



Digitalisation of the Economy in Germany

Digitalisation Index 2020

Summary of a study as part of the project “Development and Measurement of the Digitalisation of the Economy in Germany” on behalf of the German Federal Ministry for Economic Affairs and Energy

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The Digitalisation Index for Germany

The corona pandemic in 2020 gave a boost to digitalisation in Germany and showed the opportunities that it can create. However, it also became clear that there are shortcomings in the context of digitalisation. To produce valid underlying data for the status quo and the development of digitalisation in the German economy, the annually published Digitalisation Index has been developed. In particular, it provides results for digitalisation by sector, company size class, federal state group and type of region.

The index can be broken down into company-internal and company-external aspects. The company-internal aspects include the five categories of processes, products, business models, qualification, and research and innovation activities. The company-external aspects cover the categories of technical infrastructure, administrative-legal framework, society, human capital and innovation landscape. All categories contain multiple indicators. Since the availability of the data differs, not all indicators and categories are applicable for all of the aforementioned differentiations in the index.

In the following, the core results for 2020, the survey year, are provided. An extensive report on the results together with a detailed analysis will be published at the beginning of 2021. Detailed results for individual categories and indicators can be seen in the interactive indicator tool (Indikatoren-Tool) at de.digital.

Results

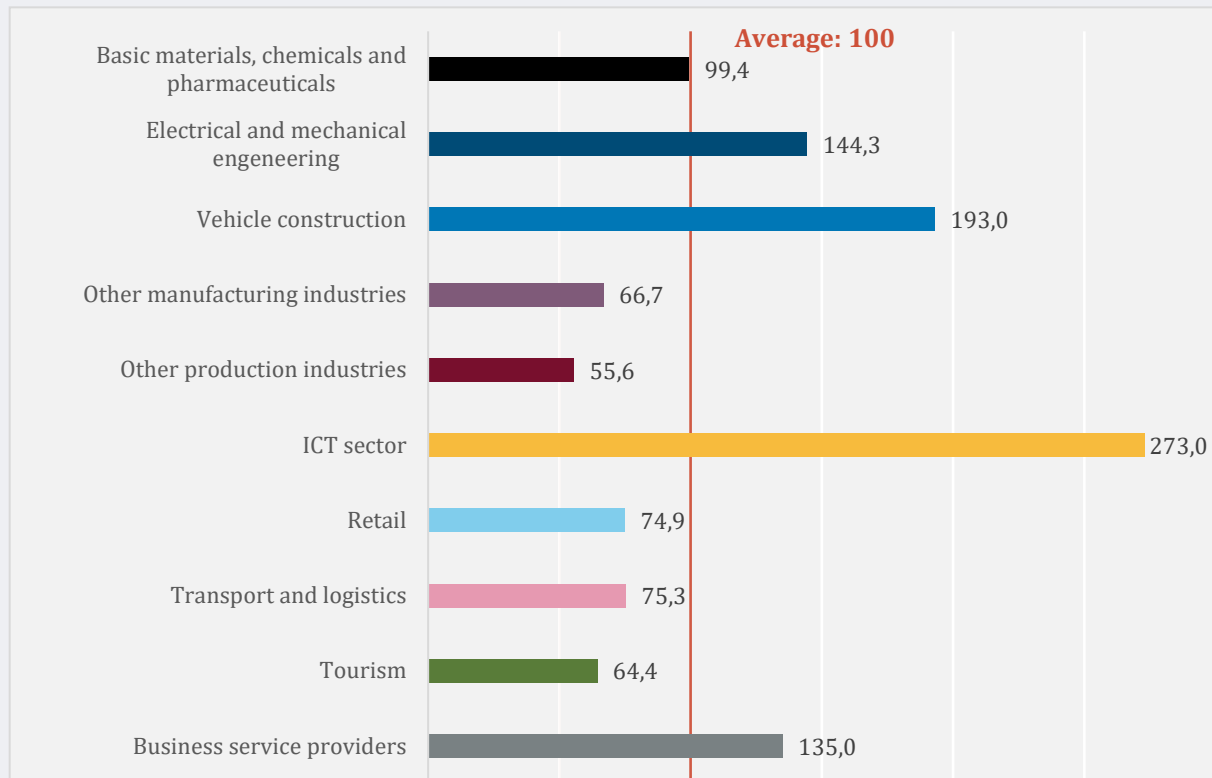
Digitalisation by sector

Ten sectors or sector groups have been included for the analysis of the differences between sectors in digitalisation (Figure 1). The weighted average of the sectors is set to a score of 100. The results show:

- The sectors that have made the most progress with digitalisation are the information and communications sector (ICT, 273.0 index points or 273% of the sector average), vehicle construction (193.0 index points) and the electrical and mechanical engineering sectors, which are considered jointly here (144.3 index points).
- The least digitalised sectors are other production industries, which include construction (55.6 index points), tourism (64.4 index points), and other manufacturing industries, which include the production of textiles (66.7 index points).

Figure 1: Results of the Digitalisation Index 2020 by sector

In index points, weighted average of sectors = 100



Source: German Economic Institute, IW Consult

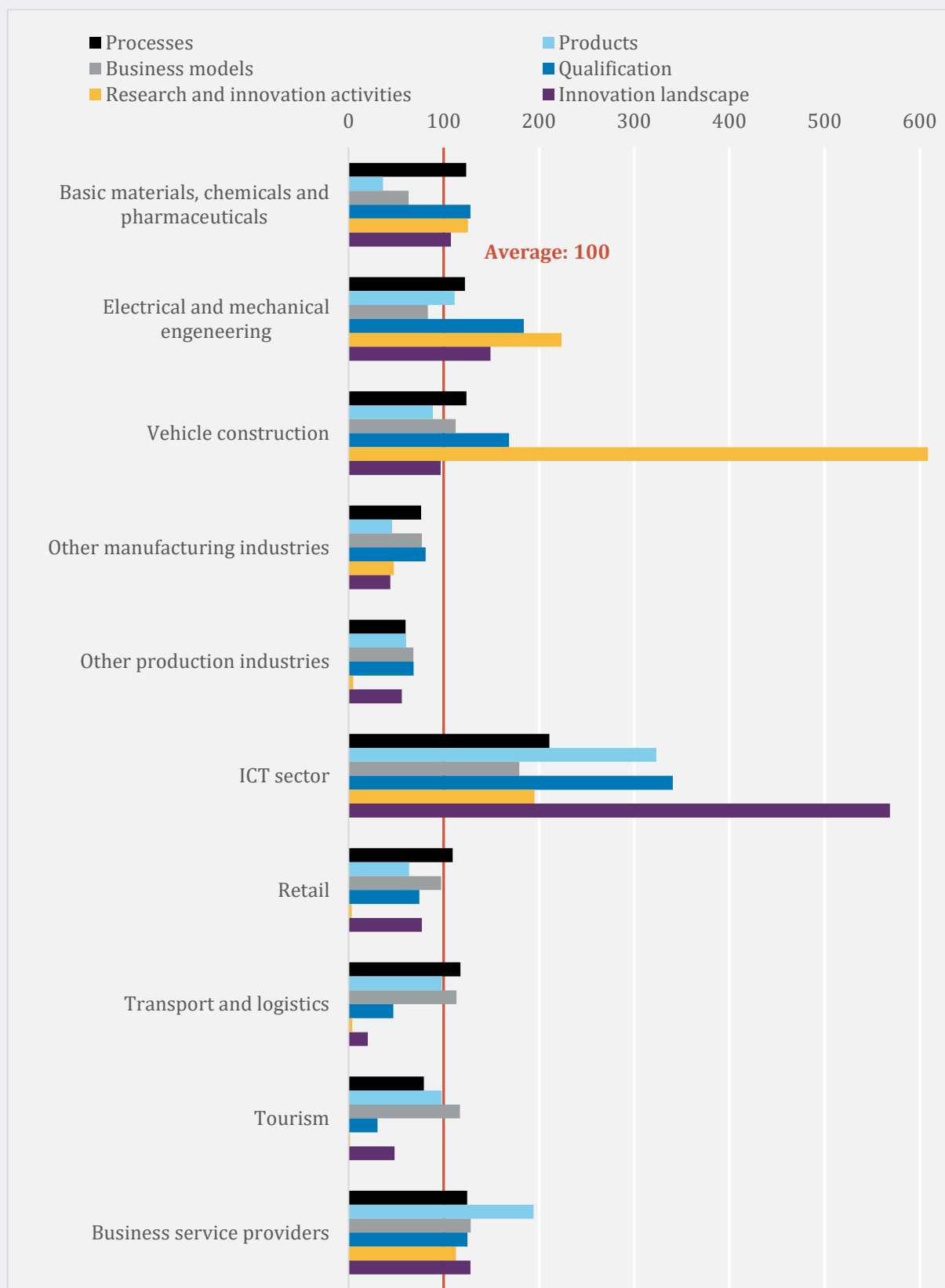
A closer look at the individual categories in the Digitalisation Index shows the digitalisation performance in different categories for each sector (Figure 2).¹ It becomes clear that the **ICT sector** has achieved far above average digitalisation in all categories. One category that stands out in particular is innovation landscape, which combines the indicators of R&D/innovation partnerships and digital start-ups. Especially high scores are seen in this sector as well for the digitalisation-relevant qualification of employees and the digital components contained in products.

Vehicle construction achieves a high total score in the Digitalisation Index 2020, especially due to the category of research and innovation activities. However, the scores for the digitalisation-relevant qualification of employees and the digitalisation of processes are also above average. The strengths in the sector of **electrical and mechanical engineering** also lie in research and innovation activities as well as digitalisation-relevant qualification. The sector also exhibits above-average scores in the category of innovation landscape. In contrast to the two previously mentioned sectors, the overall picture in electrical and mechanical engineering is fairly balanced, and there are no strong outliers.

¹ Data are not available for all ten index categories on the sector level, but only for five company-internal categories – processes, products, business models, qualification and research and innovation activities – as well as one of the five company-external categories, namely innovation landscape.

Figure 2: Results of the Digitalisation Index 2020 by sector and category

In index points, weighted average of sectors = 100



Source: German Economic Institute, IW Consult

Sectors achieving below-average scores overall in regards to their digitalisation had results below the average of the sectors in all categories, with this being the case in particular in **other production industries** and **other manufacturing industries**. Other production industries received an especially low score in the category of research and innovation activities. In comparison to these two sectors, **tourism** has above-average sector scores in the category of business models, even if the overall result in the sector is below average nonetheless.

The other examined sectors exhibit very different strengths and weaknesses in digitalisation. For example, **basic materials, chemicals and pharmaceuticals, retail, transport and logistics** and **business service providers** rank above average in the digitalisation of their processes. While the latter sector consistently achieves slightly above-average results, the sector of basic materials, chemicals and pharmaceuticals has low scores for the digitalisation of products and business models. In contrast, transport and logistics lags in the area of qualification of employees. Fundamentally, it is necessary to consider the respective peculiarities of each individual sector in the interpretation of the results. For example, especially the results in the sector of basic materials, chemicals and pharmaceuticals are logical in the categories of products and business models due to the products in the sector.

Digitalisation by company size class

The Digitalisation Index differentiates between three company size classes (Figure 3). The weighted average index value for all company size classes is set to 100 for the survey year of 2020. In Germany, the overwhelming majority of the companies fall under the group with a size of up to and including 49 employees.² The average is therefore largely determined by these small companies. This can be seen in the results:

- Large companies have an index score that is almost twice as high as the average score across all company size classes.
- Medium-sized companies achieve a score of 125.9 index points or around 126% of the average.
- Small companies reach a total of around 88.9 index points.

The results for the individual categories in the Digitalisation Index show how these results stack up for different size classes (Figure 4).³ The clearly above-average position of **large companies** in digitalisation is largely a product of higher scores in the categories of processes, qualification, research and innovation activities and in the category of innovation landscape. The last category stands out in particular – large companies clearly cooperate more with other companies and institutions on R&D or other innovation-related projects than small and medium-sized enterprises (SMEs). Furthermore, their scores are substantially above-average for the continuing education of IT skilled labour and IT users as well as for employment in digitalisation professions. However, large companies also have one category – products – in which the results are below the average for all companies. In the case of purely digital products as well as products with digital components, small

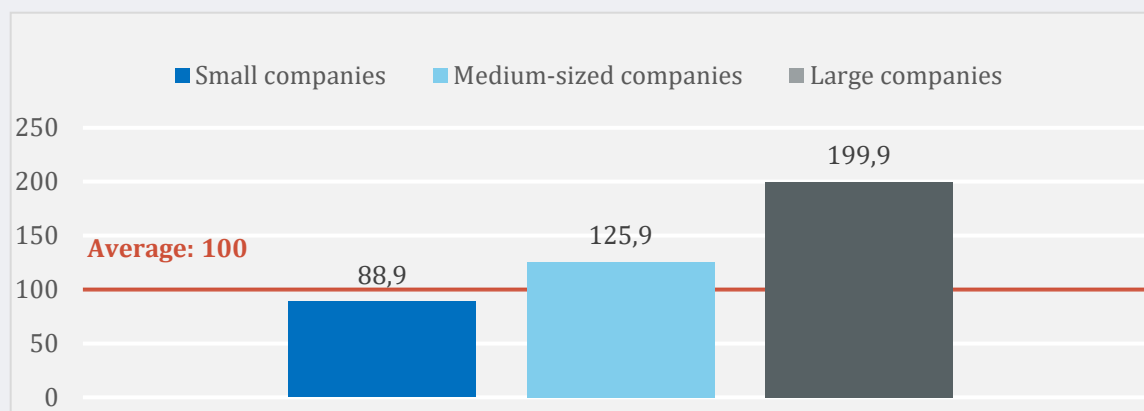
² <https://www.destatis.de/DE/Themen/Branchen-Unternehmen/Unternehmen/Unternehmensregister/Tabelle/StatUnternehmenBeschaeftigtenGroessenklassen-wz08.html> [30 October 2020].

³ Data are not available for all ten index categories on the level of company size class, but only for five company-internal categories – processes, products, business models, qualification and research and innovation activities – as well as one of the five company-external categories, namely innovation landscape.

companies in particular achieve slightly above-average scores. Here, too, special aspects of the size classes should be considered in the interpretation. The result for small companies in the category of products could be due to the size structure of the ICT sector with its particular focus on digital products.

Figure 3: Results of the Digitalisation Index 2020 by company size class

In index points, weighted average of size classes = 100



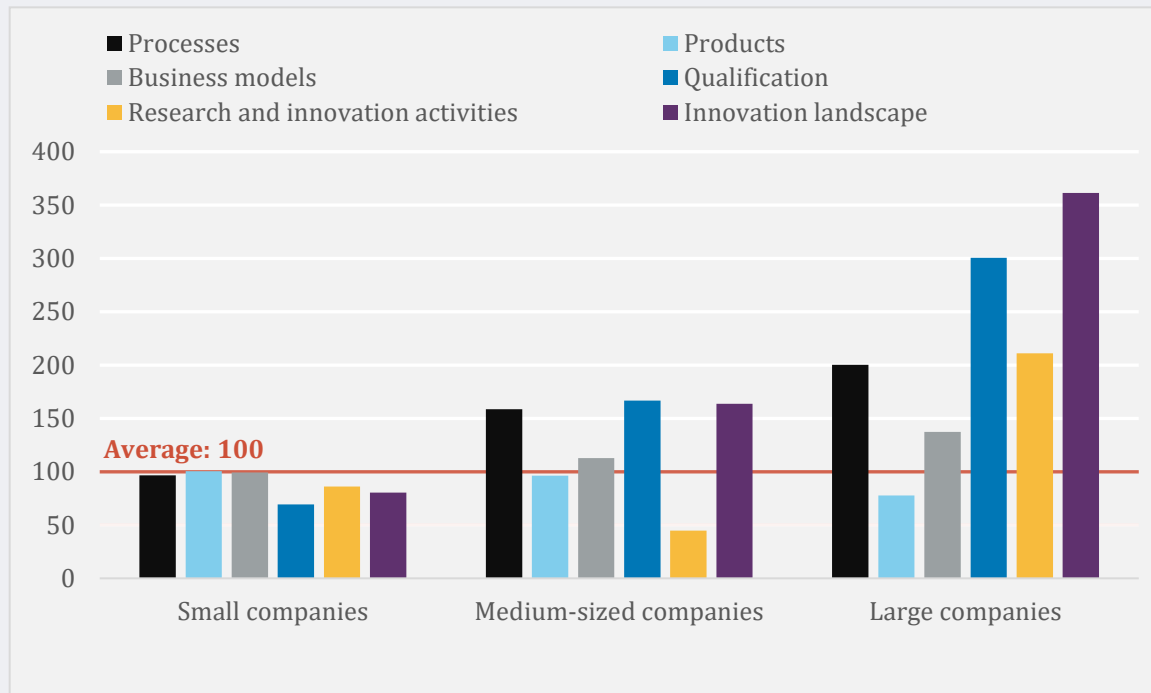
Source: German Economic Institute, IW Consult

In the category of products, **small companies** have scores that are slightly above the average for all companies. They have below-average scores in the categories of qualification, research and innovation activities and innovation landscape. The innovation landscape is determined by partnerships between companies and, for example, universities, which are found at large and medium-sized companies above all. The result for small companies, especially in research and innovation activities, is very impressive, because they achieve a higher score than medium-sized companies.

Research and innovation activities also simultaneously represent the only category in which **medium-sized companies** are clearly below average. In the categories of products and for the digitalisation of the business models, the results for medium-sized companies are roughly at the level of the average. Clearly above-average are the use of digitalisation in the processes, the R&D/innovation partnerships (category of innovation landscape) and the results for the category of qualification.

Figure 4: Results of the Digitalisation Index 2020 by company size class and category

In index points, weighted average of size classes = 100



Source: German Economic Institute, IW Consult

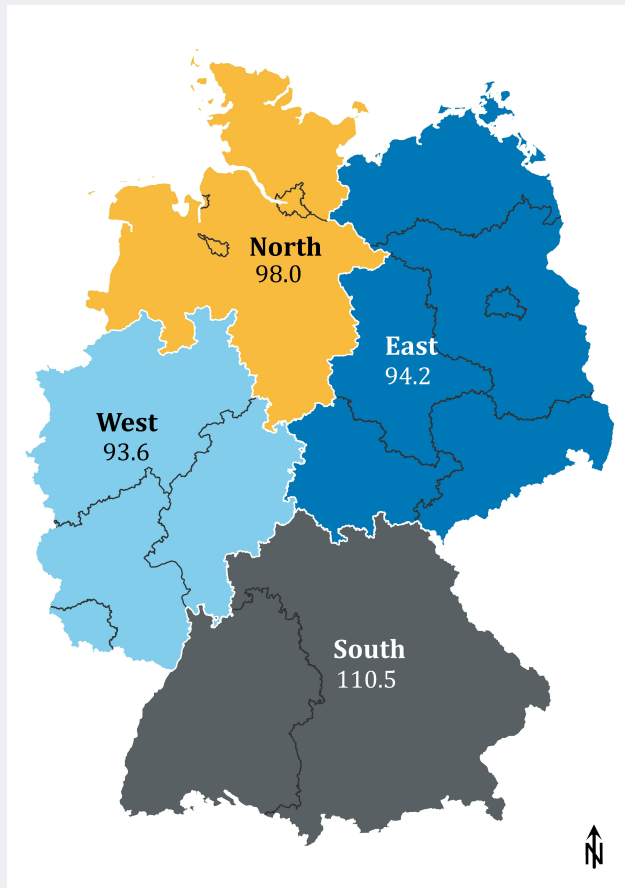
Digitalisation by German federal state group

To analyse the status quo of digitalisation by region, the German federal states are divided into four state groups whose weighted average index is set in turn to a score of 100 (Figure 5). This produces the following results:

- Baden-Württemberg and Bavaria make up the state group South and have the highest score of 110.5 index points. This means that the level of digitalisation in the state group South equates to 110% of the average for all four state groups.
- With 98 index points, the state group North (Bremen, Hamburg, Lower Saxony, Schleswig-Holstein) is close to the nationwide average.
- The state group East (Berlin, Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt, Thuringia) is slightly below average with a score of 94.2 index points.
- The state group West has the lowest score with 93.6 index points (Hesse, North Rhine-Westphalia, Rhineland-Palatinate, Saarland).

Figure 5: Results of the Digitalisation Index 2020 by federal state group

In index points, weighted average of federal state groups = 100



Source: German Economic Institute, IW Consult

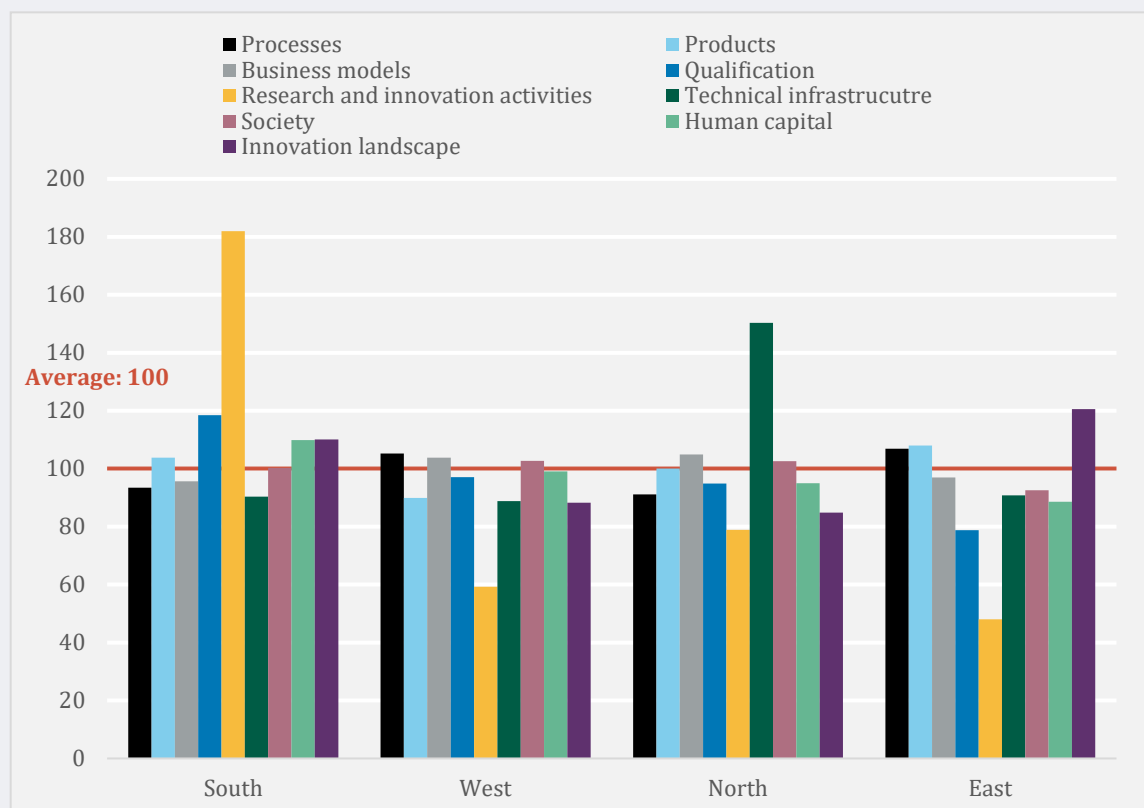
This map of the German federal state groups can be analysed in more detail on the level of the categories (Figure 6).⁴ It becomes clear that the **state group South** achieved a high score of 110.5 index points, because the results in the category of research and innovation activities in particular are above average in these federal states. This is also driven by the indicators of R&D personnel and R&D expenditures of the companies, but above all by the very good performance in digitalisation-related patents by companies. Furthermore, the result for the category of qualification in the state group South is above average. In the company-external categories of human capital and innovation landscape, these states are also better than average. It would be good to see improvement, especially in the technical infrastructure and digitalisation of processes and business models.

The **state group North** has a clearly defined strength in the area of technical infrastructure. The availability of high-speed bandwidth networks is here clearly better than average for the state groups. In addition, this group slightly outperforms in the categories of society and business models. In contrast to this, the results for the categories of research and innovation activities and innovation landscape in particular are below average.

⁴ Data are not available for all ten index categories on the level of federal state groups, but only for five company-internal categories – processes, products, business models, qualification and research and innovation activities – as well as four of the five company-external categories, namely technical infrastructure, society, human capital and innovation landscape.

Figure 6: Results of the Digitalisation Index 2020 by federal state group and category

In index points, weighted average of federal state groups = 100



Source: German Economic Institute, IW Consult

The **state group East** achieves above-average scores in the category of innovation landscape, which is probably due in particular to Berlin and Saxony. This category consists of, for example, indicators such as start-ups with digital business models and various indicators on the digital innovation activity of universities and other scientific and academic institutions. In addition to this category, the categories of products and processes stand out as above average. In contrast, the results in the categories of qualification and especially research and innovation activities are below the average for the state groups. Low scores are also found in the categories of human capital and society.

The **state group West** exhibits slightly above-average scores for the categories of processes, business models and society in the Digitalisation Index. In the first category, the state group achieves the top score for all state groups in the indicator of the digital networking of companies. In total, however, the categories evince no strong outliers on the upside as in the state groups North and South. The technical infrastructure in the state group West is average in the area of households, but far below average for industry. Furthermore, there is a substantial need to catch up in the categories of research and innovation activities, and to some extent in the categories of products and innovation landscape. Especially dramatic is the result for the indicator of R&D expenditures by companies in the category of research and innovation activities, as the state group West achieves the worst result in this category.

Digitalisation by type of region

It is possible to calculate the Digitalisation Index not only for geographic regions, but also for five different types of region (Figure 7).⁵ The weighted average of the types of region is set to a score of 100 in the survey year 2020. This can be seen in the results:

- The large agglomerations, i.e. metropolitan areas such as Berlin, Munich, Cologne, Dresden, Hanover and Hamburg, have an average of 123.1 index points (or around 123% of the average) and thus the highest scores in the Digitalisation Index.
- Core cities achieve the second-highest score and also an above-average degree of digitalisation with 112.5 index points.
- High-density rural areas are somewhat below the average for the types of region with a score of 97.8 index points.
- Likewise below average was the performance in the medium-density rural areas with a score of 83.0 index points.
- And bringing up the rear are the low-density rural areas with a score of only 76.6 index points.

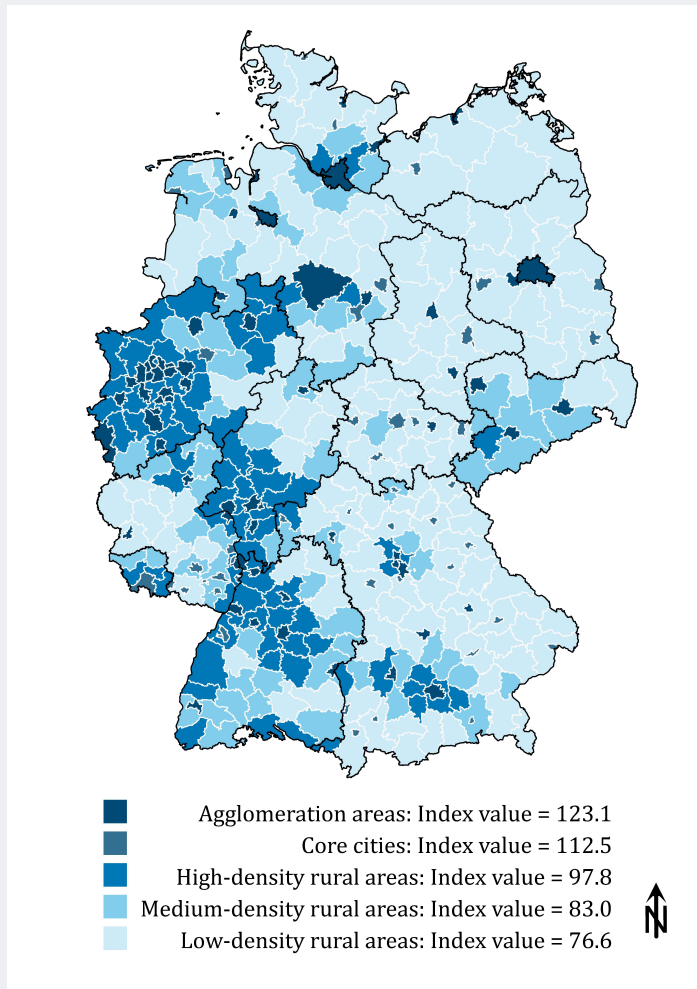
Analysing the individual categories for the types of region provides a more differentiated picture (Figure 8).⁶ The technical infrastructure in particular is far above average in the large **agglomeration areas**. Furthermore, many digital start-ups are located in these areas, contributing to a strongly above-average result in the category of innovation landscape. In the category of research and innovation activities undertaken by companies, the metropolitan areas also perform very well – especially due to the digitalisation-related patent filings by companies in these areas. Furthermore, this type of region achieves the best results in the category of products. Slightly below average, by contrast, is the result of metropolitan areas with regard to the category of processes. This is due to the somewhat lower-than-average digital maturity degree of the processes.

⁵ The types of region are differentiated by population density. District-free cities [kreisfreie Städte] are understood to be an agglomeration that has either a population of more than 500,000, or a population of at least 100,000 and a population density of at least 775 inhabitants per km². Core cities comprise those independent cities that do not meet the criteria of an agglomeration. The rural areas include districts that are ranked by population density. High-density rural areas have a population density of more than 223 inhabitants per km²; medium-density rural areas have between 139 and 223 inhabitants per km², and low-density rural areas less than 139 inhabitants per km².

⁶ Data are not available for all ten index categories on the level of types of region, but only for four of five company-internal categories – namely processes, products, business models, and research and innovation activities – as well as two of the five company-external categories, namely technical infrastructure and innovation landscape.

Figure 7: Results of the Digitalisation Index 2020 by type of region

In index points, weighted average of types of region = 100



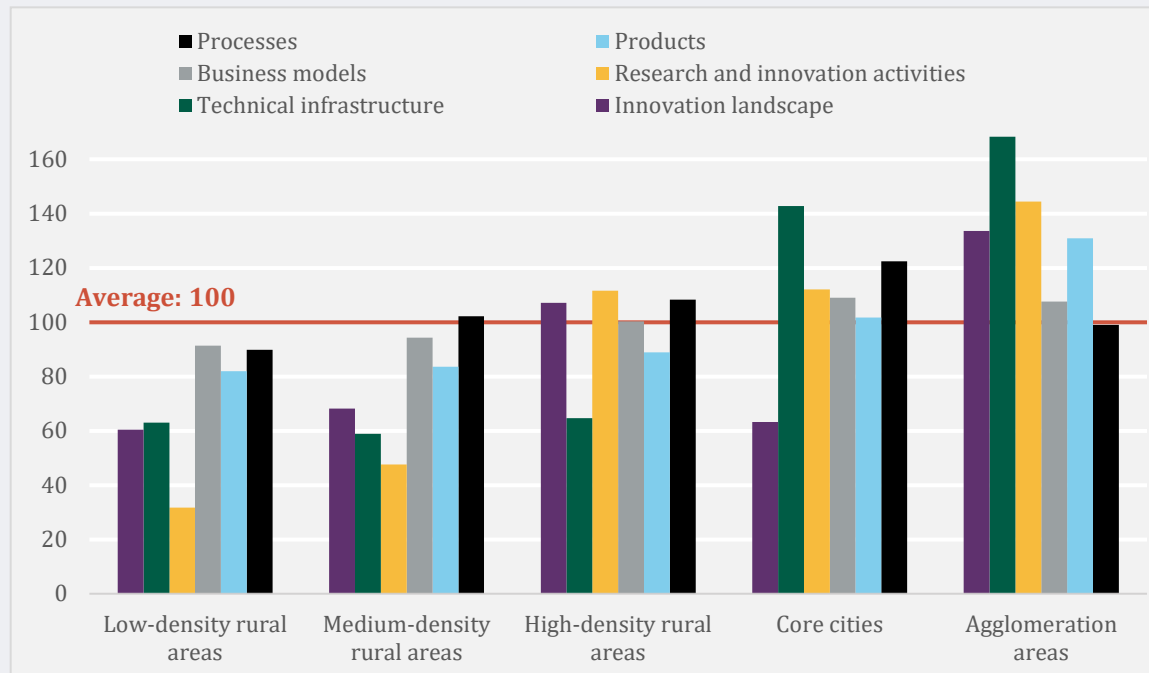
Source: German Economic Institute, IW Consult

When types of region are compared, processes are digitalised the most at companies located in **core cities**. In particular, the digital networking is far ahead, but the digital maturity degree of the processes is also high. Core cities are also above average in the categories of technical infrastructure, business models, and research and innovation activities. In the category of products, core cities are about average. By contrast, they have a need to catch up in the category of innovation landscape, which is primarily due to their limited relevance for digital start-ups.

An analysis of **high-density rural areas** shows that the degree of digitalisation in the economy falls as the distance to metropolises increases. These regions are not the leaders in any of the categories, but they also never bring up the rear. The digitalisation of processes is relatively far advanced. The above-average result in the category of research and innovation activities also stands out as a positive. This is supported by the indicator of R&D personnel. The high-density rural areas, by contrast, exhibit a below-average performance in the categories of products, technical infrastructure and innovation landscape.

Figure 8: Results of the Digitalisation Index 2020 type of region and by category

In index points, weighted average of types of region = 100



Source: German Economic Institute, IW Consult

The first weaknesses in rural Germany are seen in **medium-density rural areas**. Only the digitalisation of processes is above-average; in total, it is even substantially higher than for companies in the agglomerations. However, there is a serious drop-off from the degree of digitalisation for processes to the degree for products: The latter are substantially below-average in comparison to other types of region. The medium-density rural areas show particularly weak results in the categories of research and innovation activities as well as in the company-external categories of innovation landscape and technical infrastructure. The latter category contains the greatest weakness of medium-density rural areas – bandwidth availability.

Low-density rural areas have a need to catch up in every category. This relates to the digitalisation of companies and company-external categories. This type of region is the least digitalised in the categories of processes, products and business models. The indicator for the digitalisation of processes is, however, a ray of light, since it is only slightly below average, and is on par, for example, with the medium-density rural areas and even higher than in agglomerations. The prospects for the catch-up process necessary for digitalisation in rural areas have dimmed, however. The technical infrastructure is below average and patchy, with the peripheral location giving rise to additional disadvantages.

Conclusion and outlook

The status quo for the digitalisation of the economy in Germany is very heterogeneous. The various sectors, company size classes, federal state groups and types of region achieve different results and also have different strengths and weaknesses. It is necessary to systematically improve the weaknesses and expand on the strengths to move Germany ahead as a whole. The results for the Digitalisation Index in the coming survey years will show how well this has already succeeded and where adjustments must be made. It is up to companies to take responsibility themselves, but policymakers must also provide support and create adequate framework conditions.

In the first survey year of 2020, the index score is set to 100 for all of Germany. This will make it possible to track the development in future years relative to this base year. In the future, this will allow for detailed analyses of developments in the digitalisation of the economy in Germany and the derivation of systematic policy measures. On the level of Germany, it will be possible to make statements on the development of the digitalisation of the economy in the second index survey year.

Methodology

Parts and structure of the index

The Digitalisation Index consists of four levels (Table 1).⁷ Level 4, the lowest level, consists of 37 individual indicators that each reflect individual aspects of the digitalisation of the economy. These indicators are assigned to one of the ten categories in level 3. Five of these categories are aggregated in level 2 for the area of “company-internal” (processes, products, business models, qualification, and research and innovation activities); the other five categories are combined for the area of “company-external” (technical infrastructure, administrative-legal framework, society, human capital and innovation landscape). Finally, the company-internal and company-external areas (subindices) are combined in level one, the highest level, for the Digitalisation Index.

Standardisation of the indicators

The individual indicators are in different units and have different scales (e.g. as a percentage or share of another variable). For example, the scores for the different-sized federal state groups can be meaningfully compared with each other by initially taking the indicator scores and placing them in relation to another meaningful variable, if possible and necessary (e.g. the absolute number of patents in relation to the employees subject to social security contributions). To ensure comparability between the indicators, the score for Germany as a whole is set to a standard of 100 for each indicator in the first year of the analysis. Within an indicator, the scores for the sectors, company size classes, federal state groups and types of region are set in relation to the score for the average of the respective differentiation, which is based on a standard of 100. Therefore, the scores move on a scale around 100.

Weighting

Within the ten categories, there is an equal weighting for the individual indicators contained there at the beginning. In the case of empirical correlations and a high degree of overlap in the content between indicators, these factors are underweighted, so the effect contained in them is not taken into account twice. The ten categories are then included in the index by using a weighting from the IW Zukunftspanel for companies. The two subindices of “company-internal” and “company-external” together make up the Digitalisation Index for Germany.

Special aspects with regard to the differentiation of the index

The individual indicators are not always available on all four differentiation levels (sectors, company size classes, federal state groups and types of region). The respectively missing indicators and their weights are not considered in the calculation of the specific index values for the differentiation levels. Consequently, the explanatory power of the index on the Germany level is higher than that of the sectors, company size classes, federal state groups or types of region. A direct comparison of the scores for Germany with, for example, the scores for a federal state group is not possible on account of the

⁷ A detailed explanation of the methodology used can be found in the paper titled “Methodik des Digitalisierungsindex”.

different composition of the indicators. Instead, an average score is created for each of the four differentiation levels, which can be used as a comparative metric (e.g. the average score of the ten sector groups). This score is also set to the standard of 100 in the first year of analysis.

Table 1: Subindices, categories, weighting and indicators in the Digitalisation Index 2020

Level 1	Level 2	Level 3		Level 4
Digitalisation Index 2020	Subindex	Categories	Weight in per-cent	Indicators
	Com- pany-in- ternal Weight: 45.4%	Processes	11.0	- Digital maturity degree for processes - Digital networking
		Products	7.7	- Purely digital products - Products with digital components
		Business models	8.4	- Digital purchasing channels - Digital sales channels - Digital business models
		Qualification	11.6	- Continuing education of IT skilled labour - Continuing education of IT users - Employment in digitalisation professions
		Research and innovation activities	6.7	- R&D expenditures by companies - R&D personnel at companies - Digitalisation-related patents by companies
	Com- pany-ex- ternal Weight: 54.6%	Technical infrastructure	14.0	- Broadband availability – households - Broadband availability – industry - Fixed network and internet price - Mobile phone price
		Administrative and legal framework	11.4	- Adjustment of legal framework - Public online services - Public online forms
		Society	11.2	- Twitter announcements with connection to digitalisation - Newspaper articles with connection to digitalisation - Mobile internet use - Data volumes – mobile - Data volumes – cable-connected - Use of social media - Use of e-commerce
		Human capital	9.7	- Skilled labour gap in digitalisation professions - IT graduates - Trainees in digitalisation professions
		Innovation landscape	8.3	- Scientific and academic publications with connection to digitalisation - R&D/Innovation partnerships - Digital start-ups - R&D expenditures by federal government and states - Digitalisation-related patents – natural persons - R&D personnel – scientific institutions - Digitalisation-related patents – universities

Source: German Economic Institute, IW Consult