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Digitalisation activity defies the economy

Imprint

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The surge in digitalisation triggered by the COVID-19 pandemic is continuing. The proportion of small and medium-sized enterprises with completed digitalisation projects increased by 2 percentage points to 33%. The recent increase is mostly attributable to small businesses. However, the share of businesses with digitalisation projects is higher than before the pandemic in all enterprises size classes. In 2023, businesses spent EUR 29.3 billion on digitalisation, significantly more than before the pandemic.

The broader basis of digitalisation activities is reflected in the mix of completed projects. SMEs have stepped up basic projects such as those involving the digitalisation of interactions with customers and suppliers (+1 percentage point). After the pandemic slump, the share of businesses that are digitalising their product assortment has also recovered (+6 percentage points). More complex projects such as the reorganisation of workflows (-3 percentage points) and the integration of IT systems or capacity building measures (each -2 percentage points), on the other hand, are less common.

Despite the current trends towards a broadening of the basis of businesses active in digitalisation, digitalisation activities remain strongly concentrated in large and pioneering enterprises. Large SMEs are twice as likely to carry out digitalisation projects as small businesses and on average spend twenty times more than small businesses.

Addressing the main barriers to digitalisation and those segments that are still receiving less support constitute possible starting points for additional support through economic policy measures. They apply to both pioneers and latecomers.

Lack of in-house digital skills pose a major obstacle to digitalisation. This includes both the shortage of IT specialists – especially those with a tertiary degree – and insufficient digital skills in the broader workforce.

More young people need to be motivated to study information technology, and the dropout rate needs to be reduced. In order to improve the digital skills of the broader workforce, information technology needs to be integrated more closely into school, vocational and university education. Germany lags behind other European countries in the teaching of relevant foundation skills at school. With respect to continuing education and training, there is a need to realise the guiding principle of 'lifelong learning'.

In order to mitigate financing problems, it is important to set additional targeted financial incentives for the implementation of digitalisation projects for both pioneering and latecomer enterprises. There is a wide range of starting points, and they must take into account the maturity level of the digital technologies. Possible funding tools range from grants and tax relief for R&D activities through equity capital and quasi-equity instruments to promotional loans.

There is also a need to pay more attention to the strategic importance of digitalisation in the SME sector. With a view to digital latecomers, that means raising awareness of the need and strengthening the general strategic capacity of the businesses. For more advanced enterprises it means incorporating strategic concerns more closely into the planning of digitalisation measures and taking steps to prepare and implement a digitalisation strategy.

Creating the right framework also plays a role for a successful digital transformation. Possible measures around creating the proper enabling conditions range from expanding scientific research into digital technologies and setting standards for application to harmonising the legal framework and further improving digital infrastructure.

1. Introduction

As a general-purpose technology¹, digitalisation is an opportunity for developing new value creation potential, increasing the competitiveness of broad sections of the economy and kick-starting productivity growth. This applies not only to new technological fields such as artificial intelligence, blockchain technology and quantum computing. Digital technologies are also becoming increasingly pervasive in Germany's traditional areas of technological strength such as mechanical and automotive engineering.² In the future it will hardly be possible for Germany to develop new value creation potential or assert its existing strengths unless it develops adequate capacity in the area of digital technologies. Digitalisation is therefore deemed a key driver of innovation, competitiveness and growth for businesses as well as the overall economy.

The many different ways in which digitalisation and innovation activity are interconnected also play a role in this. Thus, digitalisation is often the technological basis that makes innovation possible in the first place.³ Conversely, it is particularly innovative enterprises that are driving digitalisation forward in great strides.⁴ So from a business perspective, digitalisation activities are important investments in the future that help enterprises position themselves in the market.

It is therefore unsurprising that numerous studies have identified positive effects of digitalisation for both individual businesses and the economy as a whole.⁵ The COVID-19 pandemic brought to light the benefits of modern information and communication technologies as well as digitalised workflows. It also revealed the deficits existing in Germany.

We define digitalisation in businesses as the implementation of projects that involve introducing or improving the use of digital technologies in an enterprise's processes, products or services and in its interactions with customers and suppliers. It also includes measures aimed at building relevant skills within the enterprise and implementing new digital marketing and sales strategies.

The diffusion of information technologies in the economy and society is not a new trend. Only the word 'digitalisation' was coined more recently. Examples of earlier digitalisation waves were the New Economy Boom of the second half of the 1990s, the rise of the PC since the 1980s, and industrial robots since the 1970s. Nevertheless, the current digitalisation wave is a far-reaching process that is generating profound changes in business and society.

What is causing concern is that the development of digital technologies is not among the strengths of Germany's innovation system⁶ and that the country is not exactly a pioneer in the application of digital technologies either. Thus, Germany achieves only mean scores compared with other European countries for the indicators measured in the revised 'DESI 2023 dashboard for the Digital Decade'.⁷ These refer to, for example, enterprise resource planning (erp) systems, electronic invoicing, social media, cloud computing and e-commerce. These ranks are likely a direct consequence of Germany's relatively low investment in information technologies.⁸ Finally, Germany's external trade in digital technologies is also decidedly weak.⁹

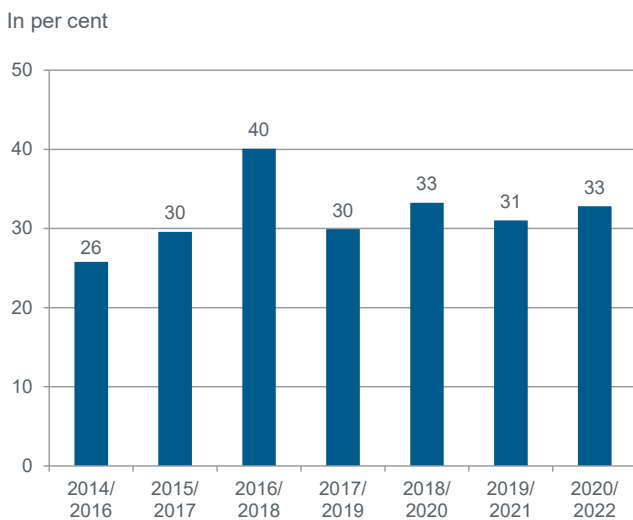
Major reasons for Germany's comparatively weak position in digitalisation likely include the fact that the focal areas of Germany's innovation ecosystem and economy gravitated to other technological fields over a long period of time. Furthermore, digitalisation activities face numerous barriers.¹⁰ Not least, many businesses still attach too little importance to strategic considerations in designing their digitalisation activities.¹¹

2. SMEs with completed digitalisation projects

Digitalisation activities are growing despite unfavourable economic environment

After digitalisation activities decreased moderately across the SME sector in the second year of the COVID-19 pandemic, the share of enterprises with completed digitalisation activities is now growing again. In the current survey of the KfW SME Panel (box: KfW SME Panel at end), which comprises the 2020–2022 period, the share of small and medium-sized enterprises with completed digitalisation projects rose moderately to 33% (Figure 1), the same level as in the first year of the pandemic. The number of SMEs with completed digitalisation projects rose by nearly 100,000 on the previous year's survey to a good 1.2 million businesses.

Figure 1: SMEs with completed digitalisation projects



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations.

This shows that unlike the activities of innovative businesses, digitalisation activities defied the economic downturn in the course of the year 2022. Thus, the business expectations of enterprises had already deteriorated in the spring of 2022, as shown by the KfW-ifo SME Barometer,¹² but also by the three-year turnover expectations surveyed under the KfW SME Panel. SMEs' profit margins were also lower in 2022 than in the previous year.¹³

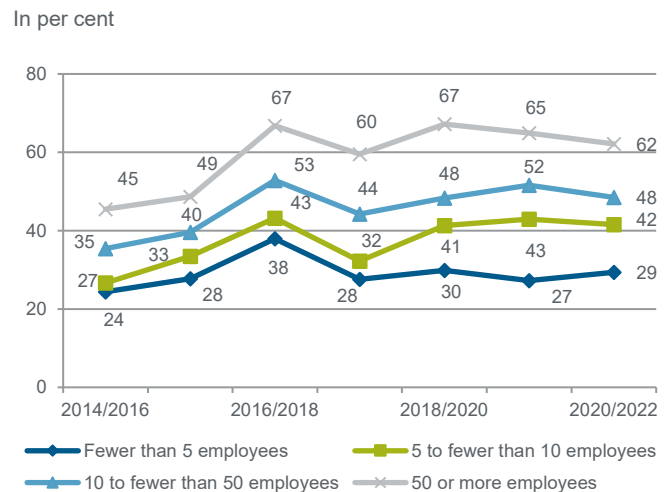
It can typically be observed that businesses are more likely to carry out digitalisation measures in favourable cyclical phases.¹⁴ This is because it is easier to fund digitalisation activities in such phases, for example from higher business profits and through better access to bank loans. Besides, (novel) processes are more

likely to be worthwhile in such phases, as they are then used at greater capacity. New (digital) products and services are more successful in the market in such phases. The current increase in the share of enterprises with completed digitalisation activities thus deviates from the typical cyclical pattern.

Small SMEs are more likely to digitalise

The increase in the share of businesses with digitalisation projects is essentially driven by the development among small businesses with fewer than five employees¹⁵ (Figure 2). In this group, which makes up just under four fifths of SMEs, the share of enterprises with digitalisation projects grew from 27 to 29%.

Figure 2: SMEs with completed digitalisation projects by enterprise size



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations.

Small businesses tended to be affected more often and, above all, more severely by the COVID-19 pandemic than larger SMEs. They recovered from turnover losses more slowly than larger enterprises.¹⁶ This likely contributed to the fact that the share of small businesses with digitalisation activities fell in the second year of the pandemic. The current rise in this share is likely to be a response to the decline in the previous year and reflect a catch-up effect.

At the same time, the share of businesses with 5 or more employees that had completed digitalisation projects fell. But it is important to note here that despite the decline, the share of businesses with completed digitalisation projects was higher in all enterprise size classes than before the outbreak of the pandemic or when this data was first collected under the KfW SME

Panel. Across the SME sector as a whole, the share of businesses with completed digitalisation projects has so far been higher in only one survey (the 2016–2018 period). That means a comparatively high share of SMEs is expanding their digitalisation activities overall.

Digitalisation activities continue to differ significantly between enterprise size classes. The share of businesses with completed digitalisation projects is more than twice as high among large SMEs than in the group of small businesses. This gap has even widened since this survey was first undertaken.

The percentage of businesses with digitalisation projects rises with enterprise size for a variety of reasons. Larger enterprises have more complex coordination problems to solve for which they require more information.¹⁷ Larger enterprises also tend to have a higher degree of automation and a broader range of activities. This means they have more extensive IT equipment which, in turn, more often provides starting points for further digitalisation measures.

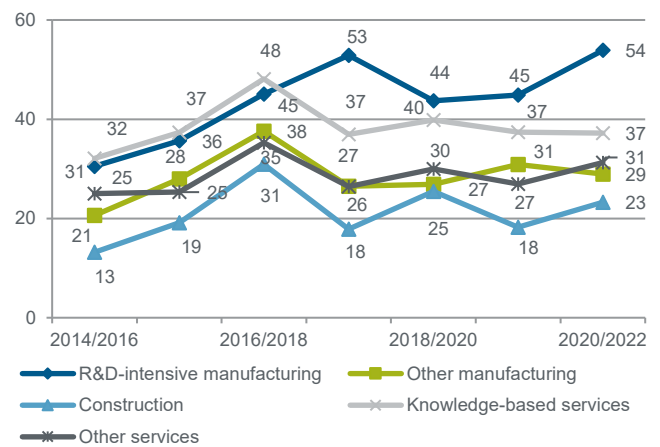
As they implement their projects, they benefit from the ability to allocate the (fixed) costs incurred to a larger sales volume.¹⁸ That gives them more capacity to absorb the risks involved and makes internal and external financial resources more readily available.¹⁹ For small businesses in particular, minimum project sizes and a higher proportion of fixed costs create a heavier burden²⁰, so that they are more likely to delay digitalisation projects. Finally, smaller businesses face greater challenges in accessing external finance for digitalisation projects.²¹

Share of businesses with digitalisation projects in R&D-intensive manufacturing has grown significantly

The sectoral comparison highlights the strong increase in the share of businesses with completed digitalisation projects in R&D-intensive manufacturing.²² Businesses in these sectors had substantially reduced their digitalisation activities during the pandemic. It is possible that the already high level of digitalisation there required them to make fewer adjustments in the pandemic than other sectors. Thus, manufacturing firms were relatively less impacted by turnover losses during the pandemic.²³ Businesses operating in R&D-intensive manufacturing clearly stood out from other sectors, with a share of 54% of companies reporting completed digitalisation projects (Figure 4). They were followed by knowledge-based services businesses²⁴, where the share of businesses with digitalisation projects was a significantly lower 37%.

Figure 3: SMEs with completed digitalisation projects by sector

In per cent



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations.

In the remaining sectors the share of businesses carrying out digitalisation projects changed less strongly and uniformly. In all groups of business sectors under review the proportion of enterprises with completed digitalisation projects was at least as high as before the outbreak of the pandemic, if not higher. This, too, reflects the fact that the digitalisation surge triggered by the COVID-19 pandemic continues – in spite of the unfavourable environment.

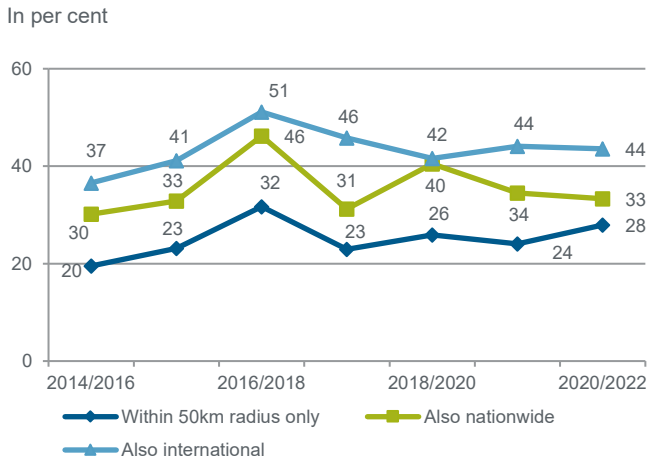
Intense competition in supra-regional markets is forcing businesses to go digital

The regional reach of a company's sales market also plays an important role in its digitalisation (Figure 4). The share of digital transformers is significantly higher among enterprises that operate in an international sales market than among those with merely regional activities (44 vs. 28%). It is known that this pattern also applies to SMEs' innovation activity.²⁵

The reasons for this are that the relevant enterprises are in more intense competition and therefore under particular pressure to keep their products up-to-date and their business processes efficient. Early adoption of new technologies and the offering of high-quality products with the latest technology provide competitive advantages over rivals.²⁶ The use of digital technologies also provides advantages in communicating across long distances. This applies to a company's visibility in foreign markets, for example, and its communication with customers and other business partners.²⁷ At the same time, innovative capacity and a certain degree of digitalisation are also likely important prerequisites for gaining a foothold in international markets. Not least, having a presence in supra-regional

and international markets is a source of inspiration and new knowledge²⁸ that can lead to both traditional innovation and to broader digitalisation.

Figure 4: SMEs with completed digitalisation projects by sales region



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations.

Compared with the previous year’s survey, only minor variations by sales market region can be observed. The share of internationally active enterprises with digitalisation projects remained unchanged. The weak performance of German export markets thus hardly impacted the digitalisation activities of these companies. Internationally active businesses thus remain well ahead of those with less extensive sales markets in terms of digitalisation activities. This share decreased minimally among companies with Germany-wide operations. However, it is higher than before the outbreak of the pandemic. The increase in the share of businesses with digitalisation projects among those with exclusively regional operations is aligned with the development among small businesses. Small businesses in particular are likely to operate mainly in a regional market.

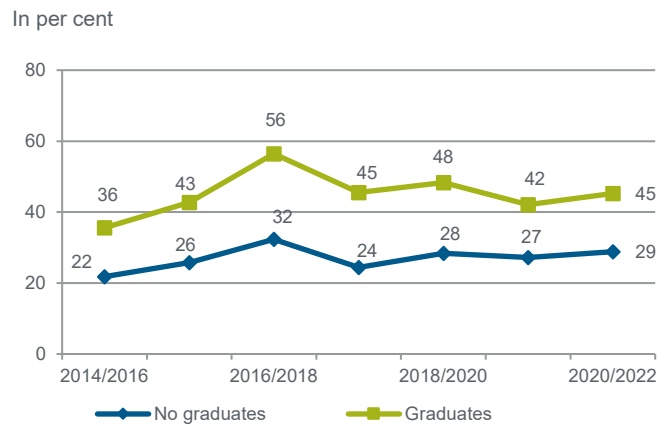
Having university graduates in the workforce is an asset for digitalisation

At present, 45% of enterprises that employ graduates have completed digitalisation projects (Figure 5). This share is thus significantly higher than in businesses without graduates.

The likely reason for this is that having a high level of human capital is an important source of innovation.²⁹ A workforce with higher formal qualifications also makes it easier to use information technologies, an observation that is also confirmed for the use of other advanced technologies.³⁰ Among other things, this may be attributed to the fact that the relevant enterprises

are better organised to prepare for the use of information technologies and that tertiary degree courses promote the development of problem-solving abilities more strongly than other qualifications. Both can increase the benefit to be drawn from the use of such technologies.³¹

Figure 5: SMEs with completed digitalisation projects with and without graduate employees



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations.

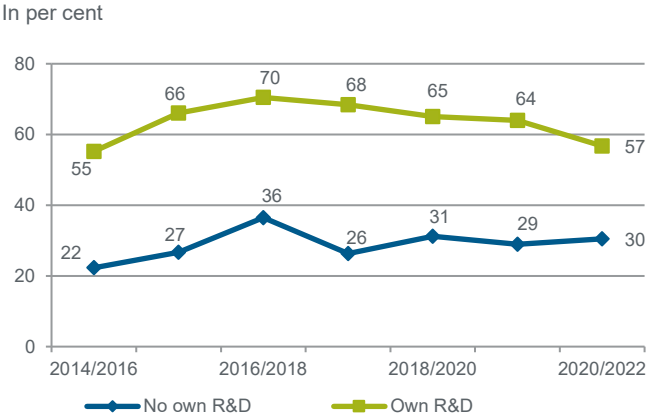
The shares of businesses implementing digitalisation projects increased in both groups on the previous year’s survey. For those that employed tertiary graduates, this means the share is now back to the pre-pandemic level. At the same time, those without tertiary graduates are much more actively engaged in digitalisation than before the pandemic.

Enterprises engaged in R&D are more likely to carry out digitalisation projects

Own research and development (R&D) activities can be a source of inspiration for designing and implementing digitalisation projects. R&D is defined as ‘creative and systematic work undertaken in order to increase the stock of knowledge [...] and to devise new applications of available knowledge’³². It enables a company to develop new digital products and production processes as well as further business applications in the context of R&D projects. What is also conceivable is that digitalisation ideas in enterprises conducting R&D do not emerge directly from their own research activity. Rather, engaging in own R&D may also indicate that the business is operating in an innovative environment and that this also translates into higher digitalisation activities – without meaning that it conducts R&D specifically targeted at digitalisation. It has generally been found that innovation and digitalisation activities reinforce each other.³³

These considerations also hold true for SMEs. Businesses that perform own R&D implement digitalisation projects significantly more often than those that do not.

Figure 6: SMEs with completed digitalisation projects with and without own R&D activities



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations.

The share of businesses engaged in R&D that have completed digitalisation projects decreased on the previous year’s survey (Figure 6). This is in line with the development among large SMEs, where there is a heavy concentration of enterprises with R&D activities. Still, the drop was surprisingly steep and is also at odds with the development among R&D-intensive manufacturing firms. It remains to be seen whether this current decline will evolve into a trend or remains a one-off survey finding that represents an outlier. At currently 57%, that share is still decidedly high among SMEs with R&D activities. It is nearly twice as high as among those without R&D activities.

3. Types of digitalisation projects completed

End of pandemic has kickstarted digitalisation of product assortment

A closer look at specific types of projects reveals that the end of the COVID-19 pandemic as well as the currently broader basis of digitalisation activities have had a significant impact on the type of digitalisation projects being carried out.

In the first year of the pandemic, SMEs primarily digitalised their interactions within the value chain and with their final customers, introduced new marketing and sales strategies and renewed their IT systems. These measures were likely carried out to immediately address the consequences of the pandemic. They were largely completed in the second year of the pandemic. Digitalisation measures shifted more towards internal processes such as the reorganisation of workflows and integrating IT systems between different functional areas. These types of projects are ambitious, more in-depth projects that have longer timelines and are likely to be of strategic importance for the business in question. Businesses that carry out digitalisation activities in pursuit of strategic goals, such as implementing a pioneer strategy, standardising and improving their range of offerings or increasing their flexibility, are more likely to undertake such projects.³⁴

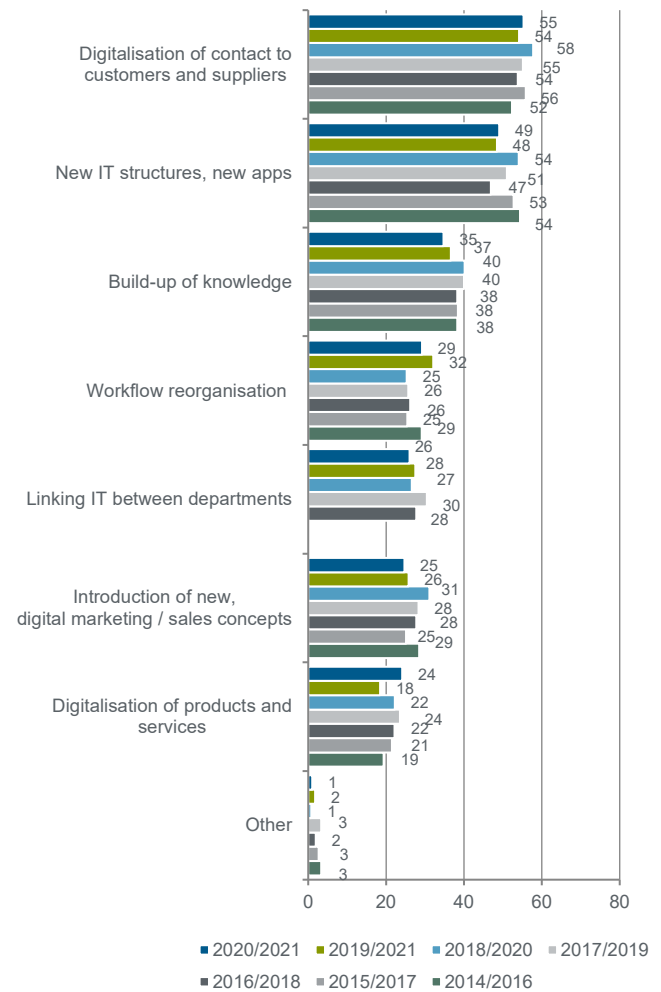
At present, however, fewer projects of this type are being implemented. This is likely a reflection of the fact that digitalisation activities are currently being pursued more intensely again by small businesses but slightly less often by large ones and those that are engaged in R&D activities. In addition to the types of projects mentioned, the share of businesses expanding their digital capacities is also decreasing. Instead, projects that involve the digitalisation of interactions with customers and suppliers and the renewal of IT structures were carried out slightly more often again (Figure 7).

The sharpest increase can be observed in the digitalisation of products and services. The share of enterprises pursuing this type of projects increased from 18% (of those businesses that have digitalisation projects) and has thus returned to pre-pandemic levels. During the pandemic, businesses attached less importance to digitalising their product assortment. The current increase therefore likely reflects a catch-up effect. The greater importance being attached to this type of projects is consistent with research findings which revealed that many businesses anticipated long-term changes in customer behaviour in their markets as a result of the pandemic.³⁵ After digitalising their

interactions with the business environment, their marketing and sales channels in the past years, businesses are now moving to digitalise their product assortment as well.

Figure 7: Types of digitalisation projects

In per cent



Note: Figures extrapolated on the basis of the number of enterprises, for all enterprises with completed digitalisation projects.

Source: KfW SME Panel, own calculations

Digitalisation of interactions with customers and suppliers remains most common project type

However, these shifts have not had an effect on the ranking of project types. Digitalising interactions with customers and suppliers remains the most common project type currently being implemented by SMEs (55% of businesses with digitalisation projects, +1 percentage point). This often involves redesigning websites and adopting internet applications such as online ordering and payment systems, using social media or setting up customer feedback mechanisms. It is also likely to include automating and, thus, digitalising the

sharing of data within the value chain.

IT infrastructure upgrades follow closely behind, with 49% of mentions. This includes installing new hardware, implementing new IT systems and adopting individual new applications (+1 percentage point). IT modernisation is therefore the second most common project type.

As in the previous period, projects aimed at boosting digitalisation expertise were the third most common type, coming in at a very distant 35% (-2 percentage points). This includes contracting digitalisation consultancy services and training employees. Lack of in-house expertise is among the most important obstacles to digitalisation. Digital skills deficits within the workforce and shortages of IT specialists (especially with tertiary degrees) equally constitute a bottleneck for businesses.³⁶ It is also difficult for companies to recruit for such skills.³⁷ Sought-after digital skills range from the basic ability to use computers and standard software through the ability to operate specialist software or digital production machines to programming and statistical analysis skills.³⁸

The fact that developing expertise ranks third in the list of digital project types shows that a significant portion of SMEs are actively tackling this obstacle and developing their digital capabilities. Advanced applications in particular often require businesses to have a minimum of expertise. Improving digital skills therefore plays a particularly important role in digitalisation.

Reorganisation of workflows is more important than pre-pandemic

Despite the decline on the previous year's survey (-3 percentage points), digitalisation measures aimed at reorganising workflows rank fourth, with a reported share of 29%. Enterprises likely reorganise workflows when the digital transformation profoundly alters their existing processes and business organisation. This suggests that affected enterprises are more likely to undertake complex digitalisation measures.

Businesses are also likely to pursue the digital integration of different functional areas from a longer-term perspective. The aim of such measures is to connect all digital applications at a whole-of-company level. They can therefore be seen as a long-term project that often has strategic significance. This type of project ranks fifth, with 26% of mentions (-2 percentage points).

Introducing new digital marketing and sales strategies is very closely behind in sixth place, with 25% of mentions. After adjustments to marketing and sales channels were made particularly in the first pandemic year, many businesses obviously see no further major need for action here at this time (-1 percentage point).

New digital marketing and sales strategies can also be introduced in connection with the digitalisation of the customer interface previously described. The frequent mention of this aspect in the first year of the pandemic was likely due to the fact that many digital latecomers were also carrying out such projects as a way of responding to the crisis. The introduction of meal pickup and delivery services by hospitality businesses was a typical example. However, enterprises that conduct R&D, in particular, also mention this type of digitalisation projects often. This suggests that at least some of these projects can also be more complex. One example of this are statistical analyses of customer behaviour.

Just as in the previous periods, digitalising products and services ranked last in the survey. At 24%, the share of businesses that completed projects of this type almost caught up with the two next higher ranks (+6 percentage points). This is probably due mainly to the fact that a certain need for catching up existed here after two years of the pandemic, even though the economic environment for the introduction of new products and services is not exactly optimal.³⁹

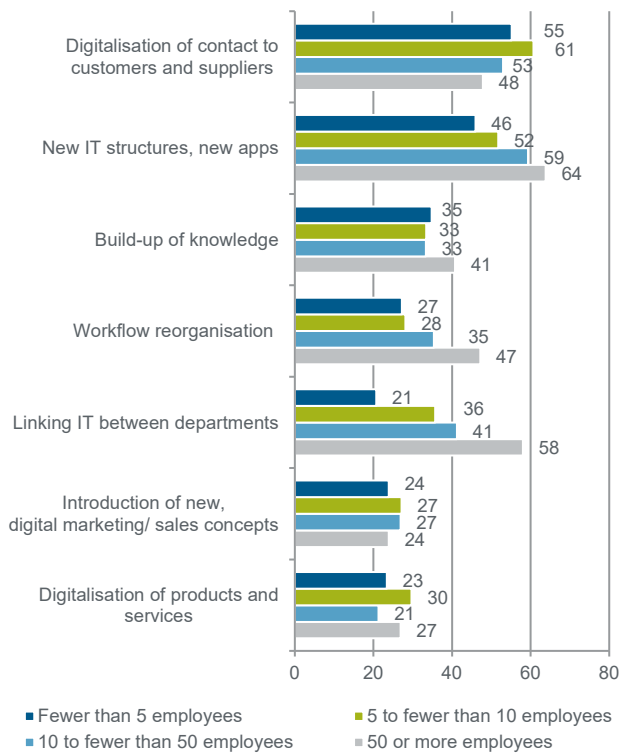
The still relatively low share of enterprises that digitalise their product assortment (rank 8) is consistent with frequently voiced complaints that digitalisation in Germany focuses too much on efficiency gains⁴⁰ and rarely includes the search for new areas of sales and activity, while also failing to sufficiently evolve business models.

Ambitious digitalisation projects are implemented mainly by large SMEs that conduct R&D

The most frequent type of digitalisation project implemented by small businesses with fewer than 10 employees involves the digitalisation of customer and supplier linkages, at 61% and 55% of enterprises. This suggests that these enterprises are often latecomers taking the first steps in this direction. Large SMEs and those that are already more digitally advanced are likely to have completed such steps already. To be sure, this type of digitalisation project also plays an important role among large enterprises and those conducting R&D. At the same time, however, the latter ones are increasingly directing their attention to other types of projects as well.

Figure 8: Types of digitalisation projects by size of enterprise in 2019–2021

In per cent



Note: Figures extrapolated on the basis of the number of enterprises, for all enterprises with completed digitalisation projects.

Source: KfW SME Panel, own calculations.

The fact that businesses with Germany-wide operations are also in the lead with respect to sales market region, at 63%, does not contradict this (Figure 10). It is likely due to the fact that companies operating regionally still continue to rarely see digitalised interaction as relevant to their business because of the shorter distances, and that businesses operating internationally are more likely to have completed this step already.

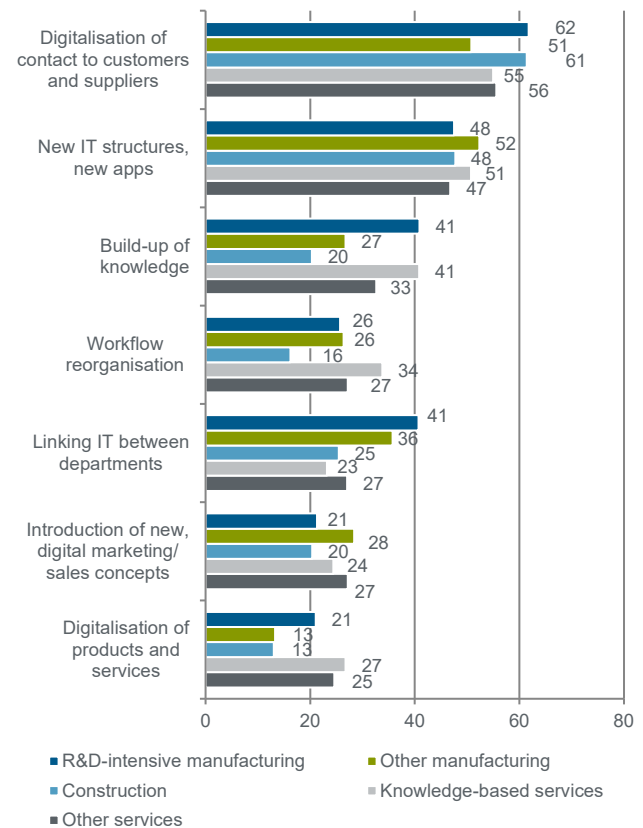
By contrast, the focus of large SMEs with 50 and more employees lies on the modernisation of their digital infrastructures and the introduction of new applications, with 64% of mentions. Furthermore, large SMEs are particularly active in carrying out projects that involve the digital integration of functional areas (58%), workflow reorganisation (47%) and the development of expertise (41%).

It is likely that the more widespread renewal of digital infrastructures, introduction of new applications and digital integration of functional areas is partly a size effect. After all, large enterprises have a greater need to digitalise such activities. Measures aimed at digitalising workflow reorganisation in particular are

probably also driven by the fact that these are usually enterprises that are generally more innovative and already more digitalised than others. Such enterprises also carry out complex digitalisation projects more often than others.

Figure 9: Types of digitalisation projects by economic sector in 2019–2021

In per cent



Note: Figures extrapolated on the basis of the number of enterprises, for all enterprises with completed digitalisation projects.

Source: KfW SME Panel, own calculations.

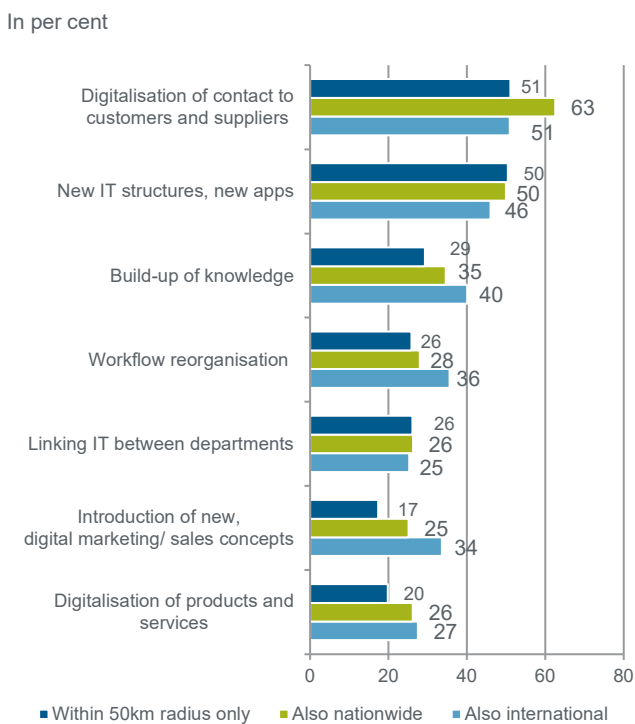
Digital pioneers are expanding their digitalisation expertise ...

Developing digital expertise was a measure mentioned much more often by large SMEs (41%) than small businesses (35%). Knowledge-intensive service providers and R&D-intensive manufacturers are particularly active in this area, with 41% of enterprises each implementing this type of digitalisation project (Figure 9). This is consistent with the fact that enterprises with own R&D (49%) also invest more often in expertise than other enterprises (Figure 11). The relevant enterprises thus possess characteristics typically associated with pioneer companies. This finding is in line with study results according to which pioneer companies are particularly likely to perceive a lack of digital skills as an obstacle to digitalisation.⁴¹

... and reorganising their workflows as part of digitalisation projects

Besides large SMEs, workflow reorganisation as part of digitalisation projects is also more widespread in knowledge-based services businesses, businesses with supra-regional operations and those engaged in R&D. This confirms the above consideration that these are more far-reaching projects that are typically more likely to be rolled out by pioneering enterprises.

Figure 10: Types of digitalisation projects by sales region in 2019–2021



Note: Figures extrapolated on the basis of the number of enterprises, for all enterprises with completed digitalisation projects.

Source: KfW SME Panel, own calculations.

Projects that involve the digital integration of functional areas are implemented by large enterprises that conduct R&D and by R&D-intensive manufacturing enterprises. To a large extent, this likely reflects a size effect because only companies larger than a certain size have clearly demarcated functional areas that can be integrated. However, the type of product or service the business provides and how much innovative capacity it has is also likely to play a role.

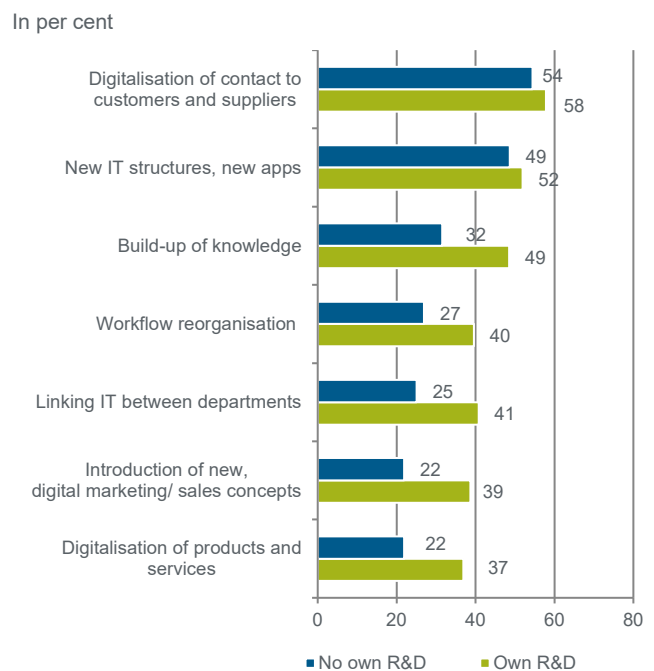
Small businesses and those that conduct R&D are both active in introducing new, digital marketing and sales strategies

There are only minor business size-related differences in how actively SMEs introduce new digital marketing and sales projects (24% to 27%). A wide variation is

evident in regard to R&D (39% among those with R&D vs. 22% for non-R&D conducting businesses) and in regard to sales markets (34% for companies with international operations vs. 17% for regionally active businesses). As mentioned above, this suggests that there is a broad range of projects of this type carried out not just by companies that are typically more often latecomers (such as small businesses, for example) but also by pioneering enterprises.

Finally, digital products and services are brought to market primarily by businesses that conduct R&D, those that have supra-regional operations and enterprises operating in the services sector. R&D-intensive manufacturing enterprises also stand out from other businesses in this regard. The digitalisation of products and services is thus heavily concentrated in pioneering enterprises with high innovative potential, even if the size of the enterprise does not play a prominent role for the implementation of this type of project.

Figure 11: Types of digitalisation projects of enterprises with and without own R&D activities in 2019–2021



Note: Figures extrapolated on the basis of the number of enterprises, for all enterprises with completed digitalisation projects.

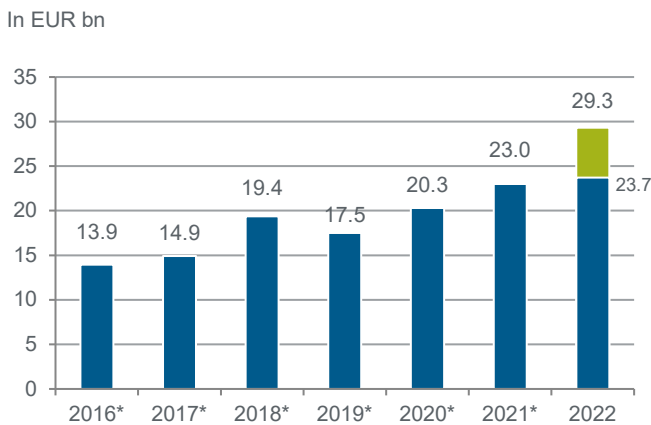
Source: KfW SME Panel, own calculations.

4. Development of digitalisation expenditure

Digitalisation expenditure is on a high level

In 2022, small and medium-sized enterprises spent EUR 29.3 billion on digitalisation projects (Figure 12). Unlike in previous surveys, the current survey also asked those businesses about their digitalisation expenditure whose digitalisation projects were not yet completed in the year under review.

Figure 12: Aggregate expenditure on digitalisation in the SME sector



Note: * Only enterprises with completed digitalisation projects, nominal, values extrapolated on the basis of the number of employees.

Source: KfW SME Panel, own calculations.

Adding the digitalisation expenditure incurred by enterprises without completed projects resulted in additional digitalisation expenditure of EUR 5.6 billion. Without these companies' digitalisation expenditure, that is, following the approach taken in previous years' surveys, the total current digitalisation expenditure in the SME sector amounts to EUR 23.7 billion. In current prices, this, too, would still document a minor increase on the previous year's survey and a much higher level than in the years before the pandemic (for example, +35% compared with 2019). A comparison with investments in physical assets (machinery, plant, equipment and similar items), however, shows that SMEs continue to spend much less on digitalisation. SMEs invested EUR 240 billion in assets in 2022.⁴² That means SMEs spent more than eight times more on investments in traditional assets than on digitalisation.

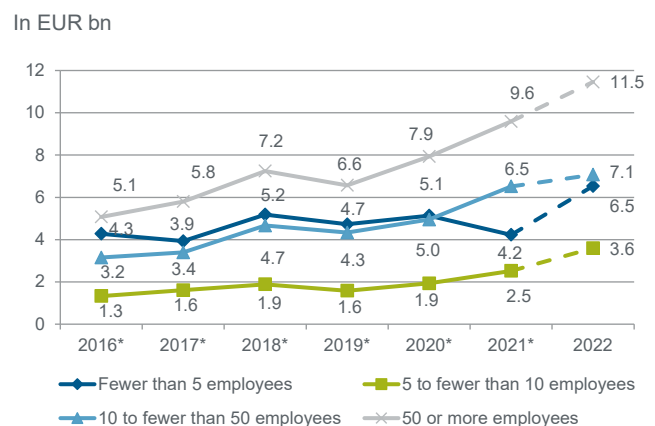
Digitalisation expenditure is heavily concentrated in large SMEs

Businesses with fewer than five employees account for a comparatively high share of EUR 6.5 billion or just under one fourth of digitalisation expenditure

(Figure 13). At first glance, this may come as a surprise because the share of enterprises with digitalisation projects in this group is relatively low. This finding can be attributed to the fact that businesses with fewer than five employees make up the bulk of small and medium-sized enterprises: 79%. Compared with larger enterprises, this group of enterprises reported a particularly steep increase in digitalisation expenditure since the previous survey. One likely reason for this is the increased share in businesses with completed digitalisation projects. Another reason is that the survey of expenditure among enterprises whose projects have not yet been completed leads to a more precise capture of digitalisation expenditure, particularly among small businesses, which often carry out only sporadic projects in irregular intervals.

Large SMEs with 50 and more employees account for the greatest share of digitalisation expenditure – EUR 11.5 billion, or 40% – even though they represent a small share of 2% of small and medium-sized enterprises. The share of digitalisation expenditure by large SMEs has grown over time. In 2016 that share was just 37%. At the same time, the share represented by micro-businesses dipped by 8 percentage points from 31%. The concentration of digitalisation expenditure in large SMEs has thus rather increased since this survey was first conducted.

Figure 13: Aggregate expenditure on digitalisation by SME size

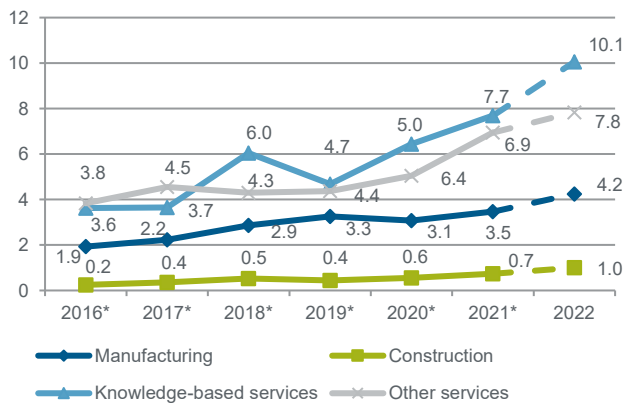


Note: * Only enterprises with completed digitalisation projects, nominal values, not counting enterprises of the remaining economic sectors, extrapolated on the basis of the number of employees.

Source: KfW SME Panel, own calculations.

Figure 14: SMEs' aggregate expenditure on digitalisation by economic sector

In EUR bn



Note: * Only enterprises with completed digitalisation projects, nominal values, not counting businesses with fewer than 5 employees, extrapolated on the basis of the number of employees.

Source: KfW SME Panel, own calculations.

A breakdown by economic sector shows that services businesses continued to spend the most on digitalisation overall, with knowledge-based service providers spending EUR 10.1 billion and other service providers EUR 7.8 billion (Figure 14). Both groups also represented the highest shares of small and medium-sized enterprises. The much smaller group of manufacturing enterprises accounted for EUR 4.2 billion in digitalisation expenditure. Construction firms spent the lowest amount on digitalisation: EUR 1.0 billion. The volume of expenditure thus also confirms the relatively low level of digitalisation activities of the businesses mentioned last.

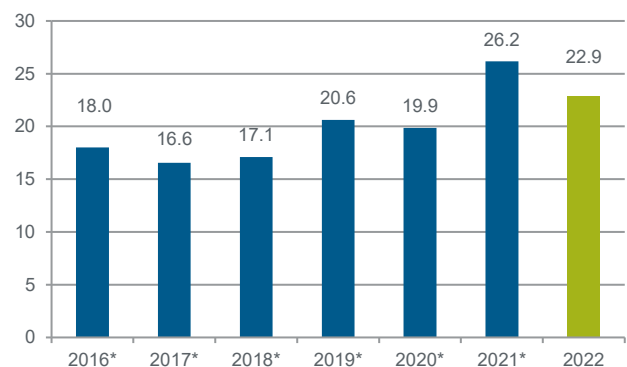
Average digitalisation expenditure continues on a high level

In order to illustrate the concentration of expenditure in different types of enterprises, the following figures show SMEs' average digitalisation expenditure. SMEs that were conducting digitalisation activities spent an average EUR 23,000 on digitalisation in 2022 (Figure 15). Although that was a minor decrease on the previous year, average digitalisation expenditure was nonetheless higher than at the beginning and before the outbreak of the pandemic.

The decline in average digitalisation expenditure on the previous survey is likely also due in part to the fact that the current survey covered businesses whose projects were not completed, which typically spend less on their digitalisation.

Figure 15: Average expenditure on digitalisation in the SME sector

EUR in thousand



Note: * Only enterprises with completed digitalisation projects, nominal, values extrapolated on the basis of the number of employees, only businesses that invested in digitalisation.

Source: KfW SME Panel, own calculations.

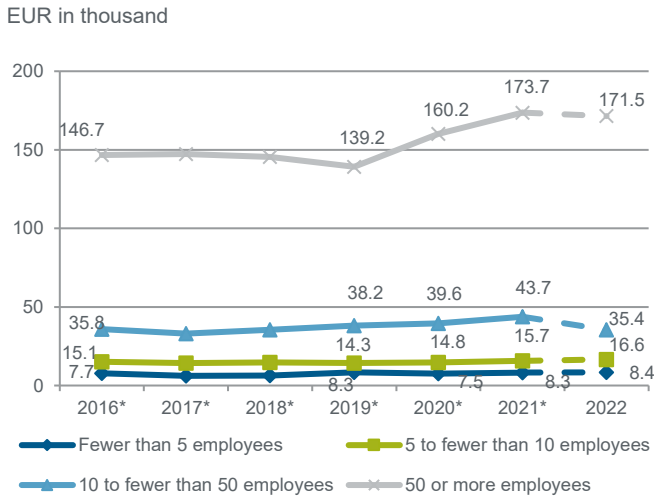
Overall, however, it is apparent that average digitalisation expenditure increased in 2021 and 2022 on the previous years. The surge in digitalisation identified last year thus continues. An important reason for this is likely the fact that many businesses are adopting a more strategic approach to digitalisation than before. Thus, a previous study revealed that the amounts spent by SMEs on digitalisation projects in the first year of the pandemic as an immediate response to its impact were significantly lower than the amounts invested by businesses with strategically aligned and typically more ambitious digitalisation projects. On average, businesses whose digitalisation activities have a strategic focus spent up to 61% more on digitalisation than businesses that carried out digitalisation projects for crisis management purposes.⁴³ In addition, the share of businesses with a company-wide digitalisation strategy increased from 16% to 20% between 2019 and 2021. Enterprises with a digitalisation strategy also spend significantly more on digitalisation than those without.⁴⁴

Wide gap in average digitalisation expenditure between small businesses and large SMEs

The level of average expenditure depends heavily on enterprise size. Businesses with fewer than five employees spent only a good EUR 8,000 on average on digitalisation in 2022. This proportion rose almost exponentially to just under EUR 172,000 in enterprises with 50 and more employees (Figure 16). What is noteworthy is that since the outbreak of the pandemic, average digitalisation expenditure rose much more strongly with increasing company size. That means large SMEs on average spent a good 20 times more on digitalisation than small businesses in 2022. This span

was ‘just’ 17-fold before the outbreak of the pandemic, for example in the years 2019 and 2016.

Figure 16: Average expenditure on digitalisation by SME size



Note: not counting enterprises of the remaining sectors, values extrapolated on the basis of the number of employees, only businesses with digitalisation expenditure.

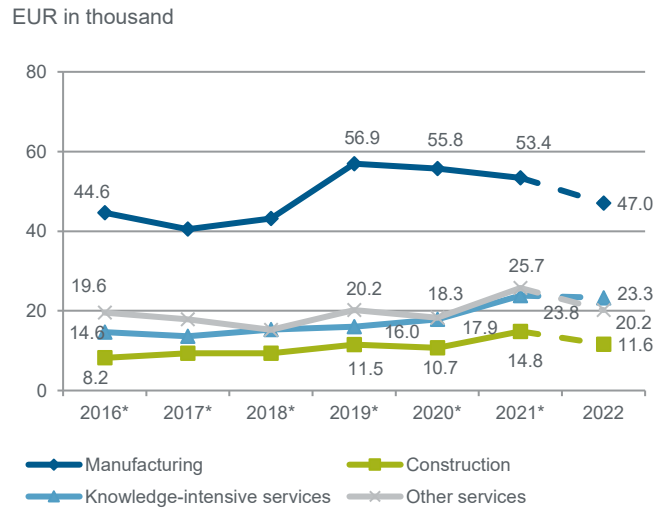
Source: KfW SME Panel, own calculations.

When we compare expenditure by enterprise size, we must always take into account that because of their size, small businesses also need to invest only smaller amounts in absolute terms in their digital transformation. Among other reasons, this is because they have less hardware and software and more work processes in which automation does not pay off. However, in relation to annual turnover, small businesses in particular invest above-average amounts in digitalisation relative to their size, which means that digitalisation places a heavier cost burden on them than on large enterprises.⁴⁵

In a sector comparison, manufacturing enterprises spent the most – approx. EUR 47,000 (Figure 1). They were followed at a significant distance by companies

providing other services and knowledge-based services, which were almost on a par at EUR 23,000 and EUR 20,000. The construction sector was in 4th position with just under EUR 12,000.

Figure 17: Average expenditure on digitalisation by economic sector



Note: Values extrapolated from the number of employees, only enterprises with digitalisation expenditure.

Source: KfW SME Panel, own calculations.

The likely main reason manufacturers spend so much on digitalisation is that digitalising production processes is very costly as it often involves replacing or retrofitting machines and equipment. Enterprises whose material investments represented a high share of their digitalisation costs spent particularly high amounts on digitalisation.⁴⁶ In service enterprises, on the other hand, the processes of service delivery are often not capital-intensive, requiring less effort to introduce changes. In the construction sector, too, digitalisation activities often focus on administrative processes and less on the direct provision of services. For this reason, they are also likely to be less capital-intensive.

5. Conclusion

Key findings on the development of digitalisation activities in the SME sector

In the current survey, the share of small and medium-sized enterprises with completed digitalisation projects grew moderately on the previous year to 33%. This share was as high as in the first year of the pandemic and higher than in the years before. The recent rise is attributable to the trend among small businesses, where the share increased to 29%. Digitalisation expenditure also continues on a significantly higher level than before the pandemic. In other words, the digitalisation surge triggered by the pandemic is continuing.

A look at the projects that have been implemented reveals that more small businesses and, hence more often, latecomer enterprises have recently been more likely to complete digitalisation projects. That means projects involving the reorganisation of workflows or the integration of IT systems and the acquisition of skills decreased on the previous year's survey. Instead, projects that involve the digitalisation of interactions with customers and suppliers and the renewal of IT structures were carried out slightly more often again. Furthermore, the share of businesses that are digitalising their product assortment also recovered – after decreasing during the pandemic.

Despite these current trends towards a broadening of the basis of businesses active in digitalisation, relevant activities are strongly concentrated in large – and pioneering – enterprises. Large SMEs are twice as likely to carry out digitalisation projects as small businesses and on average spend twenty times more than small businesses. As a result, aggregate digitalisation expenditure is also heavily concentrated in large SMEs. Since the surveys under the KfW SME Panel began, large SMEs have expanded their lead on small businesses, both in the share of enterprises with digitalisation projects and with respect to average and aggregate digitalisation expenditure. Thus, the long-term trend is that the divide between the digitalisation activities of large and small SMEs has deepened.

Possible starting points for economic policy measures

Germany has an elaborate system of measures designed to promote digitalisation, and real gaps in this promotional landscape are hardly perceivable. Nevertheless, the scope of promotion in individual segments varies, so that different potentials for further enhancing the promotional schemes on offer can be identified.

Promotional schemes currently focus mainly on supporting top performers. Activities aimed at supporting the transfer of new digital solutions to broad areas of application and fostering the application of digital technologies, on the other hand, exist to a limited extent only.⁴⁷ But it is important that promotional measures address the digitalisation activities of both pioneers and digital latecomers. Only in this way will it be possible to tap into growth areas of the future, achieve economically measurable results⁴⁸ and prevent a split into digital and non-digital SMEs.

In order to incentivise SMEs to implement digitalisation projects, one approach for economic policy is to intensify promotional activities in segments that have thus far received less attention and to address the key obstacles to digitalisation.

The main finding of the analysis of constraining factors affecting digitalisation in the SME sector is that the constraints can be summed up in four groups. The barriers that originate in the business environment can be summarised as the quality of Internet connectivity and data protection and data security requirements. Problems in implementing adjustments manifest themselves as concrete difficulties in migrating existing IT systems and difficulties in modifying the work management and business organisation. Lack of IT expertise is reflected in a shortage of IT specialists, insufficient digital skills within the broader workforce and uncertainty about future technological developments. Last but not least, difficulties in obtaining finance also pose a major hurdle for enterprises.⁴⁹

In addition, various studies have found that many businesses are not yet paying enough attention to the strategic importance of digitalisation. Although the share of businesses with a company-wide digitalisation strategy increased, it was only one fifth of SMEs at the beginning of the year 2021 – a moderate level.⁵⁰ Besides, only a small proportion of SMEs explicitly conduct digitalisation measures designed to achieve strategic objectives.⁵¹ The bulk of SMEs thus approach digitalisation less from a systematic perspective than on an ad hoc basis.

The following options can be derived from these considerations as possible starting points for economic policy:

Building skills

A key barrier to digitalisation in the SME sector is the

shortage of necessary skills. Hardly surprisingly, digital skills are exactly what businesses actively engaged in digitalisation are more likely than other enterprises to require and not have.⁵²

With respect to digital skills, one approach is to mitigate the shortage of IT skills, particularly of university-trained IT specialists. To achieve this, more young people need to be motivated to study information technology, and the dropout rate needs to be reduced. Digital skills can also be enhanced by improving the education level of school leavers and vocational and academic graduates. That makes it necessary to integrate IT skills teaching more strongly into school, vocational training and tertiary education curricula. A recent study has shown that Germany is lagging behind other European countries in the teaching of digital skills in schools.⁵³ With respect to continuing education and training, there is a need to realise the guiding principle of 'lifelong learning'.

Companies that are expanding their digitalisation, in particular, are already more active in meeting their skills requirements than other enterprises.⁵⁴ Businesses' training efforts can be supported by a range of economic policy measures. For one thing, this will require effective training incentives in the form of financial support such as promotional loans, direct cost reimbursement or the granting of tax benefits for continuing education expenditure. The certification of qualifications along with navigation and quality assurance in the confusing market for continuing education are also important starting points.⁵⁵

Advisory offers also play an important role in building skills. The existing advisory services such as Digital Jetzt, go-digital and the Mittelstand-Digital centres are experiencing high demand. But they still reach only a few thousand small and medium-sized enterprises. It can be assumed that demand is outstripping supply, so that expanding such services would reach further businesses.⁵⁶

Financing

Digitalisation projects have a variety of features that make them more difficult to finance than physical investments. For example, potential external capital providers have difficulty predicting their chances of success.⁵⁷ The share of material investments in project costs is also low, at just 37%. That is why digitalisation projects hardly generate any assets that could be used as loan collateral.⁵⁸ As a consequence, obtaining external finance for digitalisation projects is a particular challenge for businesses.

In order to mitigate financing problems, it is important to set additional targeted financial incentives for the implementation of digitalisation projects. There is a wide range of starting points, and they must be guided by the maturity level of the digital technologies.

In early phases, that means expanding the commitment of the public sector in the form of subsidies and tax benefits for R&D. Germany's support for corporate R&D is relatively moderate in an international comparison.⁵⁹ An additional approach to supporting top performers would be to more closely interlink promotion of R&D and digitalisation. To this end, investment in digitalisation, for example in software and databases, should also be classified as activities eligible for support by making corresponding adjustments to funding guidelines. A separation between R&D projects and digitalisation projects is particularly difficult in the services sector, because the introduction of new and the further development of existing service offerings and processes almost always require new digitalisation approaches and digital solutions.⁶⁰

Improving the offer of equity finance and quasi-equity financing instruments for start-ups would help new digital technologies and business models come to market quickly. The Future Fund launched in 2021 can be expected to provide positive impetus to VC offerings for German start-ups.

Low-interest loans would support the implementation of digitalisation measures across the business community as a whole and, thus, the diffusion of digital technologies. Financial support for these enterprises therefore does not have to address R&D expenditure but the costs incurred by businesses in implementing new digital applications and technologies as well as expenditure on product design and service design.

One option would be a combination of loans and grants, which could generate additional leverage effects. A sizeable proportion of the grant component would widen the financial scope for businesses and help reduce the financial risks of such projects. The credit component would help businesses manage large project volumes, particularly in the adoption of new technologies. Existing promotional instruments can also be integrated more closely or combined to achieve this. Further options could include combining such financing solutions with an advisory offer or strengthening transfer support by enabling research facilities to benefit from the grant component in their cooperation projects and the participating businesses to use the loan funds for putting into practice the research findings.⁶¹ It should also be examined to what extent

the use of financing instruments that preserve equity such as leasing or mezzanine capital can also be developed further to finance digitalisation projects.

Appreciating the strategic importance

SMEs who approach digitalisation from a strategic perspective invest more and take a broader approach to digitalisation. They also implement more ambitious digitalisation projects.⁶² Many small businesses with well-established but not very innovative business models, however, do not devote enough attention to the aspect of strategic business development. Day-to-day business often takes precedence.⁶³ Strengthening their general strategic capacity can be a lever particularly for these businesses to take greater account of strategic aspects in digitalisation.

In order to more effectively develop the potentials of digitalisation, it therefore appears to be useful to more strongly illustrate the benefits of digitalisation for businesses, especially from a strategic perspective. Greater efforts must be undertaken to raise awareness of the strategic importance of digitalisation among businesses, for instance with regard to their positioning in markets, tapping into new customer groups and the further development of existing business models.

Digital infrastructure

Although Germany has expanded its broadband Internet coverage in recent years, it still occupies a lower mid-table position in Europe.⁶⁴ Under the KfW SME Panel, even enterprises in conurbations often deplore inadequate Internet connectivity as a barrier to digitalisation. Therefore, this barrier is not limited to rural regions.⁶⁵ Even in areas that are currently better connected, there is a need to continuously assess whether the services provided still meet the requirements. While Internet expansion usually pays for itself in more densely populated areas, rural regions require additional economic policy measures.

Simplifying promotional terms would help small providers to make use of the programmes more often and, in this way, offer more broadband networks also in areas that are less profitable from a market perspective. As network development involves significant initial investment and high uncertainty about future returns, additional financial support for local network owners in the construction and maintenance of new networks could generate further impetus for expansion. The limited willingness of private users to pay for high bandwidths could be addressed with subsidy programmes for fibreglass connections. This would enable the regional usage rates required for expansion to be reached more often.⁶⁶

Data security and protection

Close to one third of small and medium-sized enterprises became a victim of cybercrime in recent years.⁶⁷ Larger businesses and pioneering enterprises are more likely to come under attack. As digitalisation continues to advance, however, smaller businesses also increasingly make worthwhile targets for criminals. SMEs in particular often do not assess the threat landscape correctly, so it is necessary to make businesses aware of the threat from cybercrime. Attractive training courses can be helpful to achieve this. Outsourcing IT security to specialised IT service providers can also be a solution. To this end, it would be helpful to increase the relevant offering and transparency for small and medium-sized enterprises in particular. Establishing further specific IT security standards and certifications can also enhance IT security and raise the awareness of employees about handling information technology.

Data protection requirements have changed significantly since the introduction of the GDPR in 2018. Many enterprises regard the data protection requirements as a constraint for their digitalisation and innovation activities.⁶⁸ But it is difficult to quantify the extent to which bureaucratic obstacles specifically act as roadblocks, as they are also an expression of intensive and ambitious digitalisation activities. A recent study pointed out that a high regulatory density does not in itself have to negatively impact business performance, but the way regulations are implemented and the quality of administration play a major role in this.⁶⁹

In order to prevent bureaucracy from placing a disproportionately heavy burden on innovation activities, it is necessary to examine bureaucratic regulations as to whether the intended protections are proportionate to the adverse impact on digitalisation.

One possible approach to preventing the emergence of new administrative burdens is a systematic appraisal of new legal regulations and to design them in a way that allows for sufficient scope. What is also important here is that new bureaucratic regulations must be consistent and formulated in a way that their interpretation is unambiguous. Another way to generally reduce the administrative burden on enterprises is to digitalise administrative processes and the interface to businesses.

Further enabling conditions

In the area of supporting top performers, a possible approach to supporting digitalisation efforts could be to expand support for basic research at universities and non-university research facilities. Expanding R&D capacities in the area of digitalisation in research

provides businesses with a basis from which to step up their own digitalisation efforts, for example because a larger number of qualified tertiary graduates and partners for joint research activities are available. The example of how R&D activities have evolved in Germany vividly illustrates the mutually beneficial interactions between academia and research work undertaken by businesses.⁷⁰

The development of digital standards, as is being undertaken by the federal and state governments and the EU (e.g. GAIA-X) is a helpful measure being implemented outside the business sector. The problem of data protection is also an expression of the legal fragmentation of digital markets, for example, which makes it difficult for businesses to operate Europe-wide and thus reach a critical scale. Realising a single internal market would support the further development and marketing of digital technologies in this respect as well.

Structure of SMEs with completed digitalisation projects in 2020–2022

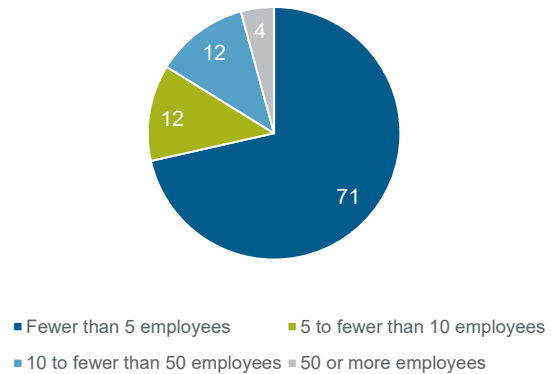
The SME sector, according to KfW’s definition, covers all enterprises in Germany whose annual turnover does not exceed EUR 500 million. By this definition, around 3.81 million SMEs exist in Germany. The SME sector thus accounts for 99.95% of all enterprises. A good 1.2 million of these enterprises have successfully completed digitalisation projects.

Most SMEs with completed digitalisation projects are small businesses. The majority of SMEs with digitalisation projects – almost 900,000 enterprises, or 71% – have fewer than five employees. This high percentage is due to the overall structure of the small and medium-sized enterprise sector. Seventy-nine per cent of SMEs have fewer than five employees. Around 6% of enterprises with digitalisation projects are manufacturers and 87% are service providers.

Eighty-three per cent of SMEs with completed digitalisation projects do not conduct any R&D of their own. A mere 10% and 7%, respectively, have conducted own R&D activities continuously or occasionally in the past three years.

Figure 18: SMEs with completed digitalisation projects by enterprise size

In per cent

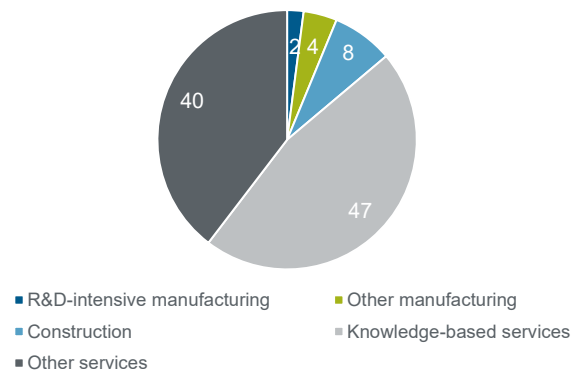


Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations

Figure 19: SMEs with completed digitalisation projects by sector

In per cent

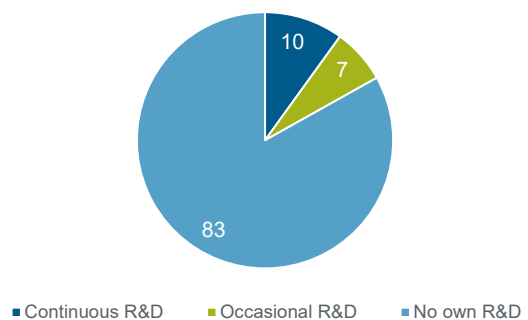


Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations

Figure 20: SMEs with completed digitalisation projects with and without own R&D activities

In per cent



Note: Figures extrapolated on the basis of the number of enterprises.

Source: KfW SME Panel, own calculations

KfW SME Panel

The KfW SME Panel (KfW-Mittelstandspanel) has been conducted since 2003 as a recurring postal survey of small and medium-sized enterprises in Germany with annual turnover of up to EUR 500 million.

With data based on up to 15,000 companies a year, the KfW SME Panel is the only representative survey of the German SME sector, making it the most important source of data on issues relevant to the SME sector. As it is representative of all SMEs of all sizes and across all branches in Germany, the KfW SME Panel offers projections for even the smallest companies with fewer than five employees. A total of 11,328 SMEs took part in the current wave.

The KfW SME Panel is used as the basis for analyses of long-term structural developments in the SME sector. It gives a representative picture of the current situation and the needs and plans of SMEs in Germany. It focuses on annually recurring information on companies' performance, investment activity, innovation and digitalisation activities and financing structure. This tool provides a unique way of determining quantitative key figures for SMEs such as investment spending, loan demand and equity ratios.

The basic population used for the KfW SME Panel comprises all SMEs in Germany. These include private-sector companies from all sectors of the economy with annual turnover of not more than EUR 500 million. The population does not include the public sector, banks or non-profit organisations. Currently there are no official statistics providing adequate information on the number of SMEs or the number of people they employ. The survey used the German Company Register (Unternehmensregister) and the official employment statistics (Erwerbstätigenrechnung) to determine the current population of SMEs as a starting point.

The KfW SME Panel sample is designed in such a way that it can generate representative, reliable data that are as precise as possible. The sample is split into four groups: type of promotion, branches, firm size as measured by the number of employees, and region. In order to draw conclusions on the basic population based on the sample, the results of the survey are weighted/extrapolated. The four main stratification criteria are used to determine the extrapolation factors. These factors look at the distribution in the net sample (in line with the four group characteristics) in relation to their distribution in the population as a whole. Overall, two extrapolation factors are determined: an unlinked factor for extrapolating qualitative parameters to the number of SMEs in Germany, and a linked factor for extrapolating quantitative parameters to the number of employees in SMEs in Germany.

The survey is conducted by the Financial Services Division of GfK GmbH on behalf of KfW Group. The project received expert advice from the Leibniz Centre for European Economic Research (ZEW) in Mannheim. The main survey of the 21st wave was conducted in the period from 6 February to 16 June 2023.

¹ Cf. Bresnahan, T. F. and Trajtenberg, M. (1995): General purpose technologies, engines of growth? *Journal of Econometrics* 65(1), p. 83–108.

² Cf. Zimmermann, V. (2021): [Information technologies are not one of Germany's strengths but of vital importance as technologies of the future](#), Focus on Economics No. 322, KfW Research and Schmoch, U. et al. (2021): Identifizierung und Bewertung von Zukunftstechnologien für Deutschland (*Identifying and assessing future technologies for Germany – our title translation, in German*), Fraunhofer Institute for System and Innovation Research.

³ Cf. OECD (2020), *The Digitalisation of Science, Technology and Innovation: Key Developments and Policies*, Paris: OECD Publishing, OECD (2019), *Digital Innovation. Seizing Policy Opportunities*, Paris: OECD Publishing or Keuper, F. et al. (2013), *Digitalisierung und Innovation. Planung – Entstehung – Entwicklungsperspektiven (Digitalisation and innovation. Planning – Creating – Development Prospects – our title translation, in German)*. Springer, Gabler Verlag.

⁴ Cf. Zimmermann, V. (2022): [KfW SME Digitalisation report 2021 Corona pandemic triggers digitalisation push but digitalisation is still not a matter of course](#), KfW Research, Rammer, C.; Fernández, G. and D. Czarnitzki, (2021): Artificial intelligence and industrial innovation: Evidence from firm-level data, ZEW Discussion Papers 21-036, Zimmermann, V. (2021): [Innovation and digitalisation in enterprises mutually reinforce each other](#), Focus on Economics No. 338, KfW Research; and Rammer, C. et al. (2021): Zusammenhang zwischen der Durchführung von Digitalisierungs- und Innovationsvorhaben im Mittelstand (*Correlation between digitalisation and innovation projects in the SME sector – our title translation, in German*), Leibniz Centre for European Economic Research and technopolis; Zimmermann, V. (2021): [Coronavirus crisis is hampering innovation, digitalisation sees a mixed trend](#), Focus on Economics No. 312, KfW Research.

⁵ Cf. Czarnitzki, D. Fernández, G. and Rammer, C. (2022): Artificial intelligence and firm-level productivity, ZEW Discussion Papers 22-005, ZEW; Truant, E., Broccardo, L. and Dana, L. (2021): Digitalisation boosts company performance: an overview of Italian listed companies, *Technological Forecasting and Social Change* 173, issue C; Behrens, V. and Trunschke, M. (2020), *Industry 4.0 Related Innovation and Firm Growth*, ZEW Discussion Paper No. 20 – 070; Niebel, T. et al. (2019), *BIG Data – BIG gains? Understanding the link between Big Data Analytics and Innovation*; *Economics of Innovation and New Technology* 28(3), p. 296–316; Gal, P., et al. (2019): Digitalisation and productivity: In search of the holy grail – Firm-level empirical evidence from EU countries; OECD Economics Department Working Papers No. 1533; Bertschek, I. et al. (2013), *More Bits – More Bucks? Measuring the Impact of Broadband Internet on Firm Performance*, *Information Economics and Policy* 25(3), p. 190–203; Cardona, M.; et al. (2013), *ICT and productivity: conclusions from the empirical literature*, *Information*

Economics and Policy 25, p. 109–125 or Kretschmer, T. (2012), Information and Communication Technologies and Productivity Growth: A Survey of the Literature; OECD Digital Economy Papers, No.195, OECD Publishing.

⁶ Cf. Zimmermann, V. (2021): [Information technologies are not one of Germany's strengths but of vital importance as technologies of the future](#), Focus on Economics No. 322, KfW Research and Schmoch, U. et. al (2021): Identifizierung und Bewertung von Zukunftstechnologien für Deutschland (*Identifying and assessing future technologies for Germany* – our title translation, in German), Fraunhofer Institute for System and Innovation Research.

⁷ Cf. European Commission: <https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi/charts>, last retrieved on 19 January 2024.

⁸ Cf. Zimmermann, V. (2021): [Digitalisation in international comparison: Germany lags far behind in IT investment](#), Focus on Economics No. 352, KfW Research.

⁹ Cf. Kroll, H. et al. (2022): Schlüsseltechnologien, Studie zum deutschen Innovationssystem (*Key technologies, study on the German innovation system* – our title translation, in German) No. 7-2022.

¹⁰ Cf. Zimmermann, V. (2022): Vielfältige Hemmnisse bremsen die Digitalisierung im Mittelstand (Various obstacles hamper digitalisation in SMEs – in German), Focus on Economics No. 380, KfW Research.

¹¹ Cf. Zimmermann, V. (2022): SMEs that have a digitalisation strategy are more proactive in their digital evolution, Focus on Economics No. 387, KfW Research. and Zimmermann, V. (2022): Digitalisierungsaktivitäten im Mittelstand zielen nur selten auf die Verfolgung von Wettbewerbsstrategien (Digitalisation activities in the SME sector only rarely pursue competitive strategies – in German), Focus on Economics No. 407, KfW Research.

¹² Cf. Scheuermeyer, P. (2023): SME business sentiment on the path to recovery, KfW-ifo SME Barometer: November 2023, KfW Research.

¹³ Cf. Schwartz, M., and Gerstenberger, J. (2023): KfW SME Panel 2023. Volume of tables, Table 4, p. 3., KfW Research.

¹⁴ Cf. Zimmermann, V. (2018): Determinants of digitalisation and innovation behaviour in the SME sector, Focus on Economics No. 236, KfW Research.

¹⁵ The number of employees is calculated including the active owners but excluding trainees and apprentices. Two part-time employees are counted as one full-time employee.

¹⁶ Cf. Zimmermann, V. and Köhler-Geib, F. (2023), Impact of the COVID-19 Pandemic on Different Groups of SMEs in Germany and Their Recovery, *Intereconomics* 58(6), p. 333–341.

¹⁷ Cf. Dasgupta, S., et al. (1999): [Determinants of information technology adoption: an extension of existing models to firms in a developing country](#), *Journal of Global Information Management* 7 (3), p. 30–40.

¹⁸ Cf. Baptista, R. (2000): Do innovations Diffuse faster within Geographical Clusters? *International Journal of Industrial Organisation* 18: 515–535 or Crepon, B.E. et al. (1998): Research, Innovation and Productivity: An Econometric Analysis at the firm level, *Economics of Innovation and New Technology* 21(3): 223–245.

¹⁹ Cf. Hwang, H.S., et al. (2004): Critical factors influencing the adoption of data warehouse technology: a study of the banking industry in Taiwan. *Decision Support Systems* 37 (1), S. 1–21; Premkumar, G. and Roberts, M. (1999): Adoption of new information technologies in rural small business, *OMEGA, International Journal of Management Science* 27 (4), p. 467–484 and Cohen, W. and Levin, R. (1989): Empirical studies of innovation and market structure. In: Schmalensee, R. and Willing, R. (eds.), *Handbook of Industrial Organization*, Vol. II., p. 1059–1107.

²⁰ Cf. Zimmermann, V. (2020), [KfW SME Digitalisation Report 2019. Digitalisation projects are gaining traction in the SME sector but digitalisation expenditure has remained low for years](#), KfW Research.

²¹ Cf. Zimmermann, V. (2020), [Financing of digitalisation and capital expenditure in SMEs – a comparison](#), Focus on Economics No. 280, KfW Research, or Zimmermann, V. (2018): [Business Survey 2018. Digitalisation is gaining momentum](#), KfW Research.

²² This sector includes mechanical engineering, electrical and chemical engineering, for example.

²³ Cf. Zimmermann, V. and Köhler-Geib, F. (2023), Impact of the COVID-19 Pandemic on Different Groups of SMEs in Germany and Their Recovery, *Intereconomics* 58(6), p. 333–341.

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²⁵ Cf. Zimmermann, V. (2018): [Determinants of digitalisation and innovation behaviour in the SME sector](#). Focus on Economics No. 236, KfW Research.

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²⁸ Cf. Schlegelmilch, B. (1988): Der Zusammenhang zwischen Innovationsneigung und Exportleistung (*The correlation between innovation propensity and export performance* – our title translation, in German). Ergebnisse einer empirischen Untersuchung in der deutschen Maschinenbauindustrie (*Results of an empiric survey of the German engineering industry* – our title translation, in German), in: *Zeitschrift für betriebswirtschaftliche Forschung* 50(3), p. 227–269; Greenaway, D. and Kneller, R. (2007), Firm heterogeneity, exporting and foreign direct investment, *The Economic Journal* 117(517), p. F134–F161 and Anderson, M. and Löf, H. (2009), Learning by Exporting Revisited – the role of intensity and persistence, *Scandinavian Journal of Economics* 111(4), p. 893–913.

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