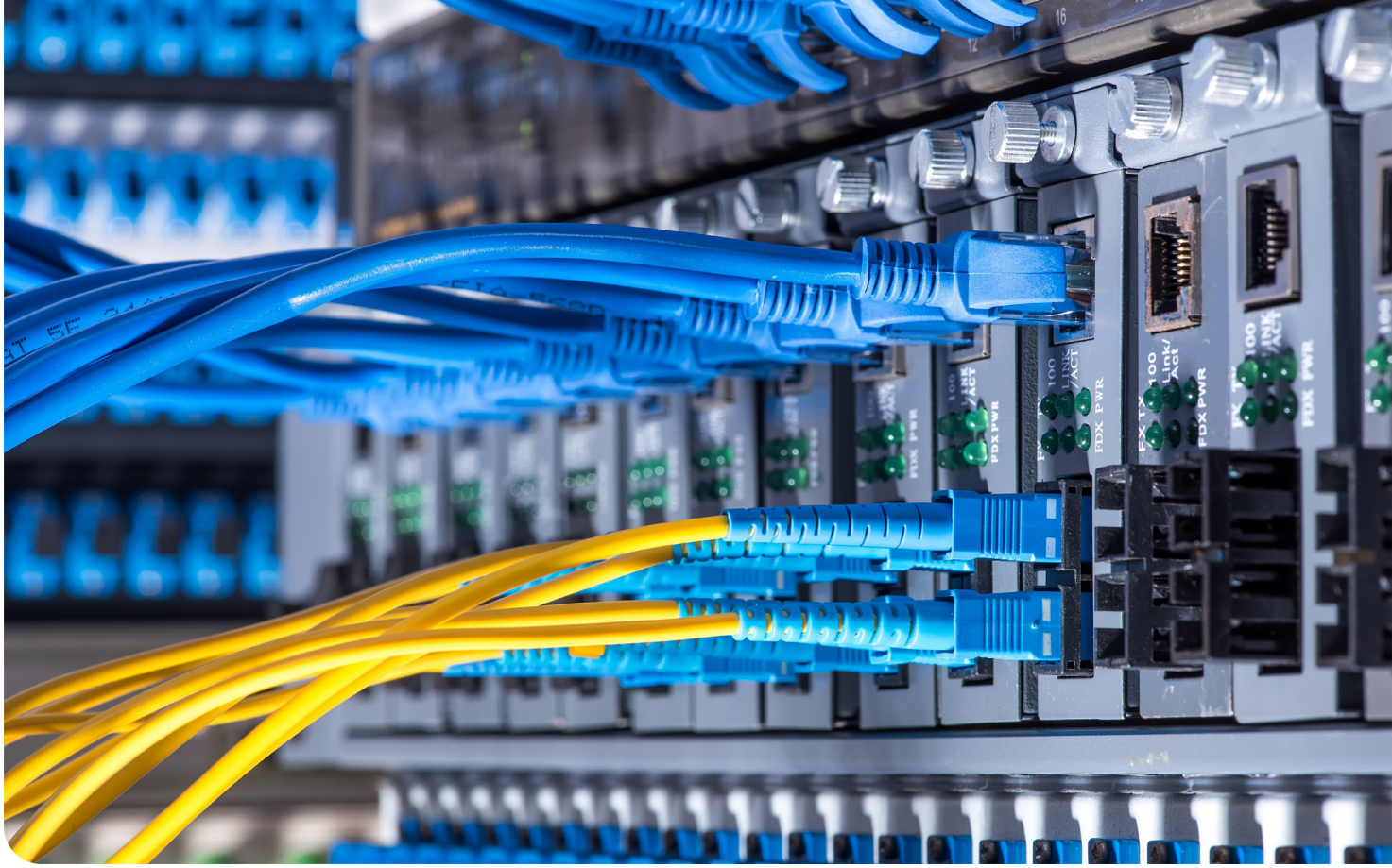

KfW Research

KfW SME Digitalisation Report 2021

Corona pandemic triggers digitalisation push but digitalisation is still not a matter of course.

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The coronavirus pandemic triggered a moderate digitalisation push in Germany. The share of small and medium-sized enterprises with completed digitalisation projects rose to 33% in the 2018–2020 period. In the previous survey that figure had plunged from 40% to 30%. SMEs spent EUR 20 billion on digitalisation in 2020, a noteworthy 16% increase on the previous year. This finding was corroborated in the further course of the pandemic. Up to autumn of 2021, the gap between SMEs that reported increasing digitalisation activities and those that reported reducing their digitalisation activities under the coronavirus pandemic grew significantly to 31 points.

But in autumn of 2021, 25% of enterprises still had no digitalisation activities while a further 6% reduced or discontinued them entirely. Average digitalisation expenditure remains low and even fell slightly on 2019. So all in all, the picture is mixed. Digitalisation has not become a matter of course even under the coronavirus pandemic.

The reason for expanding digitalisation activities was that such measures initially represented an important tool for managing the acute crisis. This can also be seen from the completed projects. More and more small and medium-sized enterprises have reported having digitalised their interaction with customers and suppliers and introduced digital marketing and sales strategies. Measures designed to have rather more long-term effects, on the other hand, such as digitally integrating internal functional areas, were addressed less often during that phase. With the acute phase of the crisis waning, businesses that expect to lose customers are investing more in digitalisation.

As before, large SMEs with 50 and more employees conduct digitalisation projects significantly more often than small businesses with fewer than five employees (67% vs. 30%). They also spend more on digitalisation (on average EUR 160,000 vs. just under EUR 8,000). The same is true of businesses that conduct R&D. Large enterprises in particular increased their expenditure significantly under the pandemic. So there remains the threat of the SME sector splitting up into a group of heavily digitalised, mostly large SMEs with R&D activities and a large body of usually small businesses left behind in the digital transformation.

In order to seize growth opportunities and emerge from the crisis stronger, it is now important to set investment incentives for the digital transformation and improve the business environment. The key barriers to digitalisation – lack of expertise, digital infrastructure and finance – and often inadequate consideration of the strategic aspect of digitalisation are particularly suitable starting points:

Lack of expertise is the main obstacle to digitalisation, both across the broad workforce and in terms of IT specialists. That makes it necessary in the medium term to mainstream digital learning in early stages of life and integrate IT skills more strongly into educational and training content. In the short term it is important to undertake greater efforts in basic and advanced training. That will require effective training incentives in the form of financial support. The certification of qualifications along with navigation and quality assurance in the continuing education market also constitute an important starting points.

The provision of fast internet services must be further improved. Deficits exist especially in rural areas. Still, many businesses deplore the quality of internet connectivity in many conurbations as well. In the countryside, where the expansion often does not pay for itself, measures such as the simplification of promotional terms and additional financial support for local network operators will be needed. Additional incentives for fibreglass connections can also be helpful to bolster the often low willingness to pay, particularly on the part of private users.

In order to mitigate financing problems it is important to set additional targeted financial incentives for the implementation of digitalisation projects. Depending on the maturity of the technology, starting points range from subsidies and tax benefits for R&D activities through equity finance for start-ups to low-interest loans. It should also be assessed to what extent financing instruments that preserve equity such as leasing or mezzanine capital can also be developed further to finance digitalisation projects.

Not least, it is necessary to step up efforts 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 or the further development of existing business models.

1. Introduction

Digitalisation is viewed as an important driver of economic growth and increasing prosperity. As a general purpose technology,[1] digitalisation is a beacon of hope for increasing the competitiveness of broad sections of the economy and for kick-starting productivity growth. The fact that digitalisation and innovation activity are connected in many different ways also contributes to this. Thus, digitalisation is often the technological basis that makes innovation possible in the first place.[2] For example, digital data are an important input for innovation. Furthermore, digital technologies enable innovative products and services, efficiency improvements, new forms of interaction with customers and business partners and accelerated innovation cycles. On the other hand, it is particularly innovative enterprises that are driving digitalisation forward in great strides.[3] Digitalisation activities are therefore important investments in the future which help businesses to position themselves in the market.

Numerous studies have thus found that digitalisation has benefits for the economy and individual businesses alike.[4] The coronavirus pandemic in particular has now brought to light the advantages of modern information and communication technologies and digitalised workflows. It has also laid bare the deficits in Germany.

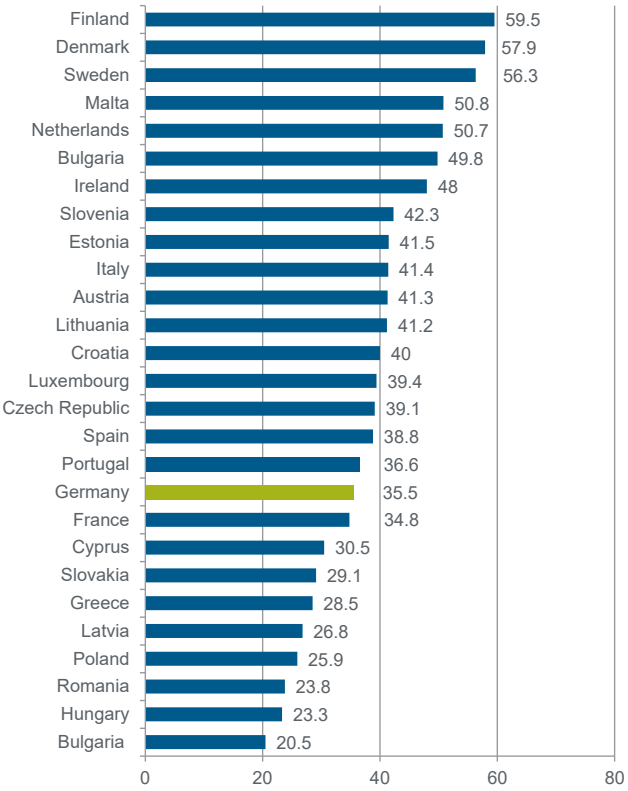
We define digitalisation as the implementation of projects that involve introducing or improving the use of digital technologies in an enterprise's processes, products and services and in its contacts with customers and suppliers. It also includes measures aimed at building corresponding skills within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

The fact that information technologies are increasingly penetrating business and society is not a new trend. It is just that the term 'digitalisation' was coined only in the recent past. 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.

Importantly, digitalisation as a 'general-purpose technology' is also becoming increasingly important for Germany's traditional technological strengths. Digital technologies are increasingly pervading these areas so that in future it will be hardly possible for Germany to assert its existing strengths unless it develops adequate capacity in the area of digital technologies. What is cause for concern is that the development of digital technologies does not constitute a strength of Germany's innovation system[5] and that the country is not exactly a pioneer in the application of digital technologies either.

Figure 1: Germany's rank in the integration of digital technologies

Index points



Source: DESI 2021

Thus, Germany ranks 11th within the EU 27 on the revised Digital Economy and Society Index of the European Union (DESI).[6] The country also merely ranks 18th in integrating digital technologies into business processes (Figure 1). This rank at the top of the bottom third of the EU countries is likely a direct consequence of Germany's comparatively low investment in information technologies and low digitalisation expenditure.[7] According to the Wirtschaft DIGITAL economic monitoring report, Germany does not possess any pronounced digitalisation-specific strengths.[8] The report identified a pronounced export weakness in information technologies as a symptomatic consequence.

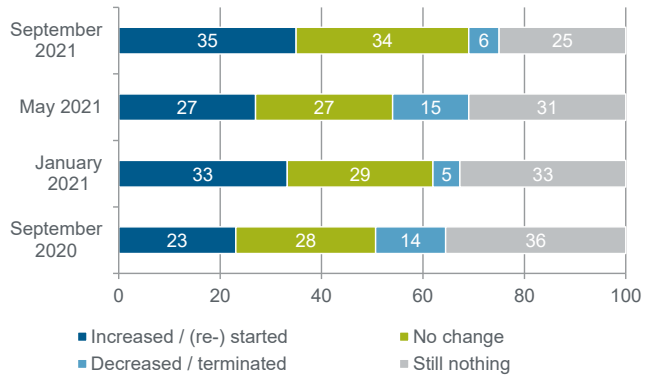
2. Digitalisation activities during the coronavirus crisis

Supplementary surveys to the KfW SME Panel to identify the impact of the coronavirus pandemic at the current margin

Digitalisation activity surged when the coronavirus pandemic began. For example, home working capacity was developed and expanded[9] within a short period of time, and online transactions increased sharply.[10] The use of online trade, cashless payment systems, virtual communication forms and e-health services experienced strong growth. It was crucial for businesses to respond flexibly to declines in demand and supply shortages, to comply with distancing rules and to ensure visibility for customers and cooperation partners,[11] responses to which digitalisation measures were able to contribute significantly, particularly under pandemic conditions.[12]

Figure 2: Variations in digitalisation activities in the course of the coronavirus pandemic

In per cent



Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, 3rd to 6th supplementary survey, own calculations

In order to examine how digitalisation activity has evolved in the course of the pandemic, KfW Research conducted a total of four supplementary surveys to the KfW SME Panel between September 2020 and September 2021, the results of which are presented below (box: Supplementary coronavirus surveys to the KfW SME Panel).

Supplementary coronavirus survey to the KfW SME Panel

The supplementary surveys conducted as part of the KfW SME Panel and evaluated in this report were carried out online from 1 to 14 September 2020, 12 to 22 January 2021, 3 to 14 May 2021 and 1 to 10 September 2021. Among other topics, they addressed the impact of the coronavirus crisis. All enterprises that participate in the KfW SME Panel and had provided a valid email address were surveyed. As the supplementary survey was linked to the main database of the KfW SME Panel,[13] the findings can be extrapolated to the total population of SMEs.

The development of digitalisation activity was surveyed by asking the following question:

'Does the coronavirus crisis have any effects on your digitalisation activities?'

Respondents could choose from the following replies:

- 'We terminated our digitalisation activities completely,'
- 'We scaled back our digitalisation activities compared with the pre-coronavirus situation,'
- 'We continued our digitalisation activities nearly unchanged from the pre-coronavirus situation,'
- 'We ramped up our digitalisation activities compared with the pre-coronavirus situation,'
- 'We resumed our digitalisation activities in the course of the coronavirus crisis after conducting no digitalisation activities prior to the coronavirus crisis.'

For the analysis, the possible responses 'terminated completely' and 'scaled back' as well as 'resumed' and 'increased' were combined for the sake of clarity.

Second wave of pandemic drove increase in digitalisation efforts

As the pandemic continued, more SMEs increased than decreased their digitalisation activities compared with the pre-coronavirus situation. However, the balance (proportion of enterprises expanding their activities less those reducing them) evolved without a clear trend throughout the pandemic. In the course of the second coronavirus wave, the balance initially rose

to 28%, as shown by the January 2021 survey results (Figure 2). However, at that time an even larger portion of SMEs – 33% – was still not carrying out any digitalisation projects.

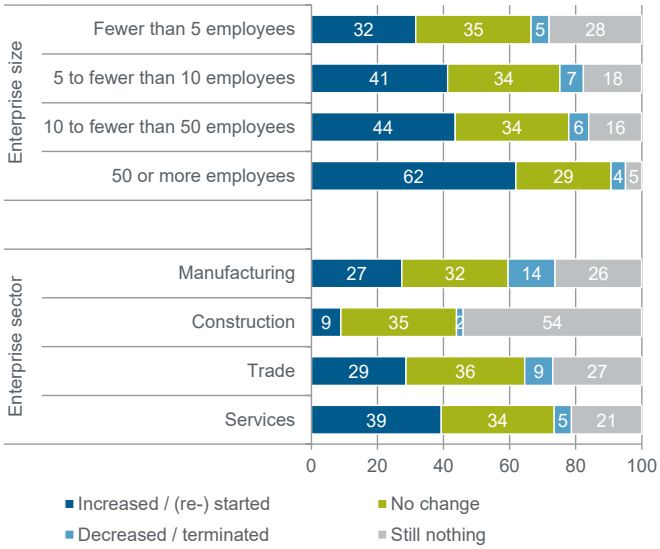
In the further course of the pandemic, digitalisation efforts decreased again – presumably because of limited resources and completed conversion measures. In the supplementary survey in May 2021, while the third coronavirus wave was ebbing, the balance dropped to just 12 points. In the course of the economic recovery, the balance rose again through autumn 2021 to 29 points, similar to that of the second wave. Businesses may have deliberately taken advantage of improvements to their situation in order to better position themselves digitally for the post-coronavirus period as well (see below).

Large SMEs are often trailblazers, even under coronavirus conditions

Even during the coronavirus pandemic, digitalisation activities have developed in significantly different ways between large and small SMEs, as was the case before the coronavirus pandemic. With increasing company size, the share of companies increasing their digitalisation activities, in particular, grows while the share of enterprises scaling back or conducting no digitalisation activities drops (Figure 3).

Figure 3: Development of digitalisation activities by enterprise size and sector

In per cent



Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, 6th supplementary coronavirus survey (September 2021), own calculations

Thus, 62% of large SMEs with 50 and more employees expanded their digitalisation activities up to the September 2021 survey, while the same is true of only 32% of businesses with fewer than five employees. Only 5% of large SMEs are still not undertaking any digitalisation activities, while that figure is 28% for small businesses.

An analysis by sector shows that on balance, service businesses were most likely to expand their digitalisation activities up to autumn 2021. Manufacturers as well as construction firms, which have generally been less active in digitalisation and relatively unaffected by the pandemic, have been the slowest to expand digitalisation activities even under coronavirus conditions.

SMEs that pushed ahead with digitalisation or innovated already before the coronavirus crisis have also been more active during the crisis

Businesses that completed digitalisation projects in the years from 2017 to 2019 – before the outbreak of the coronavirus pandemic – have also been more likely to expand their digitalisation activities than businesses that had no digitalisation activities prior to the pandemic. The same is true of businesses that innovated and conducted R&D prior to the pandemic (Figure 4).

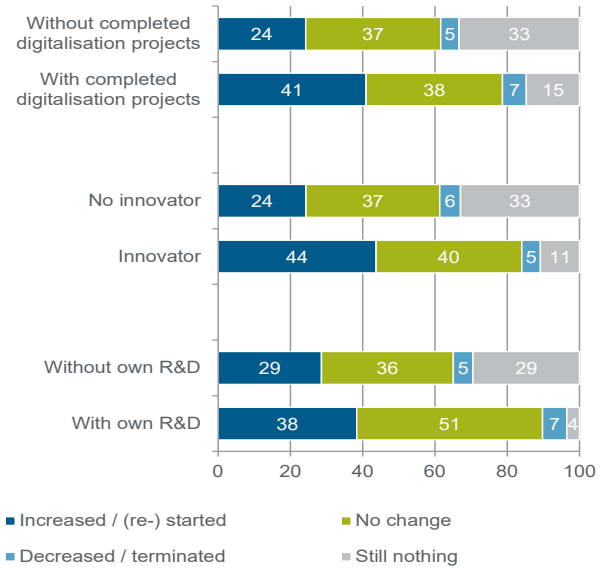
Innovators in particular were most likely to step up their digitalisation efforts, at 39 balance points. Businesses with digitalisation and R&D activities are just a few points behind. It must also be noted that a high 51% of businesses with R&D activities have maintained the typically substantial digitalisation activities of this group with no change.

This observation also corroborates the finding identified for the period before the pandemic[14] that the ability and willingness to respond to changes in the market situation are company-specific. It correlates with the extent to which relevant activities were already practised before the crisis situation set in and how deeply they are mainstreamed within the business.

This finding is not limited to businesses' digitalisation but also applies to their innovation activities. Developing corresponding capacities thus also makes them resilient in acute crises[15] and helps them regain lost ground on rivals after a crisis by being more competitive.

Figure 4: Development of digitalisation activities compared with pre-pandemic digitalisation and innovation activities

In per cent



Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, 6th supplementary coronavirus survey (September 2021), own calculations

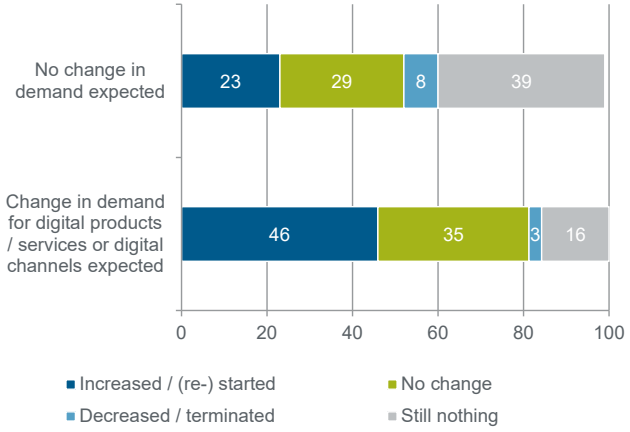
Economic recovery moves long-term perspectives of digitalisation back in the spotlight

In the first year of the coronavirus pandemic it became evident that businesses that were hit hard by the pandemic were most likely to intensify their digitalisation efforts. In particular, those with high turnover losses and those that had expected a protracted crisis increased their digitalisation activities.[16] That was an indication that digitalisation measures mainly served to keep businesses running and generate turnover during the crisis. Most were probably measures that could be quickly implemented and deliver fast results, while projects with a long-term horizon were more likely to be deferred.

That picture changed somewhat in the course of the economic recovery in 2021. Under the autumn 2021 survey, expanded digitalisation activities were reported primarily by enterprises that expected demand shifts towards digital offerings even beyond the end of the pandemic. The balance is 43% for these businesses vs. 15% for those that believe demand shifts are not very likely. Furthermore, a much lower share of the former group of businesses remains without digitalisation activities than the latter (16% vs. 39%).

Figure 5: Development of digitalisation activities by expected demand shift

In per cent



Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, 6th supplementary coronavirus survey (September 2021), own calculations

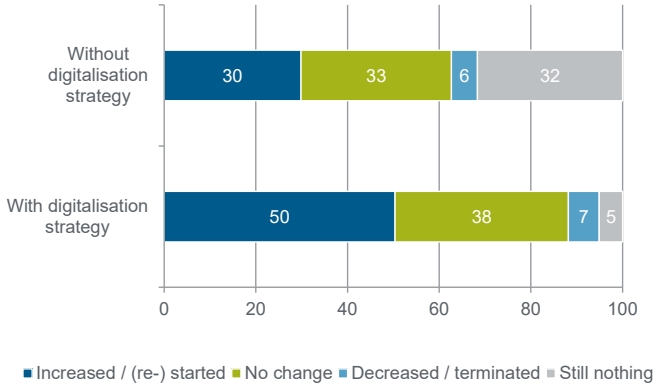
This indicates that as the economic situation increasingly returns to normal, businesses again align the scope of their digitalisation activities more closely with their perceptions of longer-term opportunities and risks than during the peak of the crisis. The relevant businesses may now believe customer behaviour has changed permanently, particularly given the long duration of the pandemic, which either holds digitalisation opportunities for their own business or forces them to go digital – depending on the perspective.[17] If this consideration is accurate, the coronavirus pandemic may also trigger a lasting digitalisation push.

Perception of strategic importance of digitalisation drives the development of digitalisation activities after the acute crisis phase

How important the longer-term view on the development of digitalisation expenditure is after the acute crisis phase has subsided is demonstrated particularly by the strategic significance which businesses attribute to digitalisation. The existence of a digitalisation strategy within a business can be taken as a key indicator that a business attaches strategic importance to digitalisation and therefore plans to act accordingly.

Figure 6: Variation in digitalisation activities of businesses with and without a digitalisation strategy

In per cent



Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, 6th supplementary coronavirus survey (September 2021), own calculations

In autumn 2021, 50% of enterprises that had a digitalisation strategy, in particular, reported an expansion of their digitalisation activities. The same is true of only 30% of enterprises without a digitalisation strategy. The proportion of businesses that are maintaining their digitalisation in the course of the pandemic is also higher in the group of businesses that have a strategy. This finding also underscores that the long-term perspective for digitalisation is becoming more important.

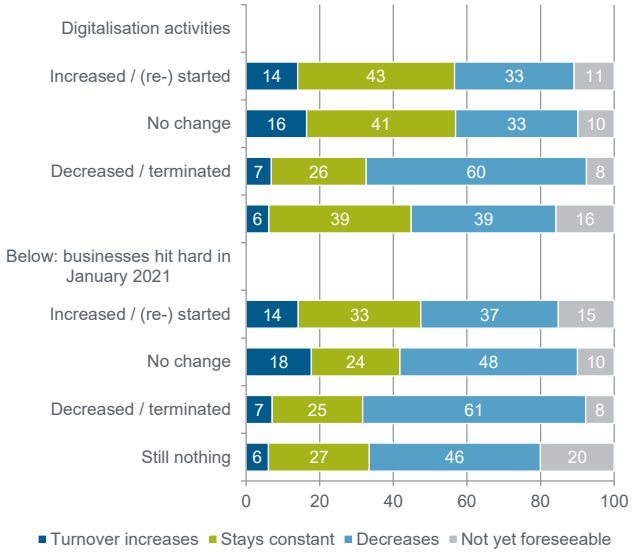
Initial, preliminary findings confirm that digitalisation is a useful crisis management tool

What is also of great interest is whether digitalisation can help businesses overcome the current crisis. With regard to past crises, it was found that businesses that actively responded to a crisis and invested in innovation and digitalisation weathered it more successfully.[18] The following analysis can offer initial indications on how this question can be answered for the current crisis.

The autumn 2021 supplementary survey asked businesses about how they expected their turnover to develop in the year 2021. Around 57% of enterprises that expanded or at least maintained their digitalisation activities expected to increase or at least maintain their turnover in 2021 (Figure 7). Only one third of these enterprises expected further turnover losses. Among businesses that reduced or still had no digitalisation activities, the percentage of those expecting rising or at least steady turnover was just 33% and 45%.

Figure 7: Expected turnover variation in 2021 by development of digitalisation activities

In per cent



Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, 5th and 6th supplementary coronavirus surveys (September 2021), own calculations

A look at the businesses that were hit hard by the coronavirus pandemic in January 2021 is particularly informative. Among these SMEs as well, 14% and 18% of businesses that expanded or maintained digitalisation activities expected to increase their turnover again in 2021. These values are roughly two to three times as high as among businesses that reduced or still have no digitalisation activities. Among businesses that increased digitalisation activities during the pandemic, the proportion expecting turnover losses in 2021 was lowest, at 37%. It is necessary to make the qualification that these initial insights are based on a small number of responses from businesses, on businesses' expectations and on a simple evaluation methodology. The findings must therefore be further corroborated by more in-depth analyses. However, they do indicate that digitalisation is making an important contribution to crisis management during the current coronavirus pandemic as well.

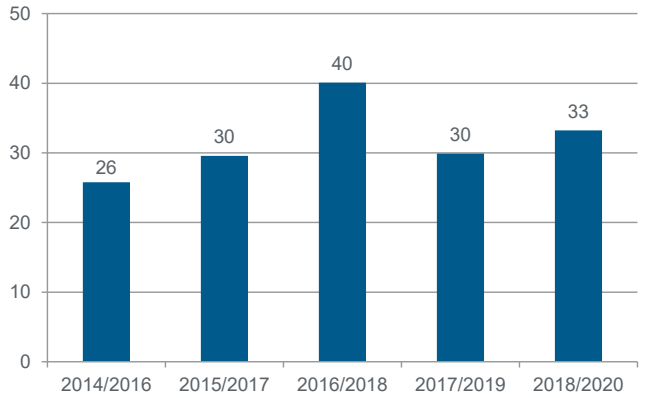
3. SMEs with completed digitalisation projects

Share of businesses with digitalisation projects increased in the first year of the coronavirus pandemic

Small and medium-sized enterprises had scaled back their digitalisation efforts in response to the cyclical downturn in the year 2019. But in the current primary survey of the KfW SME Panel (box: KfW SME Panel at end), which comprises the 2018–2020 period, the share of small and medium-sized enterprises with completed digitalisation projects rose moderately to 33% (Figure 8). This figure does not yet fully reflect the sizeable expansion of digitalisation activities reported in the supplementary coronavirus surveys because of the longer survey period. The number of small and medium-sized enterprises with completed digitalisation projects dropped by a good 110,000 to just under 1.3 million.

Figure 8: SMEs with completed digitalisation projects

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

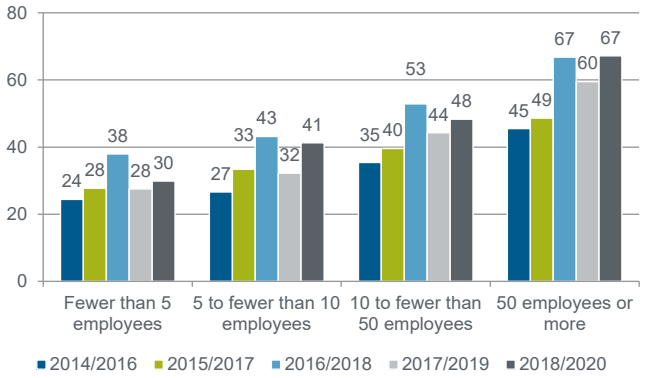
Large SMEs are more digitally active

The share of businesses undertaking digitalisation projects has grown in all SME size classes (Figure 9). As before, however, there are significant differences in digitalisation activities between enterprise size classes. The share is 30% among small businesses with fewer than five employees, but more than twice as high (67%) among large SMEs with 50 and more employees.[19]

The percentage of businesses with digitalisation projects rises with enterprise size for a variety of reasons. For example, larger enterprises tend to have more reasons to go digital, for example because their broader activities mean they possess more extensive IT infrastructure and are more closely integrated into supra-regional value chains with their corresponding demands. Larger enterprises also tend to have a higher degree of automation. They also report that they typically employ workers with higher formal qualifications and are better able to bear costs and risks.[20] For example, minimum project sizes and a higher proportion of fixed costs put more pressure on small businesses[21] and make them more likely to put off digitalisation projects. Finally, smaller enterprises have greater difficulty in accessing external finance for digitalisation projects.[22]

Figure 9: SMEs with completed digitalisation projects by enterprise size

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

R&D-intensive manufacturing and knowledge-based services top the list

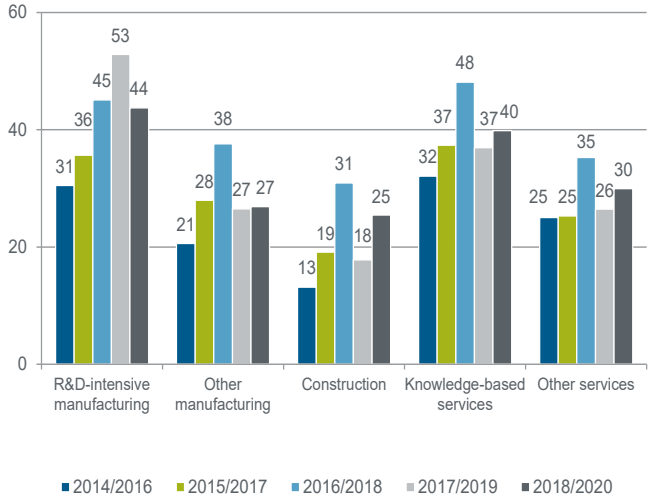
The sector comparison shows at least a minor increase in the share of businesses with completed digitalisation projects in all sectors with the exception of R&D-intensive manufacturing – which includes mechanical engineering, electrical engineering and chemicals, among others (Figure 10). Manufacturing was relatively unaffected by the coronavirus pandemic, so that there was little pressure to put in place adaptation measures in its first year. R&D-intensive manufacturing enterprises, in particular, were also likely to have already reached a higher level of digitalisation before the outbreak of the pandemic.

As in the preceding years, R&D-intensive manufacturing and the 'knowledge-based services' sector, which comprises media, IT and information services, law firms, tax consultancies and management consulting firms, are at the top of the ladder. The share of

businesses with digitalisation projects is 44% in R&D-intensive manufacturing and 40% in knowledge-based services. Here, too, there are similarities to innovation activity. Enterprises of these sectors also have the highest share of product and process innovators, which underscores the fact that innovation and digitalisation in businesses are closely linked.

Figure 10: SMEs with completed digitalisation projects by sector

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

The remaining sectors follow at a considerable distance with shares ranging from 25% to 30%. The shares of SMEs with digitalisation projects in 'other services' sectors (e.g. hospitality, transport and storage) and 'other manufacturing' (e.g. metal production and processing, garment production or animal feed production) are almost on the same level. The construction sector, in which 25% of companies have completed digitalisation projects, typically exhibits less digitalisation potential than other sectors, which is due in part to the fact that it has limited possibilities for digitalising the direct provision of services. They managed to slightly close the gap to the remaining sectors during the period under review. The use of building information modelling (BIM) is viewed as a key step towards digitalisation in the construction sector.

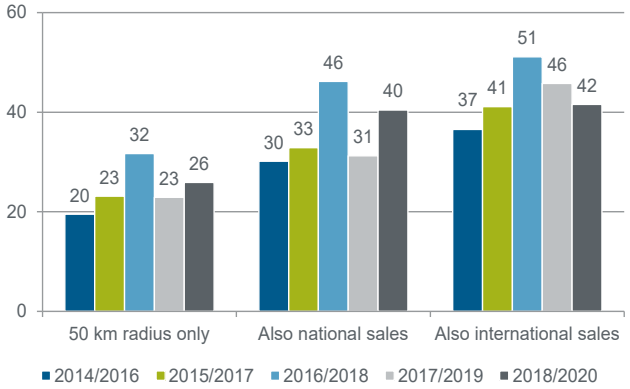
Intense competition in supra-regional markets is forcing businesses to go digital

The regional extent of a company's sales market also plays an important role in its digitalisation (Figure 11). The share of digital transformers is significantly higher among enterprises that operate in an international sales market than among those with merely regional activities (42% vs. 26%). It is known that this correlation also applies to SMEs' innovation activity.[23]

The reason for this is that the relevant enterprises are in closer competition and therefore under particular pressure to keep their products up-to-date and their business processes efficient. Moreover, having a presence in supra-regional and international markets is a source of inspiration and new knowledge[24] that can lead to both traditional innovation and to broader digitalisation. Finally, the use of digital technologies provides great advantages in communicating across long distances, for example.

Figure 11: SMEs with completed digitalisation projects by sales region

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

In the period that included the first year of the pandemic, the share of digital transformers fell particularly among businesses with international operations. To be sure, these companies were hit particularly hard by the impact of the pandemic,[25] but they probably did not consider further digitalisation steps such as continuing the expansion of digital communication to be conducive to mitigating its impact because they had already achieved a higher degree of digitalisation.

By contrast, enterprises that were less active digital transformers in the past probably increasingly acted on digitalisation incentives. Companies with Germany-wide operations in particular, which typically tend to be larger than regionally operating businesses, implemented digitalisation projects more often than in the previous year.

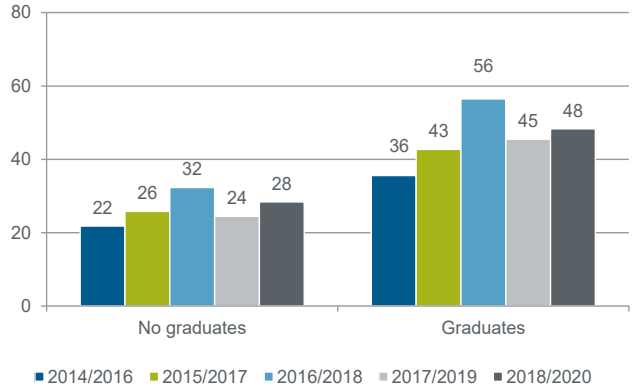
Having university graduates in the workforce is an asset for digitalisation

At present, 48% of enterprises that employ graduates have completed digitalisation projects (Figure 12). This share is thus significantly higher than in businesses

without graduates.

Figure 12: SMEs with completed digitalisation projects with and without graduate employees

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

The likely reason for this is that human capital is an important source of innovation.[26] A number of scientific studies have already highlighted the correlation between the adoption of new technologies and the human capital of the workforce.[27] This applies particularly to digitalisation and academic education.

At the current margin, the share of businesses with completed digitalisation measures is growing both in businesses that employ graduates and in those that do not.

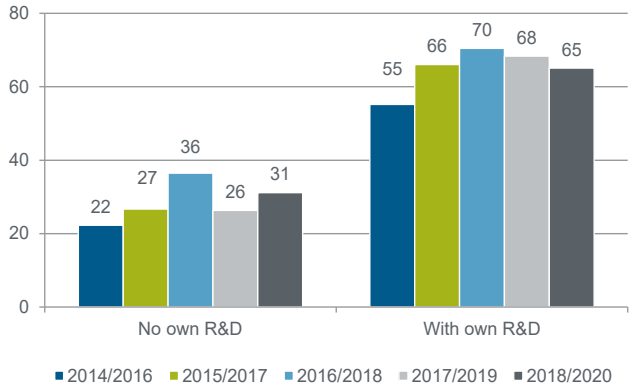
Enterprises engaged in R&D are more likely to carry out digitalisation projects

Own research and development (R&D) activities can be another source for designing and implementing digitalisation projects. R&D is defined as 'systematic creative work aimed at expanding existing knowledge [...] and using it with the objective of finding new potential applications'[28]. 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.

These considerations also hold true for SMEs. Businesses that perform own R&D implement digitalisation projects significantly more often than those that do not. At 65%, that share is currently at least twice as high among SMEs with R&D as among those without (Figure 13).

Figure 13: SMEs with completed digitalisation projects with and without own R&D activities

In per cent



Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

Compared with the previous survey, enterprises that do not conduct R&D have gained some ground on those that do. Particularly at the beginning of the pandemic, surveys found that R&D activity was also hampered by pandemic-related obstacles such as hygiene requirements, solidarity-driven short-time working schemes in R&D departments, inadequate internet connectivity in home working environments and worker absences due to childminding responsibilities. Finally, turnover losses and uncertainty surrounding further economic developments are likely to have hampered the financing of R&D-based digitalisation projects and thus delayed the completion of projects.

4. Types of completed digitalisation projects

Digitalising linkages to the business environment has gained importance under the pandemic

A closer look at specific types of projects reveals that the first year of the coronavirus pandemic influenced the type of digitalisation projects that were carried out. Different types of projects exhibited greater variations in relative shares than were seen in the preceding years.

SMEs mainly digitalise their interactions within the value chain and with their final customers. The share of SMEs that completed projects of this type in the 2018–2020 period grew to 58% (based on all businesses with completed digitalisation projects) after a mere 55% and 54% in the preceding periods (Figure 14). Many of their projects likely involved redesigning websites and adopting internet applications such as online ordering and payment systems, using social media or setting up customer feedback mechanisms. They also likely included automating and, thus, digitalising the exchange of data within the value chain.

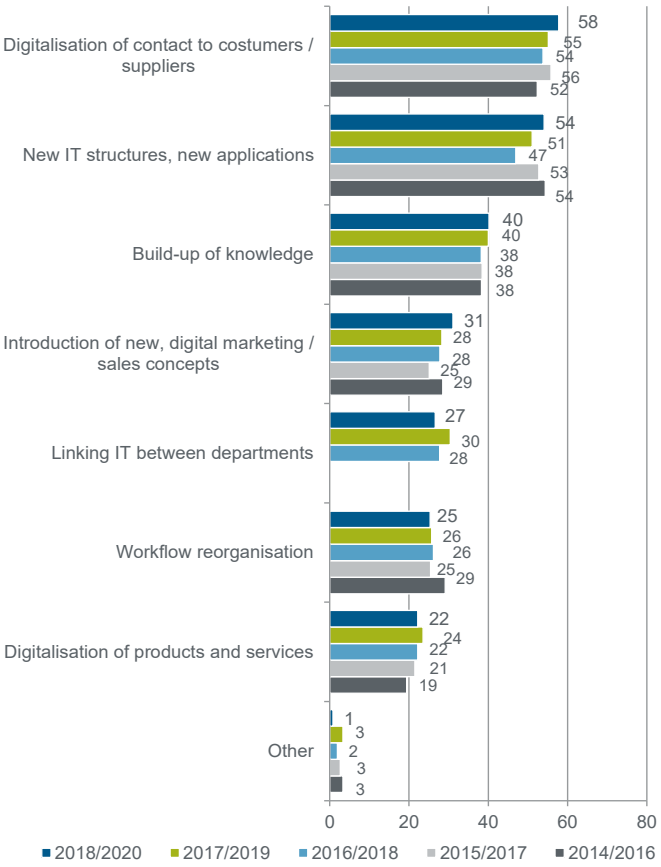
The upgrading of IT structures followed closely behind, with 54% of mentions. This included the installation of new hardware, the implementation of new systems and the adoption of individual, new applications. IT modernisation is therefore the second most common project type. The share of enterprises implementing digitalisation projects of this type has also grown by three percentage points on the previous period.

As in the previous period, and with an unchanged share of 40%, projects aimed at boosting digitalisation expertise were the third most common type. They included contracting digitalisation consultancy services and training employees. Lack of in-house expertise is among the most important obstacles to digitalisation. Shortages of both IT skills within the workforce and IT specialists constitute a bottleneck for businesses.[29] 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.[30]

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 cannot be utilised unless an enterprise has the requisite competencies. Improving digital capabilities therefore plays an important role.

Figure 14: Types of digitalisation projects

In per cent



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

Source: KfW SME Panel, own calculations

Businesses are adopting more digital marketing and sales strategies

Introducing new digital marketing and sales strategies ranks fourth, with 31% of mentions. This type of project has moved up two places on the previous period. What contributed to this was that it was mentioned three percentage points more often than in the previous period, whereas projects such as those aimed at linking IT between functional areas or reorganising workflows were mentioned at least slightly less often.

New, digital marketing and sales strategies can also be adopted in connection with the digitalisation of the customer interface described above. That would rather suggest that digital latecomers, too, are implementing these projects. 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 are also more complex in nature.

The main survey of 2021 enquired for the third time about how businesses were digitising links between functional areas as a project type. Linking IT systems aims to comprehensively connect IT applications at a whole-of-company level. It can therefore be seen as a strategically important project with a long-term horizon. As their share has dropped from 30% to 27%, these projects only rank fifth at the moment.

By contrast, projects designed to establish external linkages and sales strategies were initiated more often. This was confirmed by the findings already presented in the penultimate section, which show that the digitalisation projects put in place in the course of the pandemic were less often designed as a long-term strategy, at least during the first year – the acute phase of the crisis – but likely as measures that could be implemented quickly and deliver fast results in order to keep the business running and generate turnover.

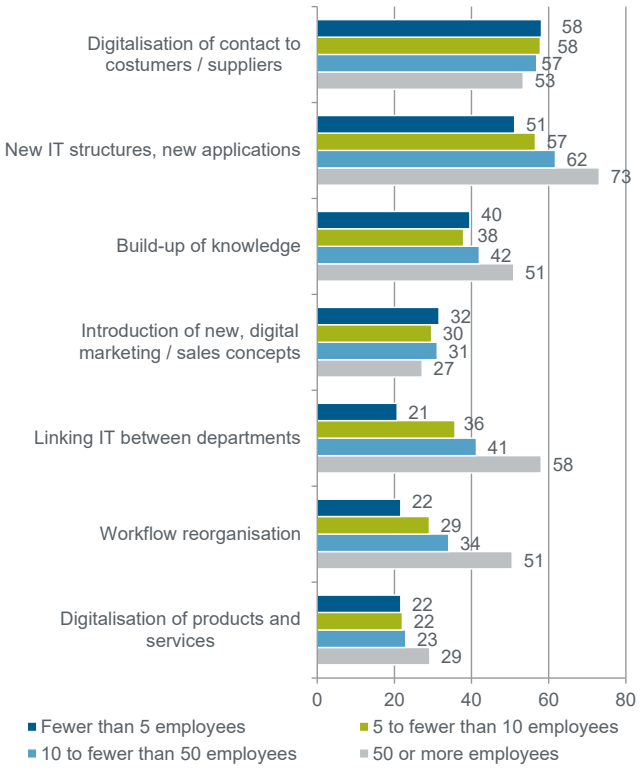
Digitalisation measures aimed at reorganising workflows rank sixth, with a currently reported share of 25%. Enterprises need to reorganise workflows when digital transformation profoundly alters existing processes and business organisation. This indicates that affected enterprises are more likely to undertake complex digitalisation measures. Projects of this type were carried out slightly less often than in the previous period, dropping -1 percentage point. The minor drop is probably due to the fact that in many enterprises, digitalising workflows constitutes an important measure to ensure business operations, particularly during the coronavirus pandemic.

Just as in the previous periods, digitalising products and services ranked last in the survey. The share of businesses that completed projects of this type has currently fallen again to 22%. The likely main reason for this is that businesses generally bring new products and services to market more often during positive business cycles because that is when they are better received by the market.[31]

The range of services on offer also played a relatively minor role in digital transformation efforts in the preceding surveys. This is consistent with the frequently voiced complaints that digitalisation in Germany focuses too much on efficiency gains[32] and rarely includes the search for new areas of sales and activity, as well as failing to sufficiently evolve business models.

Figure 15: Types of digitalisation projects by size of enterprise in 2018–2020

In per cent



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

Source: KfW SME Panel, own calculations

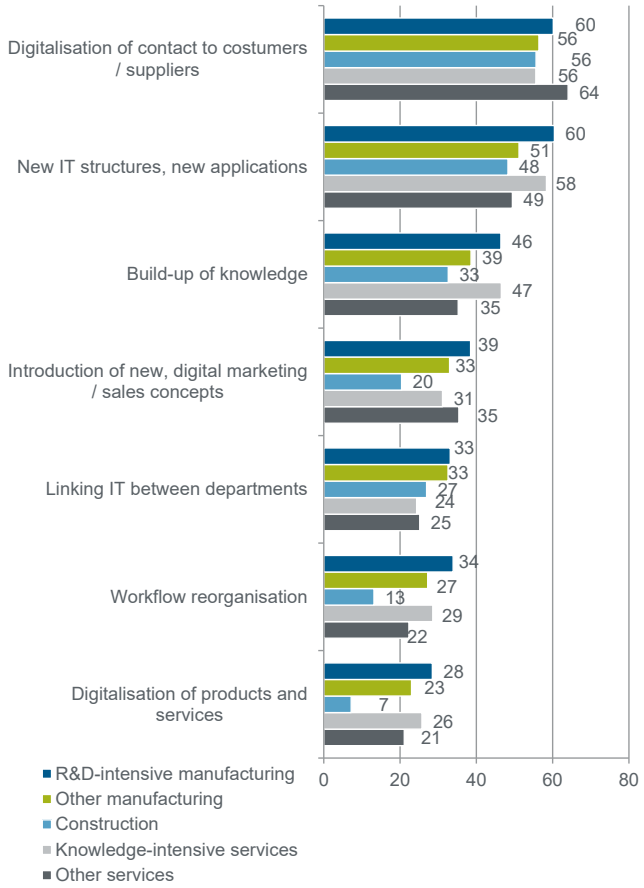
Ambitious digitalisation projects are implemented mainly by large SMEs that conduct R&D

As in the previous period, small businesses with fewer than ten employees and businesses without R&D activities were most active in digitalising their interactions with customers and suppliers, each taking a share of 58% (see Figures 15, 16, 17 and 18). This suggests that these enterprises are often latecomers. Large SMEs and those that are already more digitally advanced are likely to have completed this step already.

The fact that businesses with Germany-wide operations are in the lead with respect to sales market region as well does not contradict this. It is also likely due to the fact that companies operating regionally are even less likely to regard 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. But it also needs to be emphasised here that the imperatives of the coronavirus pandemic make digitalising customer and supplier interactions the most frequent type of project in nearly all economic sectors.

Figure 16: Types of digitalisation projects by economic sector in 2018–2020

In per cent



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

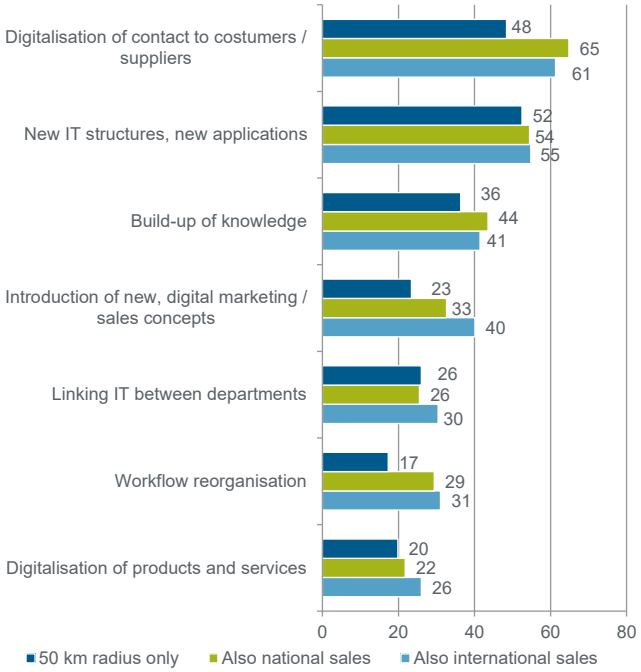
Source: KfW SME Panel, own calculations

By contrast, larger SMEs focus on upgrading IT infrastructure and introducing new applications (62% in businesses with ten to fewer than 50 employees and 73% in businesses with 50 and more employees). Furthermore, SMEs with 50 and more employees carry out projects that involve digitalising links between functional areas (58%), reorganising workflows and developing expertise (51%) with particular frequency.

It is likely that the more widespread renewal of IT infrastructure, introduction of new applications and digital integration of functional areas is in part a size effect. Large enterprises are also more likely to have a 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 17: Types of digitalisation projects by sales region in 2018–2020

In per cent

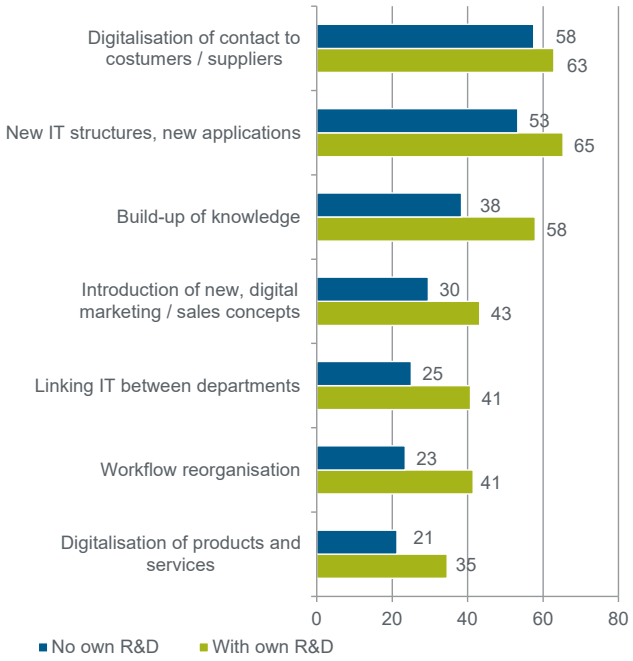


Note: Figures extrapolated to the number of enterprises, for all enterprises with completed digitalisation projects.

Source: KfW SME Panel, own calculations

Figure 18: Types of digitalisation projects of enterprises with and without own R&D activities in 2018–2020

In per cent



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

Source: KfW SME Panel, own calculations

Digital pioneers are upgrading their digitalisation expertise ...

Developing digital expertise was a measure mentioned more often by large SMEs (51%) than small businesses (40% and 38%). Knowledge-intensive service providers and R&D-intensive manufacturers are particularly active in this area, with 47% and 46% of enterprises, respectively, implementing digitalisation projects. This is consistent with the fact that enterprises with own R&D (58%) and companies operating supra-regionally (44% and 41%) also invest more often in building expertise than other enterprises. The relevant enterprises thus possess characteristics typically associated with pioneer companies. It is precisely these businesses that are particularly likely to perceive a lack of digital skills as a digitalisation barrier.[33]

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

With the exception of large SMEs, workflow reorganisation as part of digitalisation projects is more widespread in businesses with supra-regional operations and in those that conduct 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.

Projects that involve the digital integration of functional areas are pursued by large businesses that conduct R&D and by 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. What may also play a minor role is the type of product or service the business provides and how much innovative capacity it has.

Small businesses and those that conduct R&D are 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 (27% to 31%). A wide variation is apparent in regard to R&D (43% among those with R&D vs. 30% for non-R&D conducting businesses) and in regard to sales markets (40% for companies with international operations vs. 25% for regionally active businesses). As mentioned above, this indicates that there is a broad range of projects of this type carried out not just by companies that are typically more often latecomers but also by pioneering enterprises.

Finally, digitalised products and services are brought to market primarily by large enterprises, those that conduct R&D, and those that operate internationally. A sector comparison shows that R&D-intensive manufacturing enterprises as well as knowledge-based service providers are in the top positions. These sectors also occupy the top ranks for innovation and digitalisation activity. Thus, the digitalisation of products and services is heavily concentrated in pioneering enterprises.

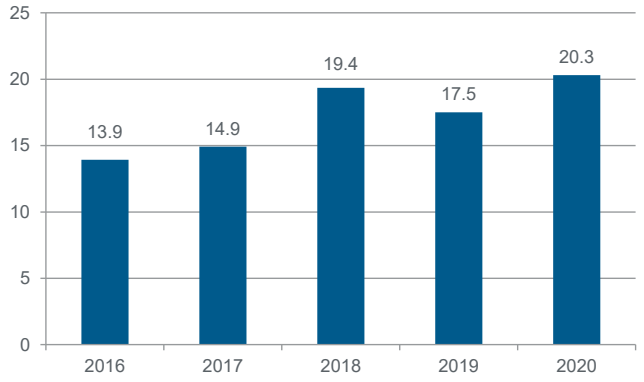
5. Development of digitalisation expenditure

Digitalisation expenditure rose in the first year of the coronavirus pandemic

In 2020, small and medium-sized enterprises spent EUR 20.3 billion on digitalisation projects (Figure 19). The amounts spent on digitalisation thus increased on the previous year, as did the share of businesses with completed digitalisation projects. A comparison with investment expenditure (on machinery, plant, equipment and similar items) shows that digitalisation expenditure is clearly lower despite the slump in investment expenditure resulting from the coronavirus pandemic. SMEs invested EUR 204 billion in assets in 2020.[34]

Figure 19: Aggregate expenditure on digitalisation in the SME sector

in EUR bn



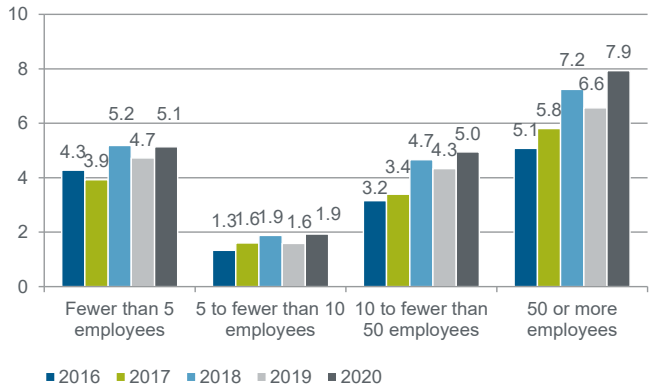
Note: Values extrapolated from the number of employees.

Source: KfW SME Panel, own calculations

Businesses with fewer than five employees take a high share of just over EUR 5 billion or approx. 25% (Figure 20). 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 enterprises with fewer than five employees make up 81%, which is the bulk of small and medium-sized enterprises. Although they represent a small proportion of 2% of small and medium-sized enterprises, large SMEs with 50 and more employees account for the largest share of digitalisation expenditure: just under EUR 8 billion or 39%. Compared with the previous year, digitalisation expenditure has grown at least moderately in all enterprise size classes. Large SMEs stepped up their digitalisation efforts most sharply, spending EUR 1.1 billion more.

Figure 20: Aggregate expenditure on digitalisation by SME size

in EUR bn

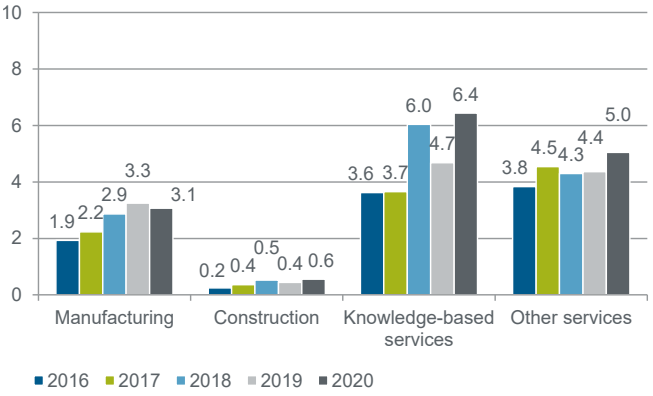


Note: not counting enterprises of the remaining sectors, values extrapolated from the number of employees.

Source: KfW SME Panel, own calculations

Figure 21: SMEs' aggregate expenditure on digitalisation by economic sector

in EUR bn



Note: not counting businesses with fewer than five employees, values extrapolated from the number of employees.

Source: KfW SME Panel, own calculations

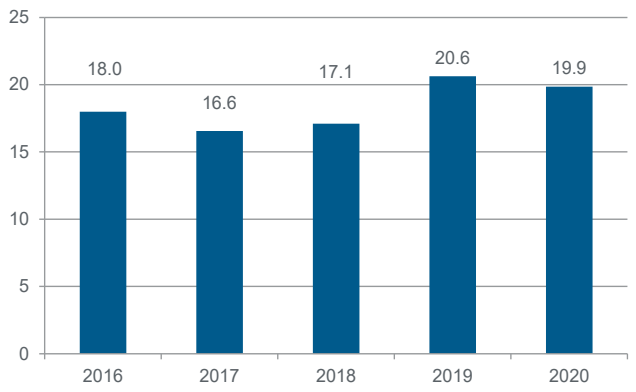
A breakdown by economic sector shows that service providers continue to spend the most on digitalisation overall, at EUR 6.4 billion for knowledge-based service providers and EUR 5 billion for other service providers (Figure 21). Both groups also account for the highest shares of small and medium-sized enterprises. Manufacturing accounts for a good EUR 3 billion in digitalisation expenditure. Construction firms spend the least on digitalisation – just under EUR 0.6 billion. The level of expenditure thus also confirms the relatively low level of digitalisation activities of these businesses.

Average digitalisation expenditure has dropped slightly

In order to examine the concentration of expenditure in different types of enterprises, the following figures illustrate average digitalisation expenditure of SMEs. SMEs spent an average EUR 20,000 on digitalising their business operations in 2020. That was a minor decrease on the previous year (Figure 22).

Figure 22: Average expenditure on digitalisation in the SME sector

EUR in thousand



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

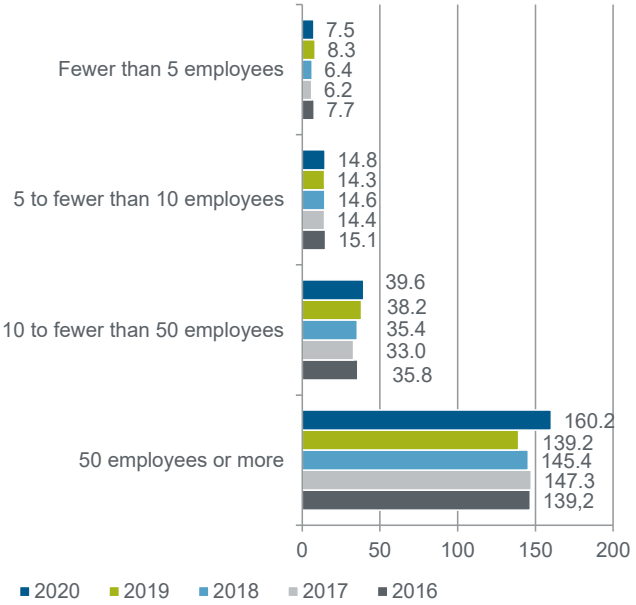
Source: KfW SME Panel, own calculations

The level of expenditure depends heavily on enterprise size. Businesses with fewer than five employees spent just under EUR 8,000 on digitalisation on average in 2020. This sum rises almost exponentially to EUR 160,000 in enterprises with 50 and more employees (Figure 23). Large SMEs in particular raised their average digitalisation expenditure significantly in the first year of the coronavirus pandemic. That means they spent on average around 21 times more on digitalisation than small businesses in 2020. That gap was 'only' 17-fold in the pre-coronavirus year 2019.

A comparison by enterprise size must generally take into account that because of their size, small businesses also need to invest only small amounts in digital transformation in absolute terms. One reason is that they have less hardware and software. However, in relation to annual turnover, small businesses invest above-average amounts in digitalisation relative to their size, so digitalisation places a heavier cost burden on them than on large enterprises.[35]

Figure 23: Average expenditure on digitalisation by SME size

EUR in thousand

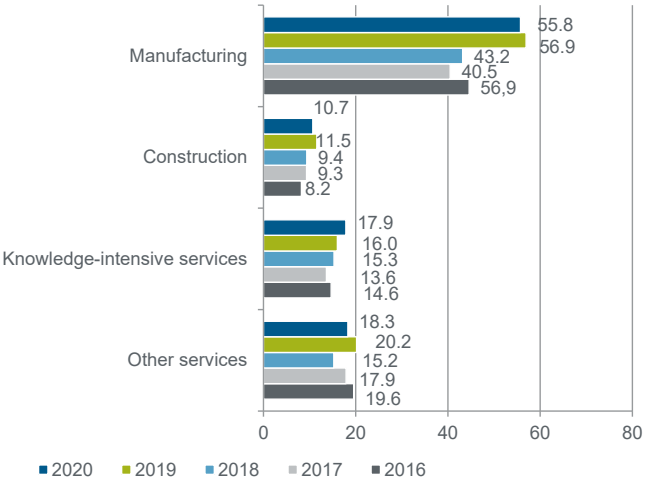


Note: not counting enterprises of the remaining sectors, values extrapolated from the number of employees, only businesses with digitalisation expenditure.

Source: KfW SME Panel, own calculations

Figure 24: SMEs' average expenditure on digitalisation by economic sector

EUR in thousand



Note: Values extrapolated from the number of employees, only enterprises without digitalisation expenditure.

Source: KfW SME Panel, own calculations

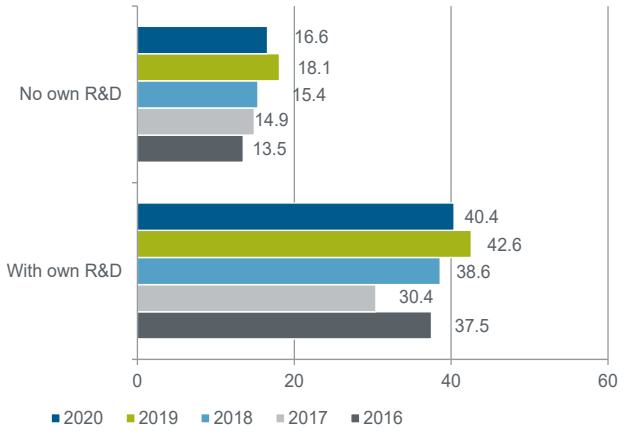
In a sector comparison, manufacturing enterprises spend the most – just under EUR 55,000 (Figure 24). They are followed at a significant distance by companies providing other services and knowledge-based services, which were almost on a par at roughly EUR 18,000. The construction sector is in fourth position with just under EUR 11,000. Compared with

the previous year, average expenditure on digitalisation has changed only little in all sectors under review.

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. In service enterprises, on the other hand, the processes of service delivery are often not so capital-intensive, so they are easier to modify. In the construction sector, too, digitalisation activities often focus on administrative processes and less often on the direct provision of services. For this reason they are also likely to be less capital intensive.

Figure 25: Average digitalisation expenditure of SMEs with and without R&D activity

EUR in thousand



Note: Values extrapolated from the number of employees, only enterprises without digitalisation expenditure.

Source: KfW SME Panel, own calculations

Finally, not only are R&D-conducting SMEs more likely to carry out more digitalisation projects, and more ambitious ones; they also spend more on digitalisation on average (Figure 25). That was a good EUR 40,000 on average in 2020 – 2.4 times as much as enterprises without own R&D activities. It also confirms the results of a recent study according to which innovative enterprises in particular spend high amounts on their digitalisation and carry out diverse and ambitious digitalisation projects.[36] This discrepancy gives rise to concerns that a gap will open up in the medium term between heavily digitalised, usually large R&D-conducting enterprises and typically small businesses without own R&D which will fall behind in digitalisation as well.

6. Conclusion

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

Small and medium-sized enterprises had scaled back their digitalisation efforts in response to the cyclical downturn in 2019. By contrast, the current primary survey of the KfW SME Panel, which covers 2020, the first year of the coronavirus pandemic, shows moderate growth not just in the share of businesses with completed digitalisation projects but also in aggregate digitalisation expenditure. Even if the pandemic has hampered the implementation and financing of digitalisation projects, it clearly had a stimulating effect on digitalisation activity in the first year of the pandemic.

Familiar findings emerge with regard to the structure of businesses with digitalisation projects. Large SMEs are more likely to tackle digitalisation projects and spend more on digitalisation on average than small businesses. The same applies to enterprises that conduct R&D which, like large SMEs, are also more likely to be among the pioneering enterprises with regard to the types of projects completed. Spending on digitalisation has recently increased substantially, particularly among large SMEs.

This is also evident across the further course of the pandemic (through autumn of 2021). It has prompted small and medium-sized enterprises to step up their digitalisation efforts. This confirms the notion that digitalisation is an important tool for managing the current crisis.

For the first year of the pandemic, this can also be seen from shifts in the type of projects implemented. Businesses have been more active in putting in place projects designed to digitalise interactions with customers and suppliers or marketing and sales strategies but less committed to projects aimed at digitally connecting functional areas of operation. This suggests that they have focused mainly on measures capable of delivering fast results to manage the acute crisis. Evidence of such shifts was already visible in the previous year. For example, businesses that were severely hit by the crisis and those that were expecting it to drag on for a long time were particularly active in increasing their digitalisation efforts.

The supplementary survey conducted in autumn of 2021 showed that as the economic recovery progresses, businesses shift their focus back on the longer-term perspective of digitalisation activities. In addition to businesses that are typically among the pioneers, those that expect demand shifts to digital sales channels, products and services in particular report that they are expanding their digitalisation activities. The long duration of the pandemic in particular may have prompted many businesses to revise their expectations and assume that digital markets are developing faster than previously thought and becoming permanent, making a digital focus appear more worthwhile than before. If this is confirmed, the coronavirus pandemic may also create a sustained push to drive digitalisation and, thus, structural change.

But digitalisation during the coronavirus pandemic is anything but a matter of course. Even in autumn of 2021, one fourth of SMEs were still not engaged in any digitalisation projects at all. Another 6% suspended or rolled them back during the pandemic. The share of enterprises with completed digitalisation projects has not yet returned to the 2016–2018 level. Furthermore, a typical small or medium-sized enterprise continues to spend little on its digitalisation. Not least, small businesses in particular incurred higher levels of debt in the course of the crisis[37], and they probably developed a greater interest in making targeted investments in crisis resilience.[38] So it is by no means a given that the coronavirus crisis will generate a sustained push to digitalisation.

Barriers to digitalisation in SMEs

This is also because, according to a recent study by KfW Research, a number of barriers are hampering SMEs' digitalisation activities.[39] These barriers can often be traced to businesses' lack of in-house expertise. A shortage of IT skills and IT experts is an immediate factor. Around one third of all SMEs currently regard these difficulties as a barrier of 'high' or 'medium' significance.

Other barriers to digitalisation often mentioned have to do with the digitalisation skills that exist within businesses. For example, problems relating to data protection and data security requirements (mentioned by just under two fifths of enterprises), the conversion of existing IT or uncertainty about future technological developments and standards (each mentioned by one fourth) can also be at least partly attributed to lack of in-house expertise.

Besides, digital infrastructure deficits constitute a major bottleneck for nearly two fifths of SMEs. Despite strong

expansion in the past years, the quality of internet connectivity is the second most frequently mentioned digitalisation barrier. It is mentioned as a barrier not just by businesses based in the countryside. It is often a limiting factor also for businesses domiciled in the typically better-connected metropolitan areas. Increased demands on internet speed and stability as a result of the pandemic may have contributed to businesses so often rating the digital infrastructure as inadequate for their needs.

A good one fifth of all SMEs have difficulty financing digitalisation projects. That is a remarkably high proportion given that the bulk of SMEs spend rather small amounts on their digitalisation. This barrier in particular is a very limiting factor. There is reason to fear that it will worsen as soon as businesses begin to seek higher amounts of finance to invest in expanding their digitalisation.

Financing barriers are attributable to the innovative character of digitalisation projects which is reflected in aspects such as uncertainty about whether the intended goals can be achieved, the difficulty for potential external providers of capital to assess such projects and the low proportion of material investment involved.[40]

Furthermore, there are indications that many businesses fail to adequately take into account the contribution which digitalisation can make to a company's strategic focus. Thus, an SME's strategic orientation is hardly reflected in its digitalisation activities.[41] Besides, only just under one fifth of enterprises have adopted an explicit digitalisation strategy. This, too, significantly contributes to the fact that SMEs spend relatively little on their digitalisation although they regard it as relevant to their business in principle.

Possible starting points for economic policy measures

In order to incentivise SMEs to implement digitalisation projects, it would make sense for economic policy to address the barriers that have been identified. Key areas are human capital, digital infrastructure and finance. It should address the digitalisation activities of both pioneers and digital latecomers. Only in this way will it be possible to develop growth areas of the future, achieve economically measurable results[42] and prevent the SME sector from splitting up into a heavily digitalised group of mostly large and R&D-conducting SMEs and a large mass of businesses left behind in the digitalisation drive.

The shortage of IT skills is likely to worsen further as a result of the demographic trend, and the general workforce will also be required to have a growing set of IT skills. That makes it necessary in the medium term to mainstream digital learning in early stages of life[43] and integrate IT skills more strongly into school, vocational training and tertiary education curricula. In the short term it will be necessary to undertake greater efforts in basic and advanced training to improve IT skills across the general workforce as well as improve the supply of IT specialists.

Enterprises in particular have great responsibility in the area of basic and advanced IT training. Without support from economic policy, however, it will hardly be possible to make progress in this area. It is important to realise the guiding principle of lifelong learning in the area of continuing education and training. For one thing, that will require effective training incentives in the form of financial support. Besides promotional loans and direct cost reimbursement, an additional measure could be to provide tax benefits for continuing education expenditure that treats investment in human capital the same as investment in assets and permits tax depreciations. The certification of qualifications along with navigation and quality assurance in the confusing market for continuing education are also important starting points.[44] An improved provision of digital services by public agencies that would enable businesses to manage administrative affairs more efficiently online can also provide additional incentives for businesses to develop expertise in the use of digital technologies.

Against the background of constantly growing demands on connection speeds it is necessary even in the better connected spaces to continuously check whether the services provided 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, for example, would help small providers with a low staff level to make use of the programmes and offer broadband networks 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 additional impetus for expansion. Furthermore, private users in particular continue to have a limited willingness to pay for high bandwidths. Subsidy programmes for fibreglass connections could therefore provide additional impetus for the expansion of a high-performance broadband network.

In order to mitigate financing problems is important to set additional targeted financial incentives for the implementation of digitalisation projects. There is a wide range of starting points that must be based on the maturity level of 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. Improving the offer of equity finance for start-ups would help new technologies come to market quickly. Low-interest loans (possibly with the inclusion of a grant component and the option of partial risk assumption) would support the implementation of digitalisation measures across the business community as a whole. 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.

The promotion of basic research and the development of digital standards, as is being done by the federal and state governments and the EU (e.g. GAIA-X) are further helpful measures to support digitalisation efforts. Not least, the problem of data protection is also an expression of the legal fragmentation of digital markets, which makes it difficult for businesses to operate Europe-wide and thus reach a critical size. Realising a single internal market in this respect as well would support the further development and marketing of digital technologies.

In order to more effectively develop the potentials of digitalisation, it also appears to be useful to more strongly illustrate the benefits of digitalisation for businesses, especially from a strategic perspective. Competence centres are already making an important contribution in conveying the opportunities offered by digitalisation. 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.

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Structure of SMEs with completed digitalisation projects in 2018/2020

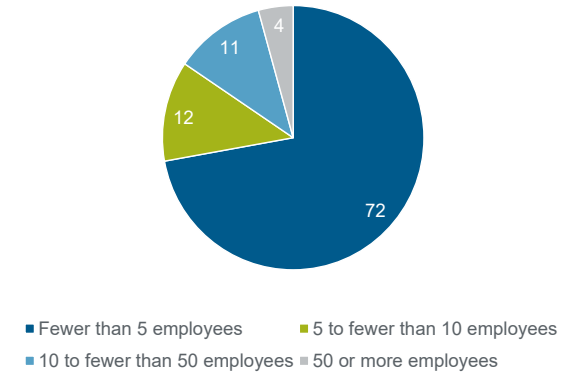
The SME sector, according to KfW's definition, covers all enterprises in Germany whose annual turnover does not exceed EUR 500 million. By this definition, around 3.8 million SMEs exist in Germany. The SME sector thus accounts for 99.95% of all enterprises. Of these enterprises, 1.3 million have successfully completed digitalisation projects.

Most SMEs with completed digitalisation projects are small businesses. The majority of SMEs with digitalisation projects – a good 2.7 million enterprises, or 72% – have fewer than five employees. This high percentage is due to the overall structure of the small and medium-sized enterprise sector. Eighty-one per cent of SMEs have fewer than five employees. Around 7% of enterprises with digitalisation projects are manufacturers and 83% are service providers.

Eighty-nine per cent of SMEs with completed digitalisation projects do not conduct any R&D of their own. A mere 6% and 5%, respectively, have conducted own R&D activities continuously or occasionally in the past three years.

Figure 26: SMEs with completed digitalisation projects by enterprise size

In per cent

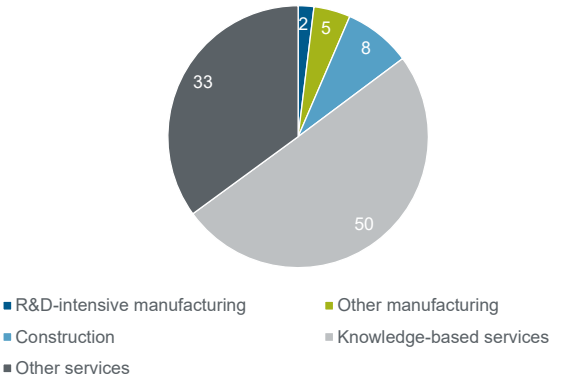


Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

Figure 27: SMEs with completed digitalisation projects by sector

In per cent

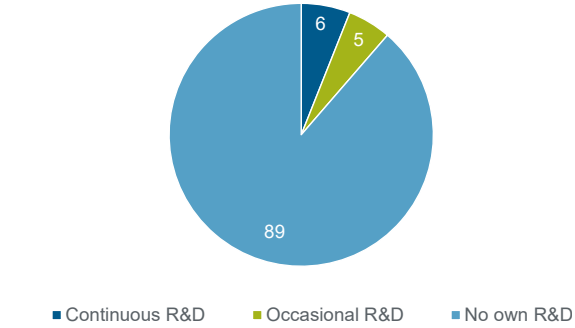


Note: Figures extrapolated to the number of enterprises.

Source: KfW SME Panel, own calculations

Figure 28: SMEs with completed digitalisation projects with and without own R&D activities

In per cent



Note: Figures extrapolated to 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 11,403 SMEs took part in the current wave.

Analyses of long-term structural developments in the SME sector are performed on the basis of the KfW SME Panel. 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 is the only way to determine 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 SE on behalf of KfW Group. The project received expert advice from the Leibnitz Centre for European Economic Research (ZEW) in Mannheim. The main survey of the 19th wave of the KfW SME Panel was conducted in the period from 15 February 2021 to 25 June 2021.

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

[2] 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 – Formation – Development* Perspectives – our title translation, in German). Springer, Gabler Verlag.

[3] Cf. 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.

[4] Cf. 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), S. 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 Nr. 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), S. 190–203; Cardona, M.; et al. (2013), ICT and productivity: conclusions from the empirical literature, Information Economics and Policy 25, S. 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.

[5] 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).

[6] Cf. DESI (2021); DESI | Shaping Europe's digital future (europa.eu); last retrieved on 12 January 2022.

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

[8] Cf. latest version: Federal Ministry of Economics and Technology (2018): Monitoring-Report Wirtschaft DIGITAL 2018 (in German). Der IKT-Standort Deutschland und seine Position im internationalen Vergleich (*Germany as an ICT location and its position in international comparison* – our title translation, in German).

[9] Cf. Abel-Koch, J. (2020): Coronavirus crisis drives shift to flexible and digital working in SMEs, Economics in Brief No. 197, KfW Research and Demmelhuber, K., et al. (2020): Homeoffice vor und nach Corona: Auswirkungen und Geschlechterbetroffenheit, (*Home working before and after the coronavirus: consequences and gender impact* – our title translation, in German), ifo Schnelldienst digital 14/2020.

[10] Cf. Federal Statistical Office, press release No. 161 dated 8 May 2020.

[11] Cf. Köhler-Geib, F. and Zimmermann, V. (2022): Die Auswirkungen der Coronapandemie auf die finanzielle Lage unterschiedlicher Gruppen von mittelständischen Unternehmen und deren Folgen für den Kreditzugang (*The impact of the coronavirus pandemic on the financial situation of different groups of small and medium-sized enterprises and its consequences for credit access* – our title translation, in German), Vierteljahreshefte zur Wirtschaftsforschung 2 / 2021, p. 31–48.

[12] Cf. Bertschek, I. (2020): Digitalisierung – der Corona-Impfstoff für die Wirtschaft (*Digitalisation as a corona vaccine for the German economy* – in German), Wirtschaftsdienst 2020/9, p. 653–656.

[13] Cf. Schwartz, M., and Gerstenberger, J. (2021): KfW SME Panel 2021: SMEs have proven to be adaptable in the coronavirus crisis, but with visible cracks in the foundations of small businesses, KfW Research.

[14] Cf. Bertschek, I. et al. (2019): ICT and Resilience in Times of Crisis: Evidence from Cross-Country Micro Moments Data, Economics of Innovation and New Technology, 28(8), p. 759–774.

[15] Cf. Dachs, B. and Peters, B. (2020): Covid-19-Krise und die erwarteten Auswirkungen auf F&E in Unternehmen (*COVID-19 crisis and expected impact on R&D in businesses* – our title translation, in German), ZEW policy brief No. 2 April 2020.

[16] Cf. Zimmermann, V. (2021), KfW SME Digitalisation Report 2020: Digitalisation activity fell before Corona, ambivalent development during the crisis, KfW Research.

[17] Cf. Zimmermann, V. (2022), Erwartete Verschiebung der Nachfrage hin zu digitalen Angeboten beschleunigt Digitalisierung im Mittelstand (Expected demand shift to digital offerings accelerates digitalisation in SMEs – – our title translation, in German), Focus on Economics No. 372, KfW Research.

[18] Cf. Dachs, B. and Peters, B. (2020): Covid-19-Krise und die erwarteten Auswirkungen auf F&E in Unternehmen (*COVID-19 crisis and expected impact on R&D in businesses* – our title translation, in German), ZEW policy brief No. 2 April 2020: Bertschek, I.; Polder, M. and Schulte, P. (2019): ICT and resilience in times of crisis: evidence from cross-country micro moments data, Economics of innovation and new technology 28(1):1–16 or Dachs et al. (2017): Innovation, creative destruction and structural change: firm-level evidence from European countries, Industry and Innovation 24(4): 346–381.

[19] 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.

[20] 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.

[21] 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.

[22] Cf. Zimmermann, V. (2020): How SMEs fund their innovation and investment expenditure – a comparison, Focus on Economics No. 280, KfW Research, or Zimmermann, V. (2018): Business Survey 2018. Digitalisation is gaining momentum, KfW Research.

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

[24] 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 Lööf, H. (2009), Learning by Exporting Revisited – the role of intensity and persistence, Scandinavian Journal of Economics 111(4), p. 893–913.

[25] Cf. Zimmermann, V. (2021): Which enterprises have been hit hardest by the coronavirus crisis and what lessons can we learn from it?, Focus on Economics No. 343, KfW Research.

[26] Cf. Hottenrott, H and Peters, B. (2012): Innovative capability and financing constraints for innovation – more money, more innovation? Review of Economics and Statistics 94(4), p. 1126–1142 and Zimmermann, V. (2018): Determinants of digitalisation and innovation behaviour in the SME sector, Focus on Economics No. 236, KfW Research.

[27] Cf. Nelson, R.R. and Phelps, E.S. (1966): Investment in Humans, Technological Diffusion and Economic Growth. American Economic Review 56, p. 69-75; Griliches, Z. (1969): Capital Skill Complementarity. Review of Economics and Statistics 5, p. 465–468; Welch, F. (1970): Education in Production. Journal of Political Economy 78(1):35–59; Schultz, T. W. (1975): The Value of the Ability to Deal with Disequilibria. Journal of Economic Literature 13(3), p. 827–846 or Tinbergen, J. (1975): Income Differences: Recent Research, Amsterdam: North Holland; .Wozniak, G.D. (1987): Human Capital, Information, and the early Adoption of new Technology, The Journal of Human Resources 22(1):101–112, or Gebhardt, J. et al. (2015): Developments 4.0 Prospects on future requirements and impacts on work and vocational education, Journal of Technical Education 3(2):45–61.

[28] Cf. OECD (2015) (ed.), Frascati Manual 2015. Guidelines for collecting and reporting data on research and experimental development.

[29] Cf. Zimmermann, V. (2022): Barriers to digitalisation in SMEs: lack of expertise, digital infrastructure and finance, Focus on Economics, forthcoming, Zimmermann, V. (2019), Business Survey 2019, More and more businesses have firm plans for digitalisation, hurdles also more widely acknowledged, KfW Research, and Zimmermann, V. (2017): Business Survey 2017. Digital transformation of industries: broad basis, multiple barriers, KfW Research.

[30] Cf. Leifels, A. (2021): German SMEs lack digital skills, need more training, Focus on Economics No. 346, KfW Research.

[31] Cf. Poschen, K. and Zimmermann, V. (2014): Falling sales expectations curb SME innovation activity in Germany, Economics in Brief No. 58, KfW Economic Research, and Zimmermann, V. (2000): Innovation und Konjunktur (*Innovation and economic activity* – in German), KfW Economic Research. Points of View No. 4, Frankfurt am Main.

[32] Cf. Zimmermann, V. (2018): Business Survey 2018. Digitalisation is gaining momentum, KfW Research.

[33] Cf. Zimmermann, V. (2022): Barriers to digitalisation in SMEs: lack of expertise, digital infrastructure and finance, Focus on Economics, forthcoming.

[34] Cf. Gerstenberger, J. and Schwartz, M. (2020), KfW SME Panel 2020: Coronavirus pandemic has dampened expectations for 2020 – SMEs entered the crisis from a strong position, KfW Research.

[35] 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.

[36] Cf. Zimmermann, V. (2021): Innovation and digitalisation in enterprises mutually reinforce each other, Focus on Economics No. 338, KfW Research;

[37] Cf. Schwartz, M., and Gerstenberger, J., (2021): KfW SME Panel 2021: SMEs have proven to be adaptable in the coronavirus crisis, but with visible cracks in the foundations of small businesses, KfW Research.

[38] Cf. Köhler-Geib, F. (2020): Where to from here? The crucial next steps in the coronavirus crisis, position paper, August 2020, KfW Research.

[39] Cf. Zimmermann, V. (2022): Barriers to digitalisation in SMEs: lack of expertise, digital infrastructure and finance, Focus on Economics, forthcoming, KfW Research.

[40] Cf. Zimmermann, V. (2020): How SMEs fund their innovation and investment expenditure – a comparison, Focus on Economics No. 280, KfW Research.

[41] Cf. Zimmermann, V. (2021): Market environment and competition strategies shape innovation and digitalisation in small and medium-sized enterprises, Focus on Economics No. 347, KfW Research.

[42] Cf. Andrews, D. et al. (2015), Frontier Firms, Technology Diffusion and Public Policy: Micro Evidence from OECD Countries, OECD Productivity Working Paper no. 2, Andrews, D. et al. (2016) The best versus the rest: The global productivity slowdown, divergence across firms and the role of public policy, OECD Productivity Working Paper No.5 or 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.

[43] Cf. Leifels, A. (2021): German SMEs lack digital skills, need more training, Focus on Economics No. 346, KfW Research.

[44] Cf. Leifels, A. (2021): German SMEs lack digital skills, need more training, Focus on Economics No. 346, KfW Research.