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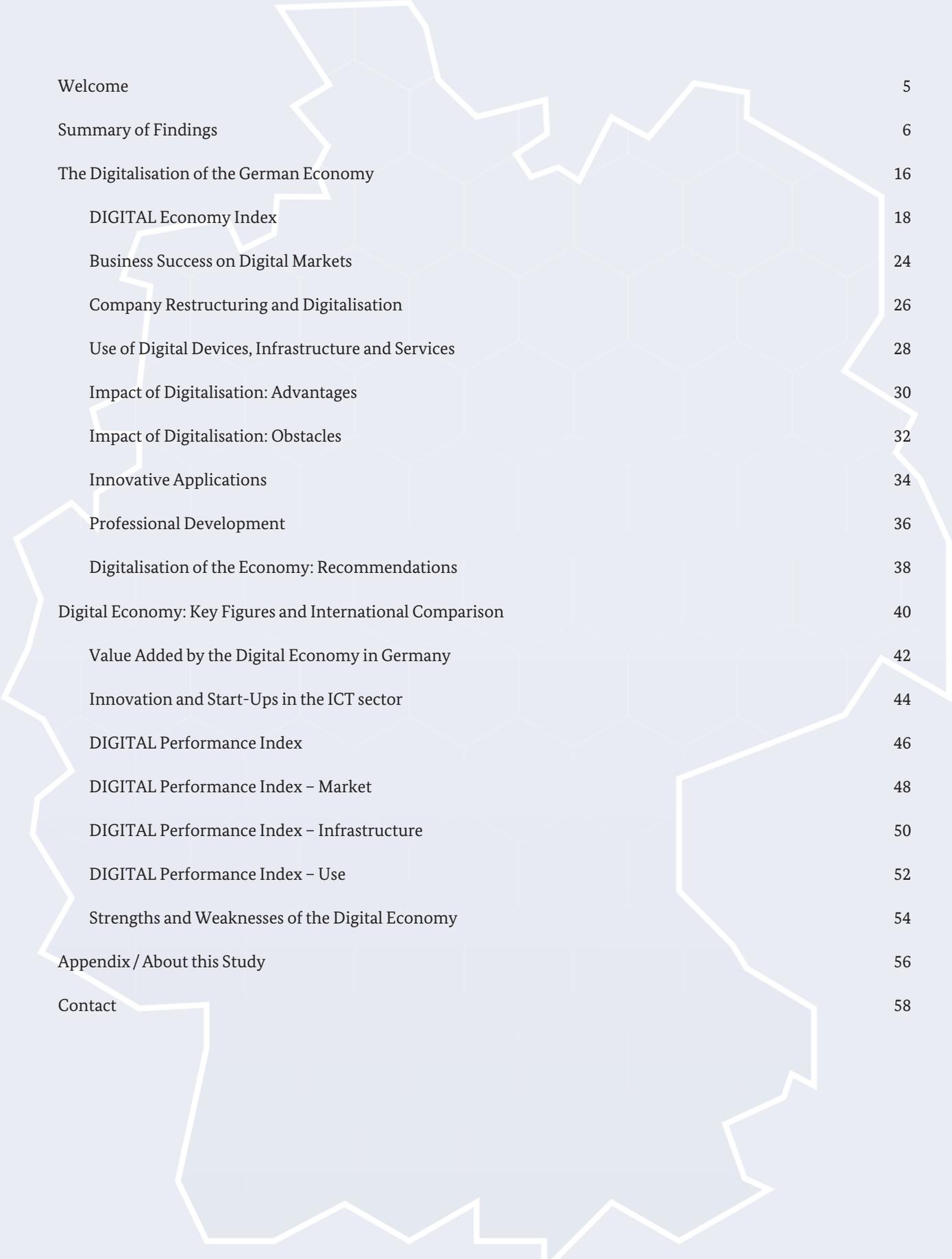
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Contents



Welcome	5
Summary of Findings	6
The Digitalisation of the German Economy	16
DIGITAL Economy Index	18
Business Success on Digital Markets	24
Company Restructuring and Digitalisation	26
Use of Digital Devices, Infrastructure and Services	28
Impact of Digitalisation: Advantages	30
Impact of Digitalisation: Obstacles	32
Innovative Applications	34
Professional Development	36
Digitalisation of the Economy: Recommendations	38
Digital Economy: Key Figures and International Comparison	40
Value Added by the Digital Economy in Germany	42
Innovation and Start-Ups in the ICT sector	44
DIGITAL Performance Index	46
DIGITAL Performance Index – Market	48
DIGITAL Performance Index – Infrastructure	50
DIGITAL Performance Index – Use	52
Strengths and Weaknesses of the Digital Economy	54
Appendix / About this Study	56
Contact	58

Welcome

The digital transformation is of great significance to Germany as a business location. The Monitoring Report DIGITAL Economy 2016 shows us the progress of digitalisation in Germany. It provides a solid information base for identifying areas of action for the public and private sector.

For the second time, the DIGITAL Economy Index measured the digitalisation of the German commercial economy by sector. The representative company survey shows that we have made good progress in digitalisation compared with the previous year. It has a greater impact on business success. The digital penetration of internal processes and workflows as well as the intensity of use of digital technologies in companies have also increased.

Our initial analysis of digitalisation by company size revealed significant room for improvement in the Mittelstand. Germany can only remain sustainable and successful if mid-sized companies in particular take advantage of the opportunities and face the challenges of digitalisation. This confirms how important it is that we support small and mid-sized companies with user-oriented guidelines, best practice case studies and networking events as part of our “Mittelstand Digital” initiative. We are also setting up eleven “Mittelstand 4.0” competence centres across Germany to offer companies reference material and hands-on examples of specific digital applications.

The digital economy is a significant sector. It is driving forward digitalisation in companies. Its potential lies in the interaction between the internet economy and the traditional information and communications technology sector. The DIGITAL Performance Index is unique because it measures the strength and economic significance of the digital economy compared with other countries. It places the German digital economy in the middle of the pack against the United States and eight other selected European and Asian countries. There is room for improvement in greater internationalisation and an export focus in particular.



To strengthen the digital economy, we must promote emerging growth areas, the intelligent networking of key infrastructure sectors and ensure a high level of IT security. Our 2025 digital strategy focuses on high-speed broadband coverage, the creation of a transparent regulatory framework for investment and innovation, as well as support for young entrepreneurs.

I would like to thank all of the experts who contributed to this monitoring report in workshops and meetings. I am confident that we will agree on further steps to drive forward economic digitalisation together with all stakeholders from politics, business and society at the 2016 National IT Summit in Saarbrücken.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'Machnig', written in a cursive style.

Matthias Machnig

State Secretary of the Federal Ministry for Economic Affairs and Energy

Summary of Findings

Points
55

Digitalisation of the economy increased compared to 2016

27%

of the commercial companies are „highly digital“

Points
39

Low digitalisation of manufacturing sector in 2016

Place
6th

German digital economy performance ranked 6th out of ten countries

€ **223** billion
revenue
generated by the
ICT sector

€ **111** billion
revenue
generated by the
internet
economy

Management Summary

The **digitalisation of the commercial economy** is gaining momentum. According to the 2016 DIGITAL Economy Index, the level of digitalisation has risen by six points compared with the previous year to 55 out of a possible 100 points. This will reach 58 index points by 2021. At 57 index points, service providers are much more digital in 2016 than the manufacturing sector, which comes in at 39 index points. Twenty-seven percent of commercial companies have a “high” level of digitalisation, 49 percent are “average” and 24 percent are classed as “low”.

Small companies are more digital than large companies as a result of their size and number of employees. The level of digitalisation in the German Mittelstand is five index points below the 2016 DIGITAL Economy Index.

The digital transformation is and will continue to be driven by the highly digital ICT sector. This is also true for knowledge-based service providers, who are expected to outpace even the ICT sector by 2021. Seven sectors have an average level of digitalisation, led by the financial and insurance sector ahead of retail and energy and water supply. Mechanical engineering, the chemical and pharmaceutical industry, transport and logistics are in the middle of the pack alongside the automotive industry. Healthcare and other manufacturing sectors are below average in terms of digitalisation.

The commercial economy has recorded strong growth on the digital markets. Forty-seven percent (2015: 34 percent) of internal processes and workflows are highly digital. Investment in digitalisation will also continue to increase between now and 2021. Forty-three percent of commercial companies (2015: 27 percent) generate the majority (>60 percent) of their revenue through digital channels in 2016. The use of digital devices and infrastructure remains at a high level. In contrast, there is significant ground to be made up in the use of digital services.

Digitalisation is significantly influenced by employees’ digital expertise. A good third of companies in the German commercial economy believe that training on digital issues is very important to the company. Data security is top priority for 83 percent of companies.

Germany’s digital economy. The information and communications technology (ICT) sector and the internet economy – was ranked sixth out of ten countries with 53 of a possible 100 points by the international 2016 DIGITAL Performance Index.

This average performance of the German digital economy is primarily attributable to export weaknesses in the ICT sector and low level of investment in information and communication technology. Germany’s sixth place ranking also reflects its technical and economic environment despite an above-average performance in individual areas. The intensity of use of new digital technologies and services is high in the private sector but underdeveloped in the public sector. Private use of digital products and services is high in some cases only. Overall, this was still only enough for sixth place.

The German ICT sector generated revenue of € 223 billion in 2015, making it the fifth largest market after the USA, China, Japan and the UK. It accounts for 4.7 percent of commercial value added, ahead of mechanical engineering and behind transport and logistics, with gross value added of € 99 billion. Revenue generated by the German internet economy continues to grow. At € 111 billion or € 1,379 per capita, it is ranked fifth in the world.

The German digital economy enjoys clear competitive advantages such as market access, strong demand and the links between ICT and other areas of the economy. Its three greatest weaknesses are the shortage of skilled workers, the network infrastructure as well as the slow response of regulatory bodies to new digital requirements. Existing strengths can be expanded by focusing on promoting innovative applications such as the internet of things and smart services. Robotics, sensor technology and big data should be second priority.

The key **policy demands** of the commercial economy mainly relate to the expansion of broadband coverage and the timely adaptation of the regulatory framework. Government funding is needed to digitalise the Mittelstand.

Digital Economy – Paving the Way for Digitalisation

Summary of Findings

The digital transformation will be a key driver of sustainable growth and prosperity in the medium and long term. However, translating the theory and practice of digital transformation into individual steps from a conceptual, strategic and political point of view has proved difficult. The 2016 DIGITAL Economy Monitoring Report produced by TNS Infratest in cooperation with ZEW Mannheim aims to address this.

Based on a representative survey of German companies, we measured the digital penetration of the commercial economy as a whole and its individual sectors and how this is expected to develop between now and 2021. In addition, we analysed the positive effects of digitalisation on companies as well as obstacles to digitalisation. The monitoring report also looks at digital skills training in commercial enterprises. We defined the most important opportunities and challenges of digitalisation based on the results. Our findings were fleshed out in an expert workshop.

The digital economy is a significant sector and is driving forward digitalisation in companies. A secondary analysis and survey of international experts were conducted to compare the performance of this sector in Germany with other countries and to identify the unique strengths and weaknesses of the German digital economy. We also calculated the value added generated by the digital economy – the ICT sector and the internet economy – for the German economy.

I The digitalisation of the German commercial economy between 2016 and 2021

Digitalisation is progressing at a fast pace. In the 2016 DIGITAL Economy Index – which measures digital penetration in the commercial economy – Germany achieved 55 of a possible 100 index points, up six index points on the previous year. Based on the outlook of the companies surveyed, Germany is expected to reach 58 points in five years.

Over one-quarter of commercial companies “highly digital”. Twenty-seven percent of commercial companies have a “high” level of digitalisation (70 index points and over). Forty-nine percent are “average” (between 40 and 69 index points) and 24 percent are

“low” (less than 40 index points). However, 25 percent of companies in the commercial economy do not believe that digitalisation is necessary.

Service companies are driving forward digitalisation. In the services sector, the DIGITAL Economy Index rose by six points year-on-year to 57 index points. Twenty-nine percent of service companies are “highly digital”, 52 percent are classed as “average” and 19 percent as “low”. Sixty-two percent of the smallest companies have an “above average” level of digitalisation. The DIGITAL Economy Index will rise to 61 points by 2021.

Manufacturing less digitalised than the services sector. The manufacturing sector is less digital than the services sector and is 18 points behind at 39 index points. It is expected to level off at 38 index points by 2021. However, this does not mean that the manufacturing sector will not make any progress in digitalisation. The level of digitalisation among large companies in this sector is expected to rise by four to 54 index points between 2016 and 2021. The Mittelstand will also increase by two index points to 45 points. According to the outlook of the companies surveyed, the level of digitalisation at small businesses is expected to decline from 38 points to 36 index points. This lowers the index as a whole, since small businesses account for by far the largest share of the manufacturing sector and are weighted accordingly in the overall index.

High level of digitalisation in large companies and small businesses; room for improvement in the Mittelstand.

The level of digitalisation in large companies (> 250 employees) was 53 points in 2016 and will increase to 56 points by 2021. Mid-sized companies (10 – 249 employees) reached 50 index points, five points below the 2016 DIGITAL Economy Index. This is expected to stagnate and fall further behind the commercial economy as a whole by 2021 (58 points). At 55 points, the smallest companies (0 – 9 employees) have the highest level of digitalisation. Small businesses will also be the most digital in 2021, at 59 points. Compared with larger companies, it is easier for small businesses to go digital or to generate a considerable proportion of their revenue via digital channels. Small businesses turned in the best performance based on the 13 criteria used to calculate the index.

Digitalisation varies greatly by sector. Digital pioneers making fast progress – late adopters stagnating. The level and speed of digitalisation varied significantly in the sectors observed:

▶ **High level of digitalisation** (70 index points and over): the ICT (information and communications technology) sector is a digital pioneer and at 75 points, clearly exceeds the 2016 DIGITAL Economy Index as a whole (55 points). Knowledge-based service providers are also highly digital (70 points). In 2016, there was not a single company with a low level of digitalisation in this sector. Knowledge-based service providers are set to reach 79 points by 2021, exceeding even the ICT economy (77 points).

▶ Seven of the eleven core sectors analysed were classed as having an **average level of digitalisation** (40–69 index points). At 61 points (2021: 64 points), the finance and insurance sector came in third. Retail ranked fourth both in 2016 and 2021 with 55 points (2021: 58), well ahead of energy and water supply with 48 points (2021: 52 points) in fifth place. It was followed by mechanical engineering in sixth place with 46 points (2021: 47 points). The chemical and pharmaceutical industry took seventh place with 45 points and is expected to fall to eighth place in 2021 with a flat index ranking of 45 points. At 43 points, the transport and logistics sector was ranked eighth in 2016 but will improve to seventh with 47 index points in 2021 as a result of strong growth. The automotive industry is and will remain in ninth place with 40 points in both 2016 and 2021.

▶ Two sectors of the commercial economy are and will continue to be characterised by a **low level of digitalisation** (less than 40 points). Healthcare will remain in tenth place despite improving from 35 points in 2016 to 38 points in 2021. Other manufacturing is last, ranked eleventh with an unchanged 35 points.

Digitalisation must be sped up. Higher levels and a faster pace of digitalisation can be achieved by:

1. Digitalising business activities and introducing new business models;
2. Creating internal company processes, resources and infrastructure that promote digitalisation;
3. Making greater use of digital devices, services and infrastructure.

Digitalisation has a greater influence on business success than in the previous year. Share of digitally generated revenue is significantly higher. Eighty-five percent (2015: 80 percent) of companies in the commercial economy believe that digitalisation is important overall. Ninety percent (2015: 88 percent) are satisfied on the whole with the level achieved. Digitalisation made a much greater contribution to business success than in the previous year. Forty-three percent of commercial enterprises (2015: 27 percent) generate the majority of their revenue through digital channels. While the share of digital products and services in the commercial economy and among service companies is at least 60 percent, the figure for the manufacturing sector is 25 percent, probably due not least to the higher share of physical components of products. Twenty-eight percent of the companies surveyed said that digitalisation made a “very strong” contribution to business success, a slight increase of two percentage points compared with the previous year.

The commercial economy as a whole rose by six to 52 index points (2015: 46 points) on the digital activity index. The services sector scored 54 points (2015: 48 points) for its digital share, well above the manufacturing sector at 38 points (previous year: 35 points).

Significant improvement in pro-digital corporate culture, including processes, value chains, investment in digitalisation as well as its integration into the corporate strategy. Forty-seven percent (2015: 34 percent) of commercial companies have highly digital internal processes and workflows. Forty-nine percent of companies are highly integrated and every fifth (20 percent) has extremely high value chain integration. In contrast, 21 percent are “not very” integrated. Seventy percent (2015: 64 percent) of companies have integrated digitalisation into their corporate strategies. There is not expected to be any significant change to this figure between now and 2021. In 2016, 30 percent (2015: 25 percent) of commercial enterprises invested more than 10 percent of total revenue in digitalisation. Spending also increased in other investment categories, although 7 percent (2015: 10 percent) of companies did not invest in digitalisation at all in 2016. This will fall to 4 percent by 2021.

The index for pro-digital culture came to 47 points in 2016 (previous year: 37 points). This increase of 10 index points represents the strongest improvement across all three core areas of digitalisation and testifies to the progress made by companies through reorganisation. The services sector achieved 49 index points (previous year: 38 points), while the manufacturing sector recorded 35 points (previous year: 29 points).

Stationary digital devices are still the most common. Digital infrastructure is still in its infancy; intensity of use has not increased compared with the previous year.

On average, 72 percent of permanent employees in the commercial economy use stationary devices and 31 percent use mobile technology. Sixty-three percent use digital infrastructure such as an intranet or the internet. In contrast, only just under one-quarter access digital services such as cloud computing, big data applications, messenger services or unified communications for business purposes. As in the previous year, the index measuring digital use came to 65 points. The manufacturing sector achieved 43 points (previous year: 48 points) compared with 69 points (previous year: 68 points) in the services sector.

How do companies benefit from digitalisation? What is hampering progress? We asked commercial enterprises what effect digitalisation has had on them. Respondents judged eight different advantages and eight different obstacles. Overall, the positive effects were ranked much higher than the disadvantages.

Advantages of digitalisation. Eighty-four percent of companies in the commercial economy saw improved cooperation with external partners and 80 percent the increased efficiency of internal processes as the two greatest advantages of digitalisation for their company. Three-quarters of respondents reported clear increases in growth. Seventy-one percent of companies observed increased innovation as a result of digitalisation. Another advantage was that digitalisation provides direct access to end consumers (67 percent). Sixty-two percent of respondents said that digitalisation had an extremely positive impact on the development of new business models. The majority of commercial enterprises – 43 percent – believed that their business was not affected by new competitors.

Obstacles to digitalisation. The greatest obstacle to digitalisation for the commercial economy was inadequate broadband coverage (40 percent). At 38 percent, the second largest obstacle was the high cost of investment. Too time-consuming (32 percent) and a lack of reliable standards (28 percent) also represented significant barriers to digitalisation. More than every fourth company (26 percent) in the commercial economy believes that digitalisation efforts are hampered by data protection and data security issues, as well as the shortage of qualified workers (23 percent). Unclear distribution of responsibilities (15 percent) and a lack of support from senior management (14 percent) are less serious obstacles.

What are the key challenges for companies?

Improvements possible and necessary in all three core areas.

Companies have made great progress toward creating a pro-digital corporate culture over the past year. Business activities have also become more digital, improving companies' prospects of success on the digital markets. The use of digital devices and infrastructure remains at a high level, although the use of digital services has room for improvement. Despite the progress made, the digitalisation of the commercial economy is still far from complete.

The participants of an expert workshop agreed that commercial enterprises must adapt and reorganise internal processes and workflows quickly and flexibly to drive forward digitalisation.

- ▶ New business models must meet changing customer requirements, particularly the individualisation of products and services desired by end customers.
- ▶ Digitalisation makes different demands on companies depending on the sector. The level of digitalisation of sectors in Germany should be compared with the digitalisation of the same sectors in other countries.
- ▶ The rapid transformation of the markets requires flexible and agile working time models.

II Strength of the German digital economy compared with other countries

The German digital economy ranked sixth out of ten countries. Germany's digital economy – the information and communications technology (ICT) sector and the internet economy – was ranked sixth out of ten countries with 53 of a possible 100 points by the international 2016 DIGITAL Performance Index. The German digital economy improved by one index point and maintained its mid-field placing at a solid sixth. The mid field was heavily contested, with only two index points between fifth and sixth place. If we compare this with the results of studies by the World Economic Forum (WEF) and the Digital Economy and Society Index (DESI) for the ten countries analysed by the DIGITAL Performance Index, all of the studies ranked Germany sixth.

- ▶ USA, South Korea and the UK again in the lead: The USA was again the clear leader at 76 index points, ahead of South Korea with 70 points and the United Kingdom with 65 points. The German digital economy ranked among the top three in six of the 48 criteria analysed. The USA achieved this 18 times, South Korea 25 times and the UK 23 times.
- ▶ Finland and Japan ahead of Germany in fourth and fifth place: Finland rose by one index point in 2016 and remained in fourth place. Japan fell by three index points but maintained its fifth-place ranking. Finland scored well in the use category (second place) as well as in individual economic indicators such as gross value added or production value (second place in both cases). Japan placed particularly well in the use category (fifth place) and also took fifth place in the market category, ahead of Germany.
- ▶ France, China, Spain and India behind Germany; no changes in the order of the last four countries. France was just one index point behind Germany, followed by China with 47 points, Spain with 45 points and finally, India with 30 points.

Market, infrastructure and use: the three pillars of the digital economy. The progress of the digital economy was measured in three core areas: the position of the digital economy on the global markets, technical access and development of infrastructure, and the use of digital technologies, infrastructure and services.

The key findings for these core areas were as follows:

► **German digital economy below average on the global markets.**

If we aggregate the results of all 17 criteria used to analyse market strength and significance in the DIGITAL Performance Index – Market, Germany was ranked in the lower mid field in seventh place with 39 index points, well behind the USA (73 points) and South Korea (63 points). Germany accounted for the fifth-largest share of global IT revenue and revenue per capita generated by the internet economy rose significantly to 8 percent (fifth place). However, since the German digital economy is not as strong as the German economy as a whole, it was only ranked ninth in ICT goods and services as a percentage of total exports. Germany was again in the lower mid field with sixth and eighth place in IT expenditure and consumer spending on telecommunications, respectively. The German digital economy placed seventh in spending on both e-commerce and online content.

► **Above-average technical and economic environment.**

If we aggregate the results of all 17 criteria used to analyse the infrastructure and technical conditions in the DIGITAL Performance Index – Infrastructure, Germany

was tied with Japan for sixth place at 72 points. This is only seven index points behind the leading countries, the UK and South Korea. Germany took first place in cooperation between the digital economy and traditional sectors, its best result out of all the criteria analysed. The German digital economy also performed well in broadband access (fourth place), although internet speed could be improved. In contrast, the shortage of skilled workers and the regulatory framework was viewed critically by almost every second ICT expert surveyed for this study, resulting in ninth place in both categories. Despite an above-average performance in individual categories, the German digital economy only achieved a mid-field ranking overall.

► **Average use of digital technologies, products and services.**

If we aggregate the results of all 14 criteria used to analyse the take-up of new technologies and services by the general population as well as the public and private sectors in the DIGITAL Performance Index – Use, Germany only took sixth place despite a high index ranking of 74 points. Germany placed a strong second in the use of e-commerce. South Korea and Germany tied for second behind Finland in companies' openness to ICT. In the music download category, Germany was one of the leading countries, taking third place. It was only eighth in the use of social networks and seventh in online banking. Openness to new ICT solutions in the public sector was viewed more sceptically by the contributing experts, who ranked Germany eighth in the international comparison. Private use of digital products and services is high in some rare cases but this does not extend to all applications. The intensity of use is high in the private sector but underdeveloped in the public sector.

Strengths and weaknesses of Germany. These findings were complemented by input from the ICT industry in an international survey of experts from ten different countries.

Germany's strengths include:

- ▶ Germany's greatest strength by far is **market access**, i. e. the ability to market products and services nationally and internationally. Germany is followed by South Korea and Spain.
- ▶ The **strong demand** for ICT products is considered a strength, especially by the Japanese experts and to a lesser extent by the French, Indian and Chinese experts.
- ▶ The experts from Germany, France and the UK in particular saw **the growth in ICT revenue** as an indicator of the strength of the digital economy in the countries analysed. The findings of the DIGITAL Performance Index confirm these positive assessments.
- ▶ The **links between the ICT sector and other areas of the economy** are stronger in Germany than in any of the other countries, followed by Finland, South Korea and the USA. Germany's ICT experts also attest to high innovation levels. However, **innovation** is considered higher in Finland, the UK, France and the USA.

Germany's weaknesses include:

- ▶ Germany's greatest weakness by far is the **shortage of skilled workers**. China and France have much the same problem.
- ▶ Another particular weakness of the German digital economy is its **network infrastructure**. The situation in India and the UK is similar.
- ▶ Experts also consider the **regulatory framework** – specifically the slow response to new digital requirements – a weakness. The same applies to South Korea, and to a lesser extent to Spain and Finland.
- ▶ Other weaknesses of Germany include a lack of **interest in technology** among the general population and only a fragmented **start-up scene**. Finland and South Korea have the highest interest in technology, while Finland, France and China lead the start-up category.

Four innovative applications set for strong growth to 2021. How successful will the four most important cross-sector applications be? We asked our international experts how they expect these innovative areas of application to develop between now and 2021. Our representative survey also examined how these areas of application are viewed by German companies.

- ▶ **Big data.** Sixty-one percent of experts are forecasting strong growth in big data in the period up to 2021. No other area of application was considered so likely to record "strong growth". Twenty-two percent of the commercial enterprises surveyed use big data applications. Forty-nine percent of companies considered big data irrelevant, while 9 percent wanted to start systematically analysing large data sets in the near future. Big data applications are most often used in the finance and insurance industry, in retail and in mechanical engineering.
- ▶ **Internet of things.** Fifty-six percent of German ICT experts anticipate strong growth in the IoT market between now and 2021. Fifty-one percent of companies use the internet of things and 7 percent plan to do so in the near future. Thirty-four percent have not yet addressed the issue of digital integration. Seventy-one percent of transport and logistics companies use the internet of things, more than in the other sectors.
- ▶ **Smart services.** Every second expert is forecasting high growth rates until 2021. Thirty-seven percent of companies offer smart services. Customer-centric sectors were well represented – ICT (56 percent), finance and insurance providers (47 percent), as well as transport and logistics, retail and energy (45 percent each). Sixteen percent of companies in the commercial economy consider smart services irrelevant or have not addressed these.
- ▶ **Robotics and sensor technology.** Fifty-two percent of experts anticipate strong growth between now and 2021. Eight percent of commercial enterprises use robotics technology, 5 percent of companies are planning to do so in the near future and 11 percent have not yet looked into robotics. This area of application is not relevant to 74 percent of companies for sector-specific reasons.

III Economic significance of the digital economy

Gross value added in the ICT sector again rose year-on-year in 2015 and now amounts to almost € 99 billion. It therefore accounts for 4.7 percent of commercial value added, ahead of mechanical engineering and only just behind transport and logistics. The ICT sector invested a total of € 14.5 billion in 2015, or 2.9 percent of total investment by the German commercial economy. Revenue generated in 2015 rose moderately to € 223 billion. A total of 1,078,759 people worked in the ICT sector in 2015, 2 percent more than in the previous year. This corresponds to 4.3 percent of all employees in the commercial economy.

Internet-based goods and services generated revenue per capita of € 1,379 in 2015. Germany therefore maintained its fifth placing behind the UK, South Korea, the USA and Finland. Overall, the German internet economy recorded revenue of almost € 111 billion.

What can the government do to drive forward the digital economy between now and 2021?

Participants developed requirements and wishes for the government in an expert workshop.

Political efforts should focus on creating a pro-digital culture.

Specifically:

- ▶ The main obstacles to digitalisation that must be tackled at a political level are inadequate broadband coverage and the skilled labour shortage.
- ▶ The legal framework must be quickly adapted to the rapid technical and economic change on an ongoing basis, particularly with respect to data protection and data security.
- ▶ The decision-makers responsible for the legal framework must receive better and continuous training on creating a suitable environment for innovative business models.

- ▶ The value of data must be consciously treated as an opportunity. Analyses should benefit customers, for instance to improve patient well-being in healthcare. Here, too, the government must create the appropriate framework.

- ▶ The same applies to digital working environments.

IV Professional development

A good third of companies in the German commercial economy believe that training on digital issues is “very important” to the company and another third see this as “important”. Eighty-three percent of companies say that they primarily need training on data security.

Small businesses also see a comparatively high need for training on research and finding information over the internet, although these are very basic skills. Most companies have so far relied on more traditional types of professional development such as in-house courses held by internal or external trainers. Only one-third of companies use local computer-based courses to communicate content. Fifteen percent of companies in the commercial economy have hired new employees with digital skills in the past year and 15 percent plan to do so by the end of 2018. The ICT sector has particularly high demand for skilled workers – 31 percent in 2015 and 43 percent in 2018.

Three-quarters of respondents agreed with the statement that current training largely meets business requirements to implement digitalisation at the companies concerned. Only 11 percent recruited qualified foreign workers to secure the talent needed to implement digitalisation. Half of companies expect jobs and roles to change over the next two years as a result of digitalisation. However, only 19 percent believe that computer programs and robots will take over tasks previously performed by employees over the next five years.

What can the government do to promote professional development between now and 2021?

- ▶ The government and businesses should create an environment in which learning and professional development is a key and ongoing part of working life. As well as traditional models, digital training methods should also be trialled.
- ▶ Basic skills such as research and finding information online, an awareness of and ability to handle data and data security, as well as programming principles should be an integral part of school education. These skills must be continually updated and developed further over an individual's working life.
- ▶ The general public should be made aware of the fact that learning does not stop with education but is an ongoing part of (working) life.

V Outlook

This 2016 DIGITAL Economy Monitoring Report, produced by TNS Infratest and ZEW for the second time in this form, shows that the digital economy and the digitalisation of the economy are closely related. Targeted promotion of the digital economy – especially among the Mittelstand – has a positive impact on all other sectors.

The DIGITAL Economy Index and the international DIGITAL Performance Index on the digitalisation of the economy and the digital economy have identified specific approaches to promote productivity, competitiveness and growth. Business, academia, research, politics and the society are encouraged to contribute to the creation of a common digital policy.

We would like to extend our sincere thanks to all of the experts who contributed to this study in workshops and interviews. Special thanks also go to the commercial companies who participated in our survey. Let us know if you would like to find out how much progress your company has made in digitalisation – we would be pleased to include you in next year's survey.

We look forward to continuing our work with you .



S. Graumann

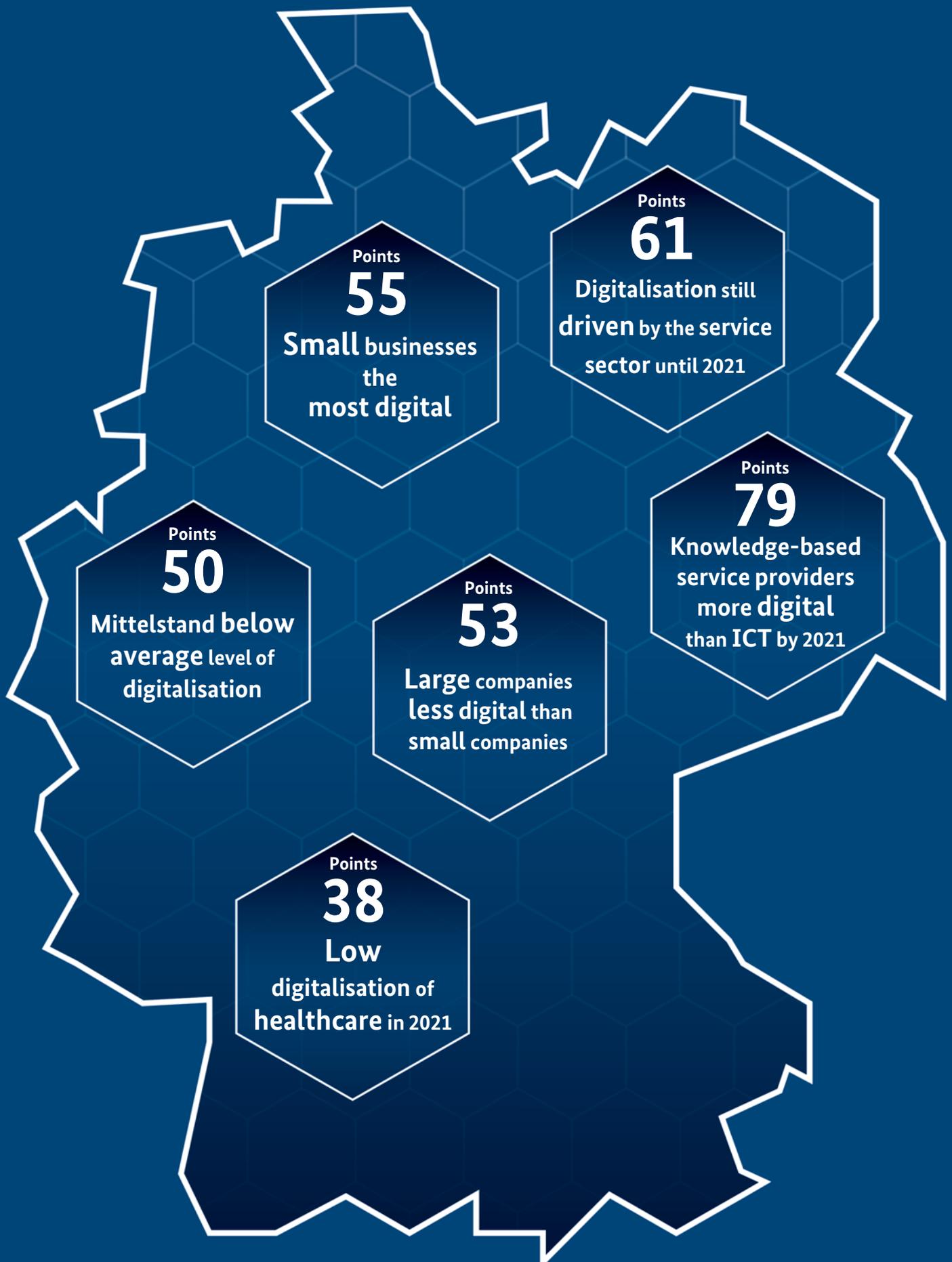
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The Digitalisation of the German Economy



The Digitalisation of the German Economy

Summary

Digitalisation is progressing at a fast pace

The 2016 DIGITAL Economy Index rose from 49 points in the previous year to 55 index points, clearly exceeding the 50-point mark. In other words, significant progress has been made towards digitalisation. Respondents expected the DIGITAL Economy Index to increase to 58 points over the next five years.

Digitalisation of the services sector significantly higher than the manufacturing sector in 2016 and 2021

Digitalisation is being driven forward by the service sector, which saw the DIGITAL Economy Index increase by six points compared with the previous year to 57 index points. This is set to reach 61 points by 2021. In comparison, the level of digitalisation in the manufacturing sector was 18 points lower in 2016, at 39 index points. Digitalisation in the manufacturing sector is expected to decline slightly by 2021.

In May 2016, we asked 899 ICT experts from the nine leading digital economies about digitalisation in their countries. The ICT experts agreed with the statement that digitalisation is progressing faster in the services sector than in manufacturing for their countries. Only the experts from Japan and Finland thought otherwise.

High level of digitalisation in large companies and small businesses

At 55 index points, small businesses with between one and nine employees had the highest level of digitalisation in 2016. The companies in this size category are expected to reach 59 index points by 2021. The level of digitalisation in large companies with over 250 employees was 53 points in 2016 and will increase to 56 points by 2021. Mid-sized companies only achieved 50 points in 2016 and are not expected to improve between now and 2021. This is why it is important to promote digitalisation among the Mittelstand.

Digitalisation varies greatly by sector

At 75 index points, the ICT sector clearly exceeds the 2016 DIGITAL Economy Index for the commercial economy (55 points). Knowledge-based service providers are also **highly digital**, at 70 points. These are set to reach 79 points by 2021, moving up to first place ahead of ICT (77 points).

Seven of the eleven core sectors analysed were classed as having an **average level of digitalisation**: financial services providers (third place), retail (fourth place), energy and water supply (fifth place), mechanical engineering (sixth place), the chemical and pharmaceutical industry (seventh place), transport and logistics sector (eighth place) and automotive engineering (ninth place).

Two sectors are and will continue to be characterised by a **low level of digitalisation**. Healthcare will remain in tenth place despite improving from 35 points in 2016 to 38 points in 2021. Other manufacturing is last, ranked eleventh with an unchanged 35 points.

Highest score for intensity of use, significant room for improvement in pro-digital culture, digital activity still relatively low

The digitalisation of the sectors analysed is influenced by three key factors: use of the latest digital technologies, digitalisation of business activities and the creation of pro-digital internal process, workflows and resources.

The digital use index, which measures the intensity of use of digital technologies in a company, was 65 points for the commercial economy. It achieved 52 points in the digital activity index but only 47 points in the pro-digital culture index. In other words, there is greater room for improvement in the creation of a pro-digital culture than in the expansion of activities on digital markets or in the use of the latest digital technologies.

Digitalisation in other countries

An international survey was conducted among 899 decision-makers in nine countries, in which ICT experts were asked to judge the level of digitalisation of the commercial economy in their country. The ICT experts from Asia (India, China and South Korea) assessed the level of digitalisation in their own countries as “very high”. Only the French experts thought that their own country was below average.

DIGITAL Economy Index



The Digitalisation of the German Economy

Measuring the Level of Digitalisation

Company survey

TNS Infratest conducted a representative survey of German companies between April and July 2016 on the current status and future prospects of digitalisation in Germany. The survey was developed in close cooperation with ZEW Mannheim.

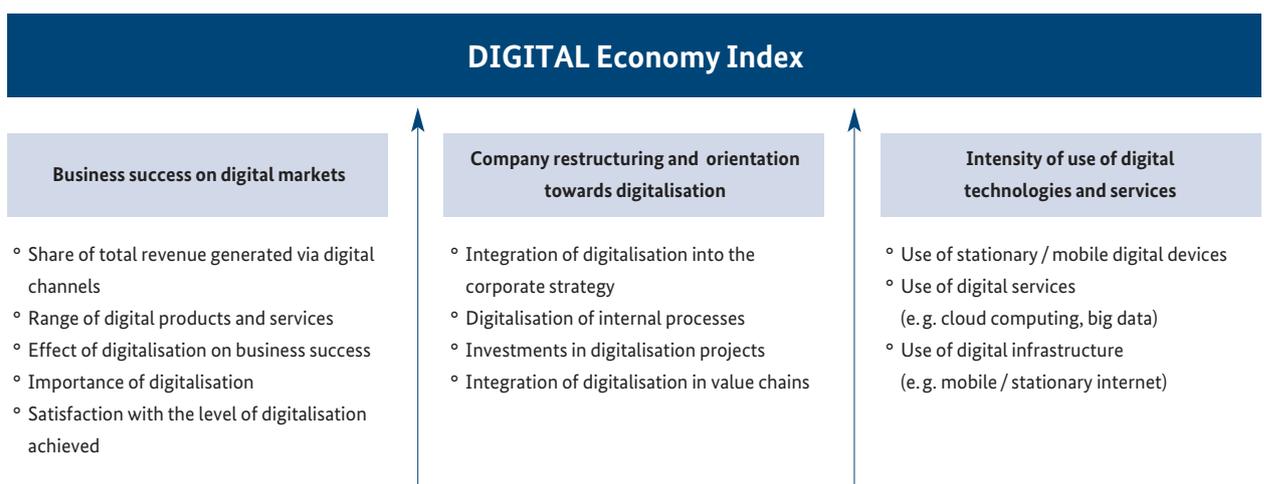
It is representative of the commercial economy, i. e. of the following eleven sectors: mechanical engineering, automotive engineering, the chemical and pharmaceutical industry, other manufacturing, information and communications technology, energy and water supply, retail, transport and logistics, finance and insurance as well as knowledge-based services (such as consulting, market research and media) and healthcare.

Digitalisation success is measured in three core areas: position on the digital markets, infrastructure and the use of digital technologies and services. We answered the following questions based on the responses to this survey:

- ▶ What effect does digitalisation have on business success?
- ▶ To what extent are internal processes and workflows geared to digitalisation?
- ▶ How high is the intensity of use of digital devices, services and technologies?

The DIGITAL Economy Index summarises the results of this survey. It shows – in a single number – the progress of digitalisation in German companies and how this is expected to change between now and 2021. The DIGITAL Economy Index measures the level of digitalisation of the German commercial economy and its sectors as a figure between 0 and 100 points. Comparisons with the prior-year show the progress made towards digitalisation. A score of zero means that no operational workflows or internal processes have been digitalised and that no digital technology is used. The highest possible rating of 100 points indicates that the economy or the company is completely digital.

The DIGITAL Economy Index enables us to compare the eleven core sectors of the commercial economy directly and classify them based on the level and scope of digitalisation. It also calculates the positive effects of digitalisation from the perspective of respondents, as well as the obstacles in the commercial economy and at sector level.

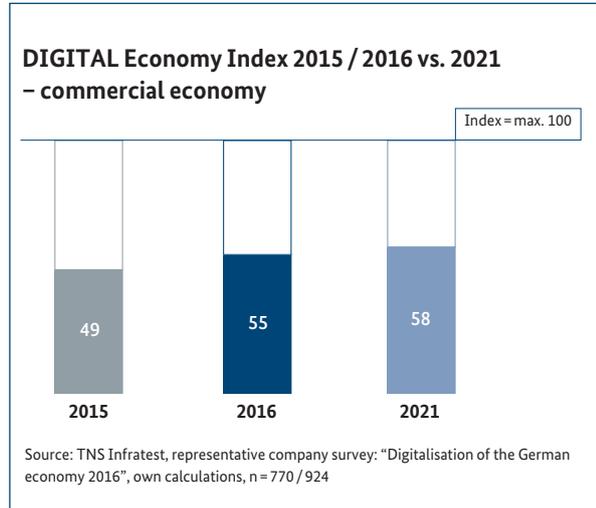


The Digitalisation of the German Economy

DIGITAL Economy Index, Services Sector, Manufacturing

2016: significant increase in digitalisation of the commercial economy – further progress to 2021

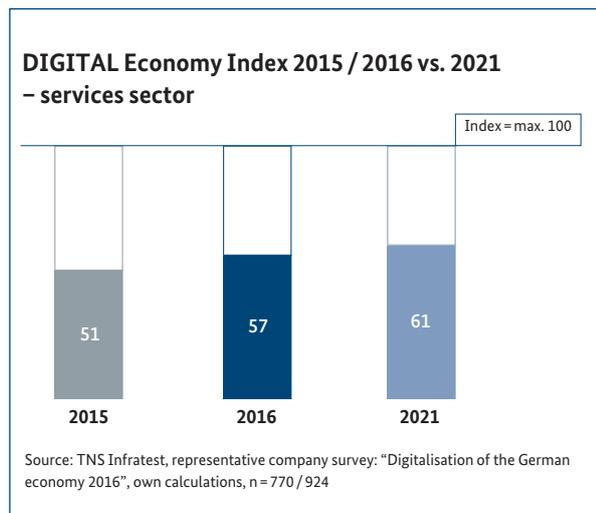
The DIGITAL Economy Index – a measure of the level of digitalisation achieved – rose from 49 to 55 out of 100 possible points in 2016. This is an increase of six index points and shows that significant progress has been made in the digitalisation of the German commercial economy between 2015 and 2016. Respondents expect the DIGITAL Economy Index to increase to 58 points by 2021.



2016: marked increase in digitalisation of services

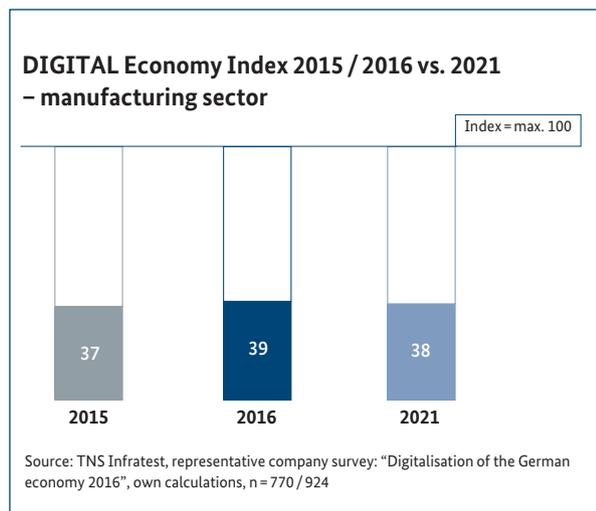
The digitalisation of the services sector improved by six index points to 57 points between 2015 and 2016, clearly exceeding half of the maximum possible index points. This is expected to grow by four points to 61 index points by 2021.

Twenty-nine percent of service companies are "highly digital", 52 percent are classed as "average" and 19 percent as "low".



2016: digitalisation of manufacturing sector much lower – slight decline over the next five years

The manufacturing sector reached 39 points in 2016, 18 index points fewer than the services sector. However, the companies surveyed expect the level of digitalisation to decline slightly by 2021, from 39 to 38 index points. However, this does not mean that the manufacturing sector will not make any progress in digitalisation. The level of digitalisation among large companies is expected to rise by four points compared with the 2016 figure to 54 index points in 2021. Mid-sized companies in the manufacturing sector are expected to see digitalisation increase by two points to 45 index points between 2016 and 2021.



Analysis of the Commercial Economy by Level of Digitalisation in 2016 and 2021

Forty-nine percent of commercial companies have an “average” level of digitalisation, 27 percent are “high” and 24 percent are classed as “low”

- ▶ Twenty-seven percent of commercial companies had a “high” level of digitalisation in 2016 (70 index points and over). This was also the case for 28 percent of small businesses, 20 percent of the Mittelstand and 16 percent of large companies.
- ▶ Forty-nine percent had an “average” level of digitalisation (between 40 and 69 index points). The figure was 59 percent for large companies and 52 percent for mid-sized companies. Slightly less than half (48 percent) of small business received an “average” rating.
- ▶ Twenty-four percent of commercial enterprises were classed as having a “low” level of digitalisation (40 index points and below). One-quarter of large companies, 28 percent of the Mittelstand and 24 percent of small businesses are characterised by low digitalisation.

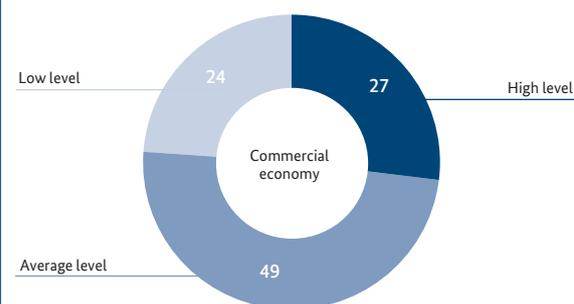
Number of highly digital companies to increase significantly by nine percentage points by 2021

Thirty-six percent of commercial companies will be highly digital by 2021, an increase of nine percentage points within five years. This will be true of 37 percent of small businesses, 19 percent of mid-sized and 24 percent of large companies. Forty-one percent of service providers will be classed as highly digital but only 7 percent of manufacturers.

In the manufacturing sector, 39 percent of companies are expected to have an “average” level of digitalisation in 2021. This is ten percentage points fewer because most of the companies in this digitalisation category will have moved up to the next level. Fifty-four percent of large companies and more than every second mid-sized company (52 percent) will have an “average” level of digitalisation. This also applies to 38 percent of small businesses. There was little difference in the digitalisation of the two sub-sectors: 40 percent of the manufacturing sector and 39 percent of service providers were shown to have an “average” level of digitalisation.

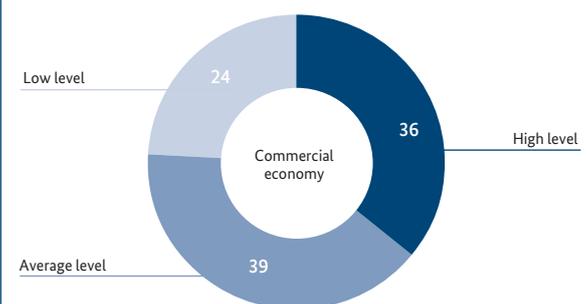
One-quarter of commercial companies will still be classed as having a low level of digitalisation in 2021, unchanged as against 2016. The same classification will apply to 25 percent of small businesses, 29 percent of the Mittelstand and 22 percent of large companies. Fifty-three percent of manufacturers and only 20 percent of service providers will still have a low level of digitalisation in 2021.

Analysis of the commercial economy by level of digitalisation in 2016



Source: TNS Infratest, representative company survey: “Digitalisation of the German economy 2016”, n=924; rounding differences may occur

Analysis of the commercial economy by level of digitalisation in 2021



Source: TNS Infratest, representative company survey: “Digitalisation of the German economy 2016”, n=924; rounding differences may occur

The Digitalisation of the German Economy

DIGITAL Economy Index by Sector in 2015 / 2016

The DIGITAL Economy Index by sector answers the following questions: What level of digitalisation have the sectors observed achieved in the period up to 2016? Which sector leads? Which sectors are below average? How fast will digitalisation progress in these sectors between now and 2021?

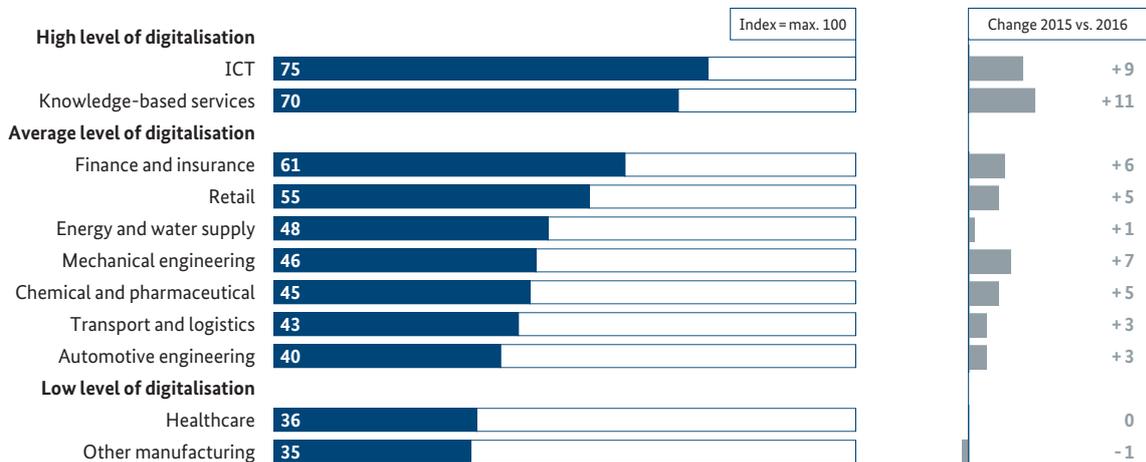
How will the ranking of the sectors by level of digitalisation change?

The percentage of companies with high digitalisation (70 points and over), average digitalisation (40 – 69 points) and low digitalisation (under 40 points) were determined for each of the core sectors observed. These were contrasted with the average figure for the commercial economy of 55 index points in 2016.

Above-average digitalisation: ICT leads ahead of knowledge-based services and finance and insurance; strong growth and first place for knowledge-based service providers in 2021

The ICT sector took first place, rising by nine points to 75 index points in 2016. This was significantly higher than the DIGITAL Economy Index for the commercial economy as a whole (55 points). Only the knowledge-based service providers recorded stronger growth of eleven index points to 70 index points, placing second. The knowledge-based service providers are set to reach 79 index points by 2021, overtaking the ICT sector at 77 index points.

DIGITAL Economy Index by sector in 2016



Source: TNS Infratest, representative company survey: "Digitalisation of the German economy 2016", own calculations, n=924
 Clustering relative to commercial economy (2016 index = 55 points): high digitalisation: = / > 70 points; average digitalisation: 40 – 69 points; low digitalisation: < / = 39 points

DIGITAL Economy Index by Sector in 2021

Average digitalisation: mid field led by financial service providers, retail and energy and water supply; improvements in mechanical engineering as well as transport and logistics but not in the chemical and pharmaceutical industry or automotive engineering

Seven of the core sectors analysed had an average level of digitalisation. The finance and insurance sector scored 61 points in 2016 and 64 points in 2021, defending its third placing. Retail improved by five points to 55 index points in 2016, putting it well ahead of energy and water supply (48 points) to lead the mid field.

Retail and energy and water supply will remain in fourth and fifth place in 2021 with 58 and 52 points, respectively. Mechanical engineering rose by seven points to 46 index points in 2016, placing sixth. It is only expected to achieve 47 index points in 2021 but maintain its ranking.

The chemical and pharmaceutical industry improved by five points compared with 2015 to 45 index points. This puts it in seventh place. It should remain at 45 points in 2021 and fall to eighth place.

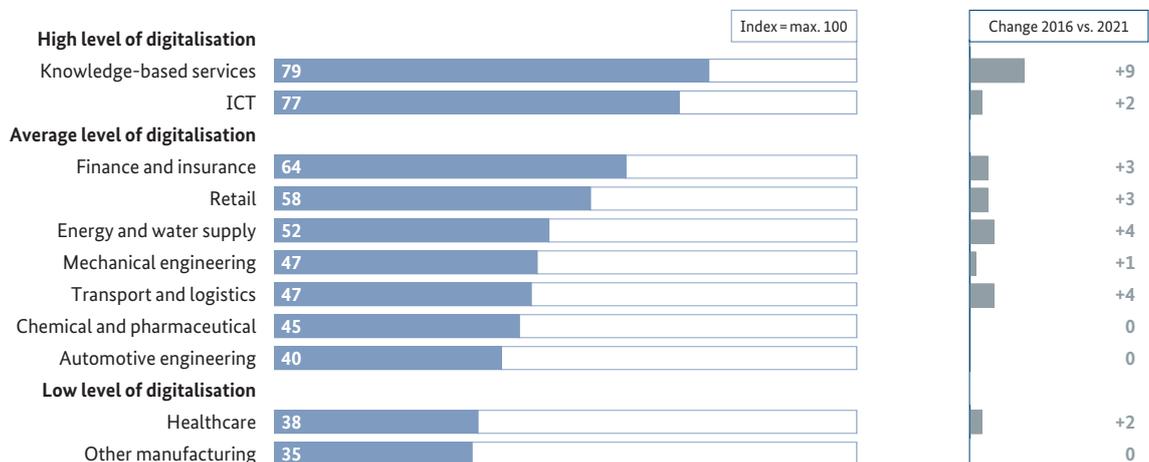
Transport and logistics rose by three points to 43 index points in 2016. The sector is expected to improve to 47 index points and move up to seventh place in 2021.

Automotive engineering placed ninth with 40 index points in both 2016 and 2021.

Below-average digitalisation: need for improvement most acute in healthcare and other manufacturing

Healthcare reached 36 points on the DIGITAL Economy Index in 2016 and will improve to 38 points in 2021, maintaining its tenth place ranking. Other manufacturing was last with 35 index points in both 2016 and 2021.

DIGITAL Economy Index by sector in 2021



Source: TNS Infratest, representative company survey: "Digitalisation of the German economy 2016", own calculations, n=924
Clustering relative to commercial economy (2021 index = 58 points): high digitalisation: = / > 70 points; average digitalisation: 40 – 69 points; low digitalisation: < / = 39 points

Business Success on Digital Markets

90%

are satisfied with
the level of
digitalisation
reached

85%

believe
digitalisation is
important

75%

of ICT companies
believe digitalisation
has a significant effect
on business
success

11%

do not
generate any
revenue
digitally

43%

generate >60%
of revenue
digitally

60%

have a
wide range of
digital products and
services

Business Success on Digital Markets

Summary

In this chapter, we analyse the extent to which digitalisation influences business success on the basis of different questions.

Almost all companies in the commercial economy believe that digitalisation is important

Eighty-five percent of commercial companies believe that digitalisation is important overall. This view is shared by 87 percent of service providers but only 67 percent of companies in the manufacturing sector. Sixteen percent of companies in the commercial economy considered digitalisation to be unimportant on the whole in 2016, compared with 21 percent in 2015. Sixty-eight percent of both ICT companies and knowledge-based service providers see digitalisation as extremely important.

Almost all commercial enterprises are satisfied with the level of digitalisation achieved

Ninety percent of respondents from the commercial economy were satisfied overall with the level of digitalisation. Satisfaction was significantly higher among manufacturers (97 percent) than in the services sector (89 percent). Almost all companies across all sectors were happy with the level achieved. Other manufacturing even had a satisfaction rating of 99 percent. Retail and ICT in particular were “extremely” or “very satisfied” with satisfaction ratings of 54 and 52 percent, respectively. Healthcare was the least satisfied, with 27 percent in the categories “less satisfied” and “not at all satisfied”.

Forty-three percent of companies in the commercial economy generate over 60 percent of revenue via digital channels; room for improvement in other manufacturing, the Mittelstand and large companies

Forty-three percent of companies in the commercial economy generate 60 percent of their revenue with digital products and services. The figure for service providers is 46 percent, while the manufacturing sector has room for improvement at 25 percent. Thirty-one percent of mid-sized companies recorded between one and 30 percent of revenue through digital channels.

Every fifth large company did not generate any digital revenue, a serious issue given their economic importance. Eleven percent of commercial enterprises, 19 percent of manufacturers and 9 percent of service providers have not yet achieved any digital revenue. The ICT sector and knowledge-based service providers are digital pioneers with 81 and 73 percent, respectively. Three-quarters of companies in this sector already generate over 60 percent of their revenue digitally.

Share of digital products and services high based on sector and company size but potential to expand

Sixty percent of commercial companies and a significant 65 percent of service providers said that they had an “extremely wide”, “very wide” or “wide” range of digital products and services. In contrast, this figure was only 36 percent for the manufacturing sector. Thirty percent of commercial enterprises – of which 47 percent of manufacturers and 27 percent of service providers – rate the level of digitalisation of their products and services as “somewhat limited” or “very limited”. The two digital pioneers already have a highly digitalised range – the ICT sector at 70 percent and knowledge-based service providers at 52 percent.

Effect of digitalisation on business success greatest in the ICT sector

In 2016, 28 percent of companies believed that digitalisation has a significant effect on their business success, compared with 26 percent in 2015. This view is shared by 63 percent of service providers but only 48 percent of manufacturers. The larger the company, the greater the expected “digital effect”. Sixty-nine percent of large companies, 66 percent of mid-sized enterprises and 61 percent of small businesses believe that these are strongly connected. Seventy-five percent of ICT companies are convinced that digitalisation has an “extremely strong” or “very strong” effect on business success. These are followed at some distance by knowledge-based service providers. Only healthcare providers are mostly of the view that this only has a minor effect (57 percent).

Company Restructuring and Digitalisation

64%

of the **Mittelstand**
have **highly**
digital processes

49%

have **highly**
integrated value
chains

78%

of **large companies**
have **highly**
integrated value
chains

7%

do not
invest in
digitalisation

53%

of **large companies**
believe that
digitalisation will be a
focus of the corporate
strategy by
2021

2%

of the **Mittelstand**
will **not** have
invested in
digitalisation by
2021

Company Restructuring and Digitalisation

Summary

In this chapter, we examine the extent to which companies will be reorganised today and in the future as a result of digitalisation.

Digitalisation of internal processes in the services sector at an advanced stage

Sixty-eight percent of all commercial companies have highly digital internal processes. The same is true of 71 percent of service providers and 46 percent of companies in the manufacturing sector. Sixty-nine percent of large companies, 64 percent of mid-sized enterprises and 68 percent of small businesses have highly digital processes. Fourteen percent of manufacturers and 5 percent of service providers have not yet digitalised any processes or workflows. The digitalisation of internal processes varies greatly by sector. Knowledge-based service providers lead the field, with 44 percent reporting an “extremely high” share of digitalised processes. They are followed by the ICT sector, at 40 percent.

Forty-nine percent of all companies have highly integrated value chains

Forty-nine percent of all commercial enterprises are highly integrated. Seventy-three percent of service providers and 46 percent of manufacturers have a “very high” level of integration. Seventy-eight percent of large companies, 70 percent of mid-sized enterprises and 69 percent of small businesses have highly integrated value chains. Knowledge-based service providers and ICT companies are typically very strongly integrated. Most companies in the mechanical engineering sector (56 percent), energy and water supply sector (55 percent) as well as in retail (54 percent) have a “high” level of integration. In contrast, 36 percent of health-care companies have “very low” integration.

Digitalisation incorporated in the strategy of 70 percent of all companies

Digitalisation plays a key strategic role for 70 percent of companies in the commercial economy (“extremely strong” or “very strong” 33 percent; “strong” 37 percent). This is not expected to increase any further between now and 2021. Digitalisation is anchored in the strategy of 73 percent of service providers but only 55 percent of manufacturers. The share of large companies that have integrated digitalisation into their strategies will increase from 39 percent in 2016 to 53 percent in 2021. In contrast, the figure for the ICT sector will increase from 58 percent to 65 percent, from 26 percent to 49 percent for finance and insurance services providers, and from 47 percent to 48 percent for knowledge-based service providers. Only the ICT sector already exceeds the 50 percent mark.

Thirty percent of all companies invest over 10 percent of revenue in digitalisation

In 2016, 30 percent of commercial enterprises invested more than 10 percent of total revenue in digitalisation. This figure is expected to rise to 32 percent in 2021. Forty-two percent of knowledge-based service providers invested at least 10 percent (2021: 44 percent), as did 31 percent of ICT companies (2021: 39 percent), Thirty-one percent of service providers and 20 percent of companies in the manufacturing sector. Seven percent of manufacturers did not invest in digitalisation projects in 2016. In 2021, this will be true of 4 percent of companies and 2 percent of the Mittelstand.

Use of Digital Devices, Infrastructure and Services

72%
of employees **USE**
stationary
digital devices

99%
of employees in the
finance and
insurance sector use
stationary digital
devices

63%
of employees
access digital
infrastructure

31%
of employees
have mobile
digital devices

52%
of employees in the
ICT sector **USE**
mobile digital
services

24%
of employees
use
digital services

Use of Digital Devices, Infrastructure and Services

Summary

In this chapter, we look at how widespread digital technologies and applications are in companies and how they are used by employees.

Stationary digital devices still the most common

Although many companies now supply their employees with mobile devices such as smartphones, tablets or laptops, desktop computers are still the most widespread digital device in companies. In the commercial economy, an average of 72 percent of permanent employees use stationary devices such as desktop computers. The same is true of 79 percent of employees in the service sector and 59 percent of manufacturing employees. The finance and insurance sector – where 99 percent of employees work at a stationary digital device – is the clear leader. At 44 percent, automotive engineering has the lowest user rate due to the high share of manual labour.

Almost one-third of employees use mobile devices

Across the commercial economy as a whole, an average of 31 percent of employees use mobile devices such as tablets, smartphones and laptops provided by the company. At 34 percent, the user rate among service providers is 10 percent higher than in the manufacturing sector, where this averages 24 percent of employees. Companies often only provide mobile devices to a limited number of employees such as managers that are expected to be available outside of usual working hours or employees who travel often. This also explains why user figures for mobile devices generally decline as company size increases. In small businesses (0–9 employees), 52 percent of employees are supplied with mobile end devices, compared with an average of 34 percent in mid-sized companies (10–249 employees) and only 23 percent of employees in large companies (over 249 employees).

The use of stationary devices is often connected with access to digital infrastructure such as the internet or intranet for business purposes. Across all sectors, the average user rate is 63 percent of permanent employees. The services sector has a user rate of 69 percent, ahead of the manufacturing sector at 54 percent.

Use of digital infrastructure varies widely by sector

On average, only just under one-quarter (24 percent) of permanent employees in the commercial economy use digital services for business purposes. While there was not as much variation between companies of different sizes, there were great sector-specific differences. ICT-intensive companies – finance and insurance providers, knowledge-based service providers and ICT companies – lead the pack with user rates of between 82 and 86 percent. In contrast, automotive engineering was at the other end of the scale with a user rate for digital infrastructure of 34 percent.

Lowest user rates for digital services

Only just under one-quarter of permanent employees in the commercial economy – both service providers and manufacturers – use digital services such as cloud computing, big data applications, messenger services (e.g. Skype) or unified communications for business purposes. Small businesses are the highest users of digital services, with a user rate of 29 percent on average.

Digital services are most common in the ICT sector, among knowledge-based service providers and in the transport and logistics sector, where user rates vary between 48 and 36 percent. In contrast, only one-tenth of employees in the energy and water supply sector use digital services.

Impact of Digitalisation: Advantages

71%
Digitalisation
increases
innovation

84%
Cooperation with
external partners the
greatest advantage
of digitalisation

74%
Digitalisation
promotes
company growth

67%
Improved
access to
end customers

80%
Increased
efficiency of
internal processes

62%
Digitalisation
drives
new business
models

Impact of Digitalisation

Summary: Advantages of digitalisation

We surveyed commercial enterprises on what effect digitalisation has had on them. Respondents were asked to judge eight different consequences of digitalisation as “very positive”, “somewhat positive”, “somewhat negative” or “with no effect”.

Main advantages: cooperation with external partners, internal efficiency improvements

Eighty-four percent of commercial enterprises saw improved cooperation with external partners and 80 percent the increased efficiency of internal processes as particular advantages. No other advantage came close to these top two. Ninety-nine percent of ICT companies said that cooperation with external partners such as suppliers and service providers had improved and 95 percent observed a significant increase in workflow efficiency.

Three-quarters of companies: digitalisation drives growth forward, improves innovation and internal cooperation

Seventy-four percent of companies in the commercial economy have noticed faster growth as a result of digitalisation. Eighty-two percent of large companies, 93 percent of ICT companies and 84 percent of both retail companies and financial service providers reported the same experience. Seventy-one percent of commercial enterprises said that innovation has increased thanks to digitalisation, as did 79 percent of large companies and 75 percent of mid-sized companies. Ninety-six percent of ICT companies, 84 percent of knowledge-based service providers and 78 percent of energy providers

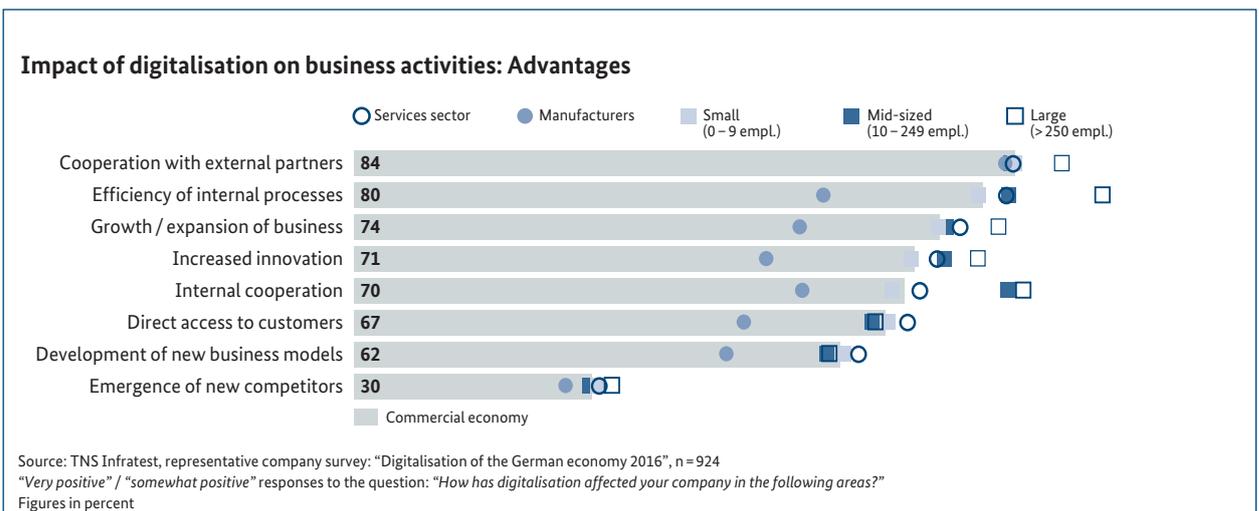
confirmed that digitalisation has had a “very positive” or “somewhat positive” effect on innovation. Seventy percent of all companies have seen a significant improvement in internal cooperation following the introduction of digital processes and workflows. This was also observed by 85 percent of large companies, 83 percent of mid-sized enterprises and 68 percent of small businesses.

Closer contact with end customers, particularly in the financial services industry; digitalisation supports development of new business models

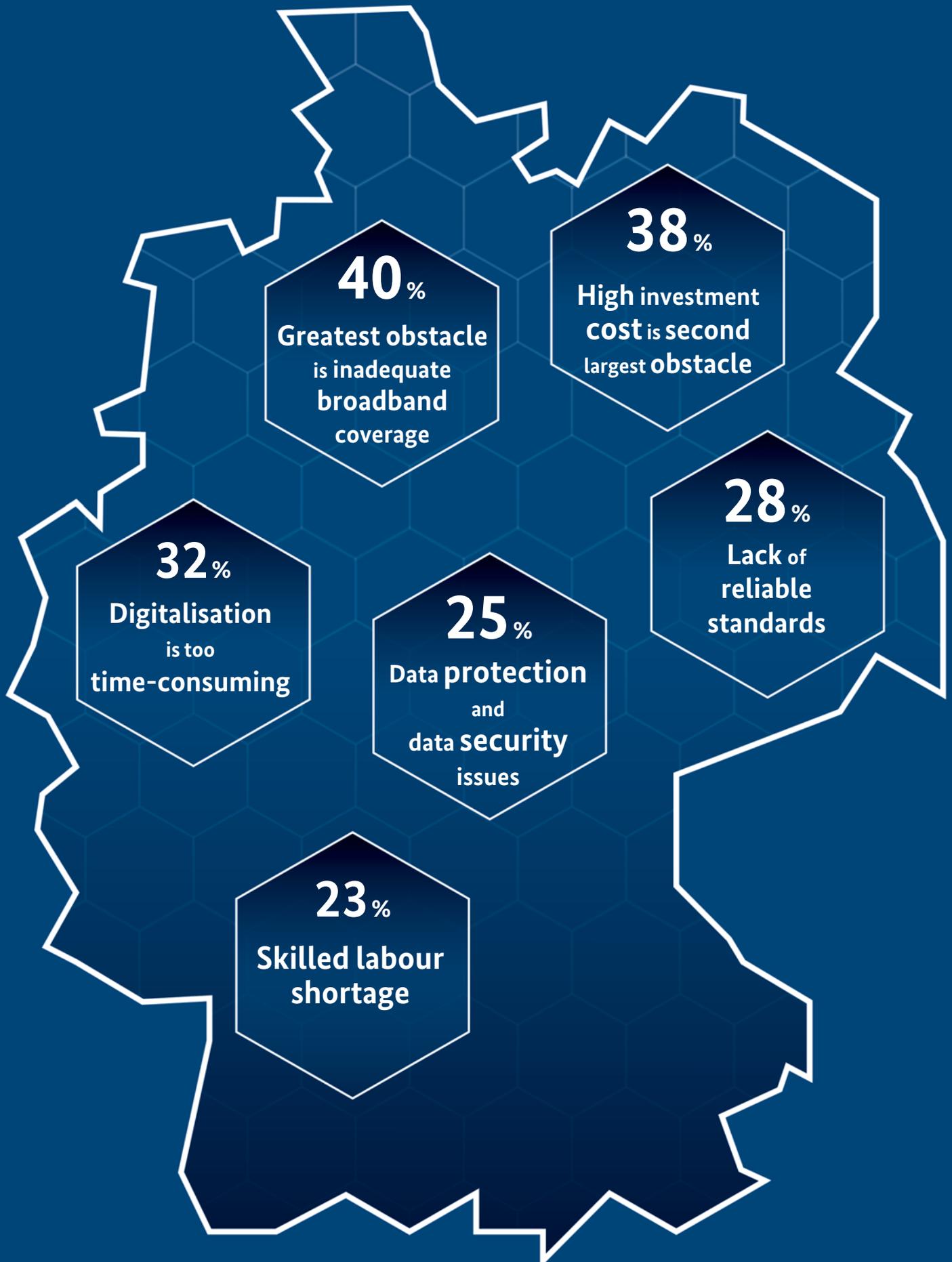
Sixty-seven percent of commercial enterprises confirmed that digitalisation had improved direct contact with their end customers. This was the case for a significant 91 percent of finance and insurance providers. Sixty-two percent of companies said that digitalisation had a “very positive” or “somewhat positive” effect on the development of new business models. Seventy-seven percent of knowledge-based service providers, 72 percent of ICT companies, 68 percent of retailers and 64 percent of financial service providers reported the same experience.

Positive effect from new competitors for only 43 percent of companies

Forty-three percent of commercial enterprises were of the opinion that the emergence of new competitors as a result of digitalisation had no impact on their business. Thirty percent said that these new competitors had a “very positive” or “somewhat positive” effect. Nineteen percent saw no advantages.



Impact of Digitalisation: Obstacles



Impact of Digitalisation: Obstacles

Summary: Obstacles to Digitalisation

Respondents were also asked to judge the effects of eight obstacles to digitalisation as “entirely true”, “generally true”, “somewhat true” “less true” or “not at all true”.

Greatest obstacles are inadequate broadband coverage and high investment cost

The greatest barrier to the further digitalisation of the commercial economy is inadequate broadband coverage. Forty percent of all companies and 55 percent of energy and water providers named this as an obstacle. The high investment cost was the second most cited reason (38 percent). Sixty-seven percent of large companies and 64 percent of energy providers said that this was a significant obstacle.

“Too time-consuming” and “lack of reliable standards” barriers to digitalisation

Thirty-two percent of commercial enterprises cited the time demands of digitalisation as an obstacle, as did 45 percent of mid-sized companies and 55 percent of energy providers. Twenty-eight percent of all companies pointed to the lack of reliable standards. A significant 41 percent of large companies and 46 percent of manufacturers thought the same.

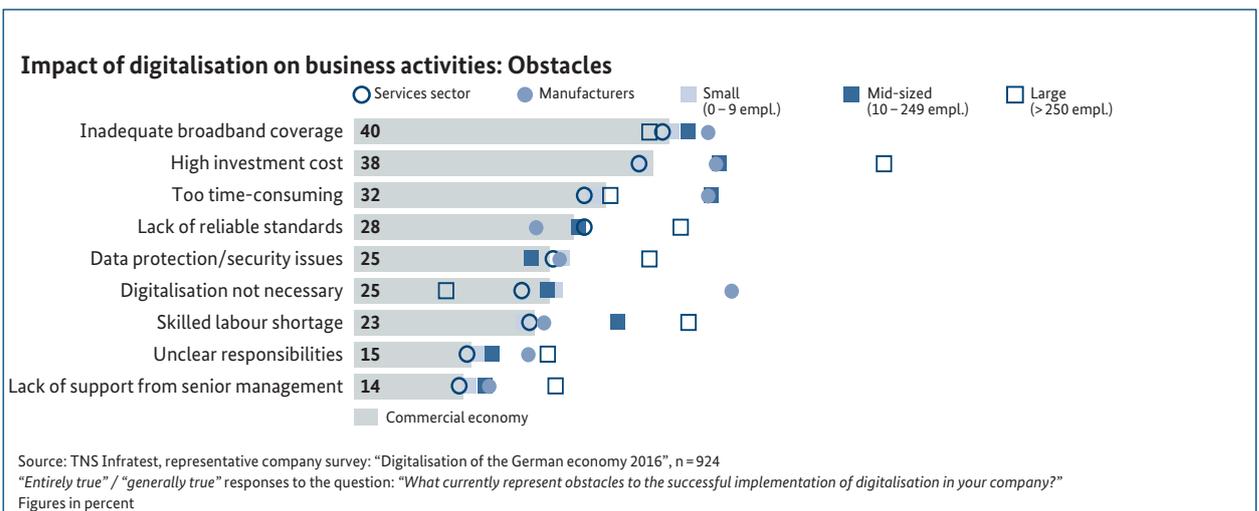
Security issues and skilled labour shortage prevent progress in digitalisation

Twenty-five percent of commercial companies believed security issues to be a significant barrier. Data protection and data security issues were a particular concern for 37 percent of large and 31 percent of all ICT companies.

Twenty-three percent of commercial companies observed a shortage of skilled workers. Forty-two percent of large companies, 33 percent of small and mid-sized companies, 38 percent of mechanical engineering companies and 34 percent of automotive engineering companies believe that the skilled labour shortage is a particular obstacle to digital progress.

Unclear distribution of responsibilities and lack of support from management rarely a barrier

Unclear distribution of responsibilities represented a large barrier to digitalisation for 15 percent of companies in the commercial economy and 24 percent of large companies. Fourteen percent of all companies and 25 percent of large companies cited a lack of support from senior management as a significant obstacle.



Innovative Applications

37%
use
smart
services

51%
use the
internet of
things

61%
of ICT experts forecast
strong growth
in big data

49%
consider
big data
applications
irrelevant

8%
use robotics
and sensor
technology

16%
plan to use
smart
services

Innovative Applications

Summary

Internet of things. Highest intensity of use for IoT applications (51 percent); strong growth expected

The internet of things is the digital integration of not just industry (this is essentially the concept behind “Industry 4.0”) but also other sectors such as transport, logistics and energy. Every second commercial company uses the internet of things (IoT) and 7 percent are planning to do so. Seventy-one percent of transport and logistics companies are active in this area, the highest intensity of use of all sectors. Fourteen percent of all companies have not yet looked into the internet of things. Sixty-two percent of German ICT experts and a good 70 percent of Indian and South Korean experts anticipate strong growth in the internet of things by 2021.

Smart services. Used by 37 percent of companies; particularly high intensity of use in customer-centric sectors

Smart services are packages of products and services for private and commercial users that are individually configured over the internet. Smart services are personalised “as a service” using digital data from different sources. Thirty-seven percent of companies in the commercial economy offer web-based services. Smart services are offered by 39 percent of service providers and 29 percent of manufacturers. The intensity of use is particularly high in customer-centric sectors. Fifty-six percent of ICT companies, 47 percent of finance and insurance providers and 45 percent companies from the transport and logistics sector, retail, energy and water supply as well as knowledge-based service providers offer smart services. Sixteen percent are planning smart service applications in the near future. Another 16 percent have not yet looked into the area. Significantly more experts from Asia and the USA than in Germany predict high growth in smart services until 2021.

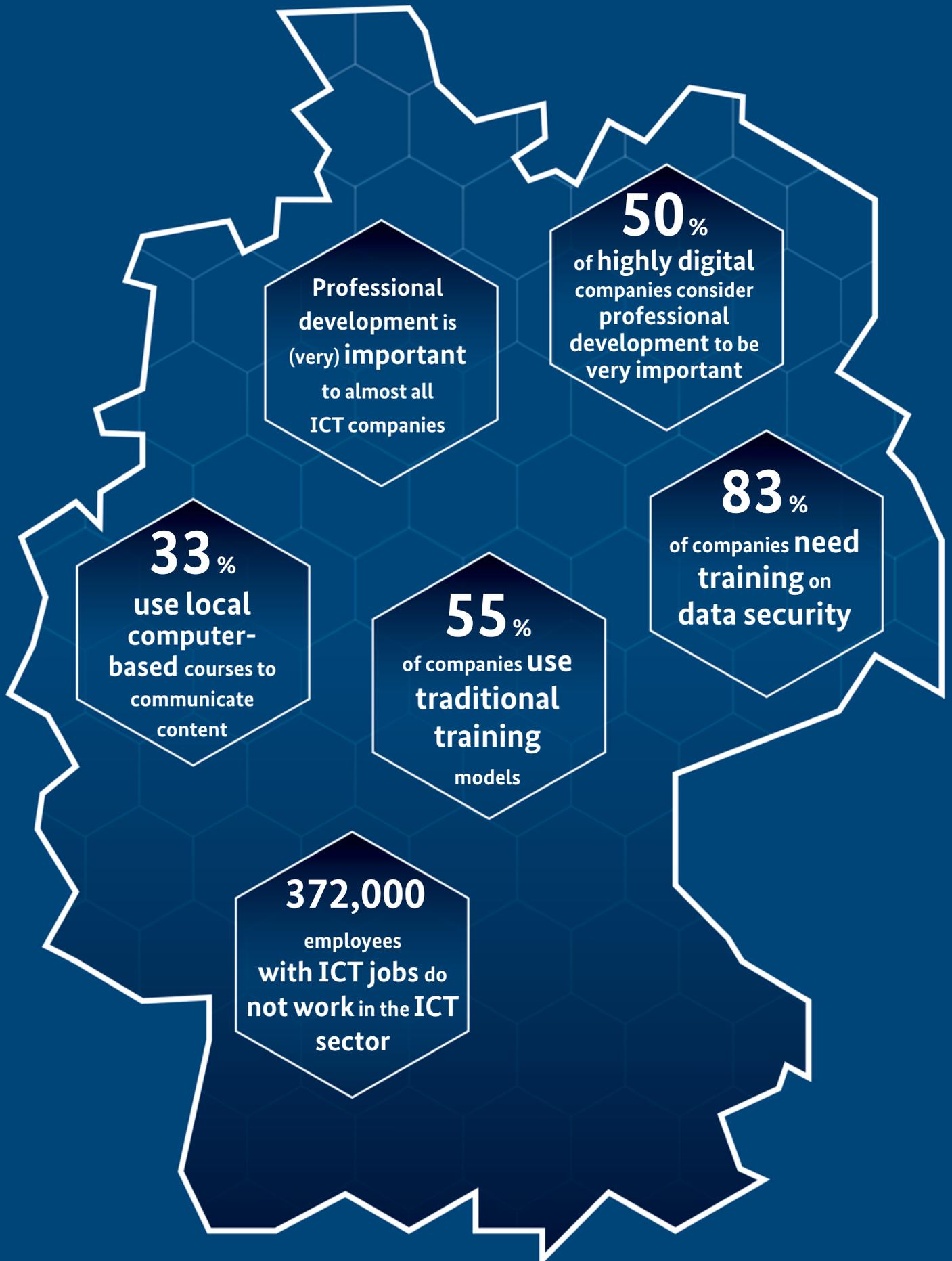
Big data. Low intensity of use but high growth to 2021

Big data is the systematic analysis of large data sets from a wide range of sources to strategically support business strategy and operational processes. Forty-nine percent of commercial enterprises consider big data applications to be not relevant. Twenty-two percent of all companies use big data and 9 percent want to start systematically analysing large data sets in the near future. Eighteen percent of companies admit they have not yet addressed the issue. Big data applications are mainly found in large companies. Thirty-seven percent of finance and insurance providers, 33 percent of retailers, 27 percent of mechanical engineering companies and 22 percent of companies from the chemical and pharmaceutical industry are active in this area. Sixty-one percent of German ICT experts anticipate strong growth in big data between now and 2021.

Robotics and sensor technology. Only used by 12 percent of manufacturers; high growth to 2021 forecast by every second German ICT expert

Robots interact with the physical world and are controlled using sensors and actuators. Robotic technology is mainly found in the manufacturing sector. Seventy-four percent of all companies say that this technology is not relevant to them. Only 8 percent of companies use robotics technology. Five percent are planning to introduce it, while 11 percent have not yet looked into the technology. Twelve percent of manufacturers use robotics technology. Robotics and sensor technology is used by 28 percent of companies in the chemical and pharmaceutical industry, 26 percent of energy and water suppliers, 24 percent of mechanical engineering companies and 18 percent of companies in the automotive engineering. Fifty-two percent of the German ICT experts surveyed are forecasting strong growth.

Internal Training on Digitalisation



Internal Training on Digitalisation

Between Tradition and Innovation

Although digitalisation is a very technocentric issue, it is becoming increasingly evident that its influence goes far beyond the technology. The use of new technologies, increasing interconnectedness and the significant role now played by data as a production factor are changing the way companies operate. As a result, investment in digitalisation goes hand-in-hand with investment in the human capital of employees. Companies must educate and train their employees accordingly and regularly refresh their knowledge and skills. Over the long term, the demand for digital skills will not be satisfied by the labour market alone, despite the increase in the number of university students enrolled in computer science and science, technology, engineering, and mathematics (STEM) courses.

Fifty percent of highly digital companies consider professional development to be very important

A good third of companies in the German commercial economy believe that training on digital issues is “very important” to the company and another third see this as “important”. Digital companies are fully aware of the importance of professional development. Almost all companies in the highly digital ICT sector consider training to be important or very important.

Eighty-three percent of companies need training on data security

Data security is the area with the greatest need for training, particularly in sectors in which data – some of it sensitive – plays a key role such as knowledge-based service providers, in healthcare or the ICT sector. Small businesses also see a comparatively high need for training on research and finding information over the internet, although these are very basic skills.

One-third of companies use local computer-based courses, while 55 percent rely on traditional training

Digital technologies enable new forms of training such as online courses or training software. However, 55 percent of companies have so far relied on more traditional types of professional development such as in-house courses held by internal or external trainers. Only one-third of companies use local computer-based courses to communicate content.

As well as through training, companies acquire skills by hiring new employees. Overall, 15 percent of companies in the commercial economy hired new employees with digital skills in the past year and 15 percent plan to do so by the end of 2018. The ICT sector has particularly high demand for skilled workers – 31 percent in 2015 and 43 percent in 2018.

Three-quarters of respondents agreed with the statement that current training largely meets business requirements to implement digitalisation at the companies concerned. Only 11 percent recruited qualified foreign workers to secure the talent needed to implement digitalisation. Half of companies expect jobs and roles to change over the next two years as a result of digitalisation. However, only 19 percent believe that computer programs and robots will take over tasks previously performed by employees over the next five years.

Over half of employees with ICT jobs work outside the ICT sector

Around 372,000 employees with ICT jobs do not work in the ICT sector. The software development and programming sub-sector – both in the ICT sector and beyond – has seen the strongest employment growth since 2012.

Digitalisation of the Economy: Recommendations

German
customers
not yet
digitalisation
drivers

Digital
knowledge of
senior management in
need of
improvement

Present
digitalisation
as an **opportunity**,
not a threat to the
general population

Training on the
legal framework
of digitalisation for
decision-makers

Value of data
must be
consciously
seen as an
opportunity

Digital
knowledge
cannot necessarily be
taught digitally

Recommendations

Summary of Findings from the Expert Workshop on the Digital Economy

The experts formulated the following demands to the government:

Create a pro-digital culture with adequate, flexible infrastructure geared to end customers.

- ▶ Infrastructure should be flexible and fast to adapt. The main obstacles to digitalisation that must be tackled at a political level are inadequate broadband coverage and the skilled labour shortage.
- ▶ The legal framework must be adapted to the rapid technological and economic change on an ongoing basis, particularly with respect to data protection and data security.
- ▶ The decision-makers responsible for the legal framework must receive better and continuous training on creating a suitable environment.
- ▶ More so than in other sectors, the regulation of the financial industry should be geared to end customers / end users.
- ▶ The value of data must be consciously treated as an opportunity. Analyses should benefit customers, for instance to improve patient well-being in healthcare. Here, too, the government must create the appropriate framework.
- ▶ The same applies to digital working environments.

Challenges for companies. Internal processes and workflows must be adapted to new technical and economic developments. Flexible and agile working models are needed.

- ▶ Ensure that consistent terms are used for key digitalisation concepts.
- ▶ New business models require changes to internal processes and workflows.
- ▶ New business models must meet changing customer requirements.
- ▶ Digitalisation makes different demands on companies depending on the sector.

- ▶ Fast-changing market conditions require new agile and flexible working models.

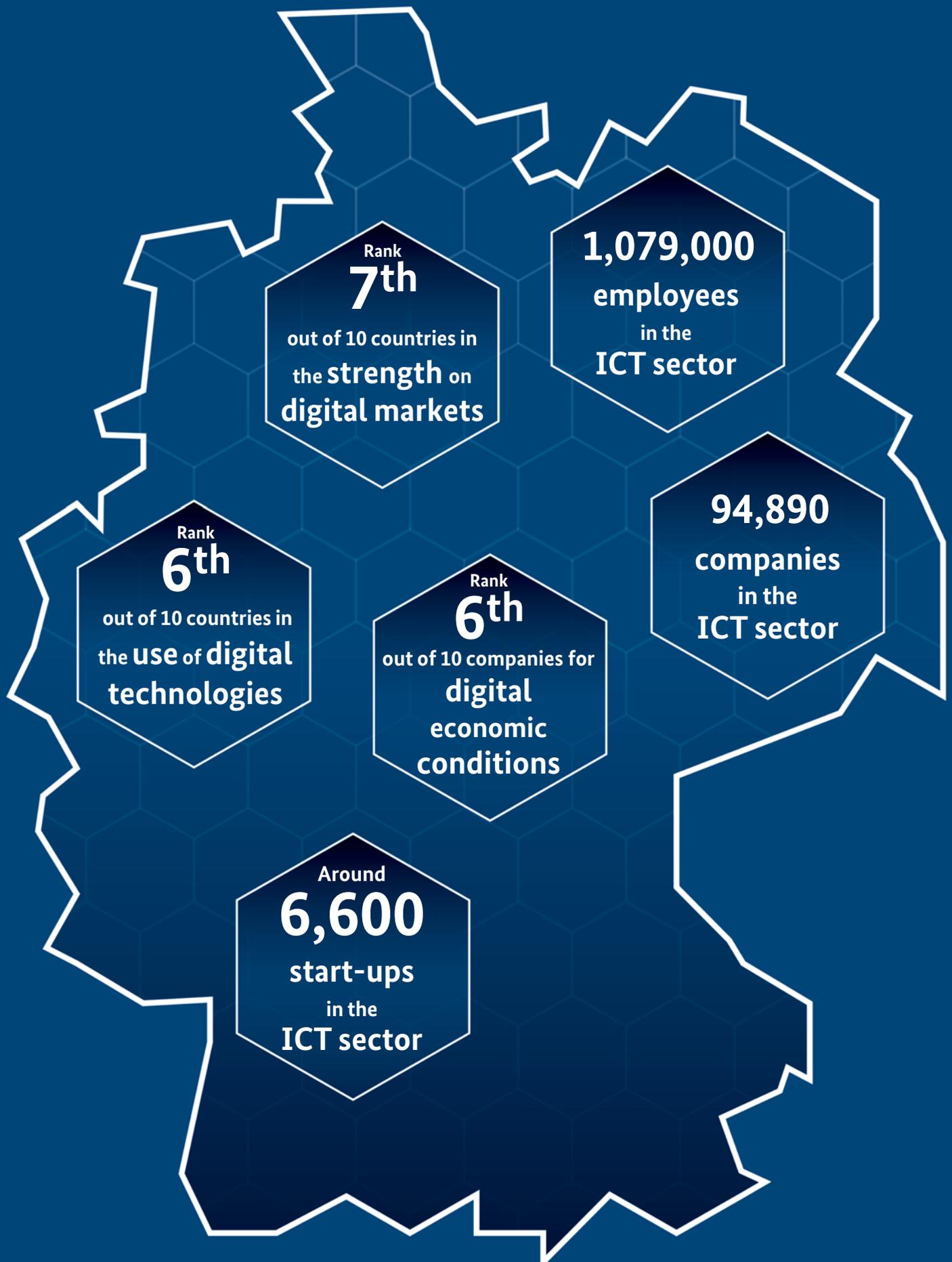
- ▶ The level of digitalisation of sectors in Germany should be compared with the level of digitalisation of the same sectors in other countries.

- ▶ The rapid transformation of the markets requires flexible and agile working time models.

Education and training. Teach digital skills early; raise awareness about digital issues among the general population. Make internal professional development opportunities available to all employees.

- ▶ Computer science should be introduced as a compulsory subject in schools. This requires a change of thinking in education and society. The subject should also be taught in a more appealing way. Software is the new engineering in Germany.
- ▶ Digital skills should be taught in an appealing way from an early age.
- ▶ IT should be understood as a professional and personal opportunity as well as lifelong learning.
- ▶ Dual-track degree programs must be expanded.
- ▶ Partnerships between universities and companies should be strengthened.
- ▶ Cooperation between the government, training organisations, trainees and apprentices as well as their supervisors should be expanded across the entire education chain.
- ▶ The general public should be made aware of issues relating to digitalisation.
- ▶ Awareness campaigns should encourage the general public to see data security as an opportunity, not a threat.
- ▶ Women should be encouraged to pursue careers in IT.
- ▶ Training must meet the specific needs of employees and employee groups; different offerings must be developed to meet these needs. Training is needed for decision-makers in particular.

Digital Economy: Key Figures and International Comparison



Digital Economy

Summary

Value added by the digital economy, innovation and ICT start-ups

The digital economy – the ICT sector and the internet economy – paves the way for digitalisation and is driving forward the digital transformation. We analysed the share of the commercial economy as a whole attributable to the digital economy and its significance to Germany. In particular, we focused on innovation and start-ups, which were primarily driven by the ICT sector.

With 94,890 companies and 1,078,759 employees, the ICT sector creates significant **value added** for the German economy. It accounts for 4.7 percent of gross value added in the commercial economy, ahead of mechanical engineering and behind transport and logistics. ICT makes a significant contribution to the long-term growth of the German economy with investment of € 14.5 billion or 2.9 percent of all investing activities in the commercial sector. The **internet economy** generated **revenue** of € 111 billion in 2015. This corresponds to 3.7 percent of gross GDP. In Germany, € 1,379 was spent per capita in 2015. This puts Germany in fifth place behind the UK, South Korea, the USA and Finland.

In 2014, the **innovator rate** – the percentage of companies that have introduced at least one new product or process within a three-year period – was 65 percent in the German ICT sector, compared with 80 percent three years previously. Despite the decline, which was also seen in a number of other sectors, ICT has one of the highest innovator rates of all the sectors in Germany. **Innovation spending** in the German ICT sector was € 14.6 billion in 2014, down 4 percent on the high prior-year figure.

As in the previous year, the number of **start-ups** in the German ICT sector remained virtually unchanged in 2015. After several years of sometimes significantly lower start-up numbers in the ICT sector, this has stabilized over the past two years. At over 97 percent, the majority of start-ups in the ICT sector were attributable to ICT service providers.

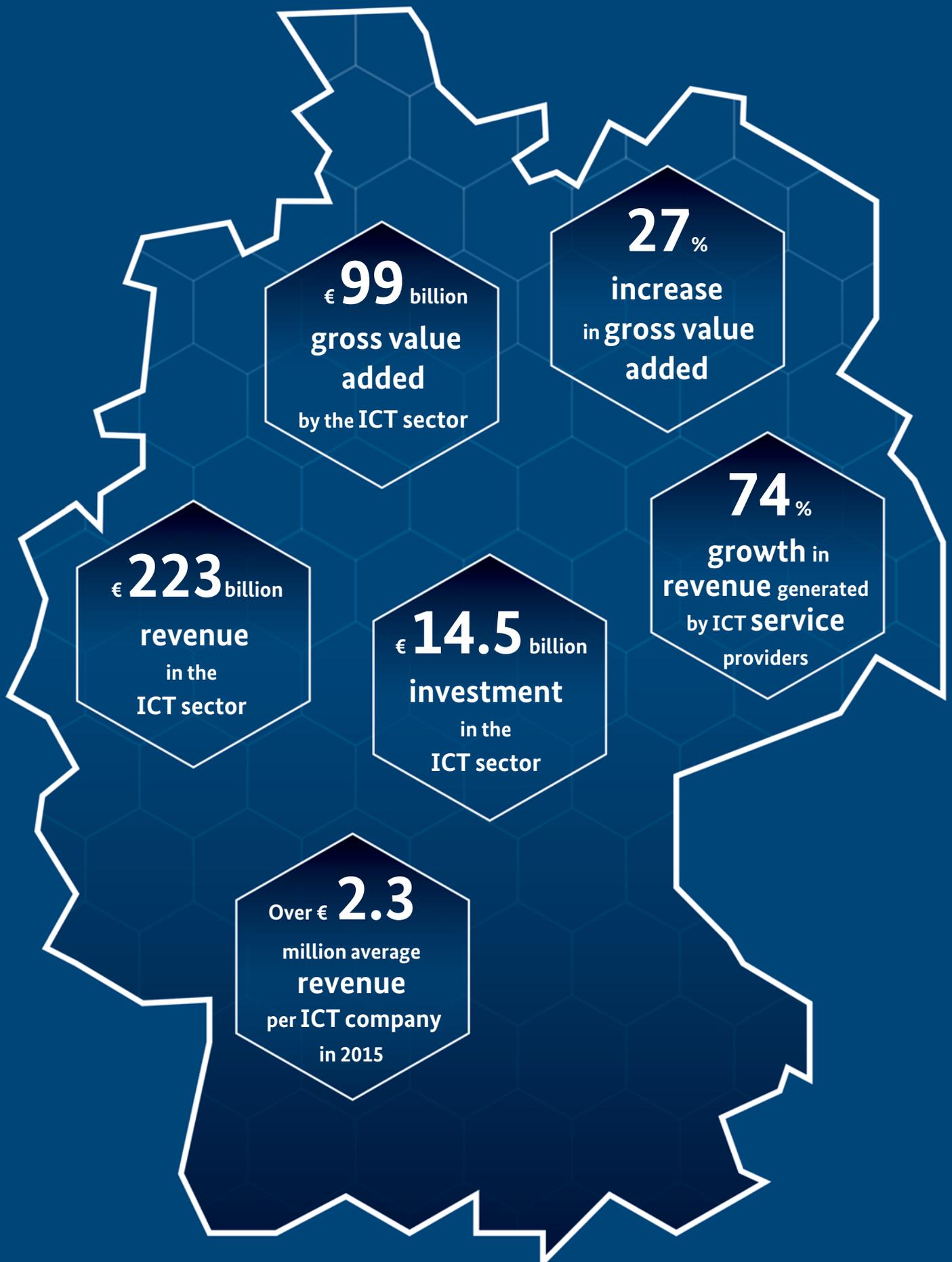
DIGITAL Performance Index: strength of the digital economy compared with other countries

We analysed the performance of the German digital economy compared with nine other countries. The international 2016 DIGITAL Performance Index, which compares the strength of the digital economy, ranked Germany sixth at 53 points. The German digital economy improved by one index point and maintained its solid sixth placing in a heavily contested mid field, only two index points behind Japan in fifth place. If we compare this with the results of studies by the World Economic Forum (WEF) and the Digital Economy and Society Index (DESI) for the ten countries, all of the studies ranked Germany sixth.

The progress of the digital economy was measured in three core areas: the position of the digital economy on the global markets, the technical, regulatory and other framework as well as the intensity of use of digital technologies and services. The **DIGITAL Performance Index – Market** confirmed the USA's domination of the global digital economy. While the USA reached 73 index points, Germany only achieved 39 points and a mid-field placing of seventh. The German digital economy fared better in the technical and economic framework categories, placing sixth in the **DIGITAL Performance Index – Infrastructure** with 72 points. It is worth noting that the highest placed country – the UK – achieved 79 points, meaning that Germany was not far behind. Germany turned in an average performance in the **DIGITAL Performance Index – Use** with 74 points and sixth place. The USA was the undisputed leader at 85 points, followed by Finland with 84 points.

According to the survey, Germany's greatest strength by far is market access, i.e. the ability to market products and services nationally and internationally. Other strengths were strong demand and the links between the ICT sector and other areas of the economy. Germany is positioned better than the other countries here (first place). Its three greatest weaknesses by far are the availability of skilled workers, network infrastructure and the regulatory framework.

Value Added by the Digital Economy in Germany



Value Added by the Digital Economy

The digital economy comprises the ICT sector and the internet economy and is the main driver of the digital transformation. As such, it is the focus of the value added analysis in this DIGITAL Economy Monitoring Report produced by TNS Infratest and ZEW Mannheim.

ICT sector driven by ICT services

The ICT sector has recorded continuous growth in gross value added, rising by over € 21 billion or 27 percent to € 99 billion since 2010. While ICT hardware manufacturers only recorded an overall increase of 2 percent in the past few years, gross value added by ICT service providers has risen continuously by a total of 31 percent.

ICT sector placed mid field compared with other sectors for gross capital expenditure

Investment in purchased or internally developed production resources in the ICT sector rose by approximately 1.5 percent in 2015 compared with the previous year to a total of € 14.5 billion. ICT therefore accounted for 2.9 percent of total investment in the German commercial economy, well ahead of mechanical engineering and only just behind automotive engineering. In contrast, gross capital expenditure was much higher in the transport and logistics sector than in the ICT sector.

ICT service providers with positive revenue growth

The ICT sector as a whole generated revenue of almost € 223 billion in 2015, over € 1 billion more than in 2014. Although this was the sector's second-highest figure over the past few years, the percentage increase against the previous year was extremely low at 0.5 percent.

Hardware manufacturers once again record lower employment figures

After both ICT service providers and ICT hardware manufacturers recorded continuous growth in employment figures between 2009 and 2014, the number of jobs in the hardware sector declined again in 2015. However, the sector as a whole saw an increase in the number of employees due to growth in ICT services.

Experts optimistic about revenue and employment trend to 2018

Over two-thirds (71 percent) of the experts surveyed anticipate a positive revenue trend in the German ICT hardware sector between 2015 and 2018. Only 5 percent expect revenue to decrease. Even more experts (74 percent) are forecasting an upturn in the ICT service sector. Sixty-nine percent predict that the number of employees in the ICT hardware sector will be higher in 2018 than in 2015. The forecast for the ICT services sector (including the software sector) is similarly positive, with 71 percent of the experts surveyed expecting an increase in employee figures.

German internet economy generated revenue of over € 111 billion in 2015

The internet economy recorded revenue of over € 111 billion in 2015. One of the reasons for the continuous growth of the internet economy in Germany is the positive development of export trade. The import surplus of internet-based goods and services has declined significantly since 2013. In the ten-country comparison, Germany recorded the fifth highest revenue per capita from the internet economy. In Germany, € 1,378 was spent per capita on internet-based goods and services in 2015. The highest per-capita revenue was recorded in the UK (€ 2,585), South Korea (€ 2,389) and the USA (€ 2,352).



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Innovation and Start-Ups in the ICT Sector

4.2%
of revenue
in the ICT sector
generated with
innovations

19.6%
of revenue
generated by
new ICT
products

65%
innovator rate
in the
ICT sector

€ **14.6** billion
invested
by the
ICT sector

€ **7.7** billion
spent on R & D and
software
development in
the ICT sector

7.0%
start-up rate
in the
ICT sector

Innovation and Start-Ups in the ICT Sector

Summary

Innovator rate still high compared with other sectors

The innovator rate is the percentage of companies that have introduced at least one new product or process within a three-year period. This was 65 percent in 2014, compared with an innovator rate of 80 percent three years previously. The decrease was particularly pronounced in the ICT services sector. Despite the decline, the ICT sector has one of the highest innovator rates in Germany. At 75 percent, only the chemical and pharmaceutical industry outperformed the ICT sector in 2014. Mechanical engineering was slightly above the ICT sector, at 68 percent.

Innovation spending of € 14.6 billion in the ICT sector

In 2014, the innovation budgets of the companies in the German ICT sector totalled € 14.6 billion, down 4 percent on the prior-year figure. However, in mid-2014, the companies had anticipated much lower innovation spending – 7 percent less – for 2014. The innovation budget in the ICT hardware sector was increased by a significant 12 percent to € 4.1 billion in 2014. In contrast, the ICT service providers saw a considerable decline of almost 10 percent to € 10.5 billion in the same year. Innovation spending attributable to the ICT sector declined slightly to 10.1 percent in 2014.

€ 7.7 billion invested in R&D and software development

The German ICT sector spent € 7.7 billion on R&D (including software development) in 2014. R&D expenses are part of total innovation spending. ICT hardware manufacturers invested € 3.02 billion in R&D, or three-quarters of innovation spending. Compared with other sectors, R&D spending accounted for a particularly high percentage of revenue in the ICT hardware sector. In 2014, 8.8 percent of revenue was reinvested in R&D, more than in any other sector. R&D spending was much lower among ICT service providers, at 3.0 percent. The ICT sector as a whole had an R&D intensity of 4.0 percent. This is slightly more than in mechanical engineering (3.8 percent) but less than in the chemical and pharmaceutical industry (5.5 percent) and in automotive engineering (6.3 percent).

One-third of innovative companies in the ICT sector receive government funding

Between 2012 and 2014, 35 percent of innovative companies in the German ICT sector – i.e. companies with product and process innovation activity – received government funding for at least one innovation project. The figure for ICT hardware manufacturers was 49 percent, higher than in any other sector. While the percentage of companies to receive government funding through R&D and innovation initiatives in the German economy as a whole peaked in the period from 2010 to 2012, the share of ICT companies to be awarded grants has continued to increase.

An important aspect of a company's innovation strategy is its openness to external knowledge. However, partnerships also involve greater coordination with external partners and the related costs as well as the risk of unintentional knowledge outflow. Thirty-three percent of innovative companies in the ICT sector cooperated with other companies in 2014. At 42 percent, the figure for ICT hardware companies was much higher than for ICT service providers (31 percent). Willingness to cooperate in the ICT sector is similar to the automotive engineering and higher than in mechanical engineering, but lower than in the chemical and pharmaceutical industry.

Number of start-ups has stabilised

As in the previous year, the number of start-ups in the German ICT sector remained virtually unchanged. At the same time, the number of newly formed companies was just over 6,600, the lowest since 2002 according to the Mannheim Enterprise Panel. The ICT sector performed better overall compared with the overall start-up trend seen in Germany over the past few years, mainly due to ICT service providers.

Above average start-up rate in the ICT sector

An average of just under 6,700 companies were founded every year in the ICT sector between 2013 and 2015. Based on the number of companies in the sector, this represents a start-up rate of 7.0 percent, higher than all of the sectors analysed.

Global DIGITAL Performance Index



Global DIGITAL Performance Index

Market, Infrastructure, Use

The success of the digital economy – the ICT sector and the internet economy – is based on three pillars: market strength, infrastructure and the use of technologies and applications.

In order to compare the performance of different countries, this study first looked at the global markets. We analysed market strength, i. e. supply and demand, revenue and exports in the digital economy.

Infrastructure was also taken into account for a comprehensive assessment of each country. Technical infrastructure and the economic environment is essential to a functioning market, innovation and growth, especially in the digital economy.

The intensity of use of digital technologies, products and services is also key to assessing the digital economy of a country. The market can only grow if it has informed, tech-savvy users and investments are only profitable if there are enough users open to new technology.

This report analyses the strength of the ten most important digital economies on the basis of 48 core indicators. TNS Infratest conducted a secondary analysis and an international survey of ICT experts in ten countries and used proprietary survey data from both ZEW and TNS Infratest. To compare the findings internationally, the best country out of ten in each category was awarded 100 index points. The other countries were positioned relative to the category leader. Based on these indicators, the countries analysed could then be ranked and compared.

Germany ranked sixth in international comparison

In the international DIGITAL Performance Index on the strength of the digital economy, Germany improved by one index point and maintained its solid sixth placing out of ten countries with 53 points. Germany was therefore ranked in the mid field behind Japan (55 points) and just ahead of France (52 points).

The DIGITAL Performance Index was led by the USA with 76 points, followed by South Korea with 70 points and the UK with 65 points. China placed eighth with 47 points. The last two places went to Spain with 45 points and India with 30 index points.

Global DIGITAL Performance Index

1.	(1.)	USA		76	(77)
2.	(2.)	South Korea		70	(74)
3.	(3.)	UK		65	(64)
4.	(4.)	Finland		62	(61)
5.	(5.)	Japan		55	(58)
6.	(6.)	Germany		53	(52)
7.	(7.)	France		52	(50)
8.	(8.)	China		47	(46)
9.	(9.)	Spain		45	(44)
10.	(10.)	India		30	(28)

Source: TNS Infratest, 2016; as of 2015, prior-year figures in brackets

Global DIGITAL Performance Index – Market

Rank
7th
in the DIGITAL
Performance Index
Market

1,397 €
revenue per capita
from internet-
based goods and
services

Rank
5th
in
ICT
revenue

Rank
9th
in
ICT
exports

Rank
7th
in
e-commerce
spending

Rank
6th
in
gross value
added

Global DIGITAL Performance Index – Market

USA still the clear leader, Germany in seventh place

Germany achieved 39 points and maintained its seventh-place ranking from the previous year in the market category. This gave Germany a solid lower mid-field placing just behind China (40 points) and Japan (42 points) but well behind the USA (73 points), South Korea (63 points), the UK (54 points) and Finland (49 points).

Germany generated **ICT revenue** of almost € 223 billion and accounted for 4 percent of global revenue, behind the UK (4.75 percent) but ahead of South Korea (3.46 percent). The front runner was the USA with a 30 percent share of global revenue, followed by China with 12.2 percent and Japan with 6.2 percent.

The German **internet economy** also continued to develop positively. In total, over € 111 billion was generated with or via the internet, a good 8 percent more than in the previous year. However, the internet economy expanded even faster with double-digit growth rates in the USA, South Korea, China and the UK. With revenue per capita of € 1,379, Germany defended its fifth place ranking in the international comparison behind the UK, South Korea, the USA and Finland.

Germany placed in the lower mid field in **IT expenditure** and **gross value added** (both sixth place) and consumer **spending on telecommunications** (eighth place). **Spending on e-commerce** and **online content** (both seventh place) by internet users in Germany was only enough for a lower mid-field placing. By way of comparison, the USA, as well as South Korea, the UK and Japan led or at least ranked in the upper mid field in all of these indicators. Finland also performed better than Germany in these categories, with the exception of telecommunications spending.

In particular, the **share of total exports** attributable to ICT goods and services was very low in Germany at only 9 percent. This placed Germany ninth since the digital economy was unable to match the export strength of the economy as a whole.

Global DIGITAL Performance Index – Market

1.	(1.)	USA		73	(75)
2.	(2.)	South Korea		63	(69)
3.	(3.)	UK		54	(54)
4.	(4.)	Finland		49	(48)
5.	(4.)	Japan		42	(48)
6.	(6.)	China		40	(41)
7.	(7.)	Germany		39	(40)
8.	(8.)	France		38	(37)
9.	(9.)	Spain		29	(28)
10.	(10.)	India		24	(21)

Source: TNS Infratest, 2016; as of 2015, prior-year figures in brackets

Global DIGITAL Performance Index – Infrastructure



Rank
6th
in the DIGITAL
Performance Index
Infrastructure

Rank
1st
in links
with **traditional**
sectors

Rank
9th
in **availability**
of **skilled**
workers

Rank
1st
in
computer
use

Rank
9th
in
regulatory
framework

Rank
4th
in
broadband
coverage

Global DIGITAL Performance Index – Infrastructure

Germany Sixth but Not Far Behind Leading Countries

Germany placed sixth together with Japan in the infrastructure and regulatory framework category at 72 points. This is only seven points behind the leading countries, the UK and South Korea. The close field shows that the industrial nations are relatively evenly positioned with a high level of infrastructure. Only China (49 points) and India (26 points) have significant room for improvement.

New digital services and applications are still dependant on **broadband internet coverage**. Germany scored well here and placed fourth behind France, South Korea and the UK, but ahead of Finland. However, Germany still has a lot of room for improvement, particularly in the faster fibre optic network.

The **links between the digital economy** and other sectors are key to driving forward the digitalisation of the German economy. Germany took first place in cooperation between companies in the digital economy and traditional sectors. Forty-four percent of the ICT experts surveyed for the study said that this cooperation was a strength. Finland was second, followed by South Korea in third place.

Germany also had the highest **computer use** out of all the countries analysed. Ninety-one percent of German households have at least one computer. The UK and Finland followed in second and third place.

The **shortage of skilled workers** in Germany is still seen as a weakness. Forty-four percent of the experts surveyed for the study considered this a weakness, putting Germany in ninth place in the international comparison.

The **regulatory framework** was also viewed critically by the experts involved in this study. Fifty-three percent saw it as a weakness for Germany, which placed ninth out of the ten countries. Germany only placed seventh in both **tax** and **industrial policy**.

Global DIGITAL Performance Index – Infrastructure

1.	(1.)	UK		79	(79)
1.	(2.)	South Korea		79	(77)
3.	(4.)	France		78	(76)
4.	(2.)	Finland		77	(77)
5.	(5.)	USA		76	(75)
6.	(6.)	Germany		72	(70)
6.	(7.)	Japan		72	(69)
8.	(8.)	Spain		71	(68)
9.	(9.)	China		49	(45)
10.	(10.)	India		26	(24)

Source: TNS Infratest, 2016; as of 2015, prior-year figures in brackets

Global DIGITAL Performance Index – Use



Global DIGITAL Performance Index – Use

Germany Sixth behind Japan

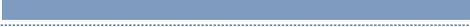
Germany maintained its sixth placing with 74 index points for the use of new technologies and services by consumers and the private and public sector. This is the highest number of index points achieved by Germany in all three sub-indices. The USA took first place followed by Finland, South Korea and the UK. Japan was ranked fifth, just one index point ahead of Germany.

The use of new services and applications by consumers in Germany was mixed. Germany performed well in the **use of e-commerce** category. Seventy-four percent of internet users buy online, the second highest figure in the international comparison. Germany was also one of the front runners in the **music download** category, taking third place. However, it was only eighth in the **use of social networks** and seventh in **online banking**.

Germany placed fourth in **internet use** and the **use of ICT technologies** in companies. South Korea and Germany tied for second behind Finland in **companies’ openness to ICT**.

Decision-makers in the German ICT sector were asked about **openness to new ICT solutions in the public sector** and 40 percent said that this was a weakness, ranking Germany eighth out of ten countries. The German public sector performed better in the **use of ICT and administrative efficiency**, placing fourth behind South Korea, the UK and Finland.

Global DIGITAL Performance Index – Use

1.	(1.)	USA		85	(84)
2.	(3.)	Finland		84	(83)
3.	(4.)	UK		82	(79)
3.	(1.)	South Korea		82	(84)
5.	(5.)	Japan		75	(75)
6.	(6.)	Germany		74	(72)
7.	(8.)	France		67	(65)
8.	(9.)	China		65	(63)
8.	(7.)	Spain		65	(66)
10.	(10.)	India		54	(51)

Source: TNS Infratest, 2016; as of 2015, prior-year figures in brackets

Strengths and Weaknesses of the Digital Economy



Strengths and weaknesses of the digital economy

Focus on Germany

An international survey of experts was conducted among 999 decision-makers from the ICT sector in ten countries to analyse the strengths and weaknesses of the different countries. The relative strengths and weaknesses of each country were identified to compensate for differences in response behaviour. This method ensured that respondents' opinions were interpreted in relation to all assessments of each category and country. It enabled us to eliminate the effects of exaggerated scepticism or self-praise due to cultural factors, for instance. A statistical expectation value was then calculated from all responses. Deviations from this value represented the relative strengths and weaknesses of a country. In this way, we were able to rank the strengths and weaknesses and identify particular or moderate strengths and weaknesses based on the degree of deviation.

Strengths and weaknesses of Germany

The expert survey revealed the following strengths and weaknesses:

Germany's strengths

- ▶ Germany's greatest strength by far is **market access**, i.e. the ability to market products and services nationally and internationally. Germany is followed by South Korea and Spain.
- ▶ The **strong demand** for ICT products is also considered a strength, especially by the Japanese experts and to a lesser extent by the French, Indian and Chinese experts.

- ▶ The experts from Germany, France and the UK in particular saw the **growth in ICT revenue** as an indicator of the strength of the digital economy in each of the countries analysed. The findings of the DIGITAL Performance Index confirm these positive assessments.

- ▶ The **links between the ICT sector and other areas of the economy** are stronger in Germany than in any of the other countries, before China and well ahead of South Korea and the USA. Germany's ICT experts also attest to high **innovation levels**. However, innovation is considered higher in Finland, the UK, France and the USA.

Germany's weaknesses

- ▶ Germany's greatest weakness by far is the **shortage of skilled workers**. China and France have much the same problem.
- ▶ Another particular weakness of the German digital economy is its **network infrastructure**. The situation in India and the UK is similar.
- ▶ Experts also consider the **regulatory framework** – specifically the slow response to new digital requirements – a weakness. The same applies to South Korea, and to a lesser extent to Spain and Finland.
- ▶ Other weaknesses of Germany include a lack of **interest in technology** among the general population and the absence of a successful **start-up scene**. Finland and South Korea have the highest interest in technology, while Finland, France and China lead the start-up category.

Appendix

About this Study

2016 DIGITAL Economy Monitoring Report

The DIGITAL Economy Monitoring Report uses the DIGITAL Economy Index to analyse the current and future level of digitalisation of the German commercial economy, broken down by eleven sectors (part 1). The DIGITAL Performance Index (part 2) measures the competitiveness of the German digital economy as a sector.

Part 1: Digitalisation in 11 core sectors of the German commercial economy

The **aim** was to measure the level of digitalisation of companies in the commercial economy in 2016 and 2021 on a representative basis, as well as to identify the advantages of and obstacles to digitalisation.

Method: TNS Infratest conducted a representative survey of German companies between April and July 2016 on the current status and future prospects of digitalisation in Germany. It is representative of the commercial economy as a whole, i.e. of the following eleven sectors: mechanical engineering, automotive engineering, the chemical and pharmaceutical industry, other manufacturing, information and communications technology, energy and water supply, retail, transport and logistics, finance and insurance as well as knowledge-based services and healthcare.

A total of 924 companies from eleven sectors were surveyed for this study. The quantitative, computer-based and standardised telephone interviews with open and closed questions were conducted by TNS Infratest. The disproportionate stratification of random sampling ensured that an adequate number of companies from different sectors and size categories were represented.

Presentation of results in the DIGITAL Economy Index: The DIGITAL Economy Index measures the effect of digitalisation on business success, the digital penetration of internal processes and workflows, as well as the intensity of use of digital technologies and services. It presents the level of digitalisation of the German commercial economy and its sub-sectors in 2016 and 2021 as a figure between 0 and 100 points.

Digitalisation profile: Digitalisation by sector has been analysed in depth in separate reports in formats suitable for presentation. A separate analysis by company size was additionally conducted in 2016.

Part 2: The German digital economy compared with other countries

The **aim** was to measure the strength of the German digital economy (the ICT sector and the internet economy) as a sector compared with nine other countries.

Method: TNS Infratest conducted an international secondary analysis in Germany and nine other countries of significant economic relevance to Germany: the USA and South Korea, the UK and Finland, France and Spain, as well as China, India and Japan. In addition, 100 ICT experts were surveyed in each of these countries. ZEW also prepared exclusive supplementary analyses. A unique feature of the DIGITAL Performance Index is the calculation of the revenue generated by the internet economy in ten countries.

Presentation of results in the DIGITAL Performance Index: The results from both parts of the study were summarised in the DIGITAL Performance Index. The DIGITAL Performance Index shows – in a single number – the strength and economic significance of the digital economy in each country. In each category, the best country functioned as the benchmark and received the maximum of 100 points. The other countries were ranked between 0 and 100 points based on how far behind the leading country they were.

Value added: Special analyses by ZEW on gross value added, innovation and investment or start-ups illustrate the value added generated by the digital economy for Germany as a business location.

In an **expert workshop**, measures were developed for both parts of the report to firstly drive forward digitalisation in the sectors and secondly the digital economy as a whole.

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