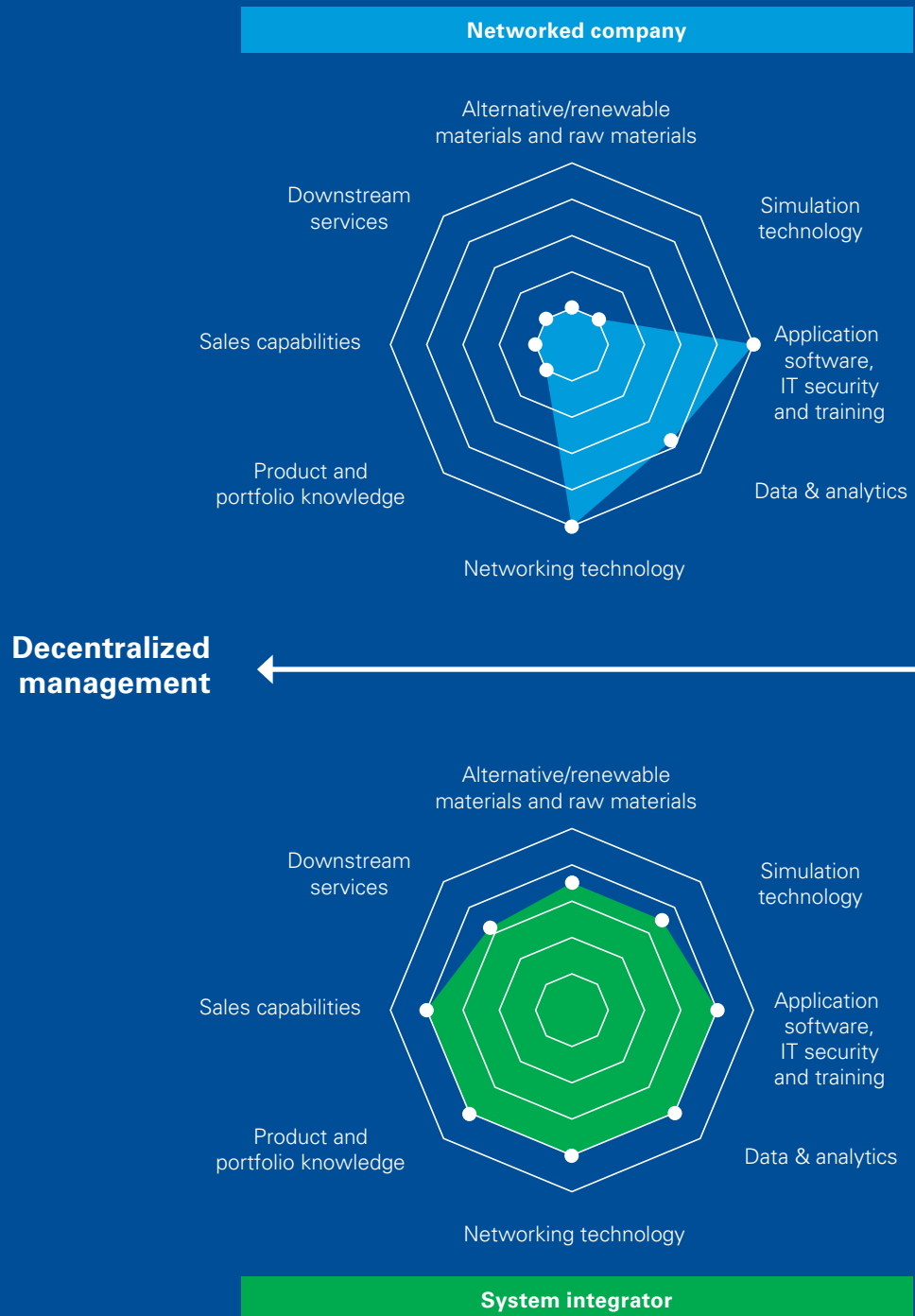
System integrator

The system integrator primarily offers its products either as packages and/or as services connected to other technologies and resources. The end markets are generally very large but the end customer structure is often very fragmented (e.g. agriculture).

Products and services are tailored to customer-specific requirements. System integrators often have a long-term relationship with their customers. Confidential collaboration with external cooperation partners is necessary (e.g. agrochemicals). These companies are for this reason decentrally managed, often according to customer segments.

Strategic positioning and competencies

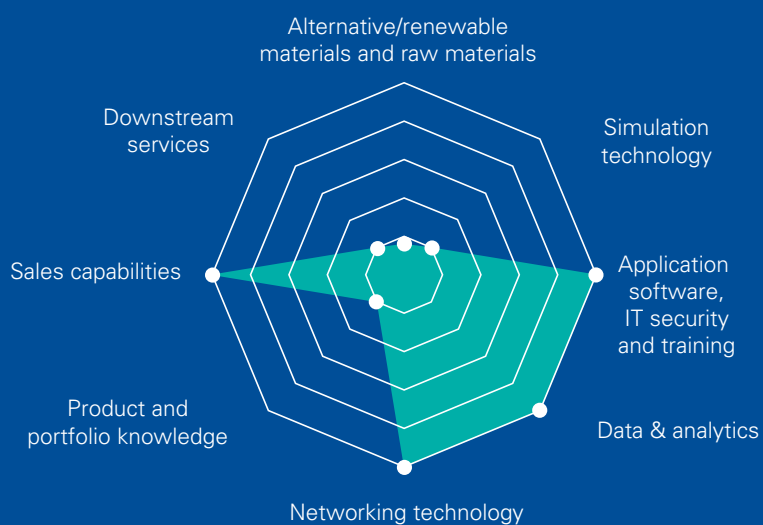
Future core competencies



Source: KPMG, 2016

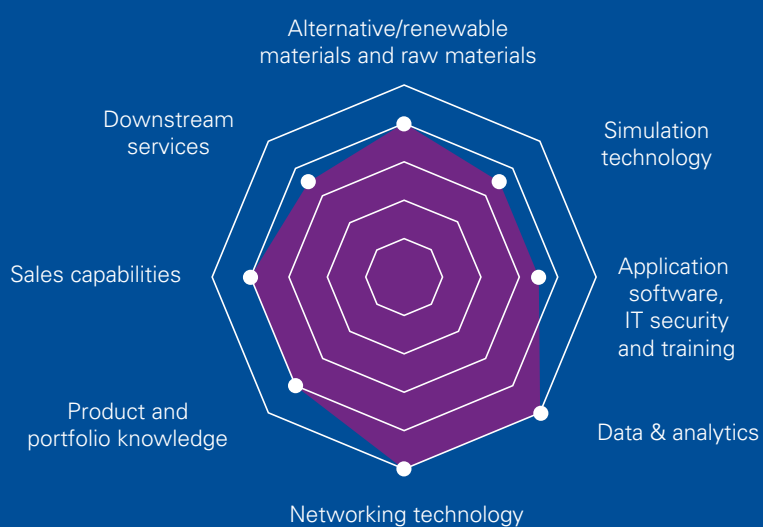
Focused on individual steps in the value chain

Intangible pure player



Centralized management

Covers the entire value chain



Value chain expert

"It's important that companies today get involved in pilot programs and learn how to apply strategies to their own companies. They have to acquire know-how in several new areas, including advanced data analysis, knowledge-based systems and robotics, and to closely consider, evaluate and understand information. You must decide individually which advantages digital transformation can bring to your own company. The important thing is to get started now."

Prof. Dr.-Ing. Stephan Schäfer,
University of Applied Sciences, Berlin

Foundations for success

The question which now arises is: How should management proceed in order to sustainably transform its company?

Processes must be identified that can be **1) standardized** in order to **2) digitalize them**, so they can ultimately be **3) automated**.

It is crucial that companies get an overview of current industry-specific solutions as soon as possible while at the same time getting involved in the joint development of scientific platforms for experiments (testbeds).

This is the only way to ensure sustainable, quick and financially viable development, especially for smaller companies. It is particularly important for chemical companies to get in contact with developers and manufacturers of pilot plants.

Depending on the company's requirements, the following steps should accompany the transformation process:

- 1. Analysis and optimization of previous digital initiatives along the core business**
- 2. Expansion of existing core business through new individualized products and services**
- 3. Creation of a technology platform which can be used by suppliers, customers and other partners to develop new products and services**
- 4. Development of a networked ecosystem into a dynamic value chain**
- 5. Involvement of employees from all hierarchical levels**

Checklist for the future

☒ I am ready for transformation.

My company already has a high degree of digital maturity. I have already digitized and automated processes at my company.

- ☐ The degree of digitalization and automation (including outside of production) at my company have increased.
- ☐ I have integrated new technologies into my existing processes.
- ☐ I have identified the risks to which my company is exposed through digital transformation.
- ☐ I have already implemented concrete change processes.

My company has expanded existing value creation into digital business models.

- ☐ I know what potential new business models looks like for my company.
- ☐ I am currently changing my products and processes accordingly.
- ☐ I have created systems and structures to ensure the secure transfer of data onto the Cloud.
- ☐ I know how the digital redesign of my business model impacts my IT landscape.
- ☐ I have developed measures to help my company meet the increased requirements of IT compliance and IT security.
- ☐ I have clarified the future role of the governance function in supporting the new business model.

A technology platform has been successfully built and positioned on the market.

- ☐ I have identified the data and processes in my company which are of interest to other service providers.
- ☐ I have set up a digital platform so that data and processes can be successfully used for economic benefit.
- ☐ I have found solutions which help me gain a high degree of traction for my platform while maintaining risk and compliance requirements.
- ☐ I have developed an approach that makes my platform attractive for new players in my industry.
- ☐ I have identified the regulatory and organizational conditions which make my platform successful.

Based on the current business model, my company has created a new ecosystem.

- ☐ I have developed a future portfolio strategy based on new business models for my company.
- ☐ I have identified targets or potential cooperation partners including start-ups, with which I can expand or have already expanded my company's portfolio.
- ☐ I have created a plan to build a sustainable corporate structure.
- ☐ I have successfully combined new business models with my previous business model and monitor it on a regular basis.
- ☐ I can optimally employ the digital ecosystem for my company.

Management has adapted to the process and open communication is maintained with employees.

- ☐ I have identified the requirements profiles for the workstations and employees.
- ☐ I have created future scenarios for the workforce with regard to their workplaces, their working hours and possibilities for collaboration.
- ☐ I have begun initial pilot projects.

Methodology

The study “Time to bloom — digital transformation of the chemical industry” provides a comprehensive picture of the changes to customers, business relationships and value chains through major technological innovations and the increasing digitalization of the economic environment.

To this end, between April and May 2016 KPMG and TNS Emnid anonymously interviewed a total of 151 managing directors, owners, CEOs and department heads from all over Germany for their view of digital transformation in the processing trade — 75 from the chemical industry and 76 from the manufacturing industry.

They included 31 companies with revenue of over EUR1 billion, 43 companies with revenue between EUR500 million and EUR1 billion and 68 companies with revenue of less than EUR500 million.

The aim of this survey was to provide an overview of the effects of digitalization on the chemical industry, the advantages it offers to the individual companies and how the industry is responding to pressure for innovation.

In addition to the survey of experts from KPMG’s international network, an internet and literature analysis was conducted to shed light on trends and their effects, including robotics, digitalization and technological developments in the business model, the labor market and economic policy framework conditions. The results of the studies were compared with the findings from the expert interviews, various statements were weighed against one another and subsequently explained in digital workshops. The overall outcome of this process is reflected in particular in the development of activities and working conditions.

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