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Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project

Best Practice Collection report (D.6)

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Directorate-General for Communications Networks, Content and Technology
2022 EN

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Abbreviations

Abbreviation	Definition
AI	Artificial intelligence
ALARA	As low as reasonably achievable
AR/VR	Augmented reality/virtual reality
B2B	Business-to-business
B2C	Business-to-consumer
BIM	Building information modelling
CAD	Computer-aided design
CAM	Computer-aided manufacturing
CEDEFOP	European Centre for the Development of Vocational Training
CEO	Chief executive officer
COVID-19	Coronavirus disease 2019
CNC	Computerised numeric control
CRM	Customer relationship management
DigComp	The Digital Competence Framework
DIH	Digital Innovation Hub
DTZ	Digital Transfer Centre
e-CF	European e-Competence Framework
EDIH	European Digital Innovation Hub
EEN	Enterprise Europe Network
EIB	European Investment Bank
ERM	Enterprise resource management
ERP	Enterprise resource planning
EU	European Union
ESCO	European Skills, Competences, Qualifications and Occupations
FAMN	Finnish Advanced Manufacturing Network
HPC	High-performance computing
ICT	Information and communication technologies
I-IoT	Industrial internet of things

Abbreviation	Definition
IoT	Internet of things
IT	Information technologies
KPI	Key performance indicator
OECD	Organisation for Economic Co-operation and Development
PLM	Product lifecycle management
POS	Point-of-sale
R&D	Research and development
RON	Romanian leu
ROI	Return on investment
RRP	Recovery and Resilience Plan
SIR	Smart industrial remoting
SME	Small and medium-sized enterprise
SMART	Specific, measurable, attainable, relevant and time-bound.
TCO	Total cost of ownership
TEF	Testing and experimentation facility
UX	User experience
VPP	Valor process preparation
WMS	Warehouse management system

Introduction

Digitalisation is one of the main contributors to European growth, resilience and competitiveness. Yet, despite the benefits brought by digital technologies, some European companies risk falling behind in their digitalisation journeys. Smaller companies in particular may struggle with adopting new technologies.[1]

Several factors can slow down the adoption of digital technologies. These include challenges such as a lack of digital skills, risk aversion and structural problems associated with a company's position in the industrial value chain. These challenges to digitalisation were explored in-depth earlier in the study 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project'.[2,3]

This report aims to shed light on best practice principles that can help companies, including SMEs, with average or below-average digital maturity, reap the benefits of digitalisation. As further elaborated in Chapter 1, for the purposes of this report, the concept of 'best practice' refers to size- and digital maturity-agnostic characteristics and behaviours exhibited by companies that have successfully adopted digital technologies. Therefore, 'best practices' are not linked to the implementation of state-of-the-art and innovative solutions, but rather ones that fit a company's needs and strategic objectives. For SMEs and companies with average or below-average digital maturity, low-cost options (e.g. off-the-shelf or open-source solutions) or relatively simple technologies (e.g. information systems, communication tools, document management systems and websites) may better address their business needs than more advanced solutions, and therefore constitute a 'best practice'.

In turn, rather than focusing on individual cases, this report presents best practice principles. Even though these principles have been developed with smaller and less digitally mature players in mind, they are relevant for all companies embarking on digitalisation journeys, regardless of their size, industry, digital maturity or the technology being implemented. Each best practice principle is also accompanied by company or ecosystem examples, illustrating how the principle has been applied in practice.

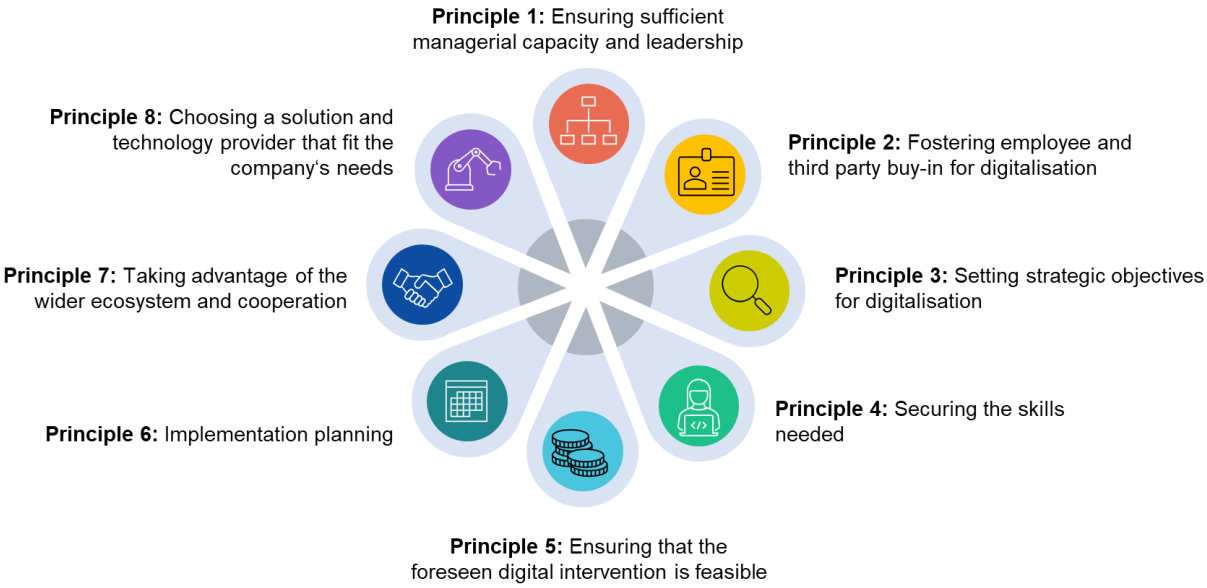
This report describes eight best practice principles, which include ensuring managerial capacity and leadership, setting strategic objectives for digitalisation, and implementation planning, among others. The eight best practice principles are illustrated in the figure below.

[1] OECD (2019). OECD SME and Entrepreneurship Outlook 2019, OECD Publishing, Paris, https://dx.doi.org/10.1787/34907e9c-en.

[2] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Gap Analysis report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-gap-analysis-report-now-published.

[3] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

Figure 1. Best practice principles included in this report



Source: compiled by the research team.

The report is the result of an extensive research exercise, consisting of interviews with company representatives, desk research and a literature review. Data were collected on a total of 69 examples of company and ecosystem digitalisation, out of which 42 are included in this report (see Annex 2). The digitalisation examples gathered focus on the digitalisation journeys of companies in the agrifood, automotive, construction, retail and textile industries. The gathered data were then analysed to identify common principles for digitalisation best practice. A more detailed description of the methodological approach is included in Annex 1.

This report forms part of a study entitled 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project'.[4] This study is being implemented by PPMI in collaboration with five Digital Innovation Hubs (DIHs): Agrifood Lithuania DIH,[5] Innomine[6] in Hungary, Iceberg+[7] in Romania, DIH4.ai[8] in Poland and CITEVE[9] in Portugal, together with industry digitalisation experts specialising in each of the industries concerned. The study is carried out for the Commission's Directorate-General for Communications Networks, Content and Technology, Unit A.4 — Digital Transformation of Industrial Ecosystems (DG CNECT A.4).

Smart industrial remoting (SIR) measures refer to those measures that support the uptake of digital technologies, undertaken by businesses to facilitate their remote operations, internally or externally. The objective of the study is to propose SIR measures for five ecosystems in which an especially high proportion of small and medium-sized enterprises (SMEs) have been hit hard by the COVID-19-related crisis: agrifood, automotive, construction, retail and the textile sector. These industries are analysed to formulate user-friendly and targeted advice on digitalisation. Each industry is studied in the context of a specific country, resulting in five

[4] More information available at: https://ppmi.lt/news-insights/study-smart-industrial-remoting-europe-new-opportunities-digital-innovation-hubs-and-smes
[5] More information available at: https://agrifood.lt/.
[6] More information available at: https://innomine.com/.
[7] More information available at: https://www.iceberg.ro/en/digital-innovation-hub/.
[8] More information available at: https://dih4.ai/en.
[9] More information available at: https://www.citeve.pt/.

country-industry pairings.[10] These are: the agrifood industry in Lithuania; the automotive industry in Hungary; the construction industry in Romania; the retail industry in Poland; and the textile industry in Portugal.

The Best Practice Collection report is structured as follows:

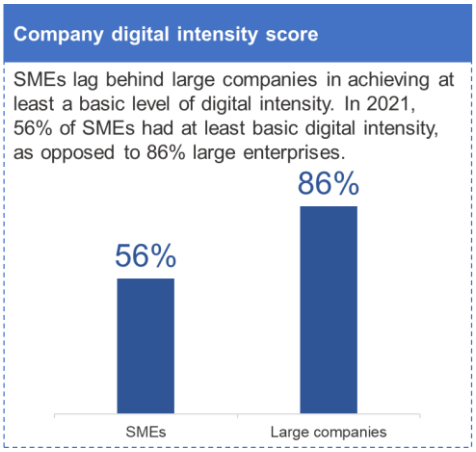
1. **Chapter 1 Why digitalisation best practice principles?** – introduces the broader context and rationale behind the scope and focus of the report.
2. **Chapter 2 Digitalisation best practice principles** – details the eight best practice principles, together with case study examples.
3. **Chapter 3 Conclusions** – summarises the study's findings and provides an overview of its main insights, drawn from the data gathered for this report.

[10] The selection of country-industry pairings is described in 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Gap Analysis report'. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-gap-analysis-report-now-published.

1. Why digitalisation best practice principles?

Digitalisation is an important enabler of industry growth and competitiveness. The adoption of digital technologies is linked to growth in productivity, new business opportunities and increased agility.[11] Digitalisation is also a key component of Industry 4.0, as the concept is characterised by the seamless sharing of data, automation and data-driven analytics.[12]

Data suggest that many European industrial companies struggle with the uptake of digital technologies.[13] While large companies are successfully reaping the benefits of digitalisation, smaller and less digitally mature players risk falling behind. According to the European Digital Intensity Index, only 56% of SMEs achieved at least a basic level of digital intensity[14] in 2021, compared with 86% of large enterprises.[15] Evidence shows that smaller companies often lack the resources and know-how to adopt digital technologies.[16] Less digitally mature companies may also be risk-averse with regard to digitalisation, due to a lack of prior experience.[17] In addition, research shows that digitalisation becomes easier once companies reach a certain level of digital maturity.[18]



The issue of digitalisation has been further exacerbated by the COVID-19 pandemic. Research conducted as part of this project shows that the COVID-19 pandemic had a heterogeneous effect on company digitalisation.[19] While large enterprises tended to accelerate their digitalisation, the effect on smaller companies was mixed. Some companies had to deprioritise investments in digital technologies and focus on business survival by directing revenues towards operational expenses.[20] For others, the adoption of technologies such as enterprise resource planning (ERP) systems helped them to switch to remote operations.[21]

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[11] MGI (2018). Assessing the economic impact of artificial intelligence, ITU Trends, Issue Paper No. 1, September 2018.

[12] Davies, R. (2015). Industry 4.0: Digitalisation for productivity and growth, EPRS: European Parliamentary Research Service. Belgium. Available at: https://policycommons.net/artifacts/1335939/industry-40/1942749.

[13] OECD (2020). The Digital Transformation of SMEs. OECD Publishing, Paris, https://doi.org/10.1787/bdb9256a-en.

[14] A company's digital intensity score is calculated by counting how many out of 12 selected technologies it uses. A basic level requires the use of at least four technologies.

[15] Eurostat (2021). Digital Intensity Index overview. Available at: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220826-1.

[16] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[17] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[18] OECD (2021). The Digital Transformation of SMEs, OECD Studies on SMEs and Entrepreneurship, OECD Publishing, Paris. Available at: https://doi.org/10.1787/20780990.

[19] Results of the Company Digitalisation survey conducted by PPMI, Question 'In your opinion, what are the main obstacles your company faces in adopting digital technologies?', N=350 (1-250 employees: 256; >250 employees: 86). Full results are available in 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Problem Identification report'. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[20] Agrawal, M., Dutta, S., Kelly, R., & Millán, I. (2021). COVID-19: An inflection point for Industry 4.0. McKinsey. Available at: https://www.mckinsey.com/capabilities/operations/our-insights/covid-19-an-inflection-point-for-industry-40.

[21] OECD (2020). The Digital Transformation of SMEs. OECD Publishing, Paris. Available at: https://doi.org/10.1787/bdb9256a-en.

Recognising the challenges faced by smaller and less digitally mature companies when attempting to digitalise, the European Commission has adopted the EU Digital Compass. It sets targets for Europe's digital transformation, including the ambitious target of more than 90% of SMEs reaching at least a basic level of digital intensity by 2030.[22] To achieve this target, a number of European initiatives have been launched, with more to follow. For example, Member States are required to dedicate at least 20% of their Recovery and Resilience plan (RRP) funding to the digital transition. Furthermore, in 2022 the European Commission launched the European Digital Innovation Hubs (EDIH) initiative. This aims to accelerate the digitalisation of companies in Europe by providing them with access to technical expertise and testing.[23] Similarly, Member States have launched numerous initiatives supporting the digitalisation of industry.

As we will demonstrate in the next chapter, European and national initiatives are important for facilitating digitalisation. Nevertheless – and perhaps more importantly – there are several principles that companies can follow when digitalising. As mentioned above, the majority of those companies lagging behind in digitalisation in Europe are SMEs. Thus, this report focuses on practices that build on the strengths of SMEs, and which consider their day-to-day operational environments. Sharing best practices is important in fostering digitalisation. They act as catalysts for digital transformation by filling in knowledge gaps, reducing the psychological barriers to undertaking change and achieving the EU's Digital Decade targets.[24] A review of the existing literature on digitalisation best practices points to a potential gap in research focusing on SMEs. This is particularly true in relation to the introduction of Industry 4.0 technologies.[25] Hence, the best practice principles described in this report offer pertinent insights into digitalisation practices that work for smaller and less digitally mature companies.

When it comes to the uptake of digital technologies, several differences exist between SMEs and large enterprises. While SMEs face a number of barriers to digitalisation, their size also offers them several unique strengths. Both the case studies and literature reviewed point to the resilience of SMEs and their capacity to adapt to rapidly changing environments.[26] First, their small size enables flexibility and agility. Typically, SMEs are not only adaptive and innovative in terms of their products, but also in terms of their manufacturing practices.[27] Thus, organisational and cultural changes can be implemented more easily across the whole company.[28] Second, SMEs also tend to be management-centric organisations, i.e. dependent on their owners. This is usually an advantage for SMEs, as decision-making can be quick and efficient. SMEs also typically have fewer intermediaries between owners, employers, suppliers and customers, making it easier to collect and exchange information.[29] Lastly, research

[22] European Commission (2022). Europe's Digital Decade: digital targets for 2030. Available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en.

[23] More information available at: https://digital-strategy.ec.europa.eu/en/activities/edihs .

[24] DG CNECT A4 - Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the Role of Best Practices' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[25] Matt, D.T., & Rauch, E. (2020). SME 4.0: The Role of Small- and Medium-Sized Enterprises in the Digital Transformation. In: Matt, D., Modrák, V., & Zsifkovits, H. (eds) Industry 4.0 for SMEs. Palgrave Macmillan, Cham. Available at: https://doi.org/10.1007/978-3-030-25425-4_1.

[26] Kuckertz, A., Brändle, L., Gaudig, A., Hinderer, S., Morales Reyes, C.A., Prochotta, A., & Berger, E. (2020). Startups in times of crisis – A rapid response to the COVID-19 pandemic. *Journal of Business Venturing Insights*, 13, e00169. Available at: https://doi.org/10.1016/j.jbvi.2020.e00169.

[27] Matt, D.T., & Rauch, E. (2020). SME 4.0: The Role of Small- and Medium-Sized Enterprises in the Digital Transformation. In: Matt, D., Modrák, V., Zsifkovits, H. (eds) Industry 4.0 for SMEs. Palgrave Macmillan, Cham. Available at: https://doi.org/10.1007/978-3-030-25425-4_1.

[28] Modrák, V., & Šoltysová, Z. (2020). Development of an organizational maturity model in terms of mass customization. In Industry 4.0 for SMEs (pp. 215-250). Palgrave Macmillan, Cham.

[29] Eggers, F. (2020). Masters of disasters? Challenges and opportunities for SMEs in times of crisis. *Journal of Business Research*, 116, 199–208. Available at: https://doi.org/10.1016/j.jbusres.2020.05.025

suggests that some SMEs are likely to be 'ambidextrous' organisations – that is, organisations that can implement both incremental and revolutionary changes in order to remain successful over long periods, and despite major changes in the market.[30]

Despite the aforementioned strengths of SMEs, the literature shows that they also face certain challenges when it comes to digitalisation.[31,32,33,34] Evidence suggests that they are more likely to face a scarcity of financial resources. As a result, they may not prioritise investments in digital technology, and may instead focus on more pressing operational challenges.[35] SMEs are also more likely to possess limited managerial capacity in terms of procedures, techniques and tools to make long-term planning decisions. Some companies therefore tend to make decisions reactively in response to external factors. In addition, the management of SMEs' IT departments tends to be oriented more towards the operational level, rather than tactical and strategic levels.[36,37] Small and micro companies often rely on tacit knowledge that is held by long-term and experienced staff. In these situations, the loss of employees makes companies vulnerable to knowledge loss.[38] Research shows that SMEs often lack the tools to objectively assess their digital maturity and in turn, their digitalisation needs.[39] Lastly, SMEs are more likely than large companies to collaborate with external actors, whether to gain access to expert advice or to outsource digitalisation. Because SMEs sometimes lack knowledge about digital technologies, such collaborations can result in vendor lock-in or the procurement of solutions that do not fully fit a company's needs.[40]

Consequently, for the purposes of this report, the concept of 'best practice' refers to size- and digital maturity-agnostic characteristics and behaviours exhibited by companies that have successfully adopted digital technologies. The data collected through the case studies, as well as existing research, show that SMEs can sometimes benefit from adopting simpler solutions to advance their digitalisation, as opposed to state-of-the-art technologies.[41] For this reason, the best practice principles identified in this report are accompanied by real-life examples of how they have been applied in practice by companies of differing sizes and levels of digital maturity, representing different industries. The best practice principles have been developed to be relevant to companies of all sizes, while keeping in mind the characteristics of SMEs

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[30] Klein, V.B., & Todesco, J.L. (2021). COVID-19 crisis and SMEs responses: The role of digital transformation. *Knowledge and Process Management*, 28(2), 117-133.

[31] Horvath, D., & Szabo, R.Z. (2019). Driving forces and barriers of Industry 4.0: do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting and Social Change*, Vol. 146, pp. 119-132.

[32] Mittal, S., Khan, M.A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing and Industry 4.0 maturity models: implications for small and medium-sized enterprises (SMEs). *Journal of Manufacturing Systems*, Vol. 49, pp. 194-214.

[33] Mittal, S., Khan, M.A., Purohit, J.K., Menon, K., Romero, D., & Wuest, T. (2020). A smart manufacturing adoption framework for SMEs. *International Journal of Production Research*, Vol. 58 No. 5, pp. 1555-1573.

[34] Moeuf, A., Lamouri, S., Pellerin, R., Tamayo-Giraldo, S., Tobon-Valencia, E., & Eburdy, R. (2020), "Identification of critical success factors, risks and opportunities of Industry 4.0 in SMEs", *International Journal of Production Research*, Vol. 58 No. 5, pp. 1384-1400.

[35] Moeuf, A., Tamayo, S., Lamouri, S., Pellerin, R., & Lelievre, A. (2016). Strengths and weaknesses of small and medium sized enterprises regarding the implementation of lean manufacturing. *IFAC-PapersOnLine*, 49(12), 71–76.

[36] Pelletier, C., & Cloutier, L. M. (2019). Challenges of digital transformation in SMEs: Exploration of IT-related perceptions in a service ecosystem. In: Proceedings of the 52nd Hawaii international conference on system sciences.

[37] Björkdahl, J. (2020). Strategies for Digitalization in Manufacturing Firms. *California Management Review*, 62(4), 17–36. Available at: https://doi.org/10.1177/0008125620920349.

[38] Durst, S., & Wilhelm, S. (2011). Knowledge management in practice: Insights into a medium-sized enterprise's exposure to knowledge loss. *Prometheus*, 29(1), 23–38.

[39] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[40] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[41] Estensoro, M., Larrea, M., Müller, J.M., & Sisti, E. (2021). A resource-based view on SMEs regarding the transition to more sophisticated stages of industry 4.0, *European Management Journal*, ISSN 0263-2373. Available at: https://doi.org/10.1016/j.emj.2021.10.001.

discussed above. It should also be noted that the best practice principles are technology-agnostic. They aim to help companies to smoothly implement digital technologies, independently of the technology chosen.

2. Digitalisation best practice principles

This chapter details the eight best practice principles identified on the basis of the analysis carried out for this study. Each principle's description includes the main digitalisation challenges the principle aims to address or existing evidence pointing to the importance of the principle, together with examples from the case studies showing how the principle has been applied in practice. Some principles are broken down into components, each highlighting a separate aspect of the principle. The principles vary in their structure. Some, such as Principle 3, 'Setting strategic objectives for digitalisation', include several components. Others, such as Principle 4, 'Securing the skills needed', have none. Nevertheless, this does not imply that certain principles are more important than others.

Before describing each of the principles in detail, this chapter presents a summary of each of the main principles included in this report.

2.1. Summary of best practice principles

On the basis of data gathered via interviews and existing research, we have identified a total of eight best practice principles**.** These principles have been developed with the goal of being relevant to all companies looking to digitalise, independent of their size, digital maturity or industry, or the technology they plan to adopt. This study forms part of a broader area of research that focuses on industry digitalisation. However, our analysis shows that most research into 'digitalisation best practices' focuses on the adoption of advanced technologies such as robotics or artificial intelligence (AI) by large companies. The purpose of this report is instead to provide pertinent examples of digitalisation for smaller and less digitally mature companies. In turn, each principle highlights certain practices that can aid companies when adopting digital technologies, rather than focusing on the digital technologies themselves.

The eight principles are interconnected and often build upon each other. Nevertheless, each principle focuses on different behaviours that companies, especially SMEs, can adopt to facilitate digitalisation. Table 1 contains a summary of the main findings for each principle. In those cases where the principles are broken down into specific components, the main findings are presented at the level of each component.

Table 1. Summary of best practice principles

Principle 1 – Ensuring managerial capacity and leadership
Component 1.1: Management buy-in and strategic alignment with digital transformation
• Company management can act as **gateways** or **gatekeepers** when it comes to digitalisation. • Management buy-in is key to **kick-starting** and **successfully implementing** digitalisation initiatives. • Several **approaches exist to obtain management buy-in**, including demonstrating the benefits of the technology, showcasing companies in which the technology was successfully adopted, and highlighting the main inefficiencies and pain-points that could be addressed by digitalisation.
Component 1.2: Adoption of good managerial practices
• Company management is more likely to lead digitalisation successfully if it is **open to change**, actively **looks for opportunities** to digitalise, and fosters a **culture of innovation.** • Managers are encouraged to adopt **agile techniques** to navigate their company through the process of digitalisation.

Principle 2 – Fostering employee and third party buy-in for digitalisation

- **Supportive organisational culture** and **employee buy-in** are key prerequisites for successful technology adoption.
- Companies need to combine their digitalisation efforts with **effective change management** that incudes defining a case for change, engaging stakeholders, communication and learning, and demonstrating progress to employees.
- **SMEs** can take advantage of characteristics such as the **proximity between management and employees**, **flexibility, and adaptability**, to secure employee buy-in.
- The **wider ecosystem** – EDIHs/DIHs, academia and public organisations – can also play an important role.

Principle 3 – Setting strategic objectives for digitalisation

Component 3.1: Monitoring trends in technology

- Awareness of **technology trends** and **digitalisation opportunities** helps companies to digitalise successfully.
- Companies can use several **sources of information**: research, patents, start-up activities, best practice repositories, digital communities and others, to learn about digitalisation opportunities.
- Companies can develop the necessary skills and expertise **in-house** or co-create knowledge together with the **wider ecosystem** and make use of **existing support mechanisms**, such as the EDIH/DIH network.

Component 3.2: Identifying digitalisation gaps and needs

- Analysis of **digitalisation gaps** helps companies determine what digital technologies the enterprise should invest in.
- To **define needs,** companies should start with an analysis of the company's strategy, environment, objectives, business processes and customers.
- Making use of **existing resources, tools and external expertise** can help companies to bypass existing resource and time constraints.
- Companies employ **various methods** to analyse their digitalisation gaps and needs (e.g. process mapping, service and sales channel auditing) depending on their relevance to their operations and digital maturity.

Component 3.3: Digital strategy: defining objectives and ensuring a shared vision

- Setting **long-term objectives** for digitalisation can help companies to persevere despite setbacks, secure funding, foster stakeholder buy-in and successfully implement digital technologies.
- Companies **can define** and document long-term objectives **in several ways**, for example, by integrating digitalisation objectives in the company's overarching strategy or setting objectives during strategic meetings.
- Strategic objectives should be **reviewed and adapted** in line with changing business realities.

Principle 4 – Securing the skills needed

- Having digital know-how is one of the **most important enablers** for digitalisation.
- A **wide range of skill sets,** including digital and hybrid skills, is important for the adoption of digital technologies,.
- **SMEs** are more affected by digital skills shortages than large companies, and rarely have **dedicated ICT specialists or departments**. Instead, they can choose to **upskill** or **reskill** their employees, **learn by doing,** or seek **external expertise**.
- Existing **digital competence frameworks**, such as the Digital Competence Framework (DigComp) and the European e-Competence Framework (e-CF) can support companies in defining career and learning paths and assessing skills needs, among other uses.

Principle 5 – Ensuring that the foreseen digital intervention is feasible

Component 5.1: Assessing the costs of digitalisation

- **Assessing the costs of digitalisation** in an important step in ensuring the feasibility of a digital intervention.
- Evidence shows that companies, especially SMEs, tend to **underestimate the costs of digitalisation** by not considering its long-term implications. Companies are encouraged to take into account maintenance or hidden costs such as, for example, a loss of productivity during the transition phase.
- Companies can also estimate the associated returns on investment (ROI). However, it is important to **take a long-term view** when estimating ROI, as the costs of digitalisation tend to outweigh its benefits in the short term.
- Multiple ways exist for companies to **drive down costs**. These include the use of low-cost components, relying on open-source solutions or simple, low-cost solutions.

Component 5.2: Ensuring capacity to implement the project

- Companies are encouraged to **assess the feasibility** of digitalisation before they embark on a digitalisation journey.
- In addition to relying on **their own funding**, companies can also leverage existing support ecosystems by collaborating with start-ups, opting for software-as-a-service solutions and **applying for public funding programmes**.

Principle 6 – Implementation planning

Component 6.1: Defining the scope of the digitalisation effort: small-scale initiatives versus broad transformations

- The scope of a company's digitalisation efforts can vary from **small-scale initiatives** to **programmes affecting the whole organisation**.
- The defined scope of a digitalisation initiative needs to **align** with the company's **needs, strategic objectives** and **transformation capabilities**.
- Companies should begin with **smaller projects**, transitioning to **broader transformations** as they gain more digitalisation experience**.**
- A **test-and-learn approach** helps companies to assess the viability of solutions on a small scale through pilots or experiments, before implementing them company-wide.

Component 6.2: Implementation planning and monitoring: the importance of iteration and feedback cycles

- Evidence suggests that **strategic roadmapping** can positively impact the uptake of digital technologies.
- The **level of detail** a plan includes should align with the **complexity** and **scope** of the digitalisation initiative.
- Planning also needs to include consideration of **monitoring, supervision** and **governance** during implementation.
- Performance improvements can be measured through a set of clearly defined **SMART KPIs**.
- An ability to **flexibly adapt plans** can help to address challenges that arise and reinforce commitment when there are setbacks.

Principle 7 – Taking advantage of the wider ecosystem and collaboration

- Companies that **collaborate** with their ecosystem are **more likely to digitalise successfully**.
- SMEs stand to benefit greatly from collaboration. External support can help them to obtain access to **funding, expertise and knowledge of the latest technical developments and testing facilities**.
- To gain access to expertise, funding and testing facilities, companies can collaborate with **various stakeholders** (public sector organisations, academia, technology extension programmes such as DIHs and sector- or technology-specific clusters).
- Companies can also collaborate with other businesses in their **value chain**. Collaborating with start-ups, for example, can enable companies to gain access to low-cost solutions. Similarly, cooperatives can help companies to overcome some of the initial costs of digitalisation. Lastly, companies can drive down the costs of digitalisation and facilitate the sharing of experience by purchasing joint solutions.

Principle 8 – Choosing a solution and technology provider that fit the company's needs

Component 8.1: Choosing a solution: taking advantage of low-cost alternatives and external expertise

- Many companies start their digitalisation process with **basic technology building blocks,** and transition to **more advanced technologies** as their digital maturity increases.
- To align with the needs of SMEs, solutions need to be **accessible, simple, unobtrusive and scalable.**
- Many commercially available solutions **fail to meet the needs of SMEs** because they may lead to vendor lock-in or be over-engineered and/or expensive.
- The use of **simple** and **low-cost technologies** can make digitalisation more accessible to SMEs. Ways to simplify and reduce the costs of digitalisation include: the use of non-industrial, off-the-shelf, open-source technologies and platforms; retrofitting; the involvement of trainees, apprentices and students; and cost sharing with other companies.
- Companies can make use of **external expertise** to **define an approach** to digital technology implementation.

Component 8.2: Ensuring effective interaction with solution providers

- For many companies, **outsourcing** is necessary to implement new digital technologies.
- To select a vendor, companies consider factors such as **cost, delivery capacity**, relevance to **business needs,** and **complexity** of implementation.
- Many companies find it difficult to choose a suitable vendor due to the **wide range of providers available,** as well as **fragmented and technology-centric information**.
- The successful adoption of digital technology requires **effective interaction** between companies and vendors. Models for interacting with providers can range from being relatively **hands-off** to close and mutually beneficial **partnerships**.
- For complex projects, successful digitalisation requires a **dedicated team** made up of members from both the company and the vendor side, who coordinate closely to implement the solution.

To develop the best practice principles above, the research team built on findings from an analysis of the case studies, as well as an analysis of the enablers of successful digitalisation. A total of 42 case studies have been developed to inform this report. The distribution of case studies by industry is provided in the table below.

Table 2. Distribution of case studies per principle

Principle	Number of case studies cited
Principle 1 – Ensuring managerial capacity and leadership	10
Principle 2 – Fostering employee and third party buy-in for digitalisation	11
Principle 3 – Setting strategic objectives for digitalisation	18
Principle 4 – Securing the skills needed	8
Principle 5 – Ensuring that the foreseen digital intervention is feasible	11
Principle 6 – Implementation planning	13
Principle 7 – Taking advantage of the wider ecosystem and collaboration	16
Principle 8 – Choosing a solution and technology provider that fit the company's needs	23

Notes: each case study can be assigned to several principles.

Each principle, including its components and case study examples, is elaborated upon below. The case studies developed for this report are available as part of Annex 2.

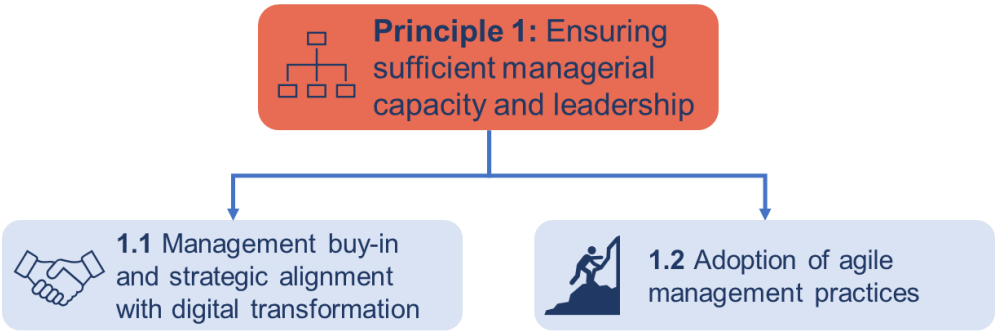
2.2. Principle 1 – Ensuring managerial capacity and leadership

The first principle concerns ensuring sufficient managerial capacity and leadership before and during the digitalisation process. Company management usually act as gateways or gatekeepers in relation to digitalisation. Having their buy-in for the adoption of digital technologies is key to smooth implementation. Similarly, certain managerial practices, including agility, can help to accelerate digitalisation.

Principle 1 'Ensuring managerial capacity leadership' was assigned as important in 10 out of the 42 case studies analysed (see Annex 2).

This principle can be further broken down into two interlinked components, as illustrated in Figure 2. Each component is described in further detail below. Both components relate to the importance of implementing the right managerial practices within the company to ensure successful company digitalisation.

Figure 2. Components of Principle 1, 'Ensuring sufficient managerial capacity and leadership'



2.2.1. Component 1.1: Management buy-in and strategic alignment with digital transformation

Company management is responsible for making decisions concerning a company's growth and evolution. Analysis of the case studies, together with the conclusions of other research, reveal that **support from top management is a key factor influencing the adoption of digital technology**.[42,43] As discussed below, digitalisation initiatives are usually initiated by the owners and managers of companies. Sometimes, however, a push for digitalisation comes from mid-level management or employees experimenting with new technologies, or due to external pressure (e.g. regulatory or market changes). In this case, securing management buy-in becomes an important enabler of change.

Leadership and commitment from management are key enablers of digital transformation. Research shows that top management's awareness of and commitment towards Industry 4.0 and its acceptance of technology are some of the main determinants of digitalisation among SMEs.[44] Furthermore, managers play a prominent role in the success or

[42] Radhakrishnan, J., & Chattopadhyay, M. (2020, December). Determinants and Barriers of Artificial Intelligence Adoption–A Literature Review. In: International Working Conference on Transfer and Diffusion of IT (pp. 89-99). Springer, Cham.

[43] González-Varona, J.M., López-Paredes, A., Poza, D., & Acebes, F. (2021). Building and Development of an Organizational Competence for Digital Transformation in SMEs. *Journal of Industrial Engineering and Management*,14(1), 15-24.

[44] Ghobakhloo, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A. (2022). Drivers and barriers of Industry 4.0 technology adoption among manufacturing SMEs: a systematic review and transformation roadmap. *Journal of Manufacturing Technology Management*, (forthcoming).

failure of an Industry 4.0 project.[45] In this regard, having management buy-in for a digitalisation project can determine whether or not it reaches the implementation phase. In the Company Digitalisation survey conducted earlier in the study, 18% of respondents stated that digitalisation 'not being a management priority' was a key obstacle to digitalisation.[46]

SMEs tend to be management-centric organisations. On the one hand, this can benefit companies' efforts to digitalise. SMEs tend to have less complex business and manufacturing processes than large companies. As a result, organisational and cultural changes may be relatively easier to implement.[47] Managers in SMEs are usually highly aware of internal processes, are often the founders or owners of the company, and are in charge of innovation. For this reason, SME management benefits from flexible and efficient decision-making with regard to digitalisation, as there are fewer stakeholders and fewer points at which the process may be vetoed.

On the other hand, managers in small companies can also act as gatekeepers. This is more likely to occur when owners run the company and the digitalisation initiative is initiated by the middle management or employees. Similarly, running the business for a significant period may make top management risk averse or more resistant to change.[48] For example, an analysis of Lithuania's agrifood industry revealed that farmers who have inherited businesses from their families tend to be more cautious when it comes to change.[49] Companies whose management has cautious attitudes to change, or focuses more on operational rather than strategic decision-making, may encounter some resistance to the adoption of digital technology.[50] These types of companies are more likely to adopt technologies only in response to external shocks, and to encounter challenges during their implementation.[51]

One way to obtain management buy-in for digitalisation is by demonstrating its benefits. Existing research shows that demonstrating the value that digitalisation can bring is a stepping-stone in the implementation of smart manufacturing solutions.[52] In the Company Digitalisation survey conducted earlier in the study, respondents were asked what drove their decision to digitalise. A total of 50% of the respondents selected 'increased profitability' as one of the main factors. Similarly, the feedback gathered from participants during the 'Workshop on SME digitalisation: how to make best practices a reality' (henceforth: the Best Practices workshop) highlighted the importance of demonstrating and clearly communicating the benefits of digitalisation.[53] This suggests that showing the impact of digitalisation on a company's

[45] Moeuf, A., Lamouri, S., Pellerin, R., Tamayo-Giraldo, S., Tobon-Valencia, E., & Eburdy, R. (2020). Identification of critical success factors, risks and opportunities of Industry 4.0 in SMEs. *International Journal of Production Research*, 58(5), 1384-1400.

[46] Results of Company Digitalisation survey conducted by PPMI., Question 'In your opinion, what are the main obstacles your company faces in adopting digital technologies?', N=350 (1-250 employees: 256; >250 employees: 86). Full results are available in 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Problem Identification report'. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[47] Modrák, V., & Šoltysová, Z. (2020). Development of an organizational maturity model in terms of mass customization. In Industry 4.0 for SMEs (pp. 215-250). Palgrave Macmillan, Cham.

[48] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[49] Ibid.

[50] Pelletier, C., & Cloutier, L.M. (2019). Challenges of digital transformation in SMEs: Exploration of IT-related perceptions in a service ecosystem. In Proceedings of the 52nd Hawaii international conference on system sciences.

[51] OECD (2019). OECD SME and Entrepreneurship Outlook 2019, OECD Publishing, Paris. Available at: https://dx.doi.org/10.1787/34907e9c-en.

[52] Ghobakhloo, M. (2020). Determinants of information and digital technology implementation for smart manufacturing. *International Journal of Production Research*, 58(8), 2384-2405.

[53] Conclusions from the panel discussion and an interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

profitability, competitiveness or resilience can be an effective way to obtain management buy-in.

Several ways exist to demonstrate the benefits of digitalisation to company decision-makers. One useful tool is a cost-benefit analysis. This provides evidence of the short and long-term benefits and costs associated with the introduction of digital technology. Nevertheless, evidence shows that when it comes to the digitalisation of small companies, short-term costs often outweigh short-term benefits, as described in Principle 5 (see Section 2.6). This is because technology adoption entails changes in business and management processes, in addition to the costs associated with purchasing and implementing a solution.[54] Research shows that companies that focus on long-term value (in terms of new business opportunities, benefits to customers and long-term impact on productivity) are more likely to digitalise successfully.[55]

Analysis of the case studies, together with existing research, points to **several 'soft' approaches to convincing management**. For instance, demonstrating examples of the successful implementation of solutions in other companies can help to overcome risk aversion.[56] Similarly, interactions with managers from more digitally mature companies may be useful in demonstrating that the costs associated with digitalisation will pay off in the long run.[57] Lastly, organising working sessions with the management team is another way to obtain their buy-in. These sessions can be used to highlight inefficiencies in existing company processes and demonstrate the issues that can be overcome through digitalisation.

Strategic alignment between a company's growth objectives and digitalisation is also an important enabler. Research shows that long-term planning in relation to digitalisation contributes to the success of such initiatives, as described in Component 3.3 (see Section 2.4.3). In practical terms, this makes it easier to identify digitalisation opportunities and understand how they benefit the company in the long run. This will also help management to determine appropriate avenues for digitalisation while remaining consistent with organisational growth.[58] Linking a company's growth goals with the necessary behavioural changes helps to increase the likelihood of success in adopting a new technology.[59]

Several case studies highlight the importance of having managerial support for digitalisation. Certain case studies also describe tools that can help in obtaining management support. These are elaborated upon in Table 3 below.

[54] Teng, X., Wu, Z., & Yang, F. (2022). Impact of the Digital Transformation of Small- and Medium-Sized Listed Companies on Performance: Based on a Cost-Benefit Analysis Framework. *Journal of Mathematics*, 2022, 1–14. Available at: https://doi.org/10.1155/2022/1504499.

[55] McGrath, R., & McManus, R. (2020). Discovery-Driven. Harvard Business Review, 98(3), 124-133.

[56] DG CNECT A4 – Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the Role of Best Practices' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[57] Ellström, D., Holtström, J., Berg, E., & Josefsson, C. (2022), "Dynamic capabilities for digital transformation", *Journal of Strategy and Management*, Vol. 15 No. 2, pp. 272-286. Available at: https://doi.org/10.1108/JSMA-04-2021-0089.

[58] CWA (2014). European E-Competency Framework.

[59] Baculard, P., Colombani, L., Flam, V., Lancry, O., & Spaulding, E. (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

Table 3. Importance of management buy-in and strategic alignment: examples from the case studies

Industry	Description
CS 8	**DTH Automotive Kft in Hungary – Adoption of 3D scanning to automate measurement processes**
Automotive	Dynamics Technology Hungary Kft. is a subsidiary of an US-based group of companies that has been operating in Hungary since 2000. The company introduced a 3D scanner to automate its measurement processes. Company representatives highlighted the importance of persuading managers to change their attitude toward the implementation of 3D scanners. The management was initially unconvinced of the need for the new technology. **Advocates of digitalisation therefore had to demonstrate the benefits of the proposed solution and show that the investment would pay off in the long run**. In addition, encouraging management to discuss the solution with other factories was also helpful in obtaining their buy-in for digitalisation.
CS 10	**Matro Gépgyártó Kft. in Hungary – Adoption of an ERP system in the area of administration, and robotics in the area of production**
Automotive	Matro Gépgyártó Kft. is mainly involved with the production of components for engine management systems, spare parts for the brake systems of trucks, and car body parts. A total of 90% of Matro Gépgyártó Kft.'s sales revenue and product portfolio come from projects in the automotive industry. Due to labour shortages and fluctuations in the number of staff available at the company, company management decided to automate certain production processes. The company introduced an ERP system, automating data collection and exchange across multiple devices. Matro Gépgyártó Kft.'s management understood that **automation and robotisation were necessary components of the company's long-term growth strategy**.
CS 19	**Têxteis Penedo in Portugal – A virtual showroom platform**
Textile	Based in Guimarães, at the heart of the Portuguese textile industry, Têxteis Penedo has been at the forefront of household textiles since 1975. The company considers itself to be an SME at the forefront of digital technology adoption. It has an internal IT team with the skills needed to address the development and implementation of new digital tools, minimising the company's dependency on third-party providers. The company credits its management with **fostering a culture that is open to innovation**. The management aims to align the company's evolution with innovation, and is aware of relevant technologies and opportunities for public support.
CS 37	**Fiber Network Wug in Germany – Cooperative-built internet infrastructure for local people, enterprises, and future stakeholders**
Construction	Fiber Network WUG is an example of a cooperative formed to speed up broadband internet connection in rural areas that are currently not sufficiently profitable for large internet providers. The cooperative has built a high-speed internet network that is connected to the pre-existing local heating network. When installing the heating network, the **company performed a cost-benefit analysis and compared different implementation options**. When deciding between the installation of copper or fibre optic lines for the purpose of communicating between control modules, the cooperative opted for the latter. Even though fibre optic lines were four times as expensive, their use allowed the town to obtain high-speed internet and use a pre-existing network to lay the cables without having to dig deeper or outsource the work.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

2.2.2. Component 1.2: Adoption of agile management practices

Certain management capabilities, such as agility and digital leadership, act as important enablers of digitalisation. An OECD study of 25 industries showed that up-to-date management practices are among the top three most important capabilities for the implementation of digital technologies.[60] Evidence suggests that a positive relationship exists between investment in organisational capital and returns on ICT investment.[61,62]

Several management practices have been shown to be important in facilitating digitalisation.[63] Visionary leaders who are strategic in making decisions and aware of the technological landscape are more likely to lead their companies successfully through a digital transformation.[64] Research also shows that companies are more likely to digitalise successfully if they have leaders who create a culture of experimentation and foster a sense of urgency for introducing changes.[65] Creating a culture of experimentation requires leaders that are able to introduce open-door policies and trust-based relationships between employees and managers. The size of SMEs and their characteristic proximity between management and employees can make it easier to achieve this.[66] Participants and speakers in the Best Practice workshop highlighted that leaders who are committed to digitalisation, and who persevere despite setbacks, are important for the successful adoption of digital technologies.[67] In situations where companies lack such leaders, it may be beneficial to hire or contract an expert to oversee digitalisation and ensure it is aligned with the company's goals.[68]

Another enabler of successful digitalisation is agility in the company's management approach. This helps to ensure the strategic alignment mentioned above between a company's growth and its digitalisation. Research shows that dynamic managerial capabilities are important in mitigating the challenges that arise during the adoption of digital technologies, including unforeseen costs, as well as the need for training and required changes to the company's operations.[69] Agile leaders are also more likely to respond quickly to external shocks or changing consumer demands. The role of agile leadership is especially important for SMEs. This was the feature of digital leadership cited most frequently by interviewees in a study analysing 42 successful European SMEs.[70] Research shows that agile leaders are more likely to exhibit the following characteristics: an agile mindset in relation to adaptability and quick reaction to changes; team building skills; knowledge and identification of future growth

[60] Andrews, D., Nicoletti, G., & Timiliotis, C. (2018). Digital technology diffusion: A matter of capabilities, incentives or both? OECD Economics Department Working Papers, No. 1476, OECD Publishing, Paris. Available at: https://doi.org/10.1787/7c542c16-en.

[61] Pellegrino, B., & Zingales, L. (2017). Diagnosing the Italian Disease. NBER Working Paper, No. 23964.

[62] Bloom, N., Genakos, C., Sadun, R., & Van Reenen, J. (2012). Management Practices Across Firms and Countries. NBER Working Paper, No 17850.

[63] Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

[64] Fachrunnisa, O., Adhiatma, A., Lukman, N., & Ab Majid, M.N. (2020). Towards SMEs' digital transformation: The role of agile leadership and strategic flexibility. *Journal of Small Business Strategy*, 30(3), 65-85.

[65] McKinsey (2018). Unlocking success in digital transformation. Available at: https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/unlocking-success-in-digital-transformations.

[66] Konopik, J., Jahn, O., Schuster, T., Hoßbach, N., & Pflaum, A., Mastering the digital transformation through organizational capabilities: A conceptual framework (2022) Digital Business, Volume 2, Issue 2, 100019, ISSN 2666-9544. Available at: https://doi.org/10.1016/j.digbus.2021.100019.

[67] Conclusions from the panel discussion and an interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[68] Ibid.

[69] Ramírez, R., Österman, R., & Grönquist, D. (2013). Scenarios and early warnings as dynamic capabilities to frame managerial attention. *Technol. Forecast. Soc. Change*.;80(4):825–838.

[70] Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). E-Leadership through Strategic Alignment: An Empirical Study of Small- and Medium-sized Enterprises in the Digital Age. *Journal of Information Technology*. 31.

opportunities; a focus on investing in future expertise; a focus on prototyping and experimentation within the company; and a pro-active attitude.[71]

Agile managers also help to make companies more adaptable. Evidence shows that adaptable and scalable digital operations are important enablers of a successful digital transformation.[72] Digitalisation often involves the reorganisation and transformation of business processes. For SMEs, agility in business processes and a flexible approach to the company's operations can aid digitalisation.[73] Successful digital managers are more likely to promote an agile culture in their organisations.[74]

Analysis of the case studies performed for this study reveals a number of differing approaches taken by company management in implementing digital technologies. However, all of these cases demonstrate the importance of flexibility, agility and leadership in the successful adoption of digital technologies, as illustrated in Table 4 below.

Table 4. Importance of appropriate management competences: examples from the case studies

Industry	Description
CS 6	**Landspeis in Austria – Digital marketing**
Retail	Landspeis are mobile food shops founded by the agricultural business Naturfrucht GmbH. Naturfrucht produces and sells bio products to supermarket chains in Austria. At its peak, Landspeis had 10 mobile stores. However, after COVID-19 the number has fallen to three. As a result, the owner of Landspeis decided to strengthen the company's online presence and introduce digital market solutions. The owner of Landspeis claimed that his **awareness of technological developments** in retail and especially agriculture was helpful in introducing changes at the company. The owner also actively **engaged in networking** with other similar companies during the pandemic. The pro-activity of the owner of Landspeis in looking for digitalisation opportunities helped the company to successfully introduce digital changes.
CS 17	**Confetil in Portugal – 3D design encouraged by clients**
Textile	Confetil is a Portuguese company specialising in circular knit ready-made garments. It works almost exclusively for international brands in foreign markets. The company remains competitive, as **company management has demonstrated flexibility and agility** in responding to clients' needs. In 2020, a major customer of the company asked it to begin using 3D computer-aided design (CAD) software for garment design. Company management not only **reacted quickly** by implementing the necessary technology, but also chose to invest significant resources in upskilling its employees to use the software successfully.

[71] Ibid.

[72] Wolf, M., Semm, A., & Erfurth, C. (2018). Digital Transformation in Companies – Challenges and Success Factors. In: Hodoň, M., Eichler, G., Erfurth, C., & Fahrnberger, G. (eds.), Innovations for Community Services. I4CS 2018. Communications in Computer and Information Science, vol 863. Springer, Cham. Available at: https://doi.org/10.1007/978-3-319-93408-2_13.

[73] Lokuge, S., & Duan, S. (2021). Towards Understanding Enablers of Digital Transformation in Small and Medium-Sized Enterprises.

[74] Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). E-Leadership through Strategic Alignment: An Empirical Study of Small- and Medium-sized Enterprises in the Digital Age. *Journal of Information Technology*. 31.

Industry	Description
CS 36.1	**LEVIATAN in Romania – 1st and 2nd phase of continuous digitalisation**
Construction	LEVIATAN SRL, a Romanian SME operating in the construction sector, provides integrated architecture and civil engineering services. Over its 10 years in business, it has evolved into a supplier of complete services to support design and building projects. The company has been digitalising since 2008, because of a labour shortage induced by the economic crisis. The company first began digitalising its internal processes by introducing an ERP system and later undertook a whole-organisation digital transformation. During the second phase of digitalisation, company management adopted **agile internal procedures** as their main way of working. Company management credits the introduction of this methodology with improved coordination among different departments and more transparent work processes.
CS 38	**PORR in Romania – Adopting 3D modelling technologies on construction sites**
Construction	PORR Romania is a subsidiary of an Austrian multinational company. In Romania, PORR is known for its work on larger infrastructure projects, in particular on the national road and railway systems. PORR's **management regularly scouts out digitalisation opportunities,** and the company's CEO is **interested in identifying digital technologies that are likely to advance the company's growth**. Company management was supportive of one department's experiments with 3D models, and later introduced them across the company.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

2.3. Principle 2 – Fostering employee and third party buy-in for digitalisation

The second principle presented in this report concerns the fostering of stakeholder buy-in for digitalisation. The successful adoption of digital technology requires stakeholder support. Therefore, effective change management is important for successful digitalisation.

Principle 2 'Fostering buy-in for digitalisation' was assigned as important in 11 out of the 42 case studies analysed (see Annex 2).

Digital initiatives can be more prone to failure and are more difficult to manage than conventional business transformations.[75] **One of the main barriers to successful digitalisation is the resistance of stakeholders to the implementation of new technologies**.[76] Lack of employee buy-in for digitalisation can be linked to limited awareness, resistance to change and risk aversion.[77] Some concerns specific to digitalisation include employees worrying about being replaced by technology, or digital tools leading to reduced human interaction and worse emotional well-being.[78,79] A global company survey from 2017 found that underinvesting in front-line employee buy-in was considered one of the biggest threats to the successful adoption of digital technologies.[80] Similarly, a more recent study found that, despite the acceleration of digitalisation during the COVID-19 crisis, employee resistance remains a barrier to digitalisation.[81]

Meanwhile, studies find that when supportive organisational culture and employee buy-in are in place, successful technology adoption is more likely. Two systematic reviews on the determinants of digital transformation and Industry 4.0 adoption in SMEs found that organisational culture is an important driver for digitalisation.[82,83] Furthermore, maintaining employee motivation throughout implementation was also highlighted as a key success factor during the Best Practice workshop carried out as part of this study.[84]

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[75] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[76] Shaikh, A.A., Kumar, A., Syed, A.A., & Shaikh, M.Z. (2021). A Two-Decade Literature Review on Challenges Faced by SMEs in Technology Adoption. *Academy of Marketing Studies Journal*, Volume 25, Issue 3, 2021, Available at SSRN: https://ssrn.com/abstract=3823849.

[77] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[78] Harvard Business Review (2019). Digital Transformation Is Not About Technology. Available at: https://hbr.org/2019/03/digital-transformation-is-not-about-technology.

[79] EY/University of Oxford (2022). How do you harness the power of people to double transformation success? Available at: https://www.ey.com/en_gl/consulting/how-transformations-with-humans-at-the-center-can-double-your-success.

[80] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[81] Amankwah-Amoah, J., Khan, Z., Wood, G., & Knight, G. (2021). COVID-19 and digitalization: The great acceleration, Journal of Business Research, Volume 136, 2021, Pages 602-611, ISSN 0148-2963, https://doi.org/10.1016/j.jbusres.2021.08.011.

[82] Lokuge, S., & Duan, S.X. (2021). Towards Understanding Enablers of Digital Transformation in Small and Medium-Sized Enterprises. arXiv preprint arXiv:2111.05989.

[83] Ghobakhloo, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A. (2022). Drivers and barriers of Industry 4.0 technology adoption among manufacturing SMEs: a systematic review and transformation roadmap. *Journal of Manufacturing Technology Management*, (forthcoming).

[84] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

Evidence suggests that combining digitalisation initiatives with effective change management can help to ensure successful implementation.[85] A study from 2021 found that a company's change management capability contributes to successful technology adoption.[86] A 2018 survey of companies showed that respondents who agreed with statements linked to effective change management (e.g. '*Management team established clear change story for transformation'* and *'People engaged in key roles encouraged employees to challenge old ways of working'*) were more likely to have implemented digital transformation projects that sustainably improved the company's performance.[87] Similarly, a qualitative study from 2019 emphasised the importance of effective communication as a tool to convince employees to change the way they work.[88]

Effective change management for digitalisation includes defining a case for change, engaging stakeholders, communication and learning, and demonstrating progress to employees (see Figure 3). The first of these dimensions concerns defining a case for change. Company leadership needs to be able to explain why the adoption of a digital technology is necessary, what benefits it will bring, and how success will be measured.[89] The second dimension is stakeholder engagement. Management needs to consider the readiness and attitudes held by stakeholders towards digitalisation. It is important to foster new behaviours and ways of working, to give stakeholders a say in digitalisation processes and to demonstrate how it adds value for them.[90,91,92] Furthermore, 'change champions' – employees who support and promote the need for digital transformation inside the company – can play an important role in facilitating buy-in.[93] The third dimension is communication and learning. Dialogue-based communication that allows stakeholders to be partners in the change effort is more effective than one-sided information sharing.[94] Stakeholders also need to be aware of targets, goals, activities and implementation timelines.[95,96,97] Lastly, the fourth dimension concerns monitoring and demonstrating progress, for example, by sharing information on efficiencies gained, success stories or results of pilots.[98]

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[85] Change management refers to the process of 'guiding organizational change to a successful resolution'. Source: Harvard Business School (n.d.). Organizational Change Management: What It Is & Why It's Important. Business Insights. Available at: https://online.hbs.edu/blog/post/organizational-change-management.

[86] Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

[87] McKinsey (2018). Unlocking success in digital transformations. Available at: https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/unlocking-success-in-digital-transformations.

[88] Ivančić, L., Bosilj Vukšić, V., & Spremić, M. (2019). Mastering the Digital Transformation Process: Business Practices and Lessons Learned. Available at: https://timreview.ca/article/1217.

[89] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[90] McKinsey (2018). Unlocking success in digital transformations. Available at: https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/unlocking-success-in-digital-transformations.

[91] EY (2020). How can the experience of change unlock the extraordinary? Available at: https://www.newrealityblog.com/2020/03/10/how-can-the-experience-of-change-unlock-the-extraordinary/.

[92] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[93] Ibid.

[94] Arnout, B., & Esposito, M. (2018). The value of communication in turbulent environments: How SMEs manage change successfully in unstable surroundings. *International Journal of Entrepreneurship and Small Business,* 34. 500-515. 10.1504/IJESB.2018.10014545.

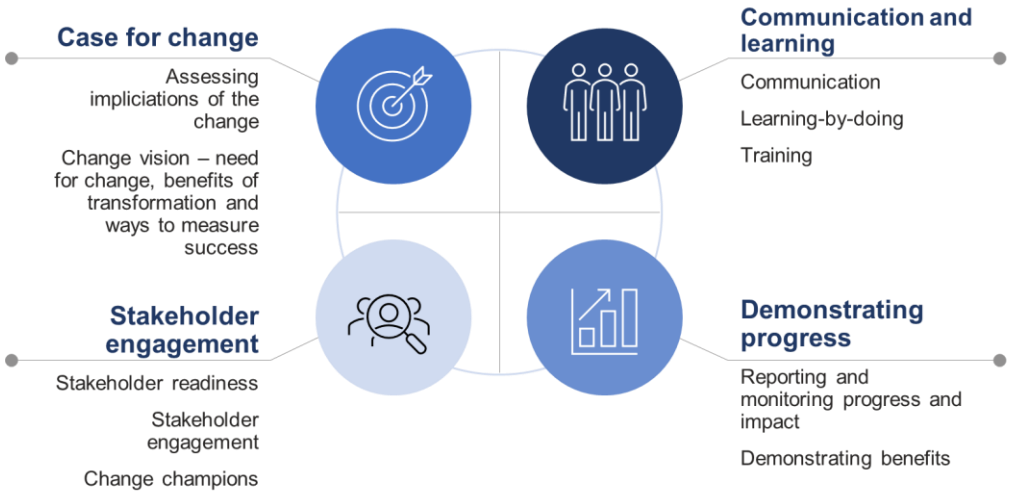
[95] McKinsey (2018). Unlocking success in digital transformations. Available at: https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/unlocking-success-in-digital-transformations.

[96]. Bordeleau, F.È. (2019). Digitalization and change management: Different ways to project success. Friedrich-Schiller-Universität Jena.

[97] Conclusions from the interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[98] McKinsey (2015). Changing change management. Available at: https://www.mckinsey.com/featured-insights/leadership/changing-change-management.

Figure 3. Dimensions of change management approach



Source: adapted by the research team on the basis of conclusions of the Best Practice workshop, Bordeleau, F.È. (2019), McKinsey (2015), McKinsey (2018), EY (2020), Mittal, S., Khan, M.A., Romero, D., & Wuest, T. (2018), the e-CF.

When it comes to the adoption of digital technologies, SMEs are often faced with resource and time constraints.[99] **Therefore, it is important that change management does not become an unnecessarily burdensome and formalised process**. Instead, SMEs can take advantage of characteristics such as the proximity between management and employees to secure employee buy-in for the implementation of new technologies. For example, management can have discussions with stakeholders to communicate the case for change and receive feedback or address concerns.[100] Examples from the case studies include large change management programmes, initiatives that help to demonstrate the benefits of technology adoption to stakeholders and the creation of tools (e.g. instruction manuals and templates) to ease the transition to new processes (see Table 5). Furthermore, panellists during the Best Practice workshop highlighted that the wider ecosystem – DIHs, academia and public organisations – can also play an important role in change management by providing necessary technical support and guidance.[101]

Table 5. Fostering employee and third-party buy-in for digitalisation: examples from the case studies

Industry	Description
CS 9	**Eckerle Automotive Bóly Kft in Hungary – Digital access control system**
Automotive	Eckerle Automotive Bóly Kft, a German-owned company in the automotive sector, recently implemented a digital access control system and updated its ProAlpha solution. According to company representatives, neither management nor employees had absolute confidence that the planned implementation would enhance the efficiency of the business. However, loss analysis conducted before implementation helped to **demonstrate the potential benefits** to

[99] Mittal, S., Khan, M.A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). *Journal of Manufacturing Systems*, 49, 194-214.
[100] Arnout, B., & Esposito, M. (2018). The value of communication in turbulent environments: How SMEs manage change successfully in unstable surroundings. *International Journal of Entrepreneurship and Small Business*, 34. 500-515.
[101] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

Industry	Description
	management. Furthermore, once the new technology was introduced, **employees could observe improvements** in the company's data management efficiency.
CS 15	**Renault in France – Office tablets and a centre of excellence[102]**
Automotive	Following the establishment of Renault Digital, French automotive manufacturer Renault decided to **change its entire company culture.** This entailed promoting a new leadership mindset, management style and agility. The human resource department has played a central role in this endeavour, being responsible for establishing various digital skills development programmes, focusing on end-to-end employee journeys and empowering employees to manage their careers and collaborate, among other initiatives.
CS 19	**Têxteis Penedo in Portugal – A virtual showroom platform**
Textile	Based in Guimarães, at the heart of the Portuguese textile industry, Têxteis Penedo has been at the forefront of household textiles in Jacquard since 1975. During the COVID-19 pandemic, the company implemented a virtual showroom. The company invested effort into **reaching out to customers and presenting the platform** as a means to overcome COVID-19-related physical distancing measures. Company representatives also stated that existing know-how and a **culture of openness towards innovation** were contributing factors towards its successful implementation of the new technology.
CS 36.1	**LEVIATAN, SRL in Romania – 1st and 2nd phases of continuous digitalisation[103]**
Construction	LEVIATAN SRL, a Romanian SME operating in the construction sector, provides integrated architecture and civil engineering services. Over its 10 years in business, it has evolved into a supplier of complete services supporting design and building projects. To identify its digitalisation needs, the company ran a **working session** with the management team to map company processes, issues that occur, and potential courses of action. According to the company, this was eye-opening for employees, as it uncovered multiple inefficiencies in the company's day-to-day operations. This **increased the team's motivation** to improve the way they worked. According to a company representative, involving **early adopters with a change mindset** in process mapping, process change, and experimentation was important in **facilitating buy-in**. To ensure the rest of the company was supportive of the digitalisation plans, the management team invested time in **developing instruction manuals and templates** for company processes, deliverables and documents.
CS 38	**PORR Romania – Adopting 3D modelling technologies on construction sites**
Construction	PORR Romania is the local subsidiary of an Austrian multinational construction company, operating in 10 countries worldwide. In Romania, PORR is known for its work on large infrastructure projects. The company has adopted several innovations aimed at the application of 3D models to construction sites. One of the challenges the company faced in the beginning was the **resistance of sub-contractors and on-site builders** towards switching to the new technologies. However, after implementation, PORR **received a positive response** from workers, who discovered numerous benefits to using the new technology.
CS 39	**Norteña de Aplicaciones y Obras in Spain – Paperless construction[104]**

[102] Scherer J.I. (2020). Renault – An industry 4.0 Case Study. The Digital Transformation People. Available at: https://www.thedigitaltransformationpeople.com/channels/the-case-for-digital-transformation/renault-an-industry-4-0-case-study/.

[103] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[104] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

Industry	Description
Construction	Norteña de Aplicaciones y Obras, located in Aranda de Duero, provides specialised services in roof waterproofing. The digital technology implemented by the company was an ERP and CRM system that allowed workers to start filling out worksheets directly on their tablets and smartphones. To support its digitalisation efforts, the company has tried to **foster a start-up mentality**. It has also promoted its story externally, for example, by applying for awards and participating in conferences, forums and associations. The company considers the commitment of its employees to the digitalisation process a key success factor.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

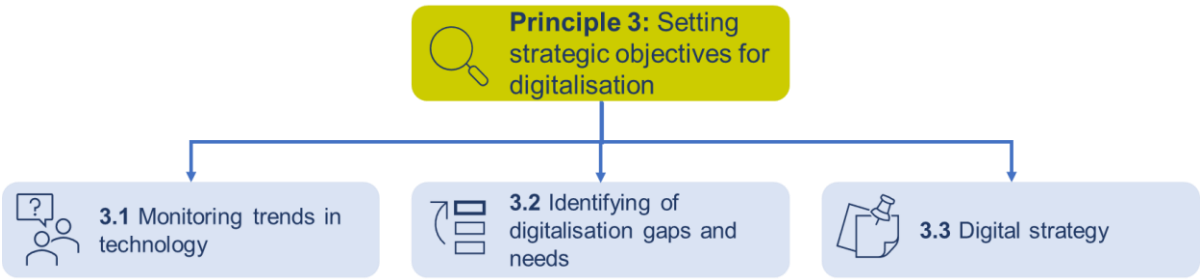
2.4. Principle 3 – Setting strategic objectives for digitalisation

The third principle identified by the research team concerns the setting of strategic objectives for digitalisation. This principle describes the definition of a company-level approach towards digitalisation: monitoring trends and opportunities, analysing gaps and needs, and defining strategic objectives. Evidence shows that long-term strategic planning for digitalisation is important for ensuring the successful adoption of new technologies. At the same time, shifting business realities require companies to remain agile in the way they approach digitalisation.

Principle 3 'Setting strategic objectives for digitalisation' was assigned as important in 18 of the 42 case studies analysed (see Annex 2).

Principle 3 'Setting strategic objectives for digitalisation' is further broken down into three interlinked components, as illustrated in Figure 4. These components relate to the importance of monitoring existing digitalisation opportunities, understanding the company's needs in relation to digitalisation, and taking a long-term approach to digitalisation. Each of these components is described in more detail below.

Figure 4. Components of Principle 3 'Setting strategic objectives for digitalisation'



2.4.1. Component 3.1: Monitoring trends in technology

The first component identified by the research team concerns the monitoring of trends in technology. This means investigating technological developments using internal and external company resources.[105] To keep track of trends, companies can choose to seek out external support or build the necessary knowledge and skills internally.

Lack of knowledge about digitalisation opportunities is a barrier to the adoption of digital technologies. According to the Problem Identification report, limited knowledge about the benefits of certain technologies slows down their adoption.[106] In the Company Digitalisation survey, 'lack of knowledge about relevant digital technologies' was ranked the third most important obstacle to investment in digital technologies. Companies with fewer than 250 employees were more likely to

Company Digitalisation survey

26%

of respondents indicated the 'lack of knowledge about relevant digital technologies' as one of the main obstacles to their adopting digital technologies

[105] CEN (2019). EN 16234-1:2019. e-Competence Framework (e-CF) – A common European Framework for ICT Professionals in all sectors - Part 1: Framework.

[106] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

indicate this as an important barrier.[107] Compared with large companies, SMEs also tend to have less access to thought leadership, research and academia.[108,109] Furthermore, participants in the Best Practice workshop also indicated that the fragmented nature of available information makes identifying digitalisation opportunities more difficult.[110]

Studies suggest that gathering information across different contexts and markets is a prerequisite for digital innovation in SMEs.[111,112] Companies can obtain relevant information from sources such as research, patents, start-up activities, trade fairs, best practice repositories and digital communities.[113,114] Identifying and interpreting trends help companies to identify ways in which digitalisation could impact their company's business.[115] SMEs also need to be aware of the challenges that can be addressed by implementing digital technologies.[116] Analysis of the case studies shows that knowledge of digitalisation opportunities can be an important factor for the successful implementation of technology by companies.

How a company keeps track of digitalisation trends is highly dependent on its priorities and capabilities. Some companies choose to develop the necessary skills and expertise in-house. However, many SMEs find it difficult to build the necessary knowledge internally.[117] Co-creating it together with the wider business ecosystem and making use of support mechanisms such as the EDIH/DIH network, helps to address this challenge.[118,119,120,121] This is discussed in more detail under Principle 7 (see Section 2.8). Another option is to use existing resources, such as technology surveying tools.[122]

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[107] Results of the Company Digitalisation survey conducted by PPMI., Question 'In your opinion, what are the main obstacles your company faces in adopting digital technologies?', N=350 (1-250 employees: 256; >250 employees: 86). Full results are available in 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Problem Identification report'. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[108] Rauch, E., Vickery, A.R., Brown, C.A., & Matt, D.T. (2020). SME requirements and guidelines for the design of smart and highly adaptable manufacturing systems. In Industry 4.0 for SMEs (pp. 39-72). Palgrave Macmillan, Cham.

[109] Mittal, S., Khan, M.A., Romero, D., & Wuest, T. (2018). A critical review of smart manufacturing & Industry 4.0 maturity models: Implications for small and medium-sized enterprises (SMEs). *Journal of Manufacturing Systems*, 49, 194-214.

[110] Conclusions from the interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[111] Khan, O., Daddi, T., & Iraldo, F. (2021). Sensing, seizing, and reconfiguring: Key capabilities and organizational routines for circular economy implementation. *Journal of Cleaner Production*, 287, 125565.

[112] Teece D.J., & Linden G. Business models, value capture, and the digital enterprise. *J. Org. Des*. 2017;6(1).

[113] CEN (2019). EN 16234-1:2019. e-Competence Framework (e-CF) - A common European Framework for ICT Professionals in all sectors - Part 1: Framework.

[114] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[115] Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). e-Leadership through strategic alignment: An empirical study of small-and medium-sized enterprises in the digital age. *Journal of Information Technology*, 31(2), 185-206.

[116] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. *Computers in Industry*, 133, 103532.

[117] Ibid.

[118] Khan, O., Daddi, T., & Iraldo, F. (2021). Sensing, seizing, and reconfiguring: Key capabilities and organizational routines for circular economy implementation. *Journal of Cleaner Production*, 287, 125565.

[119] Teece, D.J., & Linden, G. (2017). Business models, value capture, and the digital enterprise. *Journal of Organization Design*, 6(1), 1-14.

[120] Ricci, R., Battaglia, D., & Neirotti, P. (2021). External knowledge search, opportunity recognition and industry 4.0 adoption in SMEs. *International Journal of Production Economics*, 240, 108234.

[121] DG CNECT A4 – Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the Role of Best Practices' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[122] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. *Computers in Industry*, 133, 103532.

Examples from the case studies of how companies monitored digitalisation opportunities and trends are presented below.

Table 6. Knowledge of digitalisation opportunities: examples from the case studies

Industry	Description
CS 5	**MST Frieling in Germany – Introducing ERP system during COVID**
Retail	MST Frieling is a family-owned store operating since 2007. The shop mostly sells travel luggage, hats, bags and fashion jewellery. In response to the COVID-19 pandemic, it has recently implemented a cloud-based ERP system. A key enabler for the adoption of this system was the participation of the business in a support programme by the state of North Rhine-Westphalia through the Economic Development Agency of the city of Wuppertal. The company representative cited **exploring digitalisation opportunities online** as having been helpful in developing a convincing and sustainable concept for participating in the programme. Mr. Frieling, who is one of the store's owners, also cited his previous experience and know-how in IT as being useful. This knowledge helped the company to save time when applying for funding under the support programme, as they already were aware of potential solutions that could be implemented.
CS 22	**Katty Fashion in Romania – Technologies for the circular economy[123]**
Textile	Katty Fashion is a manufacturing company in the textile/fashion industry, with 40 employees. The company produces a wide range of women's outerwear and specialises in short production runs and customised clothing. On the one hand, the company has chosen to develop **in-house technical skills** to assess, apply and compare new technologies to support its digitalisation process. On the other hand, under the DigitaliseSME initiative, Katty Fashion has also received technical support to conduct a needs assessment that included exploring digitalisation opportunities and potential business directions for the company.
CS 29	**Tomato greenhouse in Lithuania – Testing of precision agriculture**
Agrifood	A tomato greenhouse in Lithuania has implemented a mobile laboratory that uses deep vision and AI technologies to identify diseases during their early, asymptomatic stage. While the technology is still being implemented, the company identifies **collaboration with academia, researchers and technology developers** as being essential for identifying, testing and deploying digital innovation.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

2.4.2. Component 3.2: Identifying digitalisation gaps and needs

The second component under Principle 3 is the identification of digitalisation gaps and needs. Companies can choose from several approaches to conduct this analysis, as well as making use of existing resources such as digitalisation frameworks, maturity models and readiness assessments.[124]

A company's awareness of its level of digitalisation relative to its peers is helpful in determining which digital technologies an enterprise should invest in. However, tools for

[123] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[124] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. *Computers in Industry*, 133, 103532.

identifying and benchmarking digitalisation gaps are not widely used in all industries.[125] For example, stakeholders in the Polish retail industry note that the wider use of tools for assessing digital maturity would help companies to make more informed decisions about the adoption of digital technologies. Such methods would also reduce some existing awareness-related barriers to digitalisation among retail companies.[126]

This view is supported by other studies. **Understanding a company's digitalisation level and needs facilitates the adoption of digital technologies**.[127,128,129] According to panellists and participants in the Best Practice workshop, companies need to carefully consider their business processes, customers and needs before embarking on digital transformation.[130] Companies will face very different digitalisation challenges depending on their level of digital maturity, as well as the timing of their technology adoption and whether or not the company uses legacy systems.[131] Successful digitalisation, according to Stich, Zeller & Hicking, should start with an analysis of a company's strategy, environment and objectives to determine how digital technologies could contribute towards achieving its goals. This should be followed by an analysis of the company's gaps in digital maturity.[132]

Analysis of case studies and survey data reveal that the adoption of digital technologies can be relevant to any area of business, although certain processes may be more relevant depending on the sector (see Figure 5).[133] **Analysis of the case studies reveals that companies selected which processes they wanted to digitalise on the basis of their business model, industry, needs and objectives.** This choice was also frequently influenced by external factors, such as the need to respond to pandemic-related restrictions or changes in consumer expectations.

[125] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[126] Ibid.

[127] Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International Journal of Information Systems and Project Management*, 8(4), 24-43.

[128] Cieciora, M., Bołkunow, W., Pietrzak, P., Gago, P., & Rzeźnik-Knotek, M. (2020). Critical success factors of ERP/CRM implementation in SMEs in Poland: pilot study. Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska.

[129] Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International Journal of Information Systems and Project Management*, 8(4), 24-43.

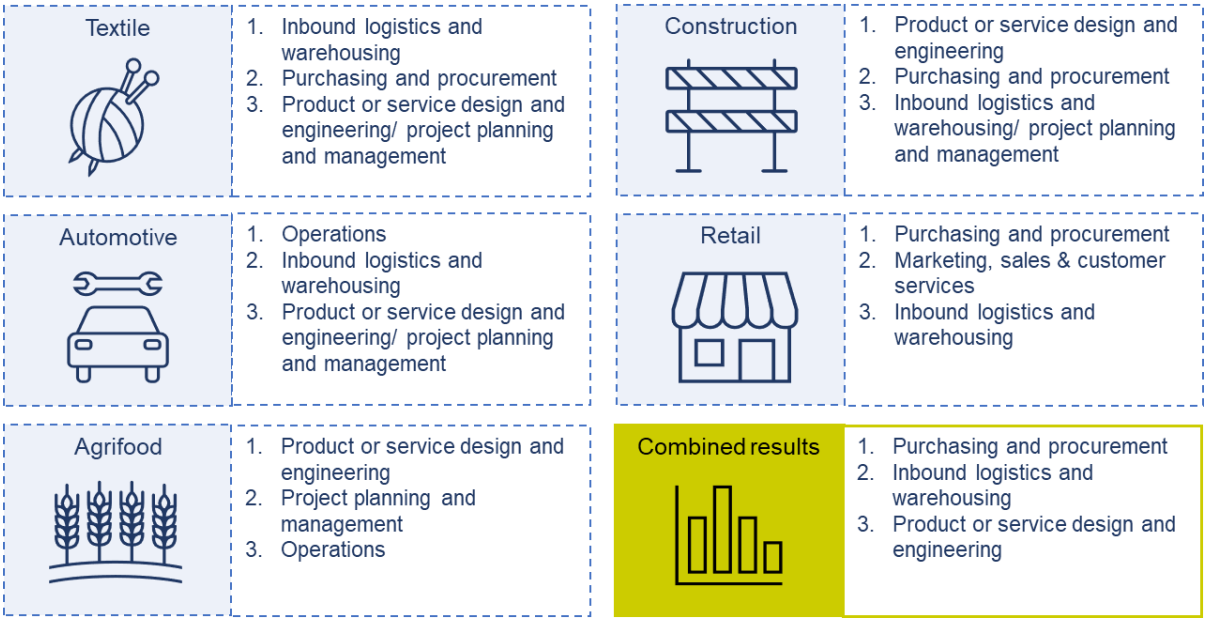
[130] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[131] Ibid.

[132] Stich, V., Zeller, V., Hicking, J., & Kraut, A. (2020). Measures for a successful digital transformation of SMEs, *Procedia CIRP*, Volume 93, 2020, Pages 286-291, ISSN 2212-8271. Available at: https://doi.org/10.1016/j.procir.2020.03.023.

[133] Results of the Company Digitalisation survey conducted by PPMI. Full results available in 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report'. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

Figure 5. Company Digitalisation Survey: most frequently focused-on areas for digital investments, by country-industry pairing



Source: results of the Company Digitalisation survey conducted by PPMI, Q7: Which areas of your company's operations have been the focus of digital technology-related investments in the last two years? N=350. Notes: respondents could choose more than one option. The three most popular choices by country-industry pairing are presented.

However, smaller companies often lack resources and time to dedicate to identifying digitalisation gaps and needs. Evidence shows that making use of existing resources for support, or discussing digitalisation with an external expert, are useful in addressing these constraints.[134] Some of those companies included in the case study analysis collaborated with external partners to analyse their gaps and needs. As noted by speakers at the Best Practice workshop, the EDIH network will play a very important role in supporting SMEs in identifying their digitalisation gaps and needs.[135,136] As mentioned above, companies can also make use of pre-existing frameworks, maturity models and readiness assessments.[137] For example, the Digital Maturity assessment[138] could help companies to identify gaps and to track and benchmark their progress against other recipients of EDIH services.[139,140]

The case studies show that companies use various mechanisms to identify their digitalisation gaps and needs. The approach chosen depends on its relevance to the

[134] Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International journal of Information Systems and Project Management*, 8(4), 24-43.

[135] DG CNECT A4 – Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the Role of Best Practices' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[136] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[137] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. Computers in Industry, 133, 103532.

[138] European Commission (2021). Digital Maturity Tool and the Innovation Radar. Shaping Europe's digital future. Available at: https://digital-strategy.ec.europa.eu/en/events/digital-maturity-tool-and-innovation-radar.

[139] European Commission (2022). Digital Maturity Assessment Framework for EDIH customers (SMEs). Presentation of the final (adopted) questionnaire. European Digital Innovation Hubs in the Digital Europe Programme: Webinar on the Digital Maturity Assessment tool. Available at: https://digital-strategy.ec.europa.eu/en/library/webinar-digital-maturity-assessment-tool.

[140] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

company's operations and digital maturity. Examples from the case studies include process mapping, auditing of services and sales channels, and loss analysis.

Some examples of how companies analysed their digitalisation gaps and needs are presented below.

Table 7. Identification of digitalisation gaps and needs: examples from the case studies

Industry	Description
CS 3	**Novia Blanca in Poland – Auditing and dividing stock**
Retail	Novia Blanca, one of the biggest retailers of wedding jewellery in Poland, overhauled its existing digital solutions to adopt a new e-commerce platform that would be aligned with current trends, market and customer requirements. Prior to implementation, the company conducted **an audit of all its services and sales channels, as well as performing process mapping.** Conclusions from the audit and process mapping informed the company's approach to implementing the new platform.
CS 9	**Eckerle Automotive Bóly Kft. in Hungary – Digital access control system**
Automotive	Eckerle Automotive Bóly Kft., a German-owned automotive company from Hungary, recently introduced a digital access control system and updated its version of the ProAlpha solution. Before implementing these changes, the company conducted a **loss analysis.** According to the company, this was an important step for identifying **inefficiencies in its processes**. This analysis helped to demonstrate to the company management that the implementation of new technologies was worth embarking on, due to the potential efficiency gains it could lead to.
CS 13	**Marelli in Italy – Digital solutions for automation, management and efficiency[141]**
Automotive	Marelli is an Italian automotive company that has implemented several technologies (e.g. production scheduling and execution using AI and machine learning, quality management with digitalised processes and data) to improve its plant operations and processes. Before implementation, it conducted **a preliminary assessment in collaboration with a consulting company** to determine how its manufacturing processes could be improved and digitalised.
CS 22	**Katty Fashion in Romania – Technologies for the circular economy[142]**
Textile	Katty Fashion is a manufacturing company in the textile/fashion industry, with 40 employees. The company produces a wide range of women's outerwear and specialises in short production runs and customised clothing. Prior to implementing digital technologies, the company undertook a **needs assessment** to evaluate its activities, skills level and digitalisation gaps. As part of the DigitaliseSME initiative, Katty Fashion **received technical support for the evaluation of its activities, skills level and needs**, as well as opportunities and potential business directions for the company.
CS 36.1	**LEVIATAN in Romania – 1st and 2nd phase of continuous digitalisation**
	LEVIATAN SRL, a Romanian SME operating in the construction sector, provides integrated architecture and civil engineering services. The company digitalised its internal and external communication channels by implementing collaborative technologies, including ERP, an

[141] Accenture (n.d.). Marelli: Smarter manufacturing. Available at: https://www.accenture.com/hk-en/case-studies/industry-x-0/marelli.

[142] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

Industry	Description
Construction	intranet, and CRM. It began this process by **mapping the current and future processes** within the company to identify an efficient course of action. This step helped employees **recognise the gaps** in existing processes and motivated them to support the changes.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

2.4.3. Component 3.3: Digital strategy: defining objectives and ensuring a shared vision

The third component of this principle describes the definition of a digital strategy. Clearly defined strategic objectives for digitalisation in a company can help to guide decisions about the implementation of new technologies. However, many SMEs may find the creation of a strategy document to be time and resource-consuming, and instead opt for other forms of agreement within the company on key objectives for digitalisation.

Studies show that a clear strategy for digitalisation helps companies to secure funding for and successfully implement digital technologies.[143] For example, a study that interviewed 42 SME leaders found that ensuring alignment between business goals and digital solutions is necessary for successful digitalisation.[144] Another study of 109 SMEs shows that strategic planning is an enabler for the adoption of Industry 4.0 technologies.[145]

Well-defined digital strategies foster stakeholder buy-in and are adaptable to changing business realities. To ensure alignment between different stakeholders, the definition of a digital strategy should involve the entire management team.[146] To ensure clarity, a strategy should cover not only strategic objectives but also principles for the prioritisation of digitalisation initiatives and resource deployment.[147] Furthermore, top economic performers adapt and regularly revise their digital strategies in line with the changing industry landscape.[148,149] A study on emerging approaches to digital transformation argues that companies should abandon a linear process of strategy definition and execution in favour of adjusting it iteratively.[150]

However, most companies lack a defined digital strategy with clear implementation plans and accountabilities.[151] Typically, the need to formalise strategies and processes increases with company size.[152] Many SMEs tend to digitalise reactively and focus on short-

[143] EY Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

[144] Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). e-Leadership through strategic alignment: An empirical study of small-and medium-sized enterprises in the digital age. *Journal of Information Technology*, 31(2), 185-206.

[145] Somohano-Rodríguez, F.M., Madrid-Guijarro, A., & López-Fernández, J.M. (2022). Does Industry 4.0 really matter for SME innovation? *Journal of Small Business Management*, 60(4), 1001-1028.

[146] McKinsey (2018). Why digital strategies fail. McKinsey Quarterly. Available at: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/why-digital-strategies-fail.

[147] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[148] Bughin, J., Catlin, T., Hirt, M., & Willmott, P. (2018), "Why digital strategies fail," McKinsey Quarterly, January 2018.

[149] McKinsey (2019). A winning operating model for digital strategy. Available at: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/a-winning-operating-model-for-digital-strategy.

[150] Li, F. (2020). Leading digital transformation: three emerging approaches for managing the transition. *International Journal of Operations & Production Management*.

[151] EY Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

[152] Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International journal of Information Systems and Project Management*, 8(4), 24-43.

term tactical benefits rather than developing a long-term strategic approach.[153,154] SMEs can use their flexibility to adopt technologies quickly in order to respond to a business need or external factors such as the COVID-19 pandemic.[155,156] Consequently, SMEs often do not possess any documented strategies at all.[157] According to a study from 2020, this can be attributed to resource and time constraints, and the perception that writing up a strategy will not bring added value.[158]

SMEs tend to be characterised by being management-centric, quick and efficient at decision-making, and having few intermediaries between stakeholders.[159] Where such characteristics are in place, informal agreement regarding a digital strategy can be sufficient to guide digitalisation efforts.[160] However, the total costs and benefits of digitalisation are usually not observable in the short-term.[161] **Therefore, it is important that companies set long-term objectives for digitalisation, while still maintaining the flexibility to adapt them as needed.** Long-term objectives can help a company persevere despite setbacks in its digitalisation journey.[162]

Companies can define and document long-term objectives in several ways. Very few of the companies included in the case study analysis mentioned having a digital strategy (examples are included below). Instead, companies can find other, less formalised ways to define their strategic vision, mission and objectives for digitalisation. For example, LEVIATAN maps objectives during strategic planning meetings, but does not have a separate digital strategy document; instead, the company relies on a digitalisation mind map. It is also possible for a company to integrate digitalisation into its overall strategy without creating a separate document. This is especially relevant, as the line between business and digital strategy becomes increasingly blurred as processes, services and products become more digitalised.[163]

[153] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. *Computers in Industry*, 133, 103532.

[154] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[155] Interviews conducted as part of the study. Further information available in the 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Problem Identification report.' European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[156] Mandviwalla, M., & Flanagan, R. (2021). Small business digital transformation in the context of the pandemic. *European Journal of Information Systems*, 30(4), 359-375.

[157] L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International Journal of Information Systems and Project Management*, 8(4), 24-43.

[158] Becker, W., & Schmid, O. (2020). The right digital strategy for your business: an empirical analysis of the design and implementation of digital strategies in SMEs and LSEs. *Bus Res* 13, 985–1005. Available at: https://doi.org/10.1007/s40685-020-00124-y.

[159] Eggers, F. (2020). Masters of disasters? Challenges and opportunities for SMEs in times of crisis. *Journal of Business Research*, 116, 199–208. https://doi.org/10.1016/j.jbusres.2020.05.025

[160] Mandviwalla, M., & Flanagan, R. (2021). Small business digital transformation in the context of the pandemic. *European Journal of Information Systems*, 30(4), 359-375.

[161] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[162] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[163] Bharadwaj, A., Sawy, O., Pavlou, P., Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. *MIS Quarterly: Management Information Systems*, 37. 471-482. 10.25300/MISQ/2013/37:2.3.

Table 8. Digital strategy: examples from the case studies

Industry	Description
CS 22	**Katty Fashion in Romania – Technologies for the circular economy[164]**
Textile	Katty Fashion is a manufacturing company in the textile/fashion industry, with 40 employees. The company produces a wide range of women's outerwear and specialises in short production runs and customised clothing. As part of the DigitaliseSME initiative, Katty Fashion received support from an advisor, who helped the company **explore various opportunities and business directions, as well as to define short, medium, and long-term strategies for digitalisation**. Adopting new technologies has also helped Katty Fashion realise its strategic objectives in relation to sustainability, by switching from a traditional to a circular digitalised business model.
CS 36	**LEVIATAN in Romania – 1st and 2nd phase of continuous digitalisation/ 3rd phase of digitalisation: fully digitalised processes[165]**
Construction	LEVIATAN SRL, a Romanian SME operating in the construction sector, provides integrated architecture and civil engineering services. Over its 10 years in business, it has evolved into a supplier of complete services supporting design and building projects. According to a company representative, LEVIATAN **does not need an extensive digital strategy document** to guide its long-term planning on digitalisation. Instead, the company management hold **strategic planning meetings, in which they create a mind map of objectives**. According to the company representative, digital transformation should be agile and based on a solid knowledge of one's needs, processes and relevant tools.
CS 39	**Norteña de Aplicaciones y Obras in Spain – Paperless construction[166]**
Construction	Norteña de Aplicaciones y Obras is a company located in Aranda de Duero that provides specialised services in roof waterproofing. When defining its digital strategy, Norteña made sure to **involve its entire team in the process**. Having the whole team aligned with the strategy is considered by the company to be a crucial success factor for digitalisation. As a result of its digitalisation, the company has reduced the time needed to complete paperwork and control budget costs, while increasing its turnover significantly.
CS 41	**Shay Murtagh Precast in the UK and Ireland – BIM software and 3D design**
Construction	Shay Murtagh group is a family full-precast company that has several factories in the UK and Ireland. The company owners realised that digitalisation and revising its traditional ways of operating could bring significant added value to the chain and to clients. In its digital intervention, the company introduced BIM software and 3D design. According to a company representative, having **a clear strategy** prior to purchasing the solutions was very valuable for the company. The company **updates its strategy annually**, setting goals for the following year and defining how they will be measured.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

[164] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021) Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209

[165] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[166] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021) Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

2.5. Principle 4 – Securing the skills needed

The fourth principle concerns securing the skills needed for digitalisation. Research, analysis of case studies and the conclusions from previous phases of this study show that ensuring sufficient human resources and skills is crucial for successful digitalisation. To address their skills needs, companies may choose from relying on existing internal capabilities, upskilling and/or reskilling their staff, or seeking out external expertise.

Principle 4 'Securing the skills needed' was assigned as important in 8 out of the 42 case studies analysed (see Annex 2).

In all industries included in this study, a shortage of human resources and the right skills was considered a significant barrier to digitalisation.[167,168] In the Company Digitalisation survey conducted earlier in this study, respondents ranked 'lack of human resources' second at 36.5% among the obstacles companies face when attempting to adopt new technologies. This was followed by 'lack of knowledge about relevant digital technologies' and 'lack of skills to implement the latest technologies' at 25.7% and 22.2%, respectively.[169] Similarly, several of the companies included in the case study analysis encountered challenges to digitalisation that were related to having insufficient expertise and skills.

Company Digitalisation survey

37%

of respondents indicated the 'lack of human resources' as one of the main obstacles to their adopting digital technologies

SMEs experience digital skills deficiencies more often than large companies.[170] Compared with large companies, SMEs are less likely to have a dedicated person or department responsible for digitalisation.[171] This is evident in the employment statistics for ICT specialists. In 2020, most (76%) large companies in the EU employed ICT specialists, compared with 18% of SMEs.[172] Furthermore, as discussed in the previous reports produced

[167] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[168] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Gap Analysis report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-gap-analysis-report-now-published.

[169] Results of Company Digitalisation survey conducted by PPMI, Question 'In your opinion, what are the main obstacles your company faces in adopting digital technologies?', N=350 (1-250 employees: 256; >250 employees: 86). Full results are available in 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Problem Identification report'. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[170] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[171] Lassnig, M., Muller, J.M., Klieber, K., Zeisler, A., & Schirl, M. (2021). A digital readiness check for the evaluation of supply chain aspects and company size for Industry 4.0. Available at: https://www.emerald.com/insight/content/doi/10.1108/JMTM-10-2020-0382/full/pdf?title=a-digital-readiness-check-for-the-evaluation-of-supply-chain-aspects-and-company-size-for-industry-40.

[172] Eurostat, Table isoc_ci_eu_en2: Computers and the internet: enterprises – summary of EU aggregates (NACE Rev. 2 activity)

for this study, the shortage of digitally skilled personnel is a challenge in all five industries analysed in the study.[173,174]

While skills shortages are viewed as an obstacle, having digital know-how is one of the most important enablers of digitalisation. For example, a systematic review from 2022 identified the availability of human resources as one of the key organisational determinants influencing the adoption of Industry 4.0 technologies among SMEs.[175] A literature review conducted as part of a 2021 study also supports this finding, suggesting that success in implementing digital manufacturing depends on having the required human resources to support the adoption, implementation and institutionalisation of digitalisation.[176] Furthermore, companies with sufficient ICT expertise are more likely to implement digital technologies successfully.[177,178,179,180]

A wide range of different skill sets is important for digital technology adoption. Examples include the ability to plan and manage digitalisation initiatives; to monitor and apply for digitalisation and support opportunities; to develop solutions; and to operate digital technologies.[181] In terms of skills level, these can be grouped into leadership skills, professional skills, and user skills.[182] The top 10 skills perceived to be growing in demand by 2025 are listed in Figure 6.[183] Notably, these include several skills linked to technology adoption, innovation and critical thinking. According to CEDEFOP, companies seek digitally skilled employees not just for ICT roles, but across a wide range of occupations.[184] Consequently, digital and hybrid skills are becoming increasingly important.

[173] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[174] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Gap Analysis report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-gap-analysis-report-now-published.

[175] Ghobakhloo, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A. (2022). Drivers and barriers of Industry 4.0 technology adoption among manufacturing SMEs: a systematic review and transformation roadmap. *Journal of Manufacturing Technology Management*, (forthcoming).

[176] Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

[177] Lokuge, S., & Duan, S. (2021). Towards Understanding Enablers of Digital Transformation in Small and Medium-Sized Enterprises.

[178] Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

[179] Ghobakhloo, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A. (2022). Drivers and barriers of Industry 4.0 technology adoption among manufacturing SMEs: a systematic review and transformation roadmap. *Journal of Manufacturing Technology Management*, (forthcoming).

[180] Andrews, D., Nicoletti, G., & Timiliotis, C. (2018). Digital technology diffusion: A matter of capabilities, incentives or both? OECD Economics Department Working Papers, No. 1476, OECD Publishing, Paris. Available at: https://doi.org/10.1787/7c542c16-en.

[181] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[182] European Commission (2020). Executive Agency for Small and Medium-sized Enterprises, Skills for SMEs : cybersecurity, Internet of things and big data for small and medium-sized enterprises, Publications Office. Available at: https://data.europa.eu/doi/10.2826/708138.

[183] World Economic Forum (2020). The Future of Jobs Report 2020. Available at: https://www3.weforum.org/docs/WEF_Future_of_Jobs_2020.pdf.

[184] CEDEFOP (2021). Digital skills: Challenges and opportunities. Available at: https://www.cedefop.europa.eu/en/data-insights/digital-skills-challenges-and-opportunities#_covid19_and_digital_skills.

Figure 6. Top ten skills with growing demand by 2025, ranked by share of companies surveyed

1	Analytical thinking and innovation	6	Leadership and social influence
2	Active learning and learning strategies	7	Technology use, monitoring and control
3	Complex problem-solving	8	Technology design and programming
4	Critical thinking and analysis	9	Resilience, stress tolerance and flexibility
5	Creativity, originality and initiative	10	Reasoning, problem-solving and ideation

Source: Future of Jobs Survey 2020, World Economic Forum.

As noted in the Best Practices workshop carried out for this study, a lack of digital skills can also make it difficult for companies to assess their skills needs and evaluate potential candidates.[185] Existing digital competence frameworks can support companies in assessing skills needs, defining career and learning paths and developing recruitment advertisements, among other uses. The DigComp[186] and the e-CF[187] are widely used and supported by the European Commission. **Both DigComp and e-CF are agnostic of region, business size and sector, and are therefore relevant to all companies, including SMEs**.[188] Together, these frameworks define digital competences from the levels of user to ICT specialist. For example, the e-CF includes the profile 'digital transformation leader', which describes what competences are required to provide leadership for the implementation of an organisation's digital transformation strategy (see Figure 7).[189] Furthermore, the ESCO database, which categorises skills, competences, qualifications, and occupations relevant for the EU labour market and education and training, includes ICT occupations and is relevant to defining the competences required for digitalisation.[190]

[185] Conclusions from the interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[186] Vuorikari Rina, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens-With new examples of knowledge, skills and attitudes (No. JRC128415). Joint Research Centre (Seville site).

[187] CEN (2019). EN 16234-1:2019. E-Competence Framework (e-CF) – A common European Framework for ICT Professionals in all sectors – Part 1: Framework.

[188] EU4Digital (2021). European competence frameworks: use cases and Job Role Profile application. Digital Skills Forum materials. Available at: https://eufordigital.eu/library/digital-skills-forum-materials/.

[189] CEN (2018). CWA 16458-1:2018 European ICT professionals role profiles – Part 1: 30 ICT profiles.

[190] European Commission (n.d.) About ESCO. Available at: https://esco.ec.europa.eu/en/about-esco.

Figure 7. E-CF ICT professional role profile: digital transformation leader

Summary: provides leadership for the implementation of the digital transformation strategy of the organisation.

Mission: drives cultural change and builds digital capability to deliver innovative business models and processes.

Deliverables

- **Accountable**: digital transformation roadmap
- **Responsible**: digital transformation strategy
- **Contributor**: solution and critical business process integration proposal

Main tasks:

1. Shape and deliver a digital strategy
2. Develop awareness and education to improve digital capability
3. Demonstrate the benefits of digital transformation implementation
4. Advise and support on a 'digital by design' approach
5. Lead cultural change required to facilitate digital strategy
6. Lead and mobilise key organisation influencers to implement digital transformation

IT macro processes (D1), e-competences (D2) and proficiency levels (D3)

D1	D2	D3				
		e-1	e-2	e-3	e-4	e-f
Plan	*A.3. Business plan development*					
	A.5. Arhitecture design					
	A.9. Innovating					
Manage	*E.7. Business change management*					
	E.9. Information systems governance					

Source: adapted from the e-CF.

There are three main ways in which companies can secure the skills necessary for digitalisation: existing in-house capabilities, upskilling and/or reskilling, or external expertise. Employees in SMEs often fulfil several job roles at once. Because many SMEs do not have dedicated IT personnel, an employee may be responsible for both digitalisation and core business functions at the same time.[191] Consequently, SME employees require hybrid competences that combine technology and business understanding. Having this type of expertise supports the adoption of new technologies and their integration into the company's business model.[192] **However, analysis of the case studies reveals that securing the necessary hybrid skills for digitalisation in-house has been a challenge for several companies**. Where such skills are available – for example, because the company owner has previous IT experience – this is cited as a success factor for digitalisation.

Digitalisation usually requires the significant upskilling and reskilling of employees.[193] Evidence suggests that employee training in Industry 4.0 technologies and ICT skills is important for the adoption of new technologies.[194,195,196] A survey of companies reveals that companies with enterprise-wide workforce planning and talent development practices, such as the analysis of skills gaps and needs, and the deployment of training for both leadership and

[191] EU4Digital Facility (n.d.). A common competence framework – this sounds very abstract… what exactly does it mean, how is EU4Digital helping, and what difference will it make? Available at: https://eufordigital.eu/e-card/?slug=eskills.

[192] Li, W., Liu, K., Belitski, M., Ghobadian, A., & O'Regan, N. (2016). E-Leadership through strategic alignment: An empirical study of small-and medium-sized enterprises in the digital age. *Journal of Information Technology*, 31(2), 185-206.

[193] Agarwal, V., Mathiyazhagan, K., Malhotra, S., & Saikouk, T. (2021). Analysis of challenges in sustainable human resource management due to disruptions by Industry 4.0: an emerging economy perspective.

[194] Andrews, D., Nicoletti, G., & Timiliotis, C. (2018). Digital technology diffusion: A matter of capabilities, incentives or both? OECD Economics Department Working Papers, No. 1476, OECD Publishing, Paris. Available at: https://doi.org/10.1787/7c542c16-en.

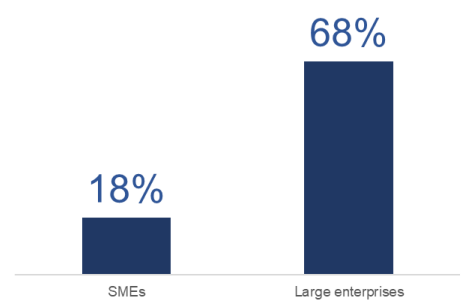
[195] Ghobakhloo, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A. (2022). Drivers and barriers of Industry 4.0 technology adoption among manufacturing SMEs: a systematic review and transformation roadmap. *Journal of Manufacturing Technology Management*, (forthcoming).

[196] Moeuf, A., Lamouri, S., Pellerin, R., Tamayo-Giraldo, S., Tobon-Valencia, E., & Eburdy, R. (2020). Identification of critical success factors, risks and opportunities of Industry 4.0 in SMEs. *International Journal of Production Research*, 58(5), 1384-1400.

employees, were up to twice as likely to report the successful adoption of digital technologies.[197]

However, ICT training is another area in which there is a significant difference between SMEs and large companies. In 2020, 68% of large enterprises in the EU provided their employees with training to develop or upgrade their ICT skills, compared with only 18% of SMEs.[198] This difference can be explained by the resource and time constraints faced by SMEs.[199] For SMEs, the decision to invest in employee training often stems from an immediate operational or business development need. Consequently, many SMEs do not perform extensive needs analysis or planning of training. Instead, they opt for training that has a direct and immediate business application.[200]

Companies providing ICT training, by company size, 2020, EU



In turn, SMEs often do not prioritise training as an option for securing digital know-how. Analysis of the case studies, and the conclusions from the Best Practice workshop, reveal that many SMEs prefer to learn by doing, obtaining the necessary skills gradually during the implementation of new technologies.[201] Some case studies also highlight the use of publicly available information, such as online sources and webinars, to upgrade skills and knowledge.

Similarly, seeking out external expertise can often make more economic sense for SMEs than investing in training.[202] This may include, for example, subcontracting experts, participating in inter-organisational experience sharing,[203,204] or engaging with public support programmes or academia to secure technical expertise. In such cases, knowledge transfer between the external expert(s) and the company is important in ensuring successful implementation, as is illustrated in the case of De Trog.

Examples of how skills challenges were addressed by various companies included in the case study analysis are available below.

[197] McKinsey (2018). Unlocking success in digital transformations. Available at: https://www.mckinsey.com/capabilities/people-and-organizational-performance/our-insights/unlocking-success-in-digital-transformations.

[198] Eurostat, Table isoc_ske_ittn2 : Enterprises that provided training to develop/upgrade ICT skills of their personnel (NACE Rev. 2 activity)

[199] European Commission, Executive Agency for Small and Medium-sized Enterprises (2019). Publications Office. Available at: https://data.europa.eu/doi/10.2826/335797.

[200] European Commission (2016). Digital Skills New Professions, New Educational Methods, New Jobs. Available at: https://digital-strategy.ec.europa.eu/en/library/digital-skills-training-blueprints-upskilling-sme-employees-and-unemployed-persons.

[201] Conclusions from the interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[202] European Commission (2016). Digital Skills New Professions, New Educational Methods, New Jobs. Available at: https://digital-strategy.ec.europa.eu/en/library/digital-skills-training-blueprints-upskilling-sme-employees-and-unemployed-persons.

[203] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. *Computers in Industry*, 133, 103532.

[204] Masood, T., & Sonntag, P. (2020). Industry 4.0: adoption challenges and benefits for SMEs *Comput. Ind.,* 121 (2020), p. 103261, 10.1016/j.compind.2020.103261.

Table 9. Securing the skills needed: examples from the case studies

Industry	Description
CS 9	**Eckerle Automotive Bóly Kft. in Hungary – Digital access control system**
Automotive	Eckerle Automotive Bóly Kft., a German-owned automotive company from Hungary, recently introduced a digital access control system and updated its version of the ProAlpha solution. According to company representatives, a lack of appropriate digital expertise was one of the most significant challenges to overcome during this process. Eckerle Automotive Bóly Kft did not have a dedicated employee who could manage the implementation process. Furthermore, insufficient knowledge and experience contributed to the reluctance of employees to implement the new technologies. However, employees **gained the necessary experience during and after implementation**, which, according to company representatives, will make it easier to pursue further digitalisation.
CS 15	**Renault in France – Office tablets and a centre of excellence[205]**
Automotive	Following the establishment of Renault Digital, French automotive manufacturer Renault decided to change its entire company culture. This was achieved by promoting a new leadership mindset, management style and agility. The human resource department has played a central role in this endeavour, being responsible for establishing **various digital skills development programmes**.
CS 22	**Katty Fashion in Romania – Technologies for the circular economy[206]**
Textile	Katty Fashion is a manufacturing company in the textile/fashion industry, with 40 employees. The company produces a wide range of women's outerwear and specialises in short production runs and customised clothing. The company has chosen to develop **in-house technical skills** to assess, apply and compare new technologies to support its digitalisation process. The company also received **support through the c-VoUCHER programme to train the team** for the implementation of 2D CAD/CAM upgrades.
CS 25	**OVF Studio in the United Kingdom – Pattern engineering for clothes**
Textile	OVF Studio, a London-based fashion brand providing a contemporary alternative to traditional tailoring and standard sizing, implemented the open-source platform Seamly2d. The company addressed its lack of skills by **collaborating with academic researchers** from the University of Manchester. The Apparel Design Engineering Collective at the university provided **knowledge exchange and expertise** on pattern digitalisation and parametrisation.
CS 26	**Hugo Boss in Germany – Digital twin and hyper learning[207]**
Textile	Hugo Boss is a large luxury fashion house based in Germany, manufacturing high-quality business wear. The company has developed a smart factory in Izmir (Turkey), which is its largest production site. Because the upskilling of employees was costly and time-consuming, the company developed a **hyper-leaning environment with the help of augmented reality/virtual reality (AR/VR) technology** and interactive tasks. The use of a 'digital twin' was also helpful here, as the human resource department could predict the staffing on production lines and provide training ahead of foreseen changes in order to reduce losses. Due to the 'hyper-learning', training time was reduced by 50%.

[205] Renault – An industry 4.0 Case Study. Available at: https://www.thedigitaltransformationpeople.com/channels/the-case-for-digital-transformation/renault-an-industry-4-0-case-study/.

[206] European Commission, Executive Agency for Small and Medium-sized Enterprises, (2021) Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document, Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[207] Case study compiled based on the following sources: https://www.digital-business-hub.com/hugo-boss-case-study-fulfillment-production-requaests-fully-4-weeks/; https://www.youtube.com/watch?v=Dbp0-fSrow; https://apparelresources.com/technology-news/manufacturing-tech/look-inside-hugo-boss-smart-factory/.

Industry	Description
CS 33	**De Trog in Belgium – An innovative and CO2-neutral bakery[208]**
Agrifood	Founded in 1970, De Trog is a bio-label bakery that produces high-quality organic bread. The company began its digital transformation in 2013, and now uses several digital technologies, including robotic applications, big data and AR. According to the company, upskilling its staff was one of the main challenges encountered during the digital transformation process. Because De Trog operates in a historically traditional sector, employees are less likely to be familiar with digital tools. To address its skills challenges, the company used two methods. First, **knowledge exchange and collaboration with the wider ecosystem** helped De Trog in its digitalisation journey. Second, **emphasis on staff training** helped the company improve employee skills and secure their buy-in for the company's strategic goals. To upskill its employees, De Trog **gamified the training process** using an app called 'Bakery Battle'. The app allows employees to challenge each other to play 'knowledge battles'.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

[208] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

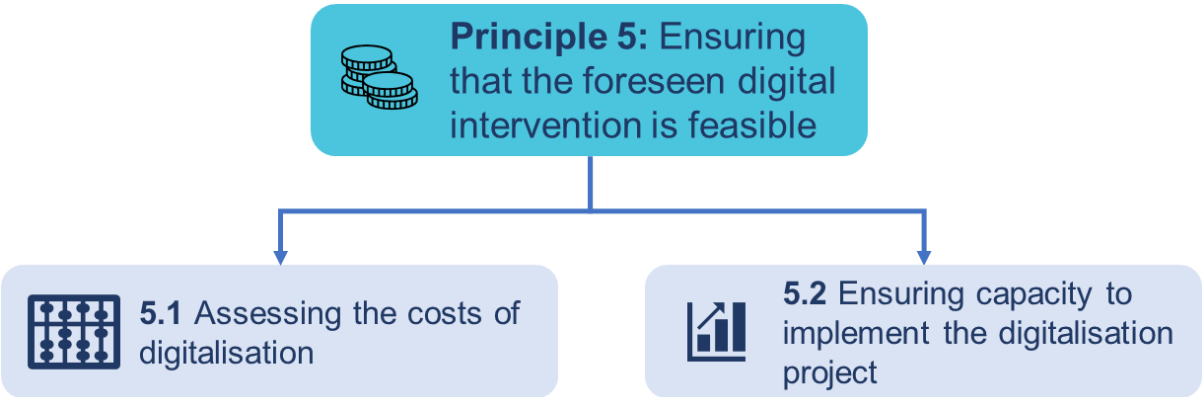
2.6. Principle 5 – Ensuring that the foreseen digital intervention is feasible

The fifth principle relates to ensuring the feasibility of the foreseen digitalisation project**.** The successful adoption of digital technologies requires companies to secure the necessary financial and human resources. Having sufficient capacity is a prerequisite for any type of change within a company, not just digital. Nevertheless, certain considerations are unique to digitalisation. Company management should carefully assess the total costs of the foreseen intervention, both human and financial. In addition, there are different ways for management to secure the necessary resources for digitalisation.

Principle 5 'Ensuring that the foreseen digital intervention is feasible' was assigned as important in 11 out of the 42 case studies analysed (see Annex 2).

This principle can be further broken down into two interlinked components, as illustrated in Figure 8. Each component is described in more detail below. The first component relates to accurately assessing the costs associated with the digital intervention. The second is concerned with securing the resources before embarking on the digitalisation journey.

Figure 8. Components of Principle 5, 'Ensuring that the foreseen digital intervention is feasible'



2.6.1. Component 5.1: Assessing the costs of digitalisation

Assessing a company's financial capabilities and the costs associated with a digital intervention is an important preparatory step for implementation**.** Doing so will help companies to decide on the most appropriate approach to digitalisation (see Component 6.1 in Section 2.7.1). This is an important task, irrespective of whether the company plans to outsource the development or deployment of digital technology, or to fully rely on in-house expertise. The costs associated with digitalisation will differ depending on the type of technology that will be adopted. Hence, assessing the costs associated with different digitalisation opportunities would be useful in deciding on the way forward.

Companies can use different approaches to assess the feasibility of digitalisation. First, **companies should explore what digital solutions are available on the market, to estimate and compare the costs of different options.** This helps to accurately allocate a budget for the foreseen digital intervention. When assessing the total costs of the digital solutions available, differentiation should be made between upfront and total costs. Upfront costs are the immediate costs of implementing new technology, including the cost of the software and hardware, the service provider (if applicable) and the human resources

associated with implementation. Meanwhile, calculating the total costs ensures that the long-term perspective is also considered. Evidence shows that companies do not always consider and factor in the long-term costs associated with digital technology adoption.[209] **Hence, an accurate estimation of the total costs of digitalisation is important, as these costs often tend to exceed what was initially calculated.**

One helpful approach to assessing digitalisation costs is the estimation of the total cost of ownership (TCO).[210] TCO helps to determine a project's long-term costs. Some of the costs that can be included when estimating TCO include the cost of exiting the software already being used, the cost of the service provider (if applicable), hiring of IT staff (if applicable), implementation of the new software or hardware, staff training and other associated productivity losses and software maintenance. Put simply, TCO involves an assessment of the human resource and financial costs associated with the adoption, implementation and institutionalisation of digitalisation.[211] Furthermore, the importance of estimating the recurring costs associated with digitalisation was highlighted during the Best Practice workshop.[212] Similarly, depending on whether a company chooses to implement the solution in-house or rely on the services of an external provider, company management will benefit from assessing whether additional staff may need to be hired in the long run.

In addition to comparing the costs of different digitalisation options, **companies can also estimate the associated returns on investment (ROI).** However, for ROI to be accurate, it is important to incorporate metrics that are closely linked to the specific improvements that are expected from digitalisation. Moreover, the calculation of an ROI may fail to consider the full benefits associated with a digital intervention – for example, by not capturing the value that digitalisation will bring to customers.[213] Specifically, the literature identifies a '**digitalisation paradox', whereby the costs of digitalisation outweigh the short-term ROI**.[214] This digitalisation paradox can also partially explain why SMEs tend to be risk-averse when it comes to pursuing digitalisation.

The failure to achieve the expected increase in profit may be linked to inappropriate planning of a digital intervention, or failure to adapt and transform the company's business model.[215] Making sure that the digital intervention plan is sufficiently detailed and regularly reviewed, as elaborated in Component 6.2, may help to reap **the full benefits of the transformation**. For many companies, digitalisation is seen as a necessity (for example, due to changing consumer needs), and the estimation of ROI may therefore prove less relevant. In such cases, companies are more likely to allocate a certain budget to digitalisation and seek out solutions that fit that budget. This was the case for Hugo Boss (CS #26), which did not rely on an ROI metric when introducing digital twins in its factory. The company estimated that digitalisation would have too many intangible benefits, and that savings would therefore be difficult to estimate.

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[209] Gebauer, H., Fleisch, E., Lamprecht, C., & Wortmann, F. (2020). Growth paths for overcoming the digitalization paradox, *Business Horizons*, Volume 63, Issue 3, Pages 313-323, ISSN 0007-6813. Available at: https://doi.org/10.1016/j.bushor.

[210] Berg, T., Kirwin, W., & Redman, B. (2016) 'TCO: a critical Tool for Measuring IT,' Gartner Advisory Strategic Analysis Report, 12-10.

[211] Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

[212] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality' organised on 10 November 2022 as part of the study.

[213] McGrath, R., & McManus, R. (2020). Discovery-Driven. *Harvard Business Review*, 98(3), 124-133.

[214] Gebauer, H., Fleisch, E., Lamprecht, C., & Wortmann, F. (2020). Growth paths for overcoming the digitalization paradox, *Business Horizons*, Volume 63, Issue 3, Pages 313-323, ISSN 0007-6813. Available at: https://doi.org/10.1016/j.bushor.

[215] Gebauer H., Fleisch, E., Lamprecht, C., & Wortmann, F. (2020). Growth paths for overcoming the digitalization paradox, *Business Horizons*, Volume 63, Issue 3, Pages 313-323, ISSN 0007-6813. Available at: https://doi.org/10.1016/j.bushor.

Several ways exist for SMEs to drive down the costs of a digital intervention. As further elaborated upon in Best Practice Principle 8 (see Section 2.9), the implementation of open-source solutions may prove cheaper in the long run. Similarly, using low-cost components or simpler and more accessible solutions will drive down project costs and increase the likelihood of a positive ROI.[216] The so-called 'frugal innovation' approach can help companies pursue digitalisation in a sustainable and low-cost way.[217]

Even though existing research and evidence highlight the importance of assessing digitalisation costs, most of the companies analysed for this report did not explicitly indicate that they had calculated the TCO of their foreseen digital interventions. However, some companies did point to issues with the implementation of digitalisation due to inaccuracies or difficulties in assessing project costs. These are illustrated in Table 10.

Table 10. Assessing the costs of digitalisation: examples from the case studies

Industry	Description
CS 2	**Henry Partners in Poland – Order processing automation**
Retail	Henry Partners is a company that operates four e-commerce shops selling various products, from sporting goods to health and safety products and cosmetics accessories. Before automating order processing for its stores, the owner was looking for a way to reduce time spent on repetitive, sales-related activities and to integrate changes across the e-commerce platforms used by the company. The company's choice of a solution was guided by the **ALARA principle, which involves keeping costs as 'as low as reasonably achievable'.** The company was well aware of its budget constraints, and decided to expand the use of the Prestashop platform.
CS 3	**Novia Blanca in Poland – Auditing and dividing stock**
Retail	Novia Blanca is one of the biggest retailers of wedding jewellery in Poland. The company operates both a physical and an online store. The company wanted to separate its warehouse operation from physical retailing. The company decided to overhaul its existing digital solutions and pilot the adoption of a single e-commerce platform. **While the company did assess the costs associated with outsourcing** the management of online orders and stockpiling, **it did not foresee the human resource cost** associated with splitting and managing the stock for online and physical stores. Consequently, stock splitting led to a reverse effect and increased operational overheads. As a result, the company went back to its old way of working, having the same team managing both online and physical orders.
CS 5	**MST Frieling in Germany – Introducing ERP system during COVID**
Retail	MST Frieling is a family-owned store, operating since 2007. The shop mostly sells travel luggage, hats, bags and fashion jewellery. Prior to the COVID-19 pandemic, the company sold its goods both through its bricks-and-mortar store and its digital store. However, due to the pandemic the company wanted to implement an ERP system that would allow it to operate remotely. The company's initial attempt to digitalise in March 2020 was unsuccessful, due to financial constraints. The company owners stated that **it was difficult to assess the costs of implementation**, as these related not only to installing and paying for the software, but also **transaction costs for every sale.**

[216] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. *Computers in Industry*, 133, 103532.

[217] Albert, M. (2019). Sustainable Frugal Innovation – The connection between frugal innovation and sustainability. *Journal of Cleaner Production*, 237. 117747. 10.1016/j.jclepro.2019.117747.

Industry	Description
	In the end, MST Frieling successfully applied for funding from a programme launched by the Germany county of North-Rhine Westphalia.
CS 32	**Oyster farms in Croatia – Assessing quality using spectral data**
Agrifood	One case study concerns an oyster farm located in the Adriatic region of Croatia. The company operates 5,000 farming lines deployed at sea, with mussels and oysters at different lifecycle stages. The farm adopted the spectrometric technology and methodology for preventative oyster quality assessment on-site (SOQA). **Before implementing the technology, the company assessed its possibilities from financial, technical and human resource perspectives.** To do so, it relied on external consultants to perform a technology audit of the company. This allowed the company to better narrow down the scope of digitalisation to a technology that would be feasible for them to implement.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

2.6.2. Component 5.2: Ensuring capacity to implement the project

The second component of this principle relates to having enough financial resources to successfully implement a digitalisation project. Evidence suggests that the availability of both financial and human resources is an important determinant of Industry 4.0 adoption among SMEs.[218] While larger companies may find it easier to allocate resources and funds to digitalisation, SMEs are often resource-constrained and may not be able to divert human and financial resources from the day-to-day management of the company towards the adoption of digital technologies.

Research conducted for this study, as well as a systematic review of the literature, show that **SMEs face structural barriers to accessing appropriate sources of finance** that are critical to their growth and digitalisation.[219] This may be due to a lack of collateral or low credit scores.[220] Lack of financial resources was identified as the main barrier to digitalisation among the companies surveyed in an earlier phase of this study, cited by a total of 43% of survey respondents.[221] Respondents with fewer than 250 employees were also more likely than larger companies to cite a lack of financial resources as a barrier (50% compared with 23%). Data show that every year, European SMEs experience a finance gap of EUR 20-30 billion.[222]

[218] Ghobakhloo, M., Iranmanesh, M., Vilkas, M., Grybauskas, A., & Amran, A. (2022). Drivers and barriers of Industry 4.0 technology adoption among manufacturing SMEs: a systematic review and transformation roadmap. *Journal of Manufacturing Technology Management*, (forthcoming).

[219] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[220] EIB (2021). Digitalisation in Europe 2020-2021. Evidence from the EIB Investment Survey.

[221] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

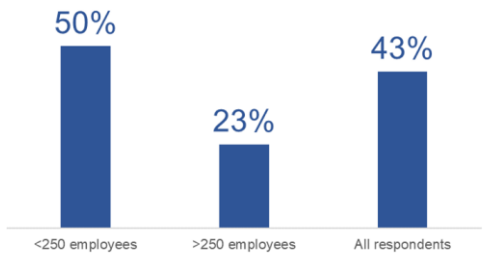
[222] Data taken from: https://www.ema.europa.eu/en/documents/presentation/presentation-sme-strategy-sustainable-digital-resilient-industrial-ecosystems-europe-m-nyman_en.pdf.

Given the financial constraints faced by smaller companies, they are more likely to leverage external support and ecosystems.[223] Both the case studies and the literature point to the importance of participating in public support programmes as a means of securing the necessary resources. As elaborated in Best Practice Principle 8 (see Section 2.9), companies can make use of low-cost alternatives to traditional industrial technologies, such as digital platforms or software-as-a-service solutions. In certain industries, such as agrifood, companies also participate in cooperatives as a way of securing access to and sharing resources.[224]

Companies can also take advantage of existing support programmes as a means of gaining access to funding. Several funding programmes targeted at digitalisation exist both at the European and national level. The European Commission has developed a guide[225] to available funding opportunities under the 2021-2027 financial period. Companies can obtain funds through Horizon Europe[226] and more specifically through the NextGenerationEU[227] programme dedicated to COVID-19 recovery. At national level, the Recovery and Resilience Facility is another important source of funding for the digitalisation of businesses. Each national RRP dedicates at least 20% of allocated expenditures to fostering the digital transition.

Lack of financial resources as a barrier to digitalisation

In a Company Digitalisation survey performed in earlier stages of the study, a total of 50% of companies with fewer than 250 employees cited lack of financial resources as a major barrier to digitalisation.



Many of the companies analysed for this report relied on external financial or technical support. Companies either applied to national funding programmes or participated in EU projects through which they were able to access expertise and test different solutions, as illustrated in Table 11 below.

Table 11. Approaches to securing digitalisation funding: examples from the case studies

Industry	Description
CS 7	**Saasil in Germany – Multichannel sales**
Retail	Saasil is a retail shop that sells lamps for living spaces, object lighting and equipment, as well as home accessories. The company decided to restructure itself in 2020. It introduced a new ERP system to connect products between its e-shop and physical store. The COVID-19 pandemic had a detrimental effect on the company's operations. As a result, the company owner **applied and received EUR 9,000 to compensate for some of the profits lost during the pandemic**.

[223] OECD (2021). The Digital Transformation of SMEs, OECD Studies on SMEs and Entrepreneurship, OECD Publishing, Paris. Available at: https://doi.org/10.1787/bdb9256a-en.

[224] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[225] European Commission (2022). Digitalisation of businesses: A guide to EU funding opportunities. Available at: https://www.ffg.at/sites/default/files/downloads/Digitalisation_of_businesses__A_guide_to_EU_funding_opportunities.pdf.

[226] European Commission, Directorate-General for Research and Innovation, (2021). Horizon Europe: strategic plan 2021-2024, Publications Office. Available at: https://data.europa.eu/doi/10.2777/083753.

[227] European Commission, Directorate-General for Communication (n.d.). NextGenerationEU. Available at: https://europa.eu/next-generation-eu/index_en.

Industry	Description
CS 22	**Katty Fashion in Romania – Technologies for the circular economy[228]**
Textile	Katty Fashion is a manufacturing company in the textile/fashion industry, with 40 employees. The company produces a wide range of women's outerwear and specialises in short production runs and customised clothing. Katty Fashion's decision to undertake digital transformation was based on a desire to improve overall efficiency, increase service diversification, gain a competitive advantage and consolidate customer loyalty. The company also conducted a **feasibility study** to assess whether the planned adoption of digital solutions was possible, given the company's financial and human resources. To successfully implement its foreseen digitalisation projects, Katty Fashion applied for **external financial and technical support.** It also sought external guidance, expertise and consulting to streamline its production.
CS 34	**Van Den Borne Aardappelen in the Netherlands – Smart farming[229]**
Agrifood	Van Den Borne Aardappelen is a family farm consisting of roughly 550 hectares of land, devoted primarily to potato crops, but also growing maize, wheat and sugar beet. The company decided to implement precision agriculture to increase the volume and quality of crop yields. Securing funding was an important factor in adopting digital technologies at the farm. The company **received public financial support** from local, regional and national SME innovation and rural economic development programmes to help finance its digital transformation ambitions. The farm has also **participated in a long list of publicly supported research and development (R&D) and innovation projects** co-funded by the Dutch government and the agricultural industry.
CS 39	**Norteña de Aplicaciones y Obras in Spain – Paperless construction[230]**
Construction	Norteña de Aplicaciones y Obras is a company located in Aranda de Duero that provides specialised services in roof waterproofing. In relation to digitalisation, the company relies on collaborations with multiple freelancers. To maintain its competitiveness and efficiency, the company has introduced several technologies aimed at improving internal operations and relationships with customers. The foreseen digital intervention required funding. Before embarking on digitalisation, **the company's management assessed several funding options, including public support.** In the end, the company managed to ensure internal capacity and relied on its own financial resources to digitalise successfully.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

[228] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[229] European Commission, Executive Agency for Small and Medium-sized Enterprises. (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[230] Ibid.

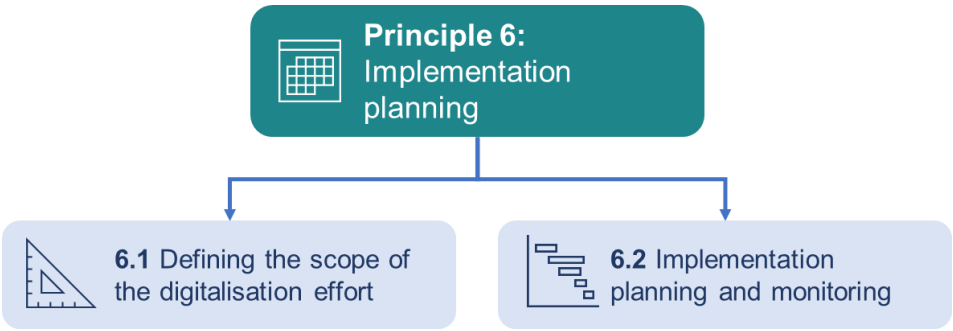
2.7. Principle 6 – Implementation planning

The sixth principle identified by the research team concerns implementation planning. Reaching a mutual understanding between internal and external stakeholders with regard to the scope and sequence of digitalisation activities is an important prerequisite for their efficient implementation, as elaborated in Principle 2 (see Section 2.3). Furthermore, iteration and the frequent recalibration of plans can help companies to implement digitalisation projects successfully. This principle describes aspects of planning relating to the digitalisation initiative or to transformation-related changes. Other planning considerations relating to the selection of solutions and vendors are described in Principle 8 (see Section 2.9).

Principle 6 'Implementation planning' was assigned as important in 13 out of the 42 case studies analysed (see Annex 2).

Principle 6 can be further broken down into two interlinked components, as illustrated in Figure 9. The first component relates to the importance of clearly defining the scope of the digital intervention. The second details the importance of planning the steps associated with digitalisation. Each component is described in more detail below.

Figure 9. Components of Principle 6, 'Implementation planning'



2.7.1. Component 6.1: Defining the scope of the digitalisation effort: small-scale initiatives versus broad transformations

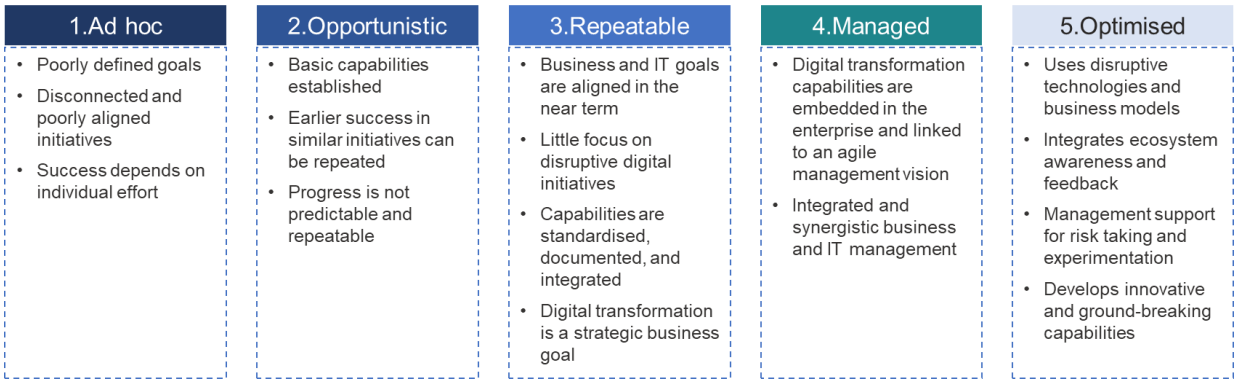
For most companies, the adoption of digital technology is not a goal in itself. Digitalisation is usually a tool to achieve the broader strategic objectives of a business.[231, 232] Therefore, the scope of a digitalisation initiative needs to align with the company's needs, strategic objectives and transformation capabilities. The scope of a company's digitalisation efforts can vary from small-scale initiatives to whole-of-the-organisation programmes.

The stages of digital transformation can be differentiated on the basis of how systematic and intentional digitalisation efforts are. On the one hand, companies in the early stages of digital transformation are prone to digitalising through isolated, *ad hoc* digital initiatives. On the other hand, companies that already possess advanced digital transformation capabilities tend to align their initiatives with strategic goals, cluster them to gain from synergies, and use

[231] EY/University of Oxford (2022). How do you harness the power of people to double transformation success? Available at: https://www.ey.com/en_gl/consulting/how-transformations-with-humans-at-the-center-can-double-your-success.
[232] McKinsey (2021). The digital-value guardian: CEOs and digital transformations. Available at: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-digital-value-guardian-ceos-and-digital-transformations.

iteration and experimentation to continuously review and improve performance**.** The IDC defines five stages of digital transformation: *ad hoc*, opportunistic, repeatable, managed and optimised (see Figure 10).[233] Another article categorises various 'digital competence levels', ranging from isolated pockets of digital activity without an overarching strategy to interconnected transformations.[234] These models suggest that companies begin with smaller, isolated projects then, as they gain more experience in digitalisation, transition to broader transformations comprised of several inter-connected initiatives.

Figure 10. Stages of digital transformation



Source: adapted by the research team from the European Commission (2019), on the basis of the IDC MaturityScape Benchmark categories.

Evidence suggests that companies should begin their digitalisation journey with basic technology building blocks.[235] These include technologies such as information systems, communication tools, document management systems and websites.[236] Starting with 'quick win' initiatives[237] allows companies to demonstrate early success to stakeholders in order to obtain buy-in for further digital transformation.[238,239] An iterative approach allows employees to familiarise themselves with the new systems and ways of working before the introduction of additional digital technologies.[240] Furthermore, companies usually perceive smaller, isolated projects as less risky than large-scale transformations.[241] This is unsurprising, as many companies face a prohibitive cost of failure in terms of capital and job loss.[242,243]

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[233] European Commission, Executive Agency for Small and Medium-sized Enterprises, Siebes, C., Linden, N., & Kolding, M. (2019). Digital organisational frameworks and IT professionalism, Publications Office. Available at: https://data.europa.eu/doi/10.2826/335797.

[234] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[235] EY-Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

[236] Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International Journal of Information Systems and Project Management*, 8(4), 24-43.

[237] Initiatives with a high likelihood of success, which can be implemented simply and within a short period of time.

[238] Müller, J.M. (2022). Presentation, 'Good and best practices – making the concept reflect reality' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[239] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[240] Ibid.

[241] Li, F. (2020). Leading digital transformation: three emerging approaches for managing the transition. *International Journal of Operations & Production Management*.

[242] McGrath, R., & McManus, R. (2020). Discovery-Driven. *Harvard Business Review*, 98(3), 124-133.

[243] Schönfuß, B., McFarlane, D., Athanassopoulou, N., Salter, L., Silva, L. D., & Ratchev, S. (2019). Prioritising low cost digital solutions required by manufacturing SMEs: a shoestring approach. In: *International Workshop on Service Orientation in Holonic and Multi-Agent Manufacturing* (pp. 290-300). Springer, Cham.

However, there are situations in which full-scale digital transformations are necessary. First, external factors, such as changes in consumer demand or regulatory requirements, often necessitate significant business transformation. For example, emerging environmental and ethical standards will significantly change the way manufacturing companies have to collect and share data across their supply chains.[244] As a result, companies need to rapidly digitalise their business models to meet these new requirements. Second, companies that have already achieved operational efficiencies may need to undertake bigger digital initiatives to secure further gains. Examples of large-scale transformations include introducing new digital products or services and clustering several digital initiatives together to achieve broader strategic goals.[245, 246]

Some digitally advanced companies implement whole-of-organisation transformations through iterative test-and-learn cycles.[247,248] This means breaking down the implementation into incremental steps that cumulatively lead to significant changes.[249] The results from each iterative stage then feed back into a continuous re-evaluation and recalibration of digitalisation plans, strategies and dynamic resource allocation.[250]

The case studies analysed during the preparation of this report include both companies that have implemented small-scale initiatives, and those that pursued large-scale transformation (see Table 12). **This suggests that both approaches can be successful when aligned with a company's needs, strategic objectives and maturity in relation to digital transformation.**

Furthermore, some companies began with smaller initiatives and, as they gained more experience with digital technologies, transitioned to larger projects. For example, LEVIATAN from Romania started by digitalising its internal and external communications. Building on the success of these digitalisation initiatives, its management decided to fully digitalise the company's operations (for a more detailed description, see Table 12).

[244] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Gap Analysis report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-gap-analysis-report-now-published.

[245] EY-Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

[246] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[247] Li, F. (2020). Leading digital transformation: three emerging approaches for managing the transition. *International Journal of Operations & Production Management*.

[248] McKinsey (2019). A winning operating model for digital strategy. Available at: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/a-winning-operating-model-for-digital-strategy.

[249] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[250] McGrath, R., & McManus, R. (2020). Discovery-Driven. *Harvard Business Review*, 98(3), 124-133.

Table 12. Small-scale initiatives and whole-of-organisation transformations: examples from the case studies

	Small-scale initiatives		Whole-of-organisation transformations	
Retail	CS 6	Landspeis in Austria – Digital marketing	CS 4	Żabka in Poland – Following customers and automating stores
Automotive	CS 8	DTH Automotive Kft. in Hungary – Adopting 3D scanning to automate measurement processes	CS 15	Renault in France – Office tablets and a centre of excellence
Textile	CS 19	Têxteis Penedo in Portugal – A virtual showroom platform	CS 22	Katty Fashion in Romania – Technologies for the circular economy
Agrifood	CS 32	Oyster farms in Croatia – Assessing quality using spectral data	CS 34	Van Den Borne Aardappelen in the Netherlands – Smart farming
Construction	CS 40	Karl Wolf GmbH & Co. KG in Germany – Single platform for clients	CS 38	PORR Romania – Adopting 3D modelling technologies on construction sites

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

The test-and-learn approach helps to assess the viability of solutions on a small scale through pilots or experiments, before they are implemented company-wide. SMEs especially can benefit from an iterative process that allows them to learn by doing.[251] When prioritising initiatives, selecting a couple of 'lighthouse' projects can help to quickly test and demonstrate the viability of a solution.[252] Initial implementation plans can then be recalibrated using data-driven insights.[253] Evidence suggests that an experimentation-based approach to digitalisation is more likely to succeed than traditional linear approaches.[254,255]

While SMEs tend to be resource- and time-constrained, some research suggests that **allocating more resources to experimenting with their business model can improve SMEs' performance**.[256] Companies included in the case study analysis, as well as participants in the Best Practice workshop, cited experimentation as an enabler for the successful adoption of technologies.[257] The example of Novia Blanca shows that even unsuccessful pilots can

[251] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.
[252] BCG (2020). Flipping the Odds of Digital Transformation Success. Available at: https://www.bcg.com/publications/2020/increasing-odds-of-success-in-digital-transformation.
[253] McKinsey (2018). Digital strategy: The four fights you have to win. McKinsey Quarterly. Available at: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/digital-strategy-the-four-fights-you-have-to-win.
[254] Li, F. (2020). Leading digital transformation: three emerging approaches for managing the transition. *International Journal of Operations & Production Management*.
[255] EY Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.
[256] Bouwman, H., Nikou, S., & de Reuver, M. (2019). Digitalization, business models, and SMEs: How do business model innovation practices improve performance of digitalizing SMEs? *Telecommunications Policy*, 43(9), [101828]. Available at: https://doi.org/10.1016/j.telpol.2019.101828.
[257] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality' organised on 10 November 2022 as part of this study.

provide valuable information on whether a solution fits the company's needs. Furthermore, the cases of HATA and a Lithuanian blueberry farm illustrate the value added through collaboration with academia, research and technology providers to test new technologies. For more details, see Table 13.

Table 13. Defining the scope of the intervention: examples from the case studies

Industry	Description
CS 3	**Novia Blanca in Poland – Auditing and dividing stock**
Retail	Novia Blanca is one of the biggest retailers of wedding jewellery in Poland. The company decided to explore a digital solution to improve the efficiency of its sales processing. Prior to implementing a full-scale solution, the company chose to **conduct a pilot**. While the pilot reduced the time needed for simple processing tasks, the company's overall overheads increased due to the cost of stock splitting. As a result, the company decided to return to its previous operating model. The example of Novia Blanca shows that piloting can help to not only identify useful digital solutions, but also to determine if a solution does not fit the company's needs.
CS 14	**MW.FEP in Italy – Interoperable solutions for multiple lines of work[258]**
Automotive	MW.FEP is a company providing tailor-made solutions in the electronics industry, including parts for the automotive industry. The company aimed to introduce a software solution that would allow them to quickly manage the introduction of new products. Prior to implementation, the company had to decide if it wanted to change only a few aspects of its production process or overhaul it completely. The company decided to carry out a **large-scale digital transformation** of all its production lines. MW.FEP also dedicated part of its production plant specifically to **prototyping new products**.
CS 15	**Renault in France – Office tablets and a centre of excellence[259]**
Automotive	After recognising that digitalisation was necessary to achieve its strategic objectives for 2017-2022, French automotive manufacturer Renault decided to **change its entire company culture**. The company found several areas in which the implementation of digital technologies could lead to cost-saving and optimisation. The potential gains were quantified to be around EUR 600 million per year as a result of efficiency and productivity gains, and new business. After defining a vision, the company **developed a long-list of use-cases**. The assumptions behind these use-cases were then **validated in end-to-end pilots**. Furthermore, the company decided to establish Renault Digital, a centre of excellence that works like a start-up incubator. An agile team is set up for each project, which then conducts the initial framing of a problem and develops a **minimum viable product following an agile development model**.
CS 16	**HATA in Portugal – Successfully testing fabric quality control**
Textile	Knitting circular sustainable fabrics since 2016, HATA is a young company committed to being part of a new and evolved global textile and manufacturing supply chain. To improve its quality management processes, the company decided to introduce a computer vision-based solution for fabric inspection. HATA chose to partner with Smartex, a start-up focused on advanced solutions for textile quality inspection using computer vision and AI. The two companies **collaborated to test and fine-tune the solution** in an industrial setting, eventually arriving at a fully working product. This partnership allowed HATA to

[258] Cadlog (n.d.). Improved NPI service thanks to fast and flexible configuration of the SMT line. Available at: https://www.cadlog.com/success-stories/improved-npi-service-thanks-to-fast-and-flexible-configuration-of-the-smt-line/.
[259] Scherer J.L. (2020). Renault – An industry 4.0 Case Study. The Digital Transformation People. Available at: https://www.thedigitaltransformationpeople.com/channels/the-case-for-digital-transformation/renault-an-industry-4-0-case-study/.

Industry	Description
	become the first company to reap the benefits of a previously untested solution, while Smartex gained an opportunity to develop its product in an industrial setting.
CS 22	**Katty Fashion in Romania – Technologies for the circular economy[260]**
Textile	Katty Fashion is a manufacturing company in the textile/fashion industry, with 40 employees. The company produces a wide range of women's outerwear and specialises in short production runs and customised clothing. To transition to an innovative and sustainable business model, the company implemented **agile practices and used co-creation methods** involving the team and external partners. According to company representatives, the digital transformation **process was incremental,** which allowed the company to work on subsequent steps in its transformation while simultaneously introducing 3D technologies**.**
CS 30	**Blueberry farm in Lithuania – Testing of precision agriculture[261]**
Agrifood	A 1,500 ha. blueberry farm in the Maišiagala district of Lithuania is **participating in a FlexiGroBots project**, the goal of which is to test the use of precision agriculture for different types of farms. Even though the implementation process is still ongoing, the farm has already observed more precise monitoring of crops. One of the lessons learned in this case is that **collaboration with academia, researchers and technology developers is essential to test and deploy** digital innovations.
CS 36.2	**LEVIATAN in Romania – 3rd phase of digitalisation: fully digitalised processes**
Construction	LEVIATAN SRL, a Romanian SME operating in the construction sector, provides integrated architecture and civil engineering services. Over several years, the company has undergone a complex digital transformation journey, beginning with automating data exchange, to the full automation of company processes. Following LEVIATAN's initial digital transformation, during which the company successfully introduced ERP, agile ways of working and BIM software, the company **decided to completely digitalise its operations**. As a result, the company leadership chose to establish a new IT company with the sole objective of developing digital solutions for its sister architecture company. **Innovation, experimentation and upscaling** of various digital solutions have helped the company become a digital leader in the Romanian construction industry.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

2.7.2. Component 6.2: Implementation planning and monitoring: the importance of iteration and feedback cycles

The second component of Principle 6 identified by the research team concerns implementation planning and monitoring. While studies suggest that creating roadmaps and action plans for technology adoption is important for successful implementation, few

[260] Information provided by company representatives via e-mail.

[261] More information available at: https://flexigrobots-h2020.eu/.

companies actually have these. This is especially true for SMEs, which often make use of their flexibility to adopt digital technologies rapidly once a business need presents itself.

Even when companies have a digital strategy, a well-defined and clear process for implementation is often missing.[262] As described in Component 3.3 (Section 2.4.3), some SMEs implement digital technologies as a response to external factors or to address immediate business needs, with limited long-term planning. Furthermore, the panel discussion held during the Best Practices workshop highlighted that even when a digitalisation plan is in place, implementation can still take a long time.[263] Lack of planning can contribute to challenges during and after implementation, such as insufficient integration between IT systems.[264]

Evidence suggests that strategic roadmapping can positively impact the uptake of digital technologies.[265,266,267] This process allows companies to effectively manage the complexity associated with digitalisation. It also contributes to transparency around activities, timelines, deliverables and resources.[268,269] The planning stage should include the following: selecting use-cases, defining the timeline and milestones, dividing up responsibilities, allocating resources, and defining key performance indicators (KPIs).[270] The plan can include several waves of prioritisation, testing and scaling.[271]

For large companies and broad transformations, it is highly useful to document plans clearly and in detail**.** However, writing up detailed plans is not always realistic for SMEs or when implementing small-scale digitalisation initiatives. The companies studied rarely mention the preparation of detailed digitalisation plans prior to implementation (see Annex 2). However, multiple case studies highlight the need to secure commitment and ensure clarity between management, employees and partners with the regard to the implementation approach. **The level of detail included in a digitalisation plan depends on the initiative's complexity and scope.** Companies can take practical actions such as drafting an implementation roadmap or regular planning meetings involving key stakeholders.

Planning also needs to include consideration of monitoring, supervision, and governance during implementation.[272] Companies with successful transformation

[262] Lassnig, M., Muller, J.,M., Klieber, K., Zeisler, A., & Schirl, M. (2021). A digital readiness check for the evaluation of supply chain aspects and company size for Industry 4.0. Available at: https://www.emerald.com/insight/content/doi/10.1108/JMTM-10-2020-0382/full/pdf?title=a-digital-readiness-check-for-the-evaluation-of-supply-chain-aspects-and-company-size-for-industry-40.

[263] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality' organised on 10 November 2022 as part of the study.

[264] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[265] Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

[266] Radhakrishnan, J., & Chattopadhyay, M. (2020, December). Determinants and Barriers of Artificial Intelligence Adoption–A Literature Review. In: International Working Conference on Transfer and Diffusion of IT (pp. 89-99). Springer, Cham.

[267] Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International journal of Information Systems and Project Management*, 8(4), 24-43.

[268] Ghobakhloo, M., & Iranmanesh, M. (2021). Digital transformation success under Industry 4.0: A strategic guideline for manufacturing SMEs. *Journal of Manufacturing Technology Management*, 32(8), 1533-1556.

[269] BCG (2020). Flipping the Odds of Digital Transformation Success. Available at: https://www.bcg.com/publications/2020/increasing-odds-of-success-in-digital-transformation.

[270] EY-Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

[271] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[272] EY-Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

programmes are more likely to have effective progress monitoring practices in place.[273] Progress monitoring allows for the early detection of risks and the implementation of any necessary changes to the digitalisation plan.

Performance improvements can be measured through a set of clearly defined SMART (specific, measurable, attainable, relevant and time-bound) **KPIs.**[274,275] Traditional financial metrics such as ROI do not always suit an iterative implementation approach or the needs of the SME (Component 5.1, see Section 2.6.1). Instead, using metrics linked to the process and outcomes of specific planned activities can help to test and refine the initial assumptions during the process.[276]

Changing market conditions, organisational realities, and the results of preceding steps in the transformation will all influence the implementation process.[277,278] **Consequently, the ability to flexibly adapt plans can help to address challenges that arise, and reinforce commitment if there are setbacks**.[279,280] The importance of adapting to new realities and results is also a frequent theme in the case studies analysed in this report. Companies often face situations in which it is necessary to change the initial plan. Consequently, continuous monitoring of progress and results can help to identify any such need to revise plans as it arises.

Examples of how companies have planned and monitored implementation are available below.

Table 14. Implementation planning and monitoring: examples from the case studies

Industry	Description
CS 4	**Żabka in Poland – Following customers and automating stores[281]**
Retail	Żabka is a retail franchise network in the Polish market. Since 1998, it has opened over 8,500 physical stores in various formats. The ongoing transformation of the company is based upon its objective to be as close as possible to its customers through the development of a convenience ecosystem. To digitalise its business processes, Żabka chose to partner with summ-it, a company specialising in system integration and professional data management. Together, they were able to employ an **agile methodology** to implement a solution that was fully aligned with the retailer's needs.

[273] BCG (2020). Flipping the Odds of Digital Transformation Success. Available at: https://www.bcg.com/publications/2020/increasing-odds-of-success-in-digital-transformation.

[274] Verhoef, P.C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J.Q., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, 122, 889-901.

[275] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[276] McGrath, R., & McManus, R. (2020). Discovery-Driven. *Harvard Business Review*, 98(3), 124-133.

[277] Bain & Company (2017). Orchestrating a Successful Digital Transformation. Available at: https://www.bain.com/insights/orchestrating-a-successful-digital-transformation/.

[278] Ibid.

[279] BCG (2020). Flipping the Odds of Digital Transformation Success. Available at: https://www.bcg.com/publications/2020/increasing-odds-of-success-in-digital-transformation.

[280] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[281] Microsoft (2020). Grocery chain Żabka digitizes its business processes via Microsoft SharePoint platform implemented by summ-it to improve efficiency. Available at: https://customers.microsoft.com/en-us/story/844212-zabka-summit-azure.

Industry	Description
CS 22	**Katty Fashion in Romania – Technologies for the circular economy**[282]
Textile	Katty Fashion is a manufacturing company in the textile/fashion industry, with 40 employees. The company produces a wide range of women's outerwear and specialises in short production runs and customised clothing. As part of the DigitaliseSME initiative, Katty Fashion received support from an advisor who helped the company explore opportunities and potential business directions. As part of the initiative, Katty **defined short, medium and long-term strategies for digitalisation**. Alongside technical support, Katty Fashion cites its **continuous progress monitoring** and the studying, testing and incorporation of proposed technology solutions into its workflow as key success factors.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

[282] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

2.8. Principle 7 – Taking advantage of the wider ecosystem and collaboration

The seventh principle concerns collaboration with the broader ecosystem for the purpose of digitalisation. Industrial companies do not operate in a vacuum. They are often part of long supply chains, and are in regular contact with other companies within their network. In addition, companies operate within national ecosystems, and can benefit from existing support schemes to gain access to technical support, test-before-invest facilities or to find partners and innovative solutions that address their needs.

Principle 7, 'Taking advantage of the wider ecosystem and collaboration was assigned as important in 16 out of the 42 case studies analysed (see Annex 2).

It should be noted that **this principle is the most horizontal one**, as access to technical support and cooperation with other stakeholders can help companies to address some of the challenges or implement the good practices outlined in other principles. In particular, companies can rely on existing support networks to gain access to necessary skills (Principle 4) or financial resources (Principle 5), to choose an appropriate solution or collaborate with an external provider in order to implement a solution effectively (Principle 8).

Companies can improve their capacity and accelerate their digitalisation by collaborating with stakeholders within their ecosystems. Surveys of SMEs consistently show that respondents indicate a need for external support. The type of support from which companies can benefit varies. For example, a survey conducted for the 2021 Annual Report on SMEs showed that 72% of SMEs consulted believed that **better access to public support** schemes would be useful in order for them to digitalise.[283] Similarly, according to the findings of the European Investment Bank (EIB) Investment survey, companies would like **technical support** and help with identifying new markets.[284] Lastly, research also indicates that SMEs that receive support from external experts are more likely to succeed in implementing Industry 4.0 projects.[285] Figure 11 below summarises the types of ecosystem players with which SMEs can collaborate to obtain access to funding, technical support and testing facilities.

[283] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[284] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[285] Moeuf, A., Lamouri, S., Pellerin, R., Tamayo-Giraldo, S., Tobon-Valencia, E., & Eburdy, R. (2020). Identification of critical success factors, risks and opportunities of Industry 4.0 in SMEs. *International Journal of Production Research*, 58(5), 1384-1400.

Figure 11. Potential collaboration opportunities

Source: compiled by the research team.

Research shows that collaboration is an enabler for SME digitalisation.[286] The results of various surveys and the literature suggest SMEs that have not yet digitalised or which have very little experience with digitalisation benefit from **mentoring-type expert support.** This helps them to identify the benefits that digitalisation could bring to their business.[287] Gaining access to technical advice and expertise can help SMEs to reduce knowledge gaps in relation to specific digital technologies.

First, companies can collaborate with **universities** to address skills shortages, gain access to piloting facilitates and obtain expert advice. Multiple ways exist for these collaborations to take place: R&D partnerships, the delegation of industrial chairs, joint research projects, the commercialisation of R&D results, academic mobility and spin-offs.[288,289] Evidence suggests that larger companies are more likely to interact with academic institutions because they have the resources needed to harness university knowledge.[290] However, collaborations with universities can also be useful to SMEs. SMEs can gain access to non-monetary resources, cutting-edge scientific knowledge and problem-solving advice as well as new products and technologies.[291] The case studies analysed show that companies tend to collaborate with

[286] OECD (2021). SME digitalisation to "Build Back Better": Digital for SMEs (D4SME) policy paper. OECD SME and Entrepreneurship Papers, No. 31, OECD Publishing, Paris. Available at: https://doi.org/10.1787/50193089-en.

[287] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[288] Deschamps, I., Macedo, M.G., & Eve-Levesque, C. (2013). University-SME Collaboration and Open Innovation: Intellectual-Property Management Tools and the Roles of Intermediaries. *Technology Innovation Management Review*, 3(3): 33-41. Available at: http://doi.org/10.22215/timreview/668.

[289] Horizon Europe Engagement Toolkit (2022). University-SME Collaboration. Available at: https://unite4horizon.eu/wp-content/uploads/2022/05/University-SME-collaboration.pdf.

[290] Guerrero, D.F. (2020). Bridging the Gap between Firms and Universities: Firm Links with Research and Technology Organisations in Different Types of Regions. Available at: https://ris.utwente.nl/ws/portalfiles/portal/182216383/03.2020_Fernandez_Guerrero.pdf.

[291] Guerrero, D.F. (2020). Bridging the Gap between Firms and Universities: Firm Links with Research and Technology Organisations in Different Types of Regions. Available at: https://ris.utwente.nl/ws/portalfiles/portal/182216383/03.2020_Fernandez_Guerrero.pdf.

universities when implementing publicly funded digitalisation projects or testing certain solutions. Companies can identify these opportunities by attending events organised by local or regional universities, or by actively reaching out to universities whose expertise or research programmes may be relevant to them.[292]

Mentoring-type support is increasingly offered through so-called **technology extension programmes**.[293] Evidence suggests that programmes of this type that specifically target SMEs have become more prevalent over recent decades.[294] Technology extension programmes usually involve an assessment of the firm's operations and processes, followed by a proposed plan for improvement and assistance with implementation. The services provided by DIHs fall under this type of support. According to the SC3 platform, some 240 regional DIHs are currently operational in Europe. Some hubs also provide specialised advice on the implementation of specific technologies, or focus on specific industries (e.g. the textile or agrifood industry). In turn, companies can benefit from the mentorship and expertise offered by such hubs. Participants in the Best Practice workshop agreed on the important role DIHs play in facilitating knowledge transfer for digitalisation.[295] In addition, the Enterprise Europe Network (EEN) offers tailored advice to SMEs. It has over 600 locations across Europe and some 6,000 experts.

In addition to DIHs, Member States have also launched several **national or regional initiatives with the aim of offering mentoring-type support to companies**. For example, The Go-Digital initiative in Germany supports SMEs through the provision of expertise by consultancy firms that work individually with SMEs in the areas of IT security, business process digitalisation and digital market development.[296] Similarly, in Hungary, the Modern Enterprises Programme – Digital Entrepreneurship aimed to increase digitalisation among rural businesses through the help of 27 IT consultants.[297]

SMEs can also benefit from access to **testing facilities,** which can help to drive down the costs of project implementation.[298] Testbed facilities allow companies to test technologies in a realistic setting, and experiment with their applications.[299] The DIH network mentioned above also provides opportunities to 'test-before-invest'. Such services can reduce the costs of implementation by allowing companies to pilot several different options. In addition, the European Commission plans to create large-scale testing and experimentation facilities (TEFs) under the Digital Europe Programme. These facilities will offer a combination of physical and

[292] Pereira, R., & Franco, M. (2022). Cooperation between universities and SMEs: A systematic literature review. *Industry and Higher Education*, 36(1), 37–50. Available at: https://doi.org/10.1177/0950422221995114

[293] OECD (2021). Digital tools and practices: SME access and uptake. Available at: https://www.oecd-ilibrary.org/sites/bdb9256a-en/1/3/1/index.html?itemId=/content/publication/bdb9256a-en&_csp_=42ee43b7fa49ef116a6caf8c78b53d84&itemIGO=oecd&itemContentType=book.

[294] Philip, P., Youtie, J., & Kay, L. (2011). National innovation systems and the globalization of nanotechnology innovation. *Journal of Technology Transfer*, 36. 587-604. 10.1007/s10961-011-9212-0.

[295] Conclusions from the panel discussion and an interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[296] OECD (2021). Digital tools and practices: SME access and uptake. Available at: https://www.oecd-ilibrary.org/sites/bdb9256a-en/1/3/1/index.html?itemId=/content/publication/bdb9256a-en&_csp_=42ee43b7fa49ef116a6caf8c78b53d84&itemIGO=oecd&itemContentType=book.

[297] Ibid.

[298] Benitez, G.B., Ayala, N.F., & Frank, A.G. (2020). Industry 4.0 innovation ecosystems: An evolutionary perspective on value cocreation, *International Journal of Production Economics*, Volume 28, 107735, ISSN 0925-5273. Available at: https://doi.org/10.1016/j.ijpe.2020.107735.

[299] NESTA (2019). Testing Innovation in the Real World. Available at: https://media.nesta.org.uk/documents/Testing_innovation_in_the_real_world.pdf.

virtual facilities.[300] Lastly, analysis of the case studies shows that SMEs can also collaborate with technology start-ups to test and receive support with scaling up their solutions.

Industrial companies can also **benefit from joining existing business ecosystems**. Business ecosystems can be defined as networked yet relatively free collaboration between several companies from one or more industries.[301] Companies can participate in existing **innovation networks or clusters**. Innovation clusters help companies to adopt new technologies and find potential partners in other industrial sectors. They promote economic growth, help to diffuse new technologies and facilitate investments in research. More information about European clusters can be found on the European Cluster Collaboration platform.[302] Similarly, companies can participate in other inter-organisational networks that bring together companies, experts and service providers focusing on a common technology, or on digitalisation more broadly. For example, the Finnish Advanced Manufacturing Network (FAMN) brings together manufacturing companies and digital service providers to accelerate their renewal and digitalisation.[303]

Companies can also **collaborate or partner with other organisations within their value chain**. For example, our case studies show that collaborations with start-ups that are looking to test solutions can be a cost-effective way to implement digital solutions. Similarly, cooperation with other similar companies (for example, as cooperatives) can also help to speed up digitalisation. Participants in the Best Practice workshop stressed that SMEs benefit from sharing experiences and collaborating with other companies along the value chain.[304] Existing research suggests that cooperating with suppliers, distributors or even competitors can help to drive digitalisation and improve cost efficiency.[305] For example, SMEs can engage in common technology purchasing, which reduces the financial costs of digitalisation, distributes risks and strengthens partnerships.[306,307]

National, regional and local **authorities can also play a supporting role in facilitating collaborations** within a particular value chain. For example, the Eindhoven Metropolitan Area launched a regional support programme for SMEs pursuing digitalisation. Through the programme, participating municipalities offer SMEs vouchers worth a maximum of EUR 1,000, which can be used to obtain advice from service providers and other companies operating within the digitalisation ecosystem.[308]

Lastly, the **participation of SMEs in digital platforms is an increasingly important enabler for digitalisation**.[309] The prevalence of online industrial platforms has grown in recent years.

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[300] European Commission (2022). Testing and Experimentation Facilities (TEFs): Questions and answers. Available at: https://digital-strategy.ec.europa.eu/en/faqs/testing-and-experimentation-facilities-tefs-questions-and-answers.

[301] Moore, J. (1999). Predators and Prey: A New Ecology of Competition. *Harvard Business Review*, 71. 75-86.

[302] European Cluster Collaboration Platform (n.d.). In Europe. Available at: https://clustercollaboration.eu/find-partners/in-europe.

[303] More information available at: https://www.famn.fi/.

[304] Conclusions from an interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[305] Abdalla, S., & Nakagawa, K. (2021). The Interplay of Digital Transformation and Collaborative Innovation on Supply Chain Ambidexterity. *Technology Innovation Management Review*, 11(3): 45-56. http://doi.org/10.22215/timreview/1428

[306] Müller, J., Maier, L., Veile, J., & Voigt, K. (2017). Cooperation strategies among SMEs for implementing industry 4.0, In: Kersten, T., Blecker, W., & Ringle, C.M. (eds.): Digitalization in Supply Chain Management and Logistics: Smart and Digital Solutions for an Industry 4.0 Environment. Proceedings of the Hamburg International Conference of Logistics (HICL), Vol. 23, ISBN 978-3-7450-4328-0, epublication GmbH, Berlin, pp. 301-318, https://doi.org/10.15480/882.1462.

[307] Müller J.M. (2022). Presentation 'Good and best practices – making the concept reflect reality' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[308] More information available at: https://metropoolregioeindhoven.nl/subsidies/adviesregeling-digitalisering

[309] Kazantsev, N., & Martens, I. (2021). Industry 4.0 Digital Platforms: Collaborative Business Models for SMEs. In: Voigt, K.-I., & Müller, J.M. (eds.) Digital Business Models in Industrial Ecosystems. Future of Business and Finance. Springer, Cham. Available at: https://doi.org/10.1007/978-3-030-82003-9_8.

In the context of industry digitalisation, digital platforms bring together SMEs to facilitate their demand-driven collaboration for tendering and manufacturing.[310] They foster innovation and collaboration between partners, suppliers and customers by easing communication and coordination.[311] Digital platforms are relevant for various industries. For example, they can be used in connected smart factories to reuse data gathered from machinery, to support farmers with crop management, or to help integrate location data and combine it with data from sensors.[312] Furthermore, platforms are relevant in the retail industry as they can bring retailers together in one place, allowing them easier access to potential consumers and business-to-business (B2B) partners. An example of a local online retail platform is Wir Kaufen Hier, launched in Switzerland.[313] Digital platforms are especially important for SMEs, as these companies are otherwise less likely to secure access to the necessary digital infrastructure due to lack of financial resources or skills.[314]

Examples of how companies have collaborated with the broader ecosystem are available below.

Table 15. Collaborations within broader ecosystems: examples from the case studies

Industry	Description
CS 7	**Saasil in Germany – Multichannel sales**
Retail	**Saasil** is a retail company focusing on the sale of lamps for living spaces, object lighting and equipment, as well as home accessories. Since 2002, the company's owners have also been selling goods via **eBay and their own e-shop, and since 2008 via Amazon**. The owner decided to implement an ERP system that would allow the company's various sales channels to be interconnected. To implement this, the company applied for external **financial support from the state of North Rhine-Westphalia through the Economic Development Agency of the city of Wuppertal.** Thanks to the funding received, Saasil managed to install a new cash register and complete its online store less than two months after the grant was approved. In addition, **a project management agency helped them with expertise on, for instance, social media presence and product photos, as well as other selling platforms.**
CS 16	**HATA in Portugal – Successfully testing fabric quality control**
Textile	Knitting circular sustainable fabrics since 2016, HATA is a young company committed to being part of a new and evolved global textile and manufacturing supply chain. The company introduced a quality inspection system to check fabrics using the aid of computer vision. To achieve this, they cooperated with Smartex, a start-up focusing on advanced solutions for quality inspection using computer vision and AI, which was looking for partners to test its products. As a result, **Smartex launched its pilot at HATA's industrial facilities.** After testing and fine-tuning, the solution was fully developed and ready to be replicated.

[310] Benitez G.B., Ayala N.F., & Frank, A.G. (2020). Industry 4.0 innovation ecosystems: An evolutionary perspective on value cocreation, *International Journal of Production Economics*, Volume 28, 107735, ISSN 0925-5273. Available at: https://doi.org/10.1016/j.ijpe.2020.107735.

[311] Schmidt, M.C., Veile, J.W., Müller, J.M., & Voigt, K.-I. (2019). Kick-start for connectivity. How to implement digital platforms successfully in Industry 4.0, *Technology Innovation Management Review*, 9(10), pp. 5–15.

[312] European Commission (n.d.). Industrial platforms and large-scale pilots. Available at: https://digital-strategy.ec.europa.eu/en/policies/industrial-platforms.

[313] https://limmatstadt.wirkaufenhier.ch/

[314] OECD (2019). OECD SME and Entrepreneurship Outlook 2019, OECD Publishing, Paris. Available at: https://dx.doi.org/10.1787/34907e9c-en.

Industry	Description
CS 21	**Protex Group in Norway and an Estonian ICT Cluster – Collaboration on smart workwear[315]**
Textile	Protex Group is a manufacturer of work clothing for Scandinavian markets. The company decided to increase its profitability by upgrading an existing product – workwear for marine industry workers in harsh conditions. To implement the necessary digital technologies, **Protex group collaborated with an Estonian ICT Cluster, the smart electronics cluster ESTRONICS, and Tallinn University of Technology.** Thanks to the expertise and testbed facilities available through the cluster, the company designed a prototype work suit for extreme environments with smart features embedded.
CS 30	**Blueberry farms in Lithuania – Testing of precision agriculture[316]**
Agrifood	A 1,500 ha. blueberry farm in the Maišiagala district of Lithuania is **participating in the FlexiGroBots project**[317], the goal of which is to test the use of precision agriculture at different farms. By **participating in the project**, the Blueberry farm gained an opportunity to **test multi-robot systems for precision agriculture**. One of the challenges encountered during the process was the absence of technical knowledge for the implementation of the project. The blueberry farm's owner highlights the **importance of collaborating with academia, researchers and technology developers** as a key enabler of digitalisation.
CS 33	**De Trog in Belgium – An innovative and CO2-neutral bakery[318]**
Agrifood	Founded in 1970, De Trog is a bio-label bakery that produces high-quality organic bread. The company combines traditional breadmaking with advanced manufacturing and digital technologies. The bakery aimed to scale up its production and improve the quality and efficiency of the processes. To upskill its staff, the bakery used a '**Bakery Battle' app, and consulted external partners for knowledge and expertise.** Overall, the company has benefitted greatly from the **support and expertise of some 20 public and private institutions and training facilities,** as well as outsourcing digital solutions in order to focus on its primary function – that of production.
CS 37	**Fiber Network WUG in Germany – Cooperative-built internet infrastructure for local people, enterprises and future stakeholders**
Construction	Fiber Network WUG is an example of a **cooperative formed to speed up broadband internet connections** in a rural area. The cooperative built a high-speed internet network connected to the pre-existing local heating network. When installing the heating network, the company performed a cost-benefit analysis and compared various implementation options. When deciding between the installation of copper or fibre optic lines for communication between control modules, the cooperative opted for the latter. The use of fibre optic lines allowed the town to obtain high-speed internet and use a pre-existing network to lay the cables without having to dig deeper or outsource the work.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

[315] Lõugas, H. & Pilvinski, K. (2018). Protex's smart work clothes help to stay out of trouble. Invest in Estonia. Available at: https://investinestonia.com/protexs-smart-work-clothes-help-to-stay-out-of-trouble/.

[316] More information available at: https://flexigrobots-h2020.eu/.

[317] More information available at: https://flexigrobots-h2020.eu/.

[318] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

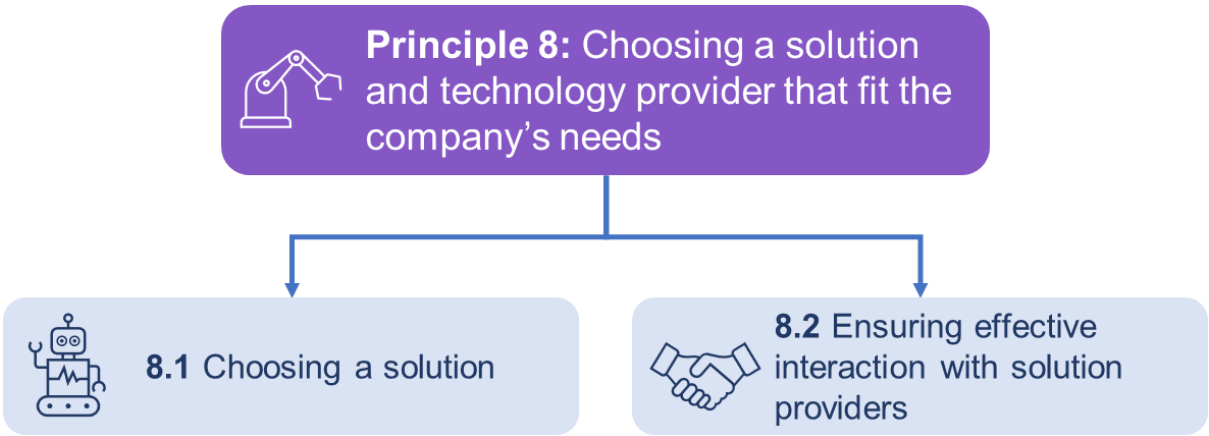
2.9. Principle 8 – Choosing a solution and technology provider that fit the company's needs

The eighth principle concerns choosing a digital solution and technology provider for the implementation of a specific digital initiative. This principle is closely linked with Principle 6, which describes the organisational aspects of implementation planning, and Principle 3, which focuses on setting the strategic objectives for digitalisation.

Principle 8, 'Choosing a solution and a technology provider that fit company needs' was assigned as important in 23 out of the 42 case studies analysed (see Annex 2).

Principle 8 'Choosing a solution and a technology provider that fit company needs' can be further broken down into two interlinked components, as illustrated in Figure 12. The first component details the possible approaches a company can take to choosing the most appropriate solution. The second component details several approaches to interacting effectively with solution providers. Each component is described in more detail below.

Figure 12. Components of Principle 8, 'Choosing a solution and a technology provider that fit the company's needs'



2.9.1. Component 8.1: Choosing a solution: taking advantage of low-cost alternatives and external expertise

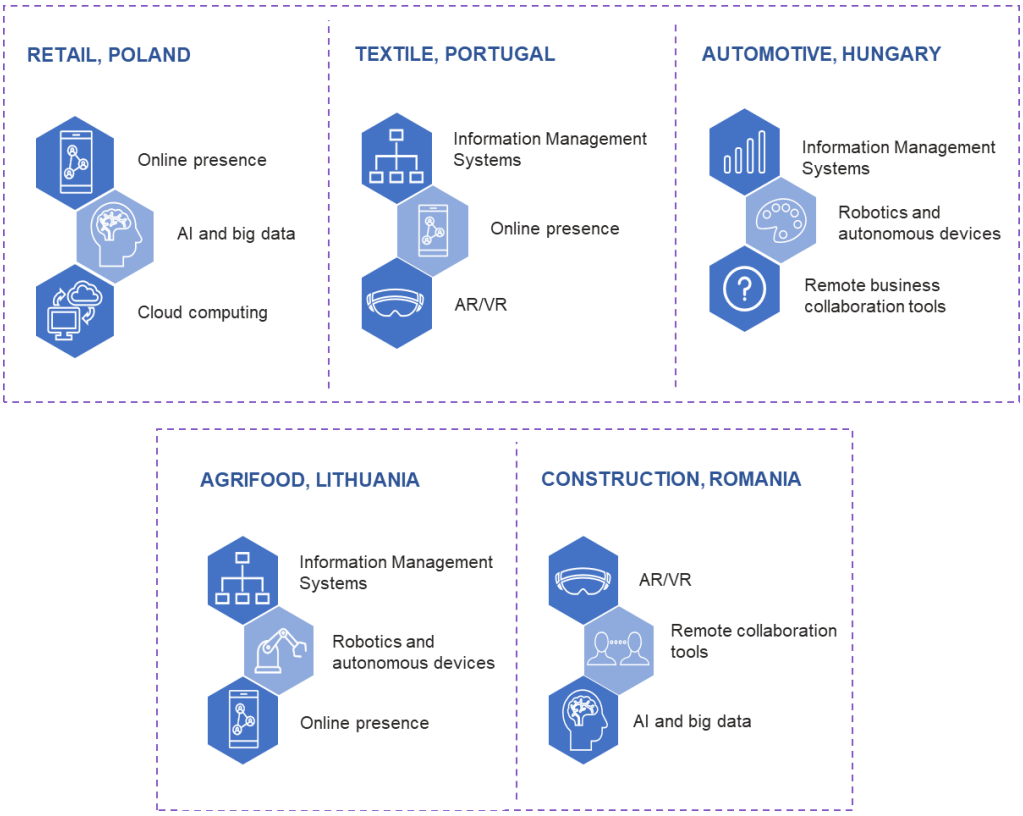
The first component identified by the research team concerns the selection of an appropriate solution to implement. The owners of small companies benefit from an in-depth understanding of their own operations and the problems their businesses face.[319] This means that, on the one hand, the analysis of requirements and technology implementation can be carried out efficiently. On the other hand, navigating the wide range of available solutions on the market may be challenging, due to the resource and time constraints often faced by

[319] Mandviwalla, M., & Flanagan, R. (2021). Small business digital transformation in the context of the pandemic. *European Journal of Information Systems*, 30(4), 359-375.

SMEs.[320,321] Particular attention in this section is given to the identification of low-cost solutions that fit the needs of SMEs.

The relevance of a particular digital technology is highly dependent on the company and sector.[322] Respondents to the Company Digitalisation survey prioritised different technologies depending on their country-industry pairing (see Figure 13). The highest-ranked technologies include a mix of basic (e.g. online presence, remote business collaboration tools) and advanced technologies (e.g. AR/VR, AI and big data). Analysis of the case studies shows that it is important for companies to choose technologies based on their needs and industry trends. However, as already described in Component 6.1 in Section 2.7.1, for many companies the digitalisation process often starts with basic technology building blocks such as information systems, communication tools, document management and websites.[323,324] As companies mature digitally, they typically transition to adopting more advanced technologies.

Figure 13. Company Digitalisation Survey: top three technologies required to remain competitive, by country-industry pairing, 2022



Source: results of the Company Digitalisation survey conducted by PPMI, Q10: Which of the below technologies are currently not present in your company but would be necessary to adopt in the next 2 years for your company to remain competitive? N=350

[320] European Commission, Executive Agency for Small and Medium-sized Enterprises (2019). Digital organisational frameworks and IT professionalism, Publications Office. Available at: https://data.europa.eu/doi/10.2826/335797.

[321] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[322] European Commission, Executive Agency for Small and Medium-sized Enterprises (2019). Digital organisational frameworks and IT professionalism, Publications Office. Available at: https://data.europa.eu/doi/10.2826/335797.

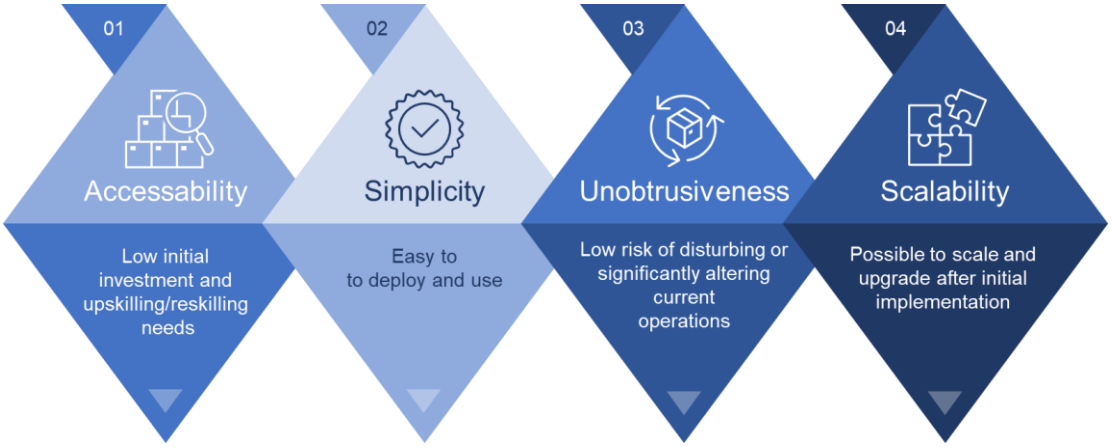
[323] Kääriäinen, J., Pussinen, P., Saari, L., Kuusisto, O., Saarela, M., & Hänninen, K. (2021). Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization. *International journal of Information Systems and Project Management*, 8(4), 24-43.

[324] EY-Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

(retail – N67, textile – N=75, construction – N=80, automotive – N=77, agrifood – N=51). Respondents could choose more than one option.

To be aligned with SMEs' needs, solutions must be accessible, simple, unobtrusive and scalable (see Figure 14). First, as previously discussed in this report, SMEs are prone to being resource-constrained. Therefore, when the adoption of a new technology does not require a large initial investment or staff upskilling or reskilling, this can reduce hesitation and the perceived risk associated with an initiative.[325, 326] Second, the simplicity of a solution contributes to faster implementation. This in turn means that decision-makers can observe the value added by the new technology sooner, thus increasing confidence in the overall digitalisation process.[327] Third, SMEs often prefer solutions that have a low risk of disturbing their current operations, due to the high cost of downtime.[328] Lastly, scalability helps SMEs to reduce the initial costs of technology adoption and increase buy-in before moving on to company-wide implementation.[329,330,331]

Figure 14. Requirements for solutions to be aligned with SME needs



Source: developed by the research team on the basis of Vuković, M., Jorg, O., Hosseinifard, M., & Fantoni, G. (2022); Terrazas Angulo, G., Hawkridge, G., McNally, M., McFarlane, D., Ling, Z., & Lau, J. (2022); Veile, J.W., Kiel, D., Müller, J.M.,& Voigt, K.I. (2019); and Schönfuß, B., McFarlane, D., Athanassopoulou, N., Salter, L., Silva, L.D., & Ratchev, S. (2019).

However, many commercially available solutions fail to meet the needs of SMEs because they may lead to vendor lock-in, or are over-engineered or expensive.[332] **Consequently, focusing on simple and low-cost technologies can make digitalisation more accessible to**

[325] Vuković, M., Jorg, O., Hosseinifard, M., & Fantoni, G. (2022). Low-Cost Digitalization Solution through Scalable IIoT Prototypes. *Applied Sciences*, 12(17), 8571.

[326] Terrazas Angulo, G., Hawkridge, G., McNally, M., McFarlane, D., Ling, Z., & Lau, J. (2022). Hackathons to Accelerate the Development of Low-Cost Digital Solutions.

[327] Vuković, M., Jorg, O., Hosseinifard, M., & Fantoni, G. (2022). Low-Cost Digitalization Solution through Scalable IIoT Prototypes. *Applied Sciences*, 12(17), 8571.

[328] Schönfuß, B., McFarlane, D., Athanassopoulou, N., Salter, L., Silva, L. D., & Ratchev, S. (2019). Prioritising low cost digital solutions required by manufacturing SMEs: a shoestring approach. In International Workshop on Service Orientation in Holonic and Multi-Agent Manufacturing (pp. 290-300). Springer, Cham.

[329] Vuković, M., Jorg, O., Hosseinifard, M., & Fantoni, G. (2022). Low-Cost Digitalization Solution through Scalable IIoT Prototypes. *Applied Sciences*, 12(17), 8571.

[330] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[331] Müller, J.M. (2022). Presentation 'Good and best practices – making the concept reflect reality' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of the study.

[332] Terrazas Angulo, G., Hawkridge, G., McNally, M., McFarlane, D., Ling, Z., & Lau, J. (2022). Hackathons to Accelerate the Development of Low-Cost Digital Solutions.

SMEs.[333] These simple digital solutions can meet the needs of SMEs without significant upfront investment. It is worth noting that what is considered 'low-cost' will be highly dependent on a company's particular characteristics, including its size.[334]

Several ways exist to simplify and reduce the cost of digitalisation. Low-cost solutions can include non-industrial, off-the-shelf and open-source technologies and platforms.[335,336,337,338] Non-industrial solutions are low-cost devices or software that have been developed for non-industrial applications (i.e. the consumer market), but which can also be used in an industrial setting. Examples include sensors, Wi-Fi cameras and game controllers.[339] Similarly, retrofitting old machines instead of purchasing new solutions can be a cost-effective option for manufacturers.[340,341] Furthermore, companies can use the digital capabilities of trainees, apprentices and students by involving them in the process of developing a solution .[342,343] Furthermore, SMEs can cooperate with the wider ecosystem to share the costs of digital tools, infrastructure, maintenance and support (see Principle 7, Section 2.8).[344] The use of simple and low-cost solutions can be an initial step towards implementing more complex technologies later on.[345]

Five examples from case studies of companies that have implemented low-cost solutions are described below.

Table 16. Low-cost solutions: examples from the case studies

Industry	No.	Case study name	Low-cost solution deployed
Retail	CS 2	Henry Partners in Poland – Order processing automation	The company was looking to integrate all the retail platforms it uses: its own web shops along with Allegro, eBay and Amazon, as well as drop-shipping providers. The company did not wish to use custom software, and decided that every tool should be from the **commercial, off-the-shelf class**. After assessing the **e-commerce**

[333] Müller, J.M. (2022). Presentation 'Good and best practices – making the concept reflect reality' during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[334] Hawkridge, G., Mukherjee, A., McFarlane, D., Tlegenov, Y., Parlikad, A.K., Reyner, N.J., & Thorne, A. (2021). Monitoring on a shoestring: Low cost solutions for digital manufacturing. *Annual Reviews in Control*, 51, 374-391.

[335] McFarlane, D., Ratchev, S., de Silva, L., Hawkridge, G., Schönfuβ, B., & Angulo, G.T. (2022). Digitalisation for SME Manufacturers: A Framework and a Low-Cost Approach. *IFAC-PapersOnLine*, 55(2), 414-419. Available at: https://doi.org/10.1016/j.ifacol.2022.04.229.

[336] Terrazas Angulo, G., Hawkridge, G., McNally, M., McFarlane, D., Ling, Z., & Lau, J. (2022). Hackathons to Accelerate the Development of Low-Cost Digital Solutions.

[337] McFarlane, D., Ratchev, S., Thorne, A., Parlikad, A.K., Silva, L. D., Schönfuß, B., ... & Tlegenov, Y. (2019). Digital manufacturing on a shoestring: Low cost digital solutions for SMEs. In: International Workshop on Service Orientation in Holonic and Multi-Agent Manufacturing (pp. 40-51). Springer, Cham.

[338] OECD (2021). SME digitalisation to "Build Back Better": Digital for SMEs (D4SME) policy paper. OECD SME and Entrepreneurship Papers, No. 31, OECD Publishing, Paris. Available at: https://doi.org/10.1787/50193089-en.

[339] McFarlane, D., Ratchev, S., de Silva, L., Hawkridge, G., Schönfuβ, B., & Angulo, G. T. (2022). Digitalisation for SME Manufacturers: A Framework and a Low-Cost Approach. IFAC-PapersOnLine, 55(2), 414-419.

[340] Ilari, S., Carlo, F. D., Ciarapica, F. E., & Bevilacqua, M. (2021). Machine Tool Transition from Industry 3.0 to 4.0: A Comparison between Old Machine Retrofitting and the Purchase of New Machines from a Triple Bottom Line Perspective. Sustainability, 13(18), 10441.

[341] Müller J. M. (2022). Presentation 'Good and best practices – making the concept reflect reality' during the 'Workshop on SME digitalisation: how to make best practice a reality' organised on 10 November 2022 as part of the study.

[342] Ibid.

[343] McFarlane, D., Ratchev, S., de Silva, L., Hawkridge, G., Schönfuβ, B., & Angulo, G. T. (2022). Digitalisation for SME Manufacturers: A Framework and a Low-Cost Approach. IFAC-PapersOnLine, 55(2), 414-419. Available at: https://doi.org/10.1016/j.ifacol.2022.04.229.

[344] Müller J. M. (2022). Presentation 'Good and best practices – making the concept reflect reality' during the 'Workshop on SME digitalisation: how to make best practice a reality' organised on 10 November 2022 as part of the study.

[345] Ibid.

Industry	No.	Case study name	Low-cost solution deployed
			platforms already in use, the company selected the Prestashop platform as its main central system.
Automotive	CS 10	Matro Gépgyártó Kft. in Hungary – Adoption of an ERP system in the administrative area, and of robotics in the production area	Following the implementation of an ERP system, the company is planning to improve its data collection by installing **terminals on 50 existing machines**.[346] The terminals will help to ensure fast, accurate and authentic data on the production process. The development process will include integration with the ERP system.
Automotive	CS 12	Lagermax in Austria and Eastern Europe – Adoption of AR goggles to guide workers	Existing solutions for augmented reality (AR) goggles on the market were 'over-engineered' and too expensive for the company to implement. Instead, the company chose to implement a '**downgraded' solution co-developed with students and** purchase a **non-industrial older model** of goggles that would be cheaper and easier to wear.
Textile	CS 18	Fonte & Faria Confeções in Portugal – Tablets for data collection	This SME introduced an **off-the-shelf** manufacturing execution system. The company selected this solution because it did not require a large upfront investment or complex changes t its existing IT infrastructure. While the chosen system is **not state-of-the-art** (data entry remains manual and not 'real-time'), it has reduced delays in data collection significantly while being relatively cheap and easy to use via smartphones and tablets.
Textile	CS 25	OVF Studio in the United Kingdom – Pattern engineering for clothes	The company first explored commercial solutions for 3D body-scanning technologies (SizeSTream, Lectra Modaris), but such processes took approximately six months, three people, and cost GBP 10,000. Instead, the company adopted an **open-source** 2D pattern creation software application, Seamly2D. In addition to being a no-cost option, the software has a vibrant support community that enables new users to develop their software skills. Moreover, a solution based on 2D pattern creation is easier to utilise compared with 3D, alternatives. The company considered this a plus given its lack of pattern engineering or apparel product development knowledge. The company saved approximately GBP 7,000 by choosing open-source software over other commercial alternatives.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

Choosing an appropriate digital solution to achieve a company's objectives is a complex process. Conclusions from the Best Practice workshop and case study analysis suggest that this is one of the main challenges faced by companies when implementing digital technologies.[347] This is unsurprising, given that many of the companies consulted have experienced resource and time constraints, possessed only limited knowledge of digitalisation opportunities, and had to navigate information asymmetries.

[346] This intervention has not been implemented yet but is planned as one of the experiments conducted during this study.

[347] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

However, companies can make use of external expertise to define an approach for the implementation of digital technologies. Examples from the case studies include companies using suggestions from members of their value chain, their clients, or external contractors. The European DIGITAL SME Alliance states that to enable sustainable and long-term digital transformation, it is important for SMEs to build on their B2B relationships and participate in the wider ecosystem.[348,349] This is expanded upon in Principle 7 (see Section 2.8). Further descriptions of the company examples from the case studies are available in Table 17 below.

Table 17. Choosing a solution: examples from the case studies

Industry	Description
CS 1	**Unikalne Kosmetyki/YEYE Natural in Poland – Integrating e-commerce channels**
Retail	Unikalne Kosmetyki/YEYE Natural is a company operating in the cosmetics retail segment. The company also produces its own self-care home SPA products. Recently the company took steps to integrate its business-to-consumer (B2C) and B2B sales channels. According to company representatives, **choosing the right technological solution was challenging,** due to a lack of objective information comparing the various potential solutions. To address this, the company **hired an external contractor** to select and implement the solution. As a result, the company chose to implement Baselinker to integrate its various sales channels.
CS 2	**Henry Partners in Poland – Order processing automation**
Retail	Henry Partners is a company that operates four e-commerce shops selling various products, from sporting goods to health and safety products and cosmetics accessories. Before automating its store order processing, the company **analysed several possible e-commerce platforms**. According to the owner, it was very useful to analyse several well-documented e-commerce tools before choosing which solution to implement.
CS 17	**Confetil in Portugal – 3D design encouraged by clients**
Textile	Confetil, a textile industry company from Portugal, began using 3D CAD software for garment design **after a request from a major customer**. The software helps to support digital interaction between both parties by making the sampling phase fully digital. This allows different parties to work collaboratively with virtual 3D simulations in real time. Since the first customer request, several other customers have requested the same approach, confirming that the chosen solution is in line with the expectations of other companies operating in the value chain.
CS 35	**BUGARU TRANSSRL in Romania – Adopting collaborative technologies**
Construction	Bugaru Trans, a construction company from Romania, implemented a platform via which topographic and building measurements and coordinates can be transmitted. The company chose to do this after they **saw that their clients had implemented similar technologies**. As a result, every employee and client now has an account on the Bugaru Group platform, which aids collaboration between construction sites and offices.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

[348] OECD (2021). SME digitalisation to "Build Back Better": Digital for SMEs (D4SME) policy paper. OECD SME and Entrepreneurship Papers, No. 31, OECD Publishing, Paris. Available at: https://doi.org/10.1787/50193089-en.

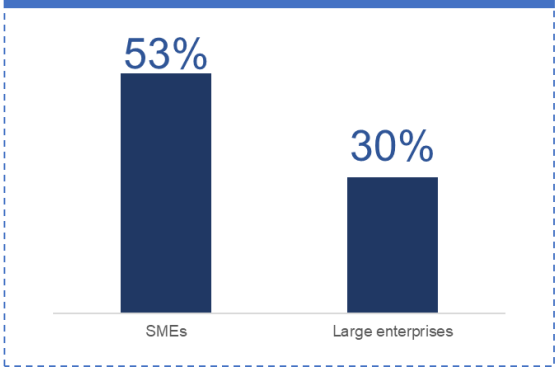
[349] European DIGITAL SME Alliance (2020). Sustainable Digitalisation: Strengthening Europe's Digital Sovereignty. Available at: https://www.digitalsme.eu/digital/uploads/Position-paper-SustainableDigital-Transformation_FINAL.pdf.

2.9.2. Component 8.2: Ensuring effective interaction with solution providers

This section describes the second component of Principle 8, which concerns interaction with solution providers. Technology providers play an important role in facilitating technology adoption, especially when companies themselves lack the knowledge and human resources to develop solutions internally.[350] Therefore, effective interaction between technology providers and companies is important for ensuring successful digitalisation.

For many companies, outsourcing is necessary in order to implement new digital technologies. For example, in 2018, more than half of European companies mainly outsourced their ICT functions[351] to external providers. The proportion was higher among SMEs (53%) than among large companies (30%).[352] Therefore, it is important for companies to effectively manage complex relationships with external providers.[353] At the same time, relying solely on third-party providers can also lead to dependence on suppliers, which can increase cost, reduce flexibility and limit the availability of technology options for further digitalisation projects.[354,355] More information on assessing the costs of outsourcing is available in Component 5.1 (see Section 2.6.1).

Companies where ICT functions are mainly performed by external providers, by company size, 2018, EU



Selecting a vendor is the first step in outsourcing**.** Because service providers are usually selected for the long-term, it is especially important for companies to analyse their needs beforehand, as well as the comprehensiveness and compatibility of the solutions offered.[356] **Several case studies, as well as the participants in the Best Practices workshop, emphasised the difficulty of choosing a suitable vendor as one of the main challenges encountered during digitalisation**.[357] Choosing from the wide range of providers available is often a complex process.[358] Furthermore, vendors often present technology-centric information, which is not always suitable for the needs of the company, especially for SMEs.[359]

[350] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[351] Functions include: maintenance of ICT infrastructures, support for office software, development and support for web solutions or business management software/systems (e.g. ERP, CRM, HR, databases), security and data protection.

[352] Eurostat, Table isoc_ci_eu_en2: Computers and the internet: enterprises – summary of EU aggregates (NACE Rev. 2 activity).

[353] Dibbern, J., & Hirschheim, R. (2020). Introduction: Riding the Waves of Outsourcing Change in the Era of Digital Transformation. In: Hirschheim, R., Heinzl, A., Dibbern, J. (eds.), Information Systems Outsourcing. Progress in IS. Springer, Cham. Available at: https://doi.org/10.1007/978-3-030-45819-5_1.

[354] OECD (2021). SME digitalisation to "Build Back Better": Digital for SMEs (D4SME) policy paper. OECD SME and Entrepreneurship Papers, No. 31, OECD Publishing, Paris. Available at: https://doi.org/10.1787/50193089-en.

[355] European DIGITAL SME Alliance (2020). Sustainable Digitalisation: Strengthening Europe's Digital Sovereignty. Available at: https://www.digitalsme.eu/digital/uploads/Position-paper-SustainableDigital-Transformation_FINAL.pdf.

[356] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[357] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[358] Mandviwalla, M., & Flanagan, R. (2021). Small business digital transformation in the context of the pandemic. *European Journal of Information Systems*, 30(4), 359-375.

[359] Conclusions from the panel discussion and interactive session during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

For business decision-making the most important factor is usually the business need that a technology can solve.[360]

To choose a technology provider, companies considered factors such as cost, delivery capacity, relevance to business needs, and the complexity of implementation. Furthermore, companies can use trade fairs and public sector support to help them identify suitable vendors.[361] The EDIH/DIH network can play an important role as matchmakers between solution providers and companies planning to digitalise.[362]

Some companies went a step beyond simply selecting a provider, and chose to build mutually beneficial partnerships. For example, HATA from Portugal chose to collaborate with a start-up that was developing an innovative solution for fabric quality inspection. The partnership added value for both parties – HATA was the first company to implement this innovative solution, and the start-up had access to an industrial setting in which to test its technology. Partnerships are described in more detail in Principle 7 (see Section 2.8).

Even after a solution provider is selected, companies often face issues when interacting with them. The Problem Identification report highlighted several challenges that can arise when outsourcing digital solutions. These include unforeseen cost increases, delays, and difficulties in keeping up with expectations and delivery plans due to the human resource and time constraints faced by SMEs.[363] Moreover, insufficient in-house capabilities to manage vendors is one of the most significant challenges faced by companies that choose to outsource.[364]

The successful adoption of digital technologies requires effective interaction between companies and vendors. A study on ERP and CRM implementation in Poland found that good communication between vendors and SMEs, as well as the skills and experience of the technology provider, were relevant success factors for the implementation of digital technologies.[365] Furthermore, taking advantage of the vendor's expertise can help to address challenges related to a lack of IT knowledge internally.[366]

The case studies demonstrate various models of interaction between companies and vendors. These range from relatively hands-off approaches to close and mutually beneficial partnerships. The choice of which model of interaction is optimal will depend on the complexity of the digital initiative concerned. For simple digital technologies, extensive technical support may not be required, or may be obtained through user communities. **For complex projects, successful digitalisation requires a dedicated team from both the company and the vendor side, which coordinates closely to implement the solution**.[367] Such a situation is illustrated by the company examples of LEVIATAN, Aqualand Limited and HATA, presented in the table below.

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[360] Schönfuß, B., McFarlane, D., Hawkridge, G., Salter, L., Athanassopoulou, N., & De Silva, L. (2021). A catalogue of digital solution areas for prioritising the needs of manufacturing SMEs. *Computers in Industry*, 133, 103532.

[361] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

[362] Ibid.

[363] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project. Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[364] McKinsey (2022). Getting business process outsourcing right in a digital future. Available at: https://www.mckinsey.com/capabilities/operations/our-insights/getting-business-process-outsourcing-right-in-a-digital-future.

[365] Cieciora, M., Bołkunow, W., Pietrzak, P., Gago, P., & Rzeźnik-Knotek, M. (2020). Critical success factors of ERP/CRM implementation in SMEs in Poland: pilot study. Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska.

[366] Ghobakhloo, M., Hong, T.S., Sabouri, M.S., & Zulkifli, N. (2012). Strategies for successful information technology adoption in small and medium-sized enterprises. *Information*, 3(1), 36-67.

[367] McKinsey (2022). Getting business process outsourcing right in a digital future. Available at: https://www.mckinsey.com/capabilities/operations/our-insights/getting-business-process-outsourcing-right-in-a-digital-future.

Table 18. Interacting with solution providers: examples from case studies

Industry	Description
CS 2	**Henry Partners in Poland – Order processing automation**
Retail	Henry Partners is a company that operates four e-commerce shops selling various products, from sporting goods to health and safety products and cosmetics accessories. The company automated its store order processing to increase efficiency. Its first step was the mapping of the digitalisation process. For this, it was important that **no custom software development would be involved, and that every tool should come from the commercial, off-the-shelf class**. The tools also had to be sufficiently easy to understand **for the owner to configure and control**. Such a strategy yielded less dependence on software development companies. In the end, the company selected Prestashop as its main central system.
CS 3	**Novia Blanca in Poland – Auditing and dividing stock**
Retail	Novia Blanca is one of the biggest retailers of wedding jewellery in Poland. The company wanted to separate its warehouse operation from its physical retailing. According to the company, evaluating different options and selecting the right solution that could carry out all sales processing activities was a challenge. After two months of thorough research and the analysis of potential collaboration schemes, an **external provider was chosen**. The company then launched and implemented a pilot. However, the stock splitting resulted in a reverse effect and increased the company's operational overheads. This strategy was therefore abandoned, and the company returned to its previous operating model. Even though the pilot did not achieve the desired goal, a lesson learned from this process is the importance of a **thorough evaluation of suppliers and their solutions** and **how they fit a company's business needs**.
CS 7	**Saasil in Germany – Multichannel sales**
Retail	Saasil is a retail shop that sells lamps for living spaces, as well as object lighting and equipment, and home accessories. To accelerate the selling process, Saasil implemented several digital solutions, including an ERP system, the Afterbuy solution and a digital catalogue of products. The company stated that an important lesson learned in this process was that it is **important to have several sales channels, instead of overly relying on e-retailers** such as eBay and Amazon.
CS 10	**Matro Gépgyártó Kft. in Hungary – Adoption of an ERP system in the are of administration, and of robotics in the area of production**
Automotive	Matro Gépgyártó Kft. is mainly involved with the production of components for engine management systems, spare parts for the brake systems of trucks, and car body parts. The company adopted technological innovations in two areas. In the area of administration, the introduction of an ERP system helped to increase the accuracy and speed with which such work was carried out. With regard to production processes, the company implemented a robotic solution. The company highlighted the difficulties it faced when trying to **find the right supplier for customised software**. Because Matro needed to develop the solution within a strict deadline, it paid particular attention to the suppliers' delivery capacity. The company also broadened its network to find the right partner.
CS 16	**HATA in Portugal – Successfully testing fabric quality control**
Textile	Knitting circular sustainable fabrics since 2016, HATA is a young company committed to being part of a new and evolved global textile and manufacturing supply chain. The company introduced a quality inspection system to check fabrics using the aid of computer vision. To achieve this, it **cooperated with a start-up called Smartex,** which focuses on advanced solutions for quality inspection using computer vision and AI. As a result, Smartex launched

Industry	Description
	its pilot at HATA's industrial facilities. After testing and fine-tuning, the solution was fully developed and ready to be replicated. While it is common for SMEs within this industry only to adopt mature technologies and to work with well-established external providers, HATA used this opportunity to experiment. It became a pioneering company, using an emerging technology and even tailoring it to its own needs, gaining valuable knowledge and competitive advantage.
CS 24	**Aqualand Limited in the United Kingdom – Stitching technology for drysuits**
Textile	Aqualand Ltd designs and makes customised made-to-measure drysuits for scuba diving under the brand Seaskin. It also acts as a supplier to other brands, and makes OEM drysuits, dry-bags and accessories for water-based first responders, the military and other scuba diving brands. The company introduced a stitching technology that provides accurate, made-to-measure, and repeatable outputs. The pattern software, cutter and cutter control software were all provided by a third company, Assyst Bulmer, and allow the cost-effective and accurate cutting of individually sized patterns. The company cites **support from the provider's technical** team as being paramount in adopting the new technology, highlighting the **importance of outsourcing operations for which the company lacks know-how**.
CS 34	**Van Den Borne Aardappelen in the Netherlands – Smart farming[368]**
Agrifood	Van Den Borne Aardappelen is a family farm, consisting of roughly 550 hectares of land, devoted primarily to potato crops, as well as maize, wheat and sugar beet. The company adopted precision farming technologies to improve the efficiency and quality of its crop yields. The main challenge highlighted in this case study concerned the **significant investment in time and money to research the technologies available for smart farming**, and to test use-cases. The company **collaborated with the broader eco-system** to keep up to date with new technologies and identify their future potential.
CS 36.1	**LEVIATAN in Romania – 1st and 2nd phases of continuous digitalisation**
Construction	LEVIATAN SRL, a Romanian SME operating in the construction sector, provides integrated architecture and civil engineering services. In its digitalisation process, LEVIATAN **collaborated with other companies**: • BIM software resellers from Romania – to develop specific adjacent software packages, and to become beta testers for them. • Sixense Romania – to develop a building monitoring solution. As a result of these collaborations, LEVIATAN decided to establish a new IT company as part of its group, dedicated to the sole purpose of developing digital infrastructure and solutions for its architecture sister company.

Source: compiled by the research team on the basis of interviews and desk research. For a full list and descriptions of company examples, see Annex 2.

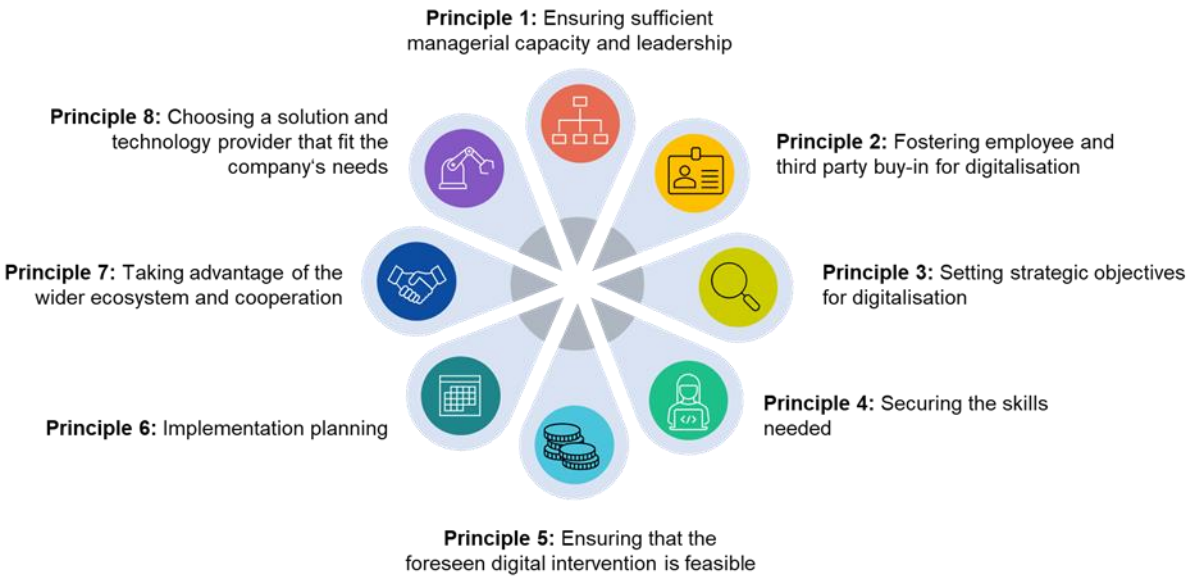
[368] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

3. Conclusions

The sharing of best practices can be a powerful tool to facilitate digitalisation. Best practices help companies fill knowledge gaps and reduce risk aversion when it comes to implementing digital technologies. However, most research on 'digitalisation best practices' tends to focus on the adoption of advanced technologies and innovative solutions. Yet, the needs of SMEs and companies with average or below-average digital maturity are often better addressed through the implementation of low-cost options and relatively simple technologies, rather than advanced solutions.

Consequently, our research contributes to the existing literature by outlining eight best practice principles to help companies successfully digitalise regardless of their size, industry or digital maturity. These principles are the result of an extensive research exercise drawing evidence from 42 case studies of companies that have implemented digital technologies. The best practice principles identified are summarised in the figure below.

Figure 15. Best practice principles included in this report



Source: compiled by the research team.

In each of the best practice principles, we highlight several differences between the ways in which SMEs and large enterprises adopt new technologies. SMEs face both unique barriers and advantages when it comes to digitalisation. On the one hand, SMEs are more likely than large companies to be constrained in terms of time or resources. On the other hand, they tend to be resilient organisations with significant capacity to adapt to changing environments. SMEs are also less likely to have formalised and documented processes in place. This in turn influences how SMEs manage, plan and implement digitalisation initiatives, as described below.

First, SMEs tend to be characterised by proximity between management and employees, as well as adaptability. Consequently, SMEs can implement organisational and cultural changes and secure stakeholder buy-in effectively, due to flexible and efficient decision-making. Management support and capacity play a pivotal role in determining whether or not digitalisation is successful. Evidence from the case studies shows that companies whose leaders are open to change, actively look for opportunities and foster a culture of innovation

are more likely to digitalise than those in which the leadership is resistant towards the adoption of new technologies.

Second, many SMEs tend to digitalise reactively and focus on short-term tactical benefits rather than developing a long-term strategic approach. While this lends SMEs flexibility, it can also contribute to underestimating the long-term costs and benefits of technology adoption. Meanwhile, setting long-term objectives for digitalisation can help companies to persevere despite setbacks, to secure funding and foster stakeholder buy-in, and thus successfully implement digital technologies. The need for detailed digitalisation strategies and plans increases with company size and with the complexity of digitalisation initiatives.

Third, evidence suggests that SMEs and companies that are not digitally mature can benefit from starting their digitalisation journeys with small projects and relatively simple technologies. Such ‘quick win’ projects reduce initial costs and human resource needs, increase stakeholder confidence in the digitalisation process, and are less likely to disturb business operations. The experience gained from implementing these digitalisation initiatives then allows companies to move to larger digital transformations and/or implement more advanced technologies.

Lastly, building B2B relationships and participating in the wider ecosystem is an enabler for sustainable and long-term SME digitalisation. Collaboration with the wider ecosystem can help SMEs to address their resource constraints. For example, companies can cooperate across the value chain to share the costs of digital tools, infrastructure, maintenance and support. Similarly, they can collaborate with various stakeholders (public sector organisations, academia, technology extension programmes) to access expertise, funding and testing facilities.

In conclusion, this report sheds light on best practice principles that can help companies, including SMEs and those with average or below-average digital maturity, to reap the benefits of digitalisation. Even though these principles have been developed with smaller and less digitally mature players in mind, they are relevant for all companies embarking on digitalisation journeys, regardless of their size, industry, digital maturity or the technology being implemented. Each principle also includes examples from the case studies, showing how companies have implemented the suggested behaviours in their day-to-day operations.

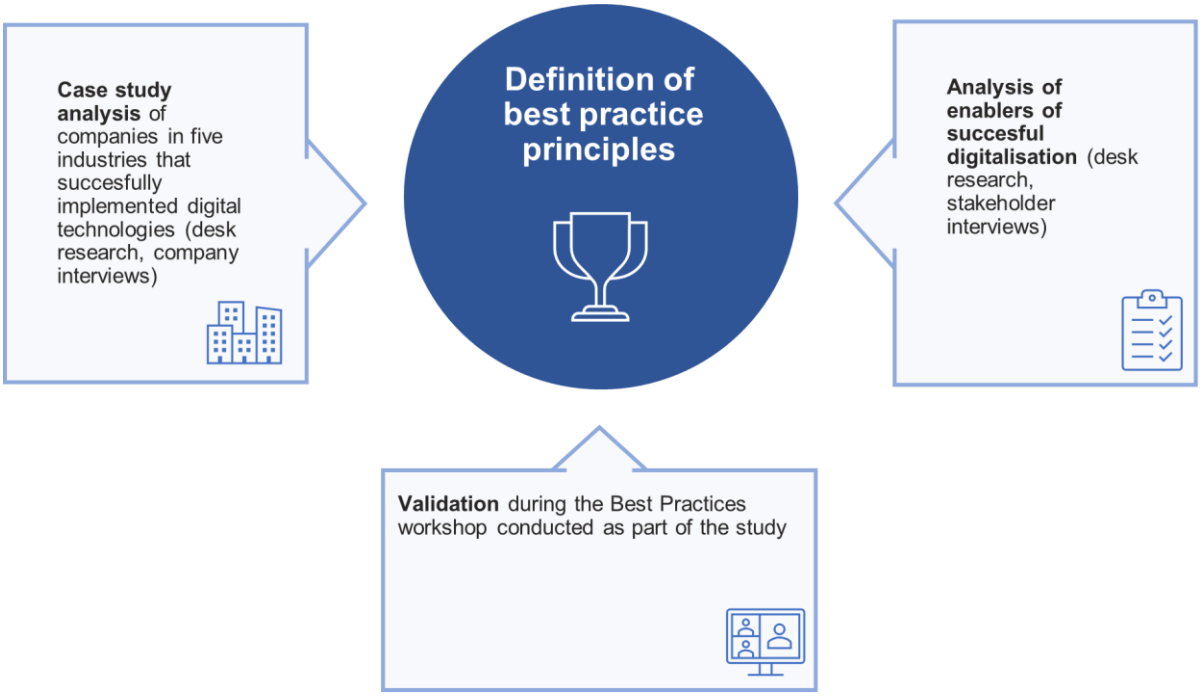
The best practice principles described in this report will be further complemented by findings from five company digitalisation experiments. At the end of this study, the results of the best practice identification will serve as a key input into the development of digitalisation toolboxes in five industries – agrifood, automotive, construction, retail and textiles. These toolboxes will aim to offer targeted, evidence-based advice to policy makers, EDIHs/DIHs and companies on fostering industry digitalisation.

Annex 1: Methodology

This section describes the methodology used in the preparation of this report. This section includes a summary of the overall methodology, a description of the case study analysis, the analysis of enablers of successful digitalisation and the definition and validation of best practice principles.

To arrive at a set of best practice principles, the research team analysed case studies of companies that successfully implemented digital technologies in five industries and enablers of successful SME digitalisation based on desk research of academic and grey literature. A preliminary set of best practice principles was then derived from a synthesis of conclusions from this analysis. Best practice principles were further validated in a Best Practices workshop conducted as part of this study. Each step is presented in Figure 16 and further elaborated upon in the sections below.

Figure 16. Summary of the methodology for best practice principles definition



Source: compiled by the research team.

The report focuses on the digitalisation of SMEs and less digitally mature companies. This has influenced the methodology used for the preparation of this report:

- The case studies selected for analysis include companies with various digital maturity levels and from all size classes, with the majority of them being SMEs.
- Analysis of enablers of successful digitalisation put particular emphasis on identifying enablers that are relevant for SMEs.

Consequently, the best practices principles included in this report should be interpreted as relevant to companies regardless of company-size and digital maturity level.

Case study analysis

Case study collection was performed taking into consideration several criteria:

- Relevance to industry-level gaps[369] and company-level problems identified during preceding phases of this study.[370]
- Representation of companies of different size classes and digital maturity levels.
- Regional and industry[371] balance.
- Company willingness to participate in interviews and/or availability of information from public sources.

Information collection on case studies was led by five DIHs and other experts specialising in the industries included in the study. The DIHs involved in the study are Agrifood Lithuania DIH,[372] representing the agrifood industry; Innomine[373] in Hungary, which represents the automotive industry; Iceberg+[374] in Romania, leading research on the construction industry; DIH4.ai[375] in Poland, providing insights on retail; and CITEVE[376] in Portugal, which focuses on the textile industry. The additional industry experts involved in the study are Katrin Schade, University of Leipzig; Julian Müller, Kufstein University of Applied Sciences; Steven Hayes, University of Manchester; Hugo Rodrigues, University of Aveiro.

The data collection methods used (interviews and desk research) for the study are further elaborated upon below.

Table 19. Data collection methods: case studies

	Interviews	Desk research
Approach	To identify and collect information on case studies, semi-structured interviews with industrial companies were conducted. Each interview covered the following topics: • characteristics of the company; • impact of the COVID-19 pandemic on the company; • digitalisation gaps; • obstacles to digitalisation; • participation in EU and national programmes supporting digitalisation; • adopted technologies (challenges, implementation steps, success factors, impact, lessons learned).	To identify case studies through desk research, the team used keywords such as 'success stories', 'best practices', 'good practices', 'examples' and 'case studies' coupled with words like 'digitalisation', 'Industry 4.0', 'digital transformation', 'digital technologies' and 'innovations'. In some cases, there was a need to use more specific terms related to digital solutions relevant for the five industries (e.g. AI, robotics, AR/VR, IoT, 3D scanning). Some of the companies were initially identified by exploring the agendas of various forums and conferences on industrial digital transformation. Sources identified included

[369] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Gap Analysis report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-gap-analysis-report-now-published.

[370] PPMI (2022). Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project: Problem Identification report. European Commission. Available at: https://ppmi.lt/news-insights/european-industry-digitalisation-problem-identification-report-now-live.

[371] In the industries in the scope of this study: agrifood, automotive, construction, retail, and textile.

[372] More information available at: https://agrifood.lt/.

[373] More information available at: https://innomine.com/.

[374] More information available at: https://www.iceberg.ro/en/digital-innovation-hub/.

[375] More information available at: https://dih4.ai/en.

[376] More information available at: https://www.citeve.pt/.

	Interviews	Desk research
	Interviews were conducted following a common interview guide and data collection template developed by the research team.	articles, blog entries, online workshops and webpages of the companies and solution providers themselves as well as industry-specific associations and media. Information was collected following a common data collection template developed by the research team.
Information collected	• Description of the company • Motivation to adopt digital technologies • Description of the technology adopted, and key steps taken • Challenges encountered • Lessons learned	

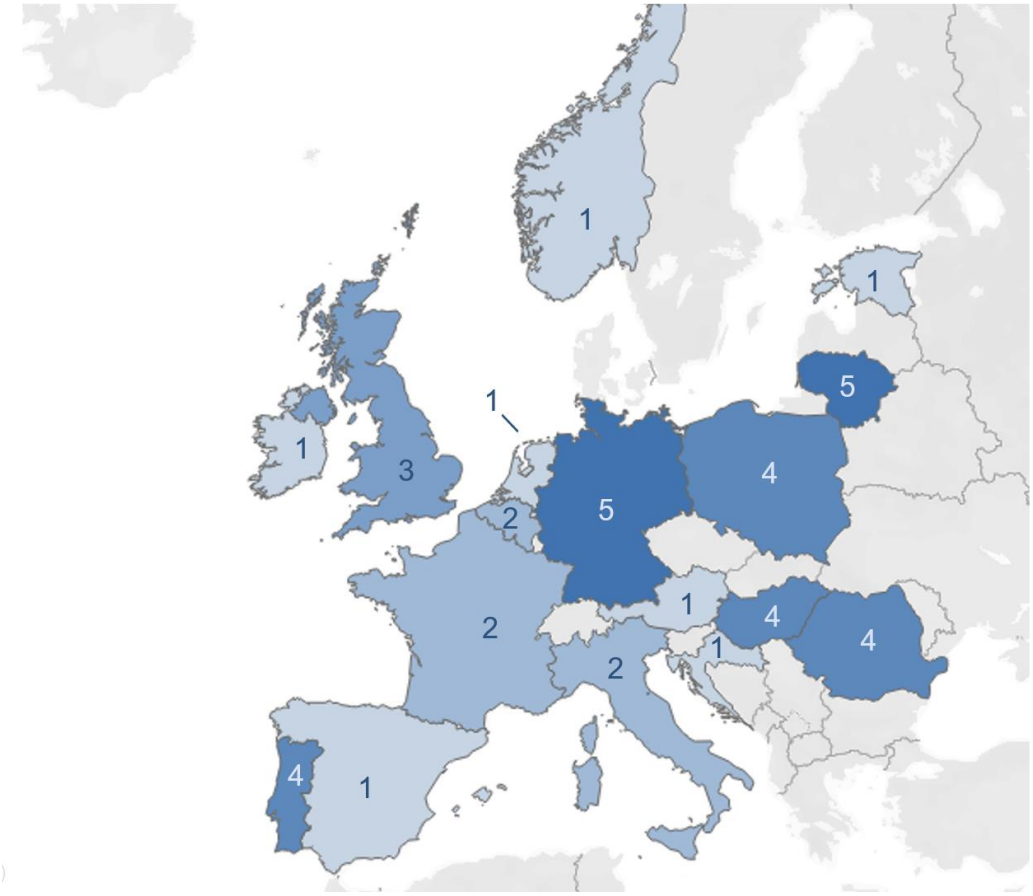
Source: compiled by the research team.

After the data collection phase, a common case study repository was created, containing descriptions of case studies identified in all five industries. The total number of case studies identified was 66. After analysing their relevance for the study, a final set of 42 case studies were selected for inclusion in this report:

- 8 in the agrifood industry:
- 8 in the automotive industry;
- 8 in the construction industry;
- 7 in the retail industry;
- 11 in the textile industry.

The geographical distribution of the selected case studies is available in the Figure 17 below. A full list of case studies is included in Annex 2.

Figure 17. Distribution of countries covered by the case studies in the analysis



Source: compiled by the research team.

Analysis of enablers of successful digitalisation

Enablers of successful company digitalisation were identified through analysis of conclusions from stakeholder interviews and desk research of relevant sources:

- Semi-structured interviews were conducted with industrial companies, public sector organisations, industry associations and academia. Interviews were conducted following a common interview guide developed by the research team, covering several topics, including obstacles to and factors facilitating industry digitalisation.
- Desk research was conducted using search terms, such as 'determinants', 'enablers', 'drivers', 'barriers', 'success factors', 'lessons learned' and terms related to specific enablers (e.g. 'skills', 'change management', 'roadmap') coupled with terms related to digitalisation (e.g. 'digitalisation', 'digital transformation', 'industry 4.0', 'smart manufacturing'). In addition, a snowballing[377] approach was used to identify additional sources. The resulting set of sources analysed included scientific and grey literature, private sector insights reports, case studies, secondary data, media articles and others.

[377] Review of bibliographies of the identified literature for additional sources.

Particular attention during desk research and interviews was paid to identifying enablers specific to SMEs and companies of average and below average digital maturity.

Definition of best practice principles

Following analysis of case studies and interviews, information was synthesised to derive a preliminary set of success factors. This was conducted in two steps. First, the research team defined a set of case-study-level principles relevant for each company based on the case study text. Second, the case-study-level principles and enablers of SME digitalisation identified in the literature were clustered and analysed to define a preliminary set of cross-cutting best practice principles. Third, relevant principles were assigned to each case study (see Annex 2). A summary of the number of case studies assigned to each principle is available below.

Table 20. Distribution of case studies per principle

Name of the principle	Number of case studies per principle
Principle 1 – Ensuring managerial capacity and leadership	10
Principle 2 – Fostering employee and third party buy-in for digitalisation	11
Principle 3 – Setting strategic objectives for digitalisation	18
Principle 4 – Securing the skills needed	8
Principle 5 – Ensuring that the foreseen digital intervention is feasible	11
Principle 6 – Implementation planning	13
Principle 7 – Taking advantage of the wider ecosystem and collaboration	16
Principle 8 – Choosing a solution and technology provider that fit the company's needs	23

Source: compiled by the research team. Notes: each case study can be assigned to several principles.

Validation of best practice principles

The Best Practices workshop took place on 10 November 2022. The objective of the workshop was to present and collect participant feedback on digitalisation best practice principles developed during the study. The workshop consisted of three presentations, a panel discussion and an interactive session. The workshop agenda is available below.

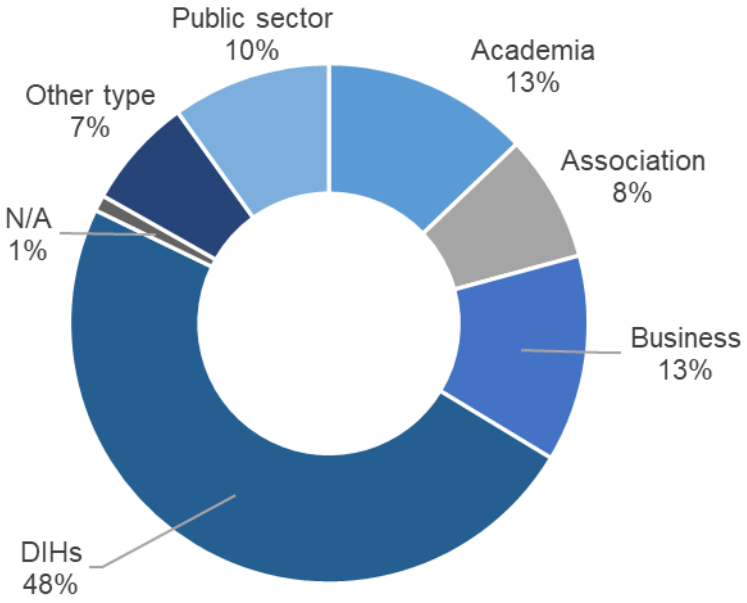
Figure 18. Workshop agenda

Time	Description
09:30 – 09:45	Introduction *Dr Egidijus Barcevičius, Research Director at PPMI,* *Dr Heidi Cigan, Senior Policy Officer at DG CNECT*
09:45 – 10:15	What works? Principles for accelerating companies' digitalisation journeys *Rūta Gabaliņa, Senior Researcher at PPMI*
10:15 – 11:00	Digitalisation in practice – panel discussion

Time	Description
	Irina Toma, Coordinator at FIT EDIH, Katrin Schade, Research Associate at University of Leipzig, Cătălin Podaru, General Manager at LEVIATAN SRL, moderated by Barbora Kudzmanaitė, Research Manager at PPMI
11:00 – 11:15	Break
11:15 – 11:35	Identifying, learning from and sharing company experiences – the view of the Commission *Dr Heidi Cigan, Senior Policy Officer at DG CNECT*
11:35 – 12:05	An interactive session to gather additional inputs *Barbora Kudzmanaitė, Research Manager at PPMI*
12:05 – 12:25	Good and best practices – making the concept reflect reality *Prof. Julian Müller, Professor at University Erlangen-Nürnberg (Germany)*
12:25 – 12:30	Closing remarks & next steps *Dr Egidijus Barcevičius, Research Director at PPMI*

The target audience of the workshop included businesses, DIHs, experts, academics and associations representing industrial companies and innovators. A total of 181 participants registered for the online workshop, and 101 of them connected to the meeting. Almost half of the participants represented DIHs (48%), followed by academia (13%) and businesses (13%) (see Figure 19).

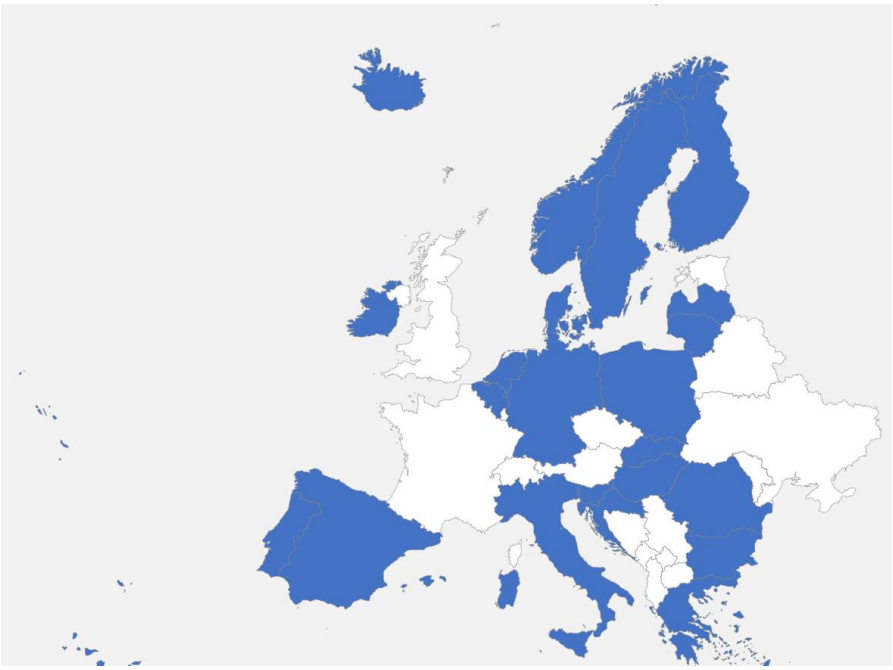
Figure 19. Workshop attendance by organisation type



Source: compiled by the research team. Notes: N=101, organisers were excluded from the total.

The event was attended by participants from 22 European countries (see Figure 20). The highest number of participants were from Italy (16), Portugal (11), Romania (9), Lithuania (9) and Spain (8).

Figure 20. Workshop participants: geographical coverage



Source: compiled by the research team. Notes: N=96, organisers and participants who did not indicate a country were excluded from the total.

The main takeaways, recordings and presentations from the Best Practice workshop are available on a dedicated online page.[378]

[378] Available at: https://ppmi.lt/news-insights/smart-industrial-remoting-event-highlights-best-practices-sme-digitalisation.

Annex 2: Company digitalisation case studies

Retail industry

Retail	CS 1	Unikalne Kosmetyki/YEYE Natural in Poland – Integrating e-commerce channels	
	Best practice principles		
		P6 *– Planning*	***P8*** *– Solution*

Company description

Unikalne Kosmetyki/YEYE Natural is a company carrying out retail sales of cosmetics (under the Unikalne Kosmetyki brand). The company also manufactures its own patented designs of self-care home spa products and sells these under the name YEYE. All of the company's logistics operations, including packaging, are run manually by company employees.

Intervention

Motivation to adopt digital technologies

The company has two different brands to manage. In addition to the company's e-shop, both brands have an online profile on e-commerce platforms. In addition the company also manages multiple sales channels. Since the management of these various channels was time-consuming, the company owners decided to integrate them.

Technology adopted

Given the company's need to integrate its e-commerce sales channels, it selected Baselinker as its solution provider. The company made this decision after comparing solution providers in the market and assessing the amount of work to be implemented by the company itself and by the software development company. The company undertook several steps to implement the solution.

- Prior to its deployment, the company identified the most important channels to be linked, defined these, and correlated all online and warehouse stocks.
- Having no in-house resources for software development or integration, the company hired Baselinker to create an integration prototype.
- The solution was tested for two weeks. As no errors were identified, it was successfully launched.

Challenges encountered

- Choosing a solution provider in a saturated market without technical advice or feedback on the providers' quality.
- Limited time availability of the external provider and increasing cost of services.

Results and lessons learned

The main impact is a significant saving in the time spent managing different channels, which can be now spent on other activities that grow sales.

The company owner acknowledges that, without skilled staff and external expertise (e.g. from the

Retail	CS 1	Unikalne Kosmetyki/YEYE Natural in Poland – Integrating e-commerce channels	
	Best practice principles		
		***P6** – Planning*	***P8** – Solution*
	• Lack of IT knowledge on the part of the company owner made it difficult to assess whether or not the solution was implemented appropriately.		state), it is challenging to adopt and adjust digital solutions.

Retail	CS 2	Henry Partners in Poland – Order processing automation				
	Best practice principles					
		***P3** – Strategy*		***P5** – Financing*		***P8** – Solution*

Company description

Henry Partners is a company that operates four e-commerce shops selling various products, ranging from sporting goods to health and safety products and cosmetic accessories. Its central warehouse, as well as packaging and logistics-related activities, are managed by the company owner.

Intervention

Motivation to adopt digital technologies

The owner was looking for a way to reduce the time spent on repetitive, sales-related activities (such as billing, invoicing, waybills, and customer support) and to integrate changes across the e-commerce platforms used by the company. These include the company's own web shops, along with Allegro, eBay and Amazon, as well as drop-shipping providers. In the eyes of the owner, it was 'natural' to choose to automate those processes that could be automated.

Technology adopted

The company decided to automate store order processing, in particular:

- order taking (meaning that all customers go through the same stages on all platforms);
- waybill generation (through shipping service providers);
- e-mail communication (uniform for all channels from a user experience (UX) perspective);
- invoicing (uniform for all channels).

The first step was to map the digitalisation process. The owner wanted to rely on existing solutions, rather than develop custom software, with the goal of selecting 'commercial, off-the-shelf' solutions. The tools also had to be sufficiently easy for the owner to configure and manage. Such a strategy yielded less dependence on software development companies. During the assessment of the various e-commerce platforms in use, the company realised that many of the necessary integrations were available as plugins for the Prestashop platform. The company decided to use this as its main system, and to connect other existing channels and tools to it. As a result, some additional features of tools such as Allegro or Amazon were lost, but from the company's point of view, all order-processing operations became streamlined and uniform.

Challenges encountered

The company faced several challenges during implementation:

- choosing the most appropriate service providers within the lowest budget. The owner tries to keep the costs down in line

Results and lessons learned

Order processing is now better organised, with all core processes having been automated. The associated sales growth is estimated at 25%. A lesson that the owner has learned is that there are various well-documented tools that one should study before selecting a service provider.

Retail	CS 2	Henry Partners in Poland – Order processing automation				
	Best practice principles					
		***P3** – Strategy*		***P5** – Financing*		***P8** – Solution*
	with the ALARA approach ('as low as reasonably achievable'); • manual transfer of data from the channels used previously to the newly selected platform.					

Retail	CS 3	Novia Blanca in Poland – Auditing and dividing stock
	Best practice principles	
	P3 *– Strategy*	***P5*** *– Financing*
	P6 *– Planning*	***P8*** *– Solution*

Company description

Novia Blanca is one of the biggest retailers of wedding jewellery in Poland. With revenues of around PLN 4 million annually (around EUR 834,000), it operates an e-store as well as a physical store. The company mostly works in the B2C and B2B channels. It also serves international customers.

Intervention

Motivation to adopt digital technologies

The business has grown throughout the last 10 years. The company is thus well-established on various social media channels. However, given the company's growing online presence, its existing IT infrastructure proved increasingly unable to meet the company's needs. Some of the tools in use at the company have not been updated for almost a decade. Due to the company's legacy infrastructure, some novel business opportunities and tools were difficult to integrate. The company therefore needed to adjust its e-commerce platform to the latest market trends and customer expectations.

At the same time, the company was predominantly focused on its e-shop. Despite having a physical store in an advantageous location, its staff mainly took care of online orders – packaging, logistics and customer relations – rather than active selling offline. The company wanted to change this by separating operations in the physical store from online commerce.

Technology adopted

The company began by auditing all of its services and sales channels, as well as creating a re-sketch of processes that have changed over time. As a result, it decided to codify its processes, abandon some channels, and analyse existing marketing tools offering the potential for integration. This research was carried out in-house. The results of this assessment were important in designing the necessary upgrades to the company's sales channels.

To address the lack of attention given to the offline store, the company needed to separate its warehouse operations from its physical retailing. The most efficient solution was to find a partner in the value chain that could take care of all its e-commerce activities. The company applied several criteria to choose its partner: swift response in delivering goods to the store from the warehouse, so that customers could try them on; the cost of shipping; the ability of the partner company to handle premium packaging materials; and the ability to handle billing and returns processing. After two months spent thoroughly researching and analysing potential collaboration schemes, an external provider was chosen, and the pilot was launched and implemented.

However, the stock splitting resulted in a reverse effect and increased the company's operational overheads. The strategy was therefore abandoned, and the company returned to its previous operating model.

Retail	CS 3	Novia Blanca in Poland – Auditing and dividing stock
	Best practice principles	
	***P3** – Strategy*	***P5** – Financing*
	***P6** – Planning*	***P8** – Solution*

Challenges encountered	Results and lessons learned
When conducting the audit of e-sales channels, the challenge arose of the lack of knowledge about e-shop configurations on the part of the company's management. Given that the company did not wish to rely on external auditors, it had to acquire the knowledge itself. With regard to stock splitting, it was problematic to synchronise and harmonise online and physical orders and stock updates.	The project is still in its implementation stage. So far, the company has identified and codified many unwritten processes and business features, and these will serve as a basis for the future implementation of digital tools. The management also highlighted the importance of auditing and staying in the loop of recent innovations. With regard to the unsuccessful separation of physical and online sales channels, the main lesson learned is that not all best practices are 'one size fits all' when it comes to different businesses, and the validity of planned interventions has to be assessed.

Retail	CS 4	Żabka in Poland – Following customers and automating stores

Best practice principles

P3 *– Strategy*	***P6*** *– Planning*

Company description

Żabka is a retail franchise network in the Polish market. Since 1998, it has opened more than 8,500 physical stores in various formats. The company's ongoing transformation is driven by the latest trends in marketing and retail. The company wants to be as close to its customers as possible, and to leverage its physical locations in a way that maximises profit.

Intervention

Motivation to adopt digital technologies

The company's owners consider physical locations to be immobile and seasonal. For them, adapting to customers' habits sometimes means closing certain stores and opening others. Furthermore, although some customers need to make purchases outside typical business hours, Żabka's employees do not work overnight, as this is hardly profitable in most locations.

Technology adopted

To become as close as possible to its customers, Żabka has implemented several new formats to expand the franchise. It has invested in and opened the first completely autonomous, 24/7 self-checkout shops in Poland. These only require a client to scan a credit card at the entrance, pick up the products they want and leave the shop. The company now has 50 such stores across Poland.

In addition, Żabka decided that some of its stores would specialise depending on their location, rather than the universal format. For example, if a store is located in an office building, it would have more ready-made meals, while a store in a residential area would offer a wider choice of fresh products for cooking. Lastly, Żabka began investing in pop-up stores located in 20 or 40ft containers that are placed in temporary, seasonal locations (e.g. music festivals, popular holiday destinations, etc.). This increased the network's popularity and market share, beating even well-established local providers.

Having analysed its sales data using AI, Żabka aspired to making more informed decisions for its future development. To achieve this, it needed to implement digital tools for on-the-spot monitoring, checkout and other security and convenience features.

Challenges encountered

For the introduced changes to work, the company needed to have a good understanding of its customers' habits. For this, it therefore had to process large amounts of data (e.g. data on the most popular locations, ROI, etc.).

Results and lessons learned

The technologies adopted helped the chain to increase its market share and cover some previously uncovered locations (e.g. mountainous and seaside regions). The company management concludes that following its customers and committing to them are key to success in retail.

Retail	CS 5	MST Frieling in Germany – introducing ERP system during COVID-

Best practice principles

P3 *– Strategy*	***P5*** *– Financing*	***P7*** *– Cooperation*

Company description

MST Frieling sells travel luggage, hats, bags, shoppers and fashion jewellery. Most of its goods are sold both online and in a physical store. Its owners have been using an online store for some time, and have a good knowledge of ERP systems. Thanks to the use of online retail channels such as eBay and Amazon, company sales have grown significantly.

Intervention

Motivation to adopt digital technologies

Like many other businesses, the COVID-19 pandemic affected MST Frieling's business. The company therefore decided to put more of its products online. This process was initially manual and cumbersome. The owners thus decided they needed a digital alternative that would not require them to go to the physical store every time to access the hardware. They also wished to remain attractive to clients and improve the company's offline experience.

Technology adopted

The main digital solution was an integrated cloud-based ERP system connected to the online platforms selling the shop's products. This allows the owners to respond to customers' requests quickly and from home. The ERP system, outsourced from an external regional provider, is now connected with eBay, Amazon, Otto and Kaufland.

For its implementation, the company applied for external financial support from the state of North Rhine-Westphalia through the Economic Development Agency of the city of Wuppertal. Thanks to this funding, it managed to install a new cash register and complete the integration of its online store within two months of the grant being approved. In addition to this grant, the company also won two small complementary ones. Furthermore, a project management agency assisted the company with its social media presence and product photos, as well as other selling platforms. To improve customer experience, MST Frieling bought tablets for the physical store so that customers can compare the colours and types of available products or watch videos of them.

Challenges encountered

Setting up an online store, including selecting the design, configuring the store and compiling product data took a long time.

The company also found it challenging to select a single ERP provider. The company owners organised several meetings between the service

Results and lessons learned

The owners relied on their past experiences and knowledge, but still chose to seek external expertise. They emphasise the importance of being well-informed about various aspects of digitalisation, including costs and legal requirements. Thanks to the changes introduced, the company boosted its sales during the

Retail	CS 5	MST Frieling in Germany – introducing ERP system during COVID-				
	Best practice principles					
		P3 *– Strategy*		***P5*** *– Financing*		***P7*** *– Cooperation*
provider and staff responsible, to align their expectations.			pandemic, and eliminated the necessity to be present in the physical store in order to process the orders.			

Retail	CS 6	Landspeis in Austria – Digital marketing

Best practice principles

***P1** – Managerial capacity*	***P3** – Strategy*	***P7** – Cooperation*

Company description

Landspeis is a mobile food shop chain founded by the agricultural business Naturfrucht GmbH. Naturfrucht produces bio products such as organic juices, jams and marmalades. Landspeis opened its first store in 2014, in the small town of Neubau, 25km from Vienna. The store was aimed at end consumers rather than other retailers (B2C rather than B2B). The concept was extremely well received, and at its peak Landspeis operated ten mobile stores.

Intervention

Motivation to adopt digital technologies

The company intended to work with locally sourced produce. However, local municipalities asked the company to invest and secure the local food supply to a degree that was unsustainable for an organic food shop. As a result, over time consumers went back to discount supermarkets, and Landspeis went down to only three stores. This made reaching end consumers much more difficult.

Technology adopted

The company engaged in a strong digital marketing effort to build a community of core consumers for Landspeis products. One way to do this was to shift marketing expenses from a related family business into Landspeis, especially in terms of posting products online.

The owner was also well aware of the relevance to his business of digital technologies. Such awareness came from his familiarity with the rapid digitalisation of the agrifood business, which he credited as the source of his knowledge. The owner also networked a lot to get ahead of the competition, since aggressive digital marketing was becoming widespread during the pandemic lockdown.

Challenges encountered

The main hurdles encountered were:

- the very personnel-intensive and personnel-dependent nature of the solution, which rested on the commitment and interest of the staff, rather than their previously acquired experience;
- the necessity to have a pre-existing network and resources to kick-start the introduction of digital solutions.

Results and lessons learned

Following the digital marketing switch, sales figures went up.

The case study emphasises three principles:

- the importance of having a leadership figure who is willing to change strategies and adopt new digital solutions;
- the necessary awareness of such solutions, which can be fostered by previous experiences in related fields;
- the ability to create local networks and communities of core consumers.

Retail	CS 7	Saasil in Germany – Multichannel sales		
	Best practice principles			
		P1 *– Managerial capacity*		***P3*** *– Strategy*
		P5 *– Financing*		***P8*** *– Solution*

Company description

Saasil is a retail shop that sells lamps for living spaces, object lighting and equipment, as well as home accessories. The company started in 2002 in a garage, from which the owner bought and sold individual items and reinvested the turnover. As business increased, the company moved to an industrial area, selling mainly to wholesalers. At the same time, Saasil began selling via eBay (2002) and Amazon (2008). The company set up a digital ERP system, but gave this up in 2015.

Intervention

Motivation to adopt digital technologies

The COVID-19 pandemic forced the business to close temporarily, and at the time of reporting (September 2022), sales have not recovered to pre-pandemic levels. The company's owner pointed to consumers' resistance to buying new goods due to higher prices and continuous external shocks (e.g. the pandemic, the Russian war in Ukraine and the energy crisis). Hence, the owner's main goal was to sell out the company's existing stock within a few years before retiring.

Technology adopted

The company underwent restructuring in 2020. It bought a new digital ERP system that connects products in the e-shop and in the physical store. However, implementation was assessed as being not worthwhile at that time due to the large number of goods present in the physical store. The costs of digitalisation were deemed too high.

Instead, to accelerate the selling process, Saasil implemented several digital solutions:

- the digital ERP system was reintroduced to connect the inventories in the digital and physical stores;
- a point-of-sale (POS) system, Afterbuy, was introduced to speed up payments across different channels;
- a digital catalogue of the products created to increase the rate of sales;
- products were marketed via social media.

Challenges encountered

The company has been through many external shocks that made the success of its digitalisation more difficult:

- the 2008 financial crisis;
- the pandemic lockdown, which caused a downsizing in personnel;

Results and lessons learned

The owner of the company has emphasised how digitalisation has saved time, and how it has helped to speed up the process of handing the business over to their children.

The owner also received further help in the form of EUR 9,000 from Germany's Corona Emergency Fund programme, although the owner noted that he would probably have been able to keep the business even without this help.

Retail	CS 7	Saasil in Germany – Multichannel sales		
	Best practice principles			
		***P1** – Managerial capacity*		***P3** – Strategy*
		***P5** – Financing*		***P8** – Solution*
• personal issues that forced the owner to abandon the digitalisation path; • water damage to the basement, which was not insured. .	The main lesson that the owner learned was about not over-relying on e-retailers, but having 'several legs to stand on' (i.e. to complement digital sales with a physical store, or vice-versa). The case study involves the clear identification of digitalisation needs, which the company has been through at various times during the past 20 years. Lastly, the owner emphasised how retailers should have a passion for their business and be professional about what they offer (i.e. 'know your stuff').			

Automotive industry

Automotive	CS 8	DTH Automotive Kft. in Hungary – Adopting 3D scanning to automate the measurement processes
	Best practice principles	
		***P1** – Managerial capacity*

Company description

DTH Automotive Kft. is a subsidiary of an American-based company that has been operating in Hungary since 2000. The company's main areas of activity are heat treatment, air conditioning technology and liquid transport product manufacturing. The company produces aluminium tubing, cuts it to size, bends it, and processes it in other ways before delivering it to automotive factories. Its final products are air conditioning pipes, fuel pipes and coolant pipes.

Intervention

Motivation to adopt digital technologies

The company periodically checks the products it manufactures using sampling methods. Before its digital intervention, this sampling was carried out manually. Employees would analyse the manufactured pieces by hand using measuring devices – a process that was time-consuming and could result in inaccuracies.

Technology adopted

The company decided to automate the measurement process using a 3D scanner. Using this technology, employees would no longer have to perform quality checks on products manually. As a result of this intervention, the measurement process became significantly faster, and the likelihood of inaccuracies was reduced.

Challenges encountered

The main challenges were:

- sceptical management, who were historically used to investing in innovations that could be demonstrated to pay off within two years;
- employee training on the changes in the quality control process.

Results and lessons learned

As a result of the intervention, efficiency increased, the scrap rate decreased, work processes became more reliable, and errors could be identified more easily.

Company representatives highlight the importance of securing management buy-in for digitalisation. Outlining the clear benefits of the digital intervention in terms of both resources saved and improved accuracy was key in obtaining the management's support. It is also important that the digitalisation was strategically aligned with the company's priorities.

Automotive	CS 9	Eckerle Automotive Bóly Kft. in Hungary – Digital access control system

Best practice principles

P2 *– Fostering buy-in*	***P3*** *– Strategy*	***P4*** *– Skills*

Company description

Eckerle Automotive Bóly Kft. was originally established as a family business in Germany but has since expanded worldwide. The company constructs injection moulding and carbon brush systems for the automotive sector, operating under the TIER3 classification.

Intervention

Motivation to adopt digital technologies

The company aimed to improve the efficiency of its resource planning processes. Before the intervention, the management carried out a loss analysis to assess the need for digitalisation programmes.

Technology adopted

The company introduced a digital access control system, as well as an update to its ProAlpha ERP system. These changes were implemented to help the company plan, control, manage and optimise resource handling. The company managed to implement between 80% and 85% of the functionalities offered by the ProAlpha solution.

Challenges encountered

The main challenges were:

- insufficient expertise in terms of planning, developing and managing digital systems;
- financial resource constraints, which stopped the company from implementing a larger digitalisation initiative;
- lack of confidence regarding digital technologies among both management and employees (employees feared that they might lose their jobs due to the introduction of the new technology).

Results and lessons learned

By identifying its digitalisation needs, fostering buy-in and implementing the digital technology, the company was able to overcome the challenges it encountered and gain the necessary experience to continue its digitalisation.

As a result of the intervention, the company's data management efficiency has improved. The company's management is now ready to pursue further technological developments to improve transparency.

Automotive	CS 10	Matro Gépgyártó Kft. in Hungary – Adoption of an ERP system in the administrative area, and of robotics in the production area

Best practice principles

***P1** – Managerial capacity*	***P5** – Financing*	***P8** – Solution*

Company description

Matro Gépgyártó Kft. produces components for engine management systems, spare parts for the brake systems of trucks, and car body parts. Recently, the company has also begun to produce air conditioning and cooling equipment. The company supplies products to automotive factories both nationally and internationally.

Intervention

Motivation to adopt digital technologies

The growth of the company was being hindered by inefficient administrative and operating systems. Moreover, the quality and quantity of its production output were decreasing.

Technology adopted

The company adopted technologies in two areas. In the area of administration, the introduction of an ERP system helped improve the accuracy and speed with which work could be carried out.

In its production process, the company implemented a robotic solution. This allowed the company to fulfil its quality requirements without losing productivity in terms of output volume. It is important to note that the company had previously conducted experiments involving robotisation.

Challenges encountered

The main challenges for the implementation of the new technologies were:

- securing the necessary financial resources;
- limited digital expertise;
- finding a company that could develop the required software within the deadline set.

Results and lessons learned

The company has managed to implement the technology successfully with financial support from the EU and the Hungarian government.

The most important lessons are:

- Leadership and the willingness of the company management to take the necessary decisions are very important. In this case, the company decided to outsource work for which it lacked expertise internally.
- Broadening the company's network to find the right partners helped the company finance and implement the new technology.
- Previous knowledge of robotisation allowed the company to accurately set expectations and assess results.

Automotive	CS 11	South Transdanubia Mechanical Engineering Cluster in Hungary – Providing vocational training and promoting business cooperation

Best practice principles

	P3 *– Strategy*		***P7*** *– Cooperation*

Cluster description

South Transdanubia Mechanical Engineering Cluster currently has 40 companies as members, representing four counties and employing approximately 5,000 workers. Currently, five of these companies operate in the automotive industry.

Intervention

Motivation to adopt digital technologies

The cluster was established in 2011 to promote cooperation between businesses that contributes to operational efficiency, without being for-profit.

Technology adopted

The most important project carried out by the South Transdanubia Mechanical Engineering Cluster – and the one most welcomed by its members – is cooperating with vocational training providers. In addition, the cluster coordinates joint purchases, market appearances, marketing and benchmarking.

The cluster's experience in dealing with automotive companies demonstrates the importance of robotisation to this sector. Automotive companies can greatly increase their efficiency with the help of robotics due to their speed and the fact that they do not produce scrap. Other technologies that would be beneficial include AI, machine learning and corporate management systems.

Results and lessons learned

- The cluster points to the importance of choosing which digital technology to use as the very first and the most crucial step in its adoption. The chosen technology should allow the company to focus on its core functions in relation to production.
- Collaboration within a cluster can help companies to improve their operational efficiency through collaboration with training providers, joint purchases and other means.

Automotive	CS 12	Lagermax in Austria and Eastern Europe – Adoption of AR goggles to guide workers

Best practice principles

P5 *– Financing*

P8 *– Solution*

Company description

Lagermax is a logistics service provider active in several industries including the automotive sector. The company employs around 3,000 people and mainly operates in Austria and Eastern Europe.

Intervention

Motivation to adopt digital technologies

The company wanted to improve the efficiency of its spare parts cross-docking process. This process involves several trucks simultaneously embarking and disembarking spare parts from several plants to different workshops. This is a non-standardised process, as the need for spare parts is irregular and difficult to predict. Hence, workers carrying objects have difficulties navigating between trucks, leading to errors and route inefficiencies.

Technology adopted

Lagermax cooperated with the Digital Transfer Centre (DTZ) at Salzburg University to create AR goggles to guide workers in the cross-docking process. The initiative received EUR 1 million of initial funding from the State of Salzburg. To ensure the sustainability of the initiative, the State of Salzburg further invested EUR 2.4 million over the following two years.

Challenges encountered

The existing industrial AR goggle solutions on the market were 'over-engineered' and too expensive for the company to implement. Such industrial goggles included several technical functionalities that the company did not need. Furthermore, workers did not like wearing these goggles for various reasons (privacy, comfort).

The company decided to use an older model of AR goggles from the consumer market. These non-industrial goggles were cheaper and easier to wear than the industrial ones.

Results and lessons learned

The solution helped to reduce mistakes in disembarking and embarking, and to optimise routes between trucks. Consequently, it also allowed employees, including those with limited experience, to work more efficiently.

The 'downgraded' solution was co-developed with students, and the AR goggles chosen to fit the company's needs were a cheaper alternative to industrial solutions.

Automotive	CS 13	Marelli in Italy – Digital solutions for automation, management and efficiency[379]	
	Best practice principles		
		P3 *– Strategy*	***P8*** *– Solution*

Company description

Marelli is a century-old Italian developer and manufacturer of components for the automotive industry. The company has 86 manufacturing plants, 12 R&D centres and 26 application centres in 19 countries.

Marelli deals with powertrain and intelligent systems for active and passive vehicle safety. Business lines include automotive lighting systems, body control systems, powertrain control systems, electronic instrument clusters, telematics systems and computers, suspension systems and components, exhaust systems and motorsport.

Intervention

Motivation to adopt digital technologies

The adoption of digital technologies was chosen for several reasons:

- to improve manufacturing operations;
- to gain a competitive advantage, increase customer satisfaction and enhance brand reputation;
- to improve manufacturing systems and monitor asset efficiency;
- to digitalise plant operations and processes in order to connect assets and unlock efficiencies.

Technology adopted

The company's digitalisation strategy involved the adoption of several digital innovations:

- The identification and adoption of an integrated information technology and operational technology application suite for manufacturing operations that would serve as a solid digital foundation for a future industrial internet of things (I-IoT) platform.
- The creation of a proof of concept for improved efficiency monitoring. The proof of concept looked at key production assets such as the engines powering the welding robots and an injection moulding machine. An I-IoT laboratory platform collected and processed data from sensors and programmable logic controllers on these assets.
- The development of predictive algorithms to identify the likelihood and potential timing of an asset failure, as well as critical conditions affecting production. When the system detects an impending failure or critical status, it notifies supervisors to act quickly before the machine breaks down.

[379] Accenture (n.d.). Marelli: Smarter manufacturing. Available at: https://www.accenture.com/hk-en/case-studies/industry-x-0/marelli.

Automotive	CS 13	Marelli in Italy – Digital solutions for automation, management and efficiency[379]
	Best practice principles	
	P3 *– Strategy*	***P8*** *– Solution*

Challenges encountered	Results and lessons learned
The main challenge faced by the company was its lack of expertise in implementing AI and machine learning, which was addressed through collaboration with a consulting firm (Accenture).	Although no results have yet been specified, a preliminary assessment suggests that the adopted technology will help Marelli to: • avoid breakdowns by monitoring and controlling plant operations remotely and in real-time, and enable remote analysis to further improve maintenance; • improve quality by introducing advanced early warning analytics; • increase automation and reduce manual paperwork for production planning processes; • optimise maintenance activity planning and costs by replacing machine components only when needed; • prepare for the future by applying additional advanced analytics on production assets. The main lesson learned from this case study is the importance of working with experts and consultants to identify needs that will help the company connect its assets and unlock efficiencies.

Automotive	CS 14	MW.FEP in Italy – Interoperable solutions for multiple lines of work[380]				
	Best practice principles					
		P3 *– Strategy*		***P6*** *– Planning*		***P8*** *– Solution*

Company description

MW.FEP provides tailor-made solutions to the electronics industry. It assists companies in design, prototyping, equipment development, mass production and after-sales service. The company operates in several sectors such as defence and avionics, medical equipment, telecoms, automotive, industrial, energy, railway and IoT. The company's facilities include 12 lines in two plants, 400 km away one from each other.

Intervention

Motivation to adopt digital technologies

MW.FEP operates in the so-called 'high mix-low volume' environment, which requires a wide variety of products to be manufactured in small series. The company's main need was to identify a software solution that would allow it to quickly manage the introduction of new products, using libraries containing the variety of components available in the market today. This would also allow the company to switch easily from one line to another without having to readjust the program each time.

The company's management faced two choices:

- whether to change only a few aspects, or completely overhaul the process;
- whether to treat the process as a whole, or differentiate the prototyping part.

Technology adopted

The company opted for so-called 'valor process preparation' (VPP), which allows engineers to prototype specific lines and switch easily to better-performing ones for mass production. It is also possible to fine-tune programs independently of the plant in which production takes place. This is because VPP is 'machine-agnostic', allowing the development of neutral programs that can be used interchangeably on different lines. The tool allows machines to recognise any type of component, even if it is not present in the library of the individual machine. This optimises setup costs by avoiding machine downtime and minimising the amount of work required before production starts.

[380] Cadlog (n.d.). Improved NPI service thanks to fast and flexible configuration of the SMT line. Available at: https://www.cadlog.com/success-stories/improved-npi-service-thanks-to-fast-and-flexible-configuration-of-the-smt-line/.

Automotive	CS 14	MW.FEP in Italy – Interoperable solutions for multiple lines of work[380]		
	Best practice principles			
		P3 *– Strategy*	***P6*** *– Planning*	***P8*** *– Solution*
	Challenges encountered		**Results and lessons learned**	
	The main challenge was identifying a solution that would fit different plants and lines of work that are geographically very distant.		The main impact of VPP was the possibility to develop a very specific and complete offer for the introduction of new products. The main lessons learned are: • assessing company needs and the desired scope of an intervention will help to identify an appropriate solution; • investing in interoperable solutions will allow them to be used for different lines of work.	

Automotive	CS 15	Renault in France – Office tablets and a centre of excellence[381]				
	Best practice principles					
		***P2** – Fostering buy-in*		***P4** – Skills*		***P6** – Planning*

Company description

Renault Group is a French multinational automotive manufacturer operating in 38 countries, and one of the three best-selling car manufacturers in the EU. The company has implemented cutting-edge innovations in areas such as connectivity, automation and mobility services. Its production line is also undergoing an Industry 4.0 transformation initiated in 2016, which aims to connect production sites, manage industrial data and transform logistics processes.

Intervention

Motivation to adopt digital technologies

Renault Group considers it important to be responsive to customers' expectations and concerns. In the company's view, the growing need for sustainability in car production can be addressed by digitalisation. In addition, Renault aspires to adopt solutions that will allow it to better manage the full lifecycle of customer relationships. Lastly, the company is eager to strengthen its position in the production of electric vehicles and become more connected and efficient.

Technology adopted

The company has adopted several solutions over the last few years:

- In 2017, it set up Renault Digital – an independent subsidiary with the sole objective of supporting the company in its digital transformation. This subsidiary functions as a centre of excellence with a 'start-up mentality', providing the skills and expertise needed for digital projects.
- Renault ensured Wi-Fi connectivity across all of its plants, and unit managers were provided with mobile office tablets and access to real-time product data. Previously, they constantly had to move around the plants to access the necessary information through desktop computers.
- The company introduced predictive maintenance by installing 2,000 sensors to collect equipment data.
- Renault introduced a new mobile app to remain connected with customers throughout a car's lifecycle.
- The company has launched experiential learning for employees to prepare for working with collaborative robots.

These changes required the company to promote a new leadership mindset, management style and agility. The human resource department played a central role in this endeavour, being responsible for establishing various digital skills development programmes, focusing on end-to-end employee journeys and empowering employees to manage their careers and collaborate, among other initiatives.

Challenges encountered

Results and lessons learned

Automotive	CS 15	Renault in France – Office tablets and a centre of excellence[381]				
	Best practice principles					
		***P2** – Fostering buy-in*		***P4** – Skills*		***P6** – Planning*
The main challenges were: • insufficient digital skills among employees; • inconsistent methodologies across the company; • governance and processes that were not adapted to digitalisation; • the presence of legacy IT systems.			• After unit managers learned to work with tablets, productivity and job satisfaction increased notably, saving around 45 minutes per employee each day. • Connecting equipment, machines and robots within plants also allowed the creation of value in other areas and improved sales. • Renault Digital has proved to be an immense asset in supporting the digital transformation of the entire organisation. • The company realised the central role of the human resources department in facilitating change management and skills development.			

[381] Scherer J.L. (2020). Renault – An industry 4.0 Case Study. The Digital Transformation People. Available at: https://www.thedigitaltransformationpeople.com/channels/the-case-for-digital-transformation/renault-an-industry-4-0-case-study/.

Textile industry

Textile	CS 16	HATA in Portugal – Successfully testing fabric quality control

Best practice principles

P6 *– Planning*	***P7*** *– Cooperation*	***P8*** *– Solution*

Company description

Knitting circular sustainable fabrics since 2016, **HATA** is a company that aims to be part of a new and evolved global textile and manufacturing supply chain. With the latest technology in circular knitting machines, HATA, together with partners, co-creates advanced knitting structures.

Intervention

Motivation to adopt digital technologies

HATA wanted to improve the quality control of circular knitting machines, which is one of the most crucial aspects of production. The detection of defects during the manufacturing process previously depended on visual inspection by human operators, resulting in insufficient accuracy and reliability.

Technology adopted

The company introduced a quality inspection system for checking fabrics using the aid of computer vision. To achieve this, it cooperated with Smartex, a start-up focusing on advanced solutions for quality inspection using computer vision and AI, which was looking for partners to test its products. As a result, Smartex launched its pilot at HATA's industrial facilities. After testing and fine-tuning, the solution was fully developed and ready to be replicated.

In addition, the company introduced a digital twin of the knit roll. As a result of this innovation, high-resolution images are produced and stored in the cloud. This also enables the automatic generation of reports containing detailed information about the position, extent and types of defects in each roll produced. These data are later used to optimise nesting and cutting processes, thus minimising knit waste.

Challenges encountered

The initial search for a suitable solution posed a challenge for HATA. Fabric inspection systems based on computer vision have been on the market for quite some time. Yet, in the company's view, none of them were sufficiently cost-effective and error-free. The typification of errors HATA needed was quite complex, due to the diversity of fabrics and the harsh working environment resulting from the speed and vibration of the knitting

Results and lessons learned

HATA successfully implemented a real-time defect detection and alert system. This informs line operators when there is a need to suspend production and correct the causes of defects, minimising the wastage of raw materials and energy.

The main lesson learned was being open to partnerships and cooperation with third-party IT and R&D players. While it is common for SMEs to only adopt mature technologies and work with well-established external providers, HATA decided to experiment. As a result, it became a pioneer in reaping the benefits of an emerging technology. The partnership allowed HATA to tailor the solution to

Textile	CS 16	HATA in Portugal – Successfully testing fabric quality control				
	Best practice principles					
		P6 *– Planning*		***P7*** *– Cooperation*		***P8*** *– Solution*
machines, and the dust produced in the process.			its needs, with the company consequently gaining valuable knowledge and a competitive advantage.			

Textile	CS 17	Confetil in Portugal – 3D design encouraged by clients

Best practice principles

	***P1** – Managerial capacity*		***P4** – Skills*		***P8** – Solution*

Company description

Confetil specialises in producing circular knit ready-made garments. The company works almost exclusively for international brands in foreign markets such as Germany, Italy, France, Spain, the Netherlands, Belgium and others.

Intervention

Motivation to adopt digital technologies

The use of 3D computer-aided design (CAD) software for garment design was encouraged by one of Confetil's major customers. The aim was to support digital interaction between both parties, making the sampling stage fully digital. Later, other customers followed suit, thus confirming the relevance of the technology for effective collaboration with other companies in the value chain.

Technology adopted

The main technology adopted was 3D CAD software. This allows the company to produce virtual samples and discuss them with the customer during the sampling/prototyping stage. As a result, the proposal, revision and approval cycles for the garment are shortened, the production of physical samples becomes more efficient, and material no longer needs to be transported to customers. The whole cycle is developed around a realistic virtual 3D simulation that can be manipulated collaboratively in real time.

The company also invested significant funds into building a digital fabrics library that not only visually represents the look of a product, but also mimics its physical and mechanical properties. This technology makes the digital simulation of the proposed fabric and garment look and feel as realistic as possible.

Challenges encountered

2D CAD systems are still widely used in the textile industry; therefore, significant investment had to be made in upskilling employees to use 3D CAD tools.

Furthermore, digitalising a fabric library can be extremely time-consuming and require a lot of manual labour, even when specialised tools are used.

Results and lessons learned

The new software accelerated the early stages of prototyping, reduced the cost of producing samples and improved the communication and collaboration between customers and manufacturers. As a result, customer satisfaction increased. Confetil is now digitally connected and shares the same information space with its customers.

Along with implementing these changes, the company has also made a significant investment in software and hardware, as well as in the skills of the design and modelling team through specialised training in 3D CAD tools.

Textile

CS 18 Fonte & Faria Confeções in Portugal – Tablets for data collection

Best practice principles

***P8** – Solution*

Company description

Fonte & Faria Confeções is a garment supplier based in Portugal with more than 25 years' experience. It was founded in April 1994 and produces around 4,000 garments per day.

Intervention

Motivation to adopt digital technologies

The company lacked real-time data regarding the necessary quality and volume. Production data were previously collected manually once or twice a day by physically counting all garments produced at each workstation. This hindered effective production control, as well as the company's ability to quickly react to issues or continuously improve of the process.

Technology adopted

Fonte & Faria introduced a manufacturing execution system, an IT tool for collecting data from shop-floor workers and supporting production order management. The system was provided by the IT supplier Prodsmart as an off-the-shelf solution. It involved equipping each workstation with a smartphone or tablet installed with a simple and easy-to-use app. Using the app, an operator can enter the number of items produced within a certain time interval. These devices were connected via a secure Wi-Fi network. The data were stored on a local server and used to monitor operations, prepare dashboards with KPIs and provide real-time feedback to both shop-floor workers and management. This helped to provide management teams with an analytical interface including performance KPIs, and allowed the company to gain a broader, more detailed and accurate view of its production process.

Challenges encountered

Technically, data entry still is manual and not precisely 'real-time'. However, the system has significantly reduced delays in data collection for the company.

Furthermore, since the solution's upfront cost was affordable, and it did not demand complex changes or upgrades to the existing IT infrastructure, the investment was deemed viable.

Results and lessons learned

The data collected enables more efficient and effective production and quality control, and strengthens management practices with regard to various processes. The innovation has also led to savings in the use of paper.

Employee training for workers and communication on the importance of the system played an important role in the introduction of the new solution.

Implementation is not yet finished, but in the end, the company expects to improve its budgeting process and gain a better understanding of its operations and existing inefficiencies.

Textile	CS 19	Têxteis Penedo in Portugal – A virtual showroom platform

Best practice principles

***P1** – Managerial capacity*	***P2** – Fostering buy-in*	***P4** – Skills*

Company description

Based in Guimarães, at the heart of the Portuguese textile industry, **Têxteis Penedo** has been at the forefront of household textiles since 1975. The company has an internal IT team with the skills to develop and implement new digital tools, minimising dependence on external providers.

Intervention

Motivation to adopt digital technologies

Even prior to the COVID-19 pandemic, Têxteis Penedo already had an above-average level of digital maturity. Yet, the cancellation of several trade fairs due to the pandemic incentivised the company to adopt additional digital tools to improve its communication with customers and demonstrate new collections. After some online research into potential tools and implementation partners, the company selected a virtual showroom solution it wanted to implement.

Technology adopted

The company equipped its existing physical showroom with lighting and professional photography equipment, and outsourced professional services to capture high-resolution photos of the entire product portfolio. These images were uploaded to the chosen virtual showroom platform, together with complementary technical and commercial data. The platform was then made available online to customers, who could browse through the simulated showroom and ask the sales team questions regarding the products. The chosen platform was cloud-based, and quick and easy to use.

Challenges encountered

The main challenges were:

- creating the necessary conditions for shooting the portfolio was time-consuming and demanded expertise not available in-house. This service was successfully outsourced to a professional photographer;
- securing customer buy-in for the new platform.

Results and lessons learned

The solution provided a competitive advantage, and was a major factor in minimising the pandemic's impact on new orders for the company. Even after the end of lockdowns, the virtual showroom remains a crucial element of Têxteis Penedo's marketing initiatives and represents a very important communication channel.

The advantages that the company had were the presence of skilled workers with know-how in IT, and the company's culture of openness towards innovation. Têxteis Penedo also possessed experience in participating in national and European collaborative R&D projects.

Textile	CS 20	Clothing company in France – Using online surveys to tailor clothes
	Best practice principles	
	***P2** – Fostering buy-in*	***P3** – Strategy*

Company description

The company[382] is a French brand providing high-quality, durable and attractive clothing at a competitive price. Its main principle is pre-ordering, which allows it to invest in quality and avoid unnecessary expenses. Manufacturing takes place in several countries, depending on the requirements of the product concerned.

Intervention

Motivation to adopt digital technologies

The company is interested in cutting all unnecessary costs in relation to clothing production in order to invest more into improving the quality of the fabrics, workmanship and service.

Technology adopted

The company decided to use online questionnaires to ask its customers what they wanted. As a result, planned collections, final designs and colours are affected by customer opinion and feedback. After the questionnaires are filled in, the style team selects the best materials, develops a perfectly adapted cut and creates a garment inspired by customers' responses. Then, an online pre-order phase is launched, which helps to avoid intermediaries and eliminate unsold items.

The technologies employed are fairly simple: the system is based on a strong relationship between the brand and its community through social networks and online digital surveys, and on a good network of partners.

Challenges encountered

The main challenges were:

- the fact that the system increases waiting times for customers;
- the business model requires the company to create, maintain and strengthen the brand's bond with its community through its online presence and entirely digital communication.

Results and lessons learned

Thanks to the pre-order system, the brand only produces what it sells, with a reduced stock margin. This minimises costs, enabling the company to offer an exceptional quality-price ratio.

[382] The company did not consent to its name being included in this report.

Textile	CS 21	Protex Group in Norway and an Estonian ICT Cluster – Collaboration on smart workwear[383]

Best practice principles

P3 *– Strategy*	***P7*** *– Cooperation*	***P8*** *– Solution*

Company description

Protex Group is a Norwegian textile company that manufactures and supplies work clothing to Scandinavian markets. To implement digital technologies, the company collaborated with the **Estonian ICT Cluster,** Tallinn University of Technology, and the smart electronics cluster ESTRONICS.

Intervention

Motivation to adopt digital technologies

In 2014, the Protex Group found it difficult to maintain competitiveness due to its position in the value chain. To increase its value-added, the company decided to introduce a novelty by upgrading one of its existing product lines – workwear for the marine industry workers in harsh conditions.

Technology adopted

The company designed a prototype of a smart work suit for extreme environments. This had a number of features embedded, such as:

- speech recognition and a 'Team Speak' system enabling workers to communicate and take notes without making additional movements;
- GPS tracking of each team member's location;
- detection of slips and falls on dangerous surfaces, enabling this information to be passed on to a supervisor and providing early notifications to other workers;
- activity monitoring for vital signs, such as heart rate and ambient temperature.

All these data are uploaded to the cloud to inform supervisors about conditions on-site.

Challenges encountered

The product developed had a very specific use, requiring a high degree of reliability. For this reason, the end users – fishermen – were constantly consulted to understand all of their key needs and identify ways to improve the prototypes. The whole development was a phased, incremental process, with several

Results and lessons learned

Protex Group now supplies Ragnarok weatherproof clothing to large Norwegian fishing corporations Leroy and Marine Harvest. The new products:

- improve worker safety in harsh conditions;
- provide managers with better and faster data for decision-making.

[383] Lõugas H. & Pilvinski K. (2018). Protex's smart work clothes help to stay out of trouble. Invest in Estonia. Available at: https://investinestonia.com/protexs-smart-work-clothes-help-to-stay-out-of-trouble/.

Textile	CS 21	Protex Group in Norway and an Estonian ICT Cluster – Collaboration on smart workwear[383]			
	Best practice principles				
		***P3** – Strategy*		***P7** – Cooperation*	***P8** – Solution*
	prototypes being tested. The suit also combined a range of technologies, which was achieved through extensive collaboration with textile, software and hardware specialists.		The company concluded that innovation can happen even in highly traditional industries such as garment manufacturing. It also benefitted greatly from cooperation with academia, ICT companies and clusters.		

Textile	CS 22	Katty Fashion in Romania – Technologies for the circular economy[384]		
	Best practice principles			
		***P3** – Strategy*		***P4** – Skills*
		***P5** – Financing*		***P6** – Planning*

Company description

Katty Fashion is a manufacturing company in the textile and fashion industry, with 40 employees. The company is experienced in producing a wide range of women's outerwear, and specialises in short production runs and customised clothing. The company has been a successful exporter since entering the textile market in 2003. It has collaborated with European partners as well as suppliers, producers, regional development agencies, educational and research institutions from local and regional markets.

Katty Fashion offers a wide spectrum of services, from original concept to the creation of new products using CAD for patterns and grading, sampling and prototyping, material sourcing, short production runs, technical support and quality control, and combining woven and jersey fabrics with very different fibre compositions and structures.

Intervention

Motivation to adopt digital technologies

Katty Fashion's decision to undertake digital transformation was based on a desire to improve overall efficiency, increase service diversification, gain a competitive advantage and consolidate customer loyalty.

Moreover, in 2017 the company adopted a 10-year sustainable development strategy to lower its environmental footprint and offer better working conditions and improved business solutions. The switch towards digital solutions would help in achieving this goal.

Technology adopted

To fulfil its sustainable development goals, the company adopted several new technologies.

First, the C-VoUCHER EU programme for the circular economy allowed Katty Fashion to purchase 3D technology and integrate virtual prototyping into its product development for zero-waste production. This allowed the company to implement digital validation of its designs, as well as on-demand, flexible customised manufacturing.

Second, the DigitalSME programme provided the company with technical support (the so-called 'Digital Enabler') to assess and evaluate its activities, skills levels and needs. Various opportunities and potential business directions for the company were explored, broken down into short, medium, and long-term strategies. These

[384] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

Textile	CS 22	Katty Fashion in Romania – Technologies for the circular economy[384]		
	Best practice principles			
		***P3** – Strategy*		***P4** – Skills*
		***P5** – Financing*		***P6** – Planning*

included the development of the company's own proprietary analytics platform powered by AI, which it named 'KARE'.

Since then, the company has:

- implemented efficient practices for pattern development and fit management, together with a pattern library protocol;
- transferred its library to cloud storage;
- identified the appropriate product lifecycle management (PLM) software for the development of layouts, graphics and front-end forms;
- worked on rebranding the company logo, imagery, website and web content;
- upgraded its CAD and computer-aided manufacturing (CAM) software and purchased 3D licences, accompanied by training for the team through the C-VoUCHER programme.

In particular, the PLM solution was an entirely cloud-based platform developed from scratch and accessible from any device. The PLM aims to integrate all administrative processes, and includes several modules of the circular manufacturing model. The idea was to allow the company to address all of its process issues, while at the same time adding unique value to its proprietary KARE platform. The platform would offer 360-degree software to other garment and textile companies as part of its main business model, while at the same time diversifying Katty Fashion's portfolio and increasing its profit margins.

Challenges encountered

The main challenges were:

- finding the most appropriate solution to optimise the company's administrative processes;
- working out how to integrate the PLM and CAD/CAM front-end data input with the ERP system;
- avoiding potential operational delays arising from the switchover to a digital platform;
- an increasing number of low-cost manufacturers in the textile industry, resulting in high competition and reduced profit margins.

Results and lessons learned

The main impacts of the adopted technologies were:

- improving the efficiency and speed of pattern development through photo-enabled pattern digitalisation;
- reducing the number of samples required by half due to the use of 3D technology, thus reducing both costs and waste;
- more appropriate visual and written content, which improved the company's attractiveness to customers;
- switching from a traditional business model towards a circular, digitalised model.

The main lessons learned are:

- applying for external financial and technical support and guidance helped to streamline production;

Textile	CS 22	Katty Fashion in Romania – Technologies for the circular economy[384]		
	Best practice principles			
		P3 *– Strategy*		***P4*** *– Skills*
		P5 *– Financing*		***P6*** *– Planning*
			• assessing the company's needs by evaluating its activities and skill levels helped to determine the path forward; • developing and using in-house technical skills to assess, apply and compare new technologies was beneficial.	

Textile	CS 23	BekaertDeslee in Belgium – Outsourcing a 3D-design solution[385]
	Best practice principles	
	P7 – Cooperation	*P8 – Solution*

Company description

BekaertDeslee is a Belgian company specialising in the development and manufacturing of mattress textiles, mattress covers and sleep solutions.

Intervention

Motivation to adopt digital technologies

The management of BekaertDeslee decided to embrace digitalisation many years ago, in order to prepare for the upcoming changes brought by emerging technologies. One process the company wanted to change was its way of presenting samples to customers – by showing a small piece of a future mattress and expecting a customer to visualise it. In addition, the company's global presence posed issues such as keeping all representatives informed, synced and up to date in a standardised way.

To resolve these challenges, the company needed a reliable digital partner that would help it explore the added value of digital solutions beyond marketing applications. Thus, it partnered with the digital product agency Bagaar.

Technology adopted

Together with Bagaar, the company wanted to start with the digitisation of its entire collection of fabrics. This process led to the launch of a whole platform for both internal and external processes, such as sales support for B2B and B2B2C operations.

On this platform, designers, the sales department and clients can collaborate and use tools for everyday tasks. It includes a 3D product configurator capable of visualising all fabrics, a collaboration module to co-create products, and an import tool for designers. A 3D mattress builder now allows designers to recreate their products for clients, applying fabrics in a realistic way and making models user-friendly, flexible and adjustable for each order.

Challenges encountered

Due to the array of materials used, the company must deal with a wide range of possible fabric constructions, finishes and designs. Many of these are interrelated and influenced both by the location and the specific application they need to serve. This complicates the provision of tailored, error-free advice to end customers.

Results and lessons learned

The introduction of the online platform helped to significantly reduce the costs associated with sample production and shipping across the world. It allowed the company to enhance its production-on-demand. The digital solutions adopted also help to avoid unnecessary stock, waste and transportation.

[385] Bagaar (n.d.). Bekaert Deslee. Available at: https://www.bagaar.be/work/bekaert-deslee/.

Textile	CS 24	Aqualand Limited in the United Kingdom – Stitching technology for drysuits

Best practice principles

P1 *– Managerial capacity*	***P8*** *– Solution*

Company description

Aqualand Ltd designs and produces customised, made-to-measure drysuits for scuba diving under the Seaskin brand. It also acts as a supplier to other brands and makes OEM drysuits, dry-bags and accessories for water-based first responders, scuba divers and the military.

Intervention

Motivation to adopt digital technologies

Drysuit patterning requires a large number of data points that can be adjusted while keeping other dimensions constant. Standard commercial software for body measurements (e.g. Gerber, Lectra, Assyst) cannot cope with such requirements, making it a challenge to keep track of different cut parts. Instead, Aqualand Ltd needed to develop an active spreadsheet as an intermediary step.

Technology adopted

The company introduced a stitching technology that provides accurate, made-to-measure and repeatable outputs. The cutting machine was set to write identifiers on each cut piece. This allowed customers to reproduce the patterning on their own. The solution is based on 2D pattern-creation software operated by computerised numeric control (CNC) machines with a shallow ply cutter.

The pattern software, cutter and control software were all provided by a third company, Assyst Bulmer. This solution allows the cost-effective and accurate cutting of individually sized patterns.

Challenges encountered

The main challenge faced by the company concerned software providers. Many web-based body measurement and pattern-making apps have been acquired by larger companies, which made these products less accessible to third parties. This steered Aqualand Ltd away from such solutions.

Results and lessons learned

The company saw it as very useful to be able to draw on the positions of components and guide marks for the sewing and gluing operations. It also considered it important to develop a manual measurement process that could be reproduced by customers.

Two main lessons can be learned from this case study:

- the vision of the company owner was important in steering its course away from standard solutions;
- Support from the provider's technical team was also paramount in the adoption of the new technology, highlighting the importance of outsourcing those operations for which the company lacked in-house know-how.

Textile	CS 25	OVF Studio in the United Kingdom – Pattern engineering for clothes[386]				
	Best practice principles					
		***P3** – Strategy*		***P7** – Cooperation*		***P8** – Solution*

Company description

OVF Studio is a London-based fashion brand providing a contemporary alternative to traditional tailoring and standard sizing. It combines cutting-edge technology with artisanal craftsmanship to create convenient and affordable bespoke garments. OVF Studio is a concept brand of NRDA Studio Ltd.

Intervention

Motivation to adopt digital technologies

Some companies offer tailor-made clothing by allowing customers to submit their measurements online. However, this solution relies on consumers measuring themselves, and therefore creates a high probability of error. Furthermore, it also reduces the complex nature of people's bodies to a set of limited dimensions.

Other made-to-measure brands offer an in-house tailoring experience. They are able to capture a much larger range of measurements more accurately, and can offer more complicated tailoring. This process is, however, expensive, labour-intensive and lengthy, and requires the customer to be available for multiple in-person fittings.

Technology adopted

NRDA Studio partnered with the Apparel Design Engineering Collective at the University of Manchester to develop a concept demonstration for pattern digitalisation and parametrisation via a 3D body-scanning app.

The company first explored commercial solutions for 3D body-scanning technologies (SizeSTream, Lectra Modaris), but such processes took approximately six months, three people, and cost GBP 10,000.

Instead, the company chose to adopt an open-source 2D pattern creation software application, Seamly2D, which is premised on the parametrisation of pattern block creation. It is a derivative of the Valentino software package. In addition to being a no-cost option, the software has a vibrant support community that enables new users to develop their software skills. Moreover, a solution based on 2D pattern creation is easier to use compared with 3D alternatives. The company considered this a plus, given its lack of knowledge about pattern engineering or developing apparel products.

Challenges encountered

The company encountered several challenges along the way:

- scarcity of financial resources was one of the main obstacles. This steered the

Results and lessons learned

There have been two main tangible outcomes for the company:

[386] OVF Studio (n.d.). About. Available at: https://ovf.studio/pages/about.

Textile	CS 25	OVF Studio in the United Kingdom – Pattern engineering for clothes[386]				
	Best practice principles					
		***P3** – Strategy*		***P7** – Cooperation*		***P8** – Solution*

company away from commercial software packages;

- the open-source software lacked some of the functionalities offered by commercial alternatives;
- a lack of knowledge about pattern engineering on the part of the company owner rendered the adoption of sophisticated software more difficult. As a result, preference was given to easier-to-implement solutions.

- the company saved approximately GBP 7,000 by choosing open-source software over other commercial alternatives;
- using Seamly2D connected the company with a supportive, collaborative community that helped OVF Studio to gain the necessary knowledge to successfully implement and use the software.

These results point to three key lessons.

- it is important to identify digital solutions that can minimise human errors in measurement;
- engaging with the wider community can be beneficial for building a company's know-how;
- implementing open-source software solutions over commercial ones can be time- and cost-saving, while involving minimal compromises in terms of functionality.

Textile	CS 26	Hugo Boss in Germany – Digital twin and hyper learning[387]
	Best practice principles	
	P4 *– Skills*	***P5*** *– Financing*

Company description

Hugo Boss is a large luxury fashion house based in Germany that manufactures high-quality business wear. The company employs around 4,000 people.

Intervention

Motivation to adopt digital technologies

The main motivation driving the company to innovate was changing customer behaviour and the increasing need for personalisation in garment production. COVID-19 became another factor that incentivised near-shoring to reduce lead times and minimise disruptions to the supply chain.

Technology adopted

The company has developed a smart factory in Izmir (Turkey), which is its largest production site. Hugo Boss analysed its analogue processes to replicate them in a digital twin, which is a virtual model accurately reflecting real-world physical objects and processes. The digital twin collects production data, and AI is used to build predictive algorithms and forecast potential issues that may arise in operations. In addition, an Access Digital Assistant was introduced to provide a voice-operated interface.

Since the upskilling of employees was costly and time-consuming, the company developed an intensive learning environment with the help of AR/VR technology and interactive tasks. The use of the digital twin was also helpful, as the human resources department could predict staffing on production lines 2-3 months in advance and provide training ahead of foreseen changes in order to reduce losses.

Challenges encountered

Implementing the manufacturing technology for sewing apparel was challenging, due to the variety of processes involved and the environment in which it was carried out:

- no equipment for measuring machine data;
- high machine and human density in a compact area, leading to poor Wi-Fi connectivity.

In addition, financing such projects without patient capital is challenging in this industry, due to short payback times of two years and the difficulty of quantifying intangible benefits and savings. Hence, it was not possible to estimate a traditional ROI metric.

Results and lessons learned

Due to the 'hyper learning' initiative, training time was reduced by 50%. The introduction of the digital twin proved effective for predictive maintenance, quality control and simulating new production lines.

The company emphasises that the most important thing is not the technology that has been implemented, but rather the people who are use and manage it.

Agrifood industry

Agrifood	CS 27	Grain exporters in Lithuania and Latvia – use of software-as-a-service for crop quality monitoring and management[388]

Best practice principles

***P7** – Cooperation*

***P8** – Solution*

Ecosystem description

More than 30 major grain exporters in Lithuania and a large harvest procurement network in Latvia have been using the AgroSmart Silo solution to monitor and manage crop quantity and quality, and to exchange data.

The solution was developed in 2008 and first implemented on a small farm. The system was then successfully marketed and deployed at the Robusta grain farm and Gerkoniai grain elevator. The solution was later adopted by the biggest players in the Lithuanian grain production sector, including Agrokoncernas Group, Biofuture, Fasma, Galinta and many others.

Intervention

Motivation to adopt digital technologies

Grain producers face difficulties when it comes to efficient time planning, monitoring of products and allocation of resources. Thus, a unified and centralised business management system is the first step in digitalisation for many in the sector. This supports crop quality monitoring and quantity management activities, and allows the integration of all processes within the grain storage and trading business.

Technology adopted

The main objective of the digital solution is to improve companies' existing accounting and grain management systems. It improves the traceability of data and facilitates more accessible and precise management of information regarding crops.

Several key steps are involved in implementing the technology:

- analysis of the company's needs in close collaboration with the farm;
- technical feasibility and infrastructure assessment;
- deployment in close collaboration with farm employees;
- improvement and the development of new models;
- system maintenance and support.

[387] Case study compiled based on the following sources: https://www.digital-business-hub.com/hugo-boss-case-study-fulfillment-production-requaests-fully-4-weeks/; https://www.youtube.com/watch?v=Dbp0-fSrow; https://apparelresources.com/technology-news/manufacturing-tech/look-inside-hugo-boss-smart-factory/.

[388] AgroSmart (n.d.). Home. Available at: https://silos.agrosmart.lt/.

Agrifood	CS 27	Grain exporters in Lithuania and Latvia – use of software-as-a-service for crop quality monitoring and management[388]
	Best practice principles	
	***P7** – Cooperation*	***P8** – Solution*
	Challenges encountered	**Results and lessons learned**
	When implementing the digital solution, grain companies normally encounter several challenges: • Company employees lack the necessary expertise to deploy and work with the system. Thus, the service provider usually organises several training sessions to make sure everyone feels comfortable with the new system. • it takes time and resources to map the data points that need to be included in the new system. Not all companies are familiar with this process at the start of implementation.	The AgroSmart Silos solution led to more effective management of grain flow, more efficient preparation of data for accounting purposes, improvements in weighing accuracy, and better monitoring of grain quality and quantity. Several lessons can be learned from implementing the solution: • for a SaaS solution to be deployed successfully, close collaboration needs to take place between the company and the provider; • it is crucial to assess clients' needs at the beginning of the implementation in order to adapt the implementation process accordingly (e.g. running additional training);

Agrifood	CS 28	Lithuanian potato and wheat farms – use of UAV images to detect plant stress[389]

Best practice principles

P7 *– Cooperation*	***P8*** *– Solution*

Ecosystem description

This case comes from a collaboration between six farms in Lithuania. Two of these mainly grow potatoes or other vegetable crops, depending on the season. Four others specialise in wheat, rapeseed and corn production. The farms range in size from 240 to 2,000 hectares.

Intervention

Motivation to adopt digital technologies

The farms previously experienced difficulties in maintaining regular crop monitoring. They also experienced losses due to the overuse or underuse of fertilisers and agrochemicals. Traditional crop-health research methods that involve manual analysis and complex tools were too expensive, time-consuming and yielded results that were difficult for the farms to implement.

Technology adopted

The farms decided to implement a new source of remote sensing data – hyperspectral images captured by an automated drone system (UAV). Hyperspectral imaging is a fast and cost-efficient way to detect the amounts of micro- and macro-nutritional elements in plants to determine nutritional deficits at different growth stages. This technology also automatically generates recommendations regarding the use of agrochemicals, and allows the early detection of plant stress and its causes. This non-invasive and remote sensing technology enables the analysis of large amounts of data for precise decision-making.

Challenges encountered

When integrating the solution, the following challenges were faced:

- the need to develop spectral indices and algorithms for data analysis regarding certain species;
- linking sensor information to the existing data infrastructure, and linking data from hyperspectral imaging sensors to the database and data storage platform;
- developing big data infrastructure for automated analysis of spectral images.

Results and lessons learned

The solution showed how data from sensors and images captured by the hyperspectral camera can be used to predict yields, define management zones, and calculate the precise need for fertilisers, herbicides and other agrochemical products.

The impact of the solution in terms of a reduction in fertiliser use is predicted to reach 30% and soil fertility is expected to increase by 20%.

The farms are experiencing difficulties in implementing the solution, since the data model chosen does not cover all aspects of the information required. This gap is, however, being tackled through collaboration with the solution development team.

Agrifood	CS 29	Tomato greenhouse in Lithuania – Testing of precision agriculture
	Best practice principles	
	***P3** – Strategy*	***P7** – Cooperation*

Company description

Digitalisation project aimed at an industrial tomato greenhouse covering four hectares of land, which is also a member of the Lithuanian Greenhouse Association – the largest greenhouse complex in the Baltic States, bringing together greenhouses covering a total of 30 hectares.

Intervention

Motivation to adopt digital technologies

The company wanted to optimise the work of agronomists and increase the efficiency and accuracy of the work carried out in the laboratory. The company's goal was to identify tomato diseases during the early, asymptomatic stage. Previously, this required detailed plant inspections to be carried out by highly skilled personnel.

Technology adopted

The tomato farm decided to develop a system for the automatic identification of disease pathogens – the Mobile Laboratory of Tomato Diseases. This is based on deep vision[390] and AI technologies. To implement this digital solution, the tomato greenhouse is using the services of a digital provider, and is collaborating with academics to gain access to the required expertise.

The system consists of hardware and software. The mobile hardware of the system allows effective monitoring of the plants grown in the greenhouse. The software identifies signs of disease on various parts of the plant (leaves, stem flowers, fruit) during both the asymptomatic and later stages of the disease, and can differentiate and identify pathogens. The system provides the user with real-time monitoring results in digital map format, indicating the location of disease outbreaks, the extent of lesions, and the stages of the disease.

The key implementation steps are:

- plant monitoring and zoning – the mobile hardware will monitor the entire greenhouse area and enable the zoning of plants according to relevant characteristics;
- identifying and classifying disease symptoms – the software will identify the signs of diseases on various parts of the plant (leaves, stem flowers, fruits) during the asymptomatic and later stages of the disease, being able to differentiate them and identify the pathogens of a particular disease;
- data processing and presentation – the system will provide monitoring results in the form of a digital map, showing the foci and stages of disease lesions.

[389] IoF2020 (n.d.). Within-field management zoning Baltics. Available at: https://www.iof2020.eu/use-case-catalogue/arable/within-field-management-zoning-baltics.

[390] Deep vision is the acquisition of information from a wide range of light, from visible to infra-red light. The collection of information can be performed with the help of various technologies, from optical cameras to molecular vibration spectrometers.

Agrifood	CS 29	Tomato greenhouse in Lithuania – Testing of precision agriculture
	Best practice principles	
	***P3** – Strategy*	***P7** – Cooperation*

Challenges encountered	Results and lessons learned
Even though the project is still ongoing, the team at the greenhouse has already encountered some challenges: • having the expertise to understand the working principles of digital solutions; • mapping all the necessary in-house agronomy-related data so that it can be integrated; • ensuring proper conditions for the testing and installation process without affecting production processes; • devoting time and resources to communication and integration processes.	The case study is still in its implementation phase, but some lessons learned can already be drawn: • collaboration with academia, researchers and technology developers is essential when testing and deploying digital technologies; • the team benefits from knowing the solution being implemented; • investments spent on experimentation and innovative digital solutions have the potential to pay off in the future – it is therefore important to take a long-term perspective.

Agrifood	CS 30	Blueberry farms in Lithuania – Testing of precision agriculture[391]

Best practice principles

***P6** – Planning*	***P7** – Cooperation*	***P8** – Solution*

Company description

A 1,500 ha. blueberry farm based in the Maišiagala district of Lithuania is participating in a FlexiGroBots project. The project aims to test the use of precision agriculture at different farms.

Intervention

Motivation to adopt digital technologies

Blueberry farmers, like other crop farmers, face several challenges in relation to their production. These relate to efficient monitoring of the crop, efficient use of pesticides and fertilisers, and the need for more accurate forecasting of crop yields.

Technology adopted

To become cost-effective, multi-robot systems for precision agriculture need to become more flexible. This can be achieved by employing multiple heterogeneous versatile (e.g. multi-task) robots, which collaborate to accomplish complex missions.

Several technologies were deployed during the implementation process.

- Deployment of multipurpose drones mounted with specialised imaging equipment and used to gather large amounts of precise multi- and hyperspectral data from blueberry fields.
- Open access data have been aggregated and integrated from various sources including Earth Observation data, current and historical weather data from dedicated service providers, as well as data provided by local public sector institutions.
- Other multi-sourced data from on-site IoT systems, local weather stations, and the results of previous research.

Data gathered via these sources is processed using deep learning techniques, resulting in analytical models that enable the remote assessment of plant needs and the detection of diseases, pests or other risk factors to blueberry plant health in their early stages.

Challenges encountered

Even though the implementation process is still ongoing, several challenges have already been encountered:

- a lack of digitalisation knowledge due to limited digitalisation experience;

Results and lessons learned

The farm has already observed more precise monitoring of crops, thanks to the aggregation of information from multiple sources, improvements in the targeting of herbicide and pesticide applications, and

[391] FlexiGroBots (n.d.) Flexible robots for intelligent automation of precision agriculture operations. Available at: https://flexigrobots-h2020.eu/flexible-robots-intelligent-automation-precision-agriculture-operations.

Agrifood	CS 30	Blueberry farms in Lithuania – Testing of precision agriculture[391]				
	Best practice principles					
		***P6** – Planning*		***P7** – Cooperation*		***P8** – Solution*
	• the farm's lack of human and financial resources during the implementation process; • specific environmental challenges (field layout, size, weather conditions).		optimised field activities according to the true needs of crops and the soil conditions evaluated. Some lessons learned are already evident. • collaboration with external stakeholders is helpful in testing new technologies and gaining access to technical support; • investments spent on experimentation, and innovative digital solutions have the potential to pay off in the future.			

Agrifood	CS 31	Agriculture farms in Lithuania – farm data integration[392]

Best practice principles

P2 – Fostering buy-in	P7 – Cooperation	P8 – Solution

Company description

This case study concerns the digitalisation of six agricultural farms located in Lithuania. Their sizes range from 130 to 900 hectares, while the crops they grow include rapeseed, wheat and corn.

Intervention

Motivation to adopt digital technologies

Even though these farms are equipped with modern agricultural machinery, they face the problem of incompatibility between software and data structures. Since there are several different formats and systems in use at the farms, data collection, processing, storing and display could not happen comprehensively and seamlessly. The farmers were thus motivated to increase the efficiency of their agriculture in promoting sustainable development by implementing advanced and innovative technologies.

Technology adopted

The farms adopted an intelligent agricultural machinery information system to increase the efficiency of agricultural production by implementing advanced technologies and making efficient use of available farm resources. The system allows complex data operation and analysis activities to be performed with the help of algorithms. The databases integrated into the system primarily store data generated by intelligent agricultural machinery. The processed data is stored in specially designed and configured databases. The data gathered allows the visual analysis of agricultural operations and yields, and provides quantitative information about the work performed during a selected period, such as the amount harvested, or the quantity of fertilisers or chemical products used for plant protection, etc.

Challenges encountered

The main technological challenge in adaptation related to differences in data formats and their integration together.

Results and lessons learned

The results of the system implementation were threefold:

- economic: a more efficient management system helps increase yield and reduce cost;
- environmental: in terms of the resources and materials used;
- social: farmers' work becomes easier, while the working environment becomes more favourable.

The farms recognised the role of user-friendly & understandable digital solutions and learned how to make use of the opportunities provided by the system.

Agrifood

CS 32 Oyster farms in Croatia – Assessing quality using spectral data[393]

Best practice principles

P5 – Financing

P6 – Planning

Company description

This shellfish farming company, located in the Adriatic region of Croatia, currently operates 5,000 farming lines deployed at sea with an estimated biomass of 100,000 kg of mussels and 30,000 oysters at various stages in their lifecycles.

Intervention

Motivation to adopt digital technologies

The main motivation for this digitalisation project stemmed from innovation trends in this market niche – namely, the introduction of preventative oyster testing on-site. This technology is based on the use of near-infrared (NIR) spectrometry in combination with machine learning and advanced data analytics. It helps farmers to assess oyster quality and growth conditions, to evaluate potential risks and plan at both the oyster growing and harvesting stages. It also enables the monitoring of oyster quality and preventive screening at different stages in the supply chain.

Technology adopted

The farm adopted the spectrometric technology and methodology for the preventive assessment of oyster quality on-site (SOQA). This software system is based on vibrational spectroscopy of the oyster meat and a neural network analysis of the spectral data. The company successfully created a functional software system model for the analysis of oyster meat samples and the identification of the main quality parameters.

The key steps in quality assessment using this technology are:

- scanning oysters using an NIR spectrometer;
- submitting data to the SOQA platform via an automated process;
- performing data analysis using the SOQA platform;
- receiving results regarding the main parameters of oyster quality, freshness and safety.

Challenges encountered

The main challenges faced during the adaptation process included the following:

- the solution required knowledge of both digitalisation and biotechnology;

Results and lessons learned

As a result, overall expenses were reduced by 35%.

The solution is still being implemented, but the farm owners highlight the importance of clearly stating the company's needs and objectively assessing its technical

[392] EIP-AGRI (n.d.). Integruotos kenksmingųjų organizmų kontrolės sistemos sukūrimas naudojantis aerodistanciniais-spektrometriniais metodais. Available at: https://ec.europa.eu/eip/agriculture/en/find-connect/projects/integruotos-kenksming%C5%B3j%C5%B3-organizm%C5%B3-kontrol%C4%97s-0.

[393] More information available at: https://agrifoodcroatia.com/.

• the farm had no previous digitisation experience; • ensuring the right conditions on-site.	and financial capabilities. Consulting experts and conducting training and a technology audit are helpful in this regard.

Agrifood

CS 33 De Trog in Belgium – An innovative and CO2-neutral bakery[394]

Best practice principles

- ***P2** – Fostering buy-in*
- ***P4** – Skills*
- ***P7** – Cooperation*

Company description

Founded in 1970, **De Trog** is a bio-label bakery that produces high-quality organic bread. The company combines traditional breadmaking with advanced manufacturing and digital technologies.

Intervention

Motivation to adopt digital technologies

De Trog initiated its digital transformation in 2013. The bakery aimed to scale up its production and improve the quality and efficiency of its processes. At the same time, De Trog's owners wanted to remain committed to both tradition and sustainability.

Technology adopted

At the core of De Trog's digitalisation were process automation and the use of various accompanying technologies such as Google Glass and AR, inspection cameras, automated monitoring and custom-made machinery.

The company then integrated data about its production conditions such as temperature and humidity to build algorithms that could help with decision-making in relation to product quality.

The company also gamified employee training: workers can challenge each other to play 'knowledge battles' using an app called 'Bakery Battle', covering various areas such as packaging, warehousing, etc.

Challenges encountered

While embracing sustainability, the bakery wanted to preserve traditions, and it was challenging to find the right way to do so.

The upskilling of the staff proved challenging, but the 'Bakery Battle' app and consulting external partners for knowledge and expertise helped to overcome this.

Results and lessons learned

Due to the combined effect of automation and significant investment in green infrastructure, De Trog became the first Belgian bakery to receive a CO2-neutral label. In parallel, the Bakery Battle app ensures its staff are well informed and up to date not only with safety and quality protocols, but also upcoming changes associated with digitalisation.

The company has benefitted greatly from the support and expertise of more than 20 public and private institutions, training facilities and competence centres, as well as outsourcing digital solutions in order to focus on its primary function – that of production.

Agrifood	CS 34	Van Den Borne Aardappelen in the Netherlands – Smart farming[395]

Best practice principles

***P5** – Financing*	***P6** – Planning*
***P7** – Cooperation*	***P8** – Solution*

Company description

Van Den Borne Aardappelen is a family farm, consisting of roughly 550 hectares of land, devoted primarily to potato crops, but also to maize, wheat and sugar beet. Thanks to innovative spirit, it has now evolved into one of the most digitally advanced farms in the Netherlands, gaining industry recognition for its innovative practices.

Intervention

Motivation to adopt digital technologies

The motivating factor behind the farm's adoption of digital technologies was to increase the volume and quality of crop yields.

Technology adopted

The company chose to implement precision agriculture. For this purpose, it introduced several solutions: GPS, drones and sensors. Thanks to these solutions, the farm could monitor the health of the soil and accurately determine cultivation requirements. The management of field operations is further supported by crop monitoring tools and software that provides real-time data and insights to help ensure maximum efficiency and productivity.

To adopt such technologies, the company relied on two strategies. On the one hand, it has received public financial support from local, regional and national SME innovation and rural economic development programmes to help finance the farm's digital transformation ambitions, as well as participating in a long list of publicly supported R&D and innovation projects, co-funded by the Dutch government and the agricultural industry. On the other hand, the company has also benefitted from collaboration with knowledge institutions and other companies.

Challenges encountered

The main challenge concerned significant investments in time and money to research the technologies available for smart farming, and to test out use-cases.

Results and lessons learned

Precision farming has allowed the company to make informed decisions about irrigation and fertiliser use. As such, it managed to increase crop yields, reduce the amount of water, fertilisers and fuel used, and increase revenue.

[394] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

[395] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

Agrifood	CS 34	Van Den Borne Aardappelen in the Netherlands – Smart farming[395]		
	Best practice principles			
		***P5** – Financing*		***P6** – Planning*
		***P7** – Cooperation*		***P8** – Solution*
	This case study emphasises several important lessons: • seeking support through funding and guidance/training programmes; • collaborating with the broader ecosystem to keep up to date with new technologies and identify their future potential; • running initial test trials and use-cases before scaling up company-wide.			

Construction industry

Construction	CS 35	BUGARU TRANS SRL in Romania – Adopting collaborative technologies
	Best practice principles	
	***P3** – Strategy*	***P8** – Solution*

Company description

Bugaru Trans SRL is a company from southwestern Romania that was established in 2010. In 2021, the company employed 96 workers and had a turnover of RON 2.7 million. Its services include civil construction, renovation, sewage, construction site management, as well as other specific services such as refurbishments, demolition, setting foundations, and exterior painting and decoration.

Intervention

Motivation to adopt digital technologies

The company's growth has resulted in a rapid increase in the number of employees and clients. This has led to certain inefficiencies emerging within the company in relation to data and process management.

The company was also motivated to adopt technologies relating to process management and data exchange after seeing these being implemented successfully by its clients.

Technology adopted

The company decided to automate the management of its internal processes, in particular the exchange of documentation between the company and its clients.

An internal communication system (intranet) has already been established at Bugaru Trans. The company implemented licensed project management software that enables the monitoring of common Gantt charts. In addition, it set up a platform via which clients and company employees can work together and exchange data. It also connected topometric services to the internal server. These technologies were adopted incrementally. While these initiatives had already been planned, the digitalisation process was accelerated due to the COVID-19 pandemic.

Challenges encountered

The company found it challenging to hire digitally skilled staff and train its employees to use the newly implemented system.

The most challenging period was digitising the company's internal databases, previously held in basic .xls format. This required significant resources from the Bugaru Trans team.

Results and lessons learned

Thanks to the technologies implemented, every employee and client now has an account on the Bugaru Group platform, via which topographic and building measurements and coordinates are transmitted. In this manner, a close link is maintained, via topometric stations, between the construction sites and the company's offices.

Construction	CS 36.1	LEVIATAN in Romania – 1st and 2nd phases of continuous digitalisation[396]	
	Best practice principles		
	***P1** – Managerial capacity*	***P3** – Strategy*	
	***P6** – Planning*	***P8** – Solution*	

Company description

LEVIATAN SRL provides integrated architecture and civil engineering services. Over its 10 years in business, it has evolved into a supplier of complete services supporting design and building projects.

Thanks to its digitalisation journey, the company now uses several digital technologies to assist in the design and building process. These include Microsoft HoloLens2 devices; mixed reality software, such as Visual Live and Next BIM; and cutting-edge data collection and processing equipment such as the FARO Laser Scanner, as well as the Phantom 4 RTK drone and HoloKase.

Intervention

Motivation to adopt digital technologies

The company's digitalisation journey began shortly after the 2008 economic crisis and its effects on the Romanian construction market. The company struggled to attract and retain highly skilled employees. LEVIATAN's company management decided to increase its competitiveness and differentiate itself from the competition by becoming more efficient through digitalisation.

In addition, architects and designers struggled to track changes made to building plans. They would often take paper-based building plans to construction sites. Cross-checking the changes introduced later diverted time away from other activities. In addition, the use of 2D plans was insufficient to monitor and showcase the various layers of the construction process.

Technology adopted

The first step in the process was to digitalise internal and external communications. The team aimed to integrate all communications into a single platform. LEVIATAN initially adopted several different ERP-type technologies. However, in the end, the company opted for Microsoft Teams.

To identify further digitalisation needs, the company ran a working session with the management team to map company processes, identify issues that occur regularly, and formulate potential courses of action. According to the company, this process was eye-opening for employees, as it uncovered multiple inefficiencies in the company's day-to-day operations. This increased the team's motivation to improve the way they worked. This process took the company around one year to implement.

[396] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

Construction	CS 36.1	LEVIATAN in Romania – 1st and 2nd phases of continuous digitalisation[396]	
	Best practice principles		
	***P1** – Managerial capacity*	***P3** – Strategy*	
	***P6** – Planning*	***P8** – Solution*	

To ensure the rest of the company was supportive of its digitalisation plans, the management team invested time in developing instruction manuals and templates for company processes, deliverables and documents. The company also incorporated the agile methodology into its daily work. Company management reported that the introduction of the agile decision-making process resulted in reduced coordination times and more transparent work processes.

Lastly, because the company gained significant digital skills carrying out the digitalisation steps above, it decided to collaborate with BIM software resellers in Romania to develop specific adjacent software packages, and to become beta testers for them. It also collaborated with a service provider in Romania to develop a building monitoring solution that provides transparency regarding the technical specifications of a building (and all of its installations), to help with building maintenance across all phases of its lifecycle, as well as transitions between multiple owners.

Over several years, the company has undergone a complex digital transformation journey, beginning with automating data exchange, and resulting in the full automation of company processes.

Challenges encountered	Results and lessons learned
The continuous digitalisation process brought several 'waves of shocks' to company employees. The company underwent a steep learning curve that required patience from all parties.	The company has managed to stand out in the local market through its ability to adapt. The company points to digitalisation, the automation of internal processes and the adoption of innovative working methods such as BIM as reasons for its flexibility. According to a company representative, involving early adopters with a change mindset into process mapping, process change and experimentation was important in facilitating buy-in. Furthermore, the company relies on strategic planning meetings rather than committing to a written Digital Strategy. The company now has a mind map of digitalisation objectives. The results of these steps, particularly the introduction of templates and instruction manuals, were helpful in the training of new employees, who could feel they were already operational in their new positions within a record time of 1-2 months. As a result, the company has grown very quickly, from 31 to 96 employees in just three years.

Construction	CS 36.2	LEVIATAN in Romania – 3rd phase of digitalisation: fully digitalised processes[397]	
	Best practice principles		
	***P1** – managerial capacity*	***P2** – fostering buy-in*	
	***P3** - Identifying needs*	***P6** – Planning*	

Company description

LEVIATAN SRL, on which the previous case study was also based, provides integrated architecture and civil engineering services. Over its 10 years in business, it has evolved into a supplier of complete services supporting design and building projects.

Intervention

Motivation to adopt digital technologies

As a result of the company's continuous digitalisation efforts since 2008, and given the success of the ERP, agile ways of working and BIM software introduced, LEVIATAN's management has decided to fully digitalise the way in which the company operates. Furthermore, thanks to successful collaboration with digital service providers, company leadership has decided to establish a new IT company with the sole objective of developing digital solutions for its sister architecture company.

Technology adopted

The establishment of the new company and the digitalisation of the LEVIATAN architecture branch took 2.5 years. During this time, the company implemented the following digital technologies:

- The newly established IT team developed databases of standardised and codified building materials (such as prefabricated walls, windows, doors etc), with historical data in terms of price developments.
- The historical price data sets allowed the development of predictive algorithms for price progressions and fluctuations, as well as for the analysis of the most frequently occurring errors and miscalculations in architects' work. This led to significant improvements in price quotations and the accuracy of cost estimates.
- The development of the aforementioned databases of building processes and documentation allowed for the clustering of several templates for rooms, spaces and other structures of various sizes. As a result, the team is now able to prepare detailed building plans and designs more quickly.
- In parallel with the implementation of the third phase – namely, the scaling of BIM and creating IT teams to develop databases and predictive algorithms – the company experimented with digitalising the processes involved in a building site visit. It equipped all architects with tablets connected to the BIM-common data environment. Lastly, the team at LEVIATAN began testing and employing BIM-based AR technologies using a Microsoft HoloLens device, which could be regularly updated with

[397] Conclusions from the panel discussion during the 'Workshop on SME digitalisation: how to make best practice a reality', organised on 10 November 2022 as part of this study.

Construction	CS 36.2	LEVIATAN in Romania – 3rd phase of digitalisation: fully digitalised processes[397]	
	Best practice principles		
	***P1** – managerial capacity*	***P2** – fostering buy-in*	
	***P3** - Identifying needs*	***P6** – Planning*	

construction site monitoring data transmitted by a newly acquired drone with photometric and laser scanning properties.

Challenges encountered

One of the major challenges encountered was finding the necessary time and resources to introduce the new technologies. Nevertheless, LEVIATAN's management was convinced about the need for further digitalisation, in part due to the success of the digitalisation steps taken in earlier phases (see Case Study 36.1).

When asked how the management and employees managed to find the time to digitalise their company, a representative stated that 'If you cannot find 1-2h every day to work on making your processes more efficient, it is as if you are pushing a huge boulder uphill every day and you do not take time to stop and install wheels on it'.

Results and lessons learned

As a result of the centralised databases and the use of predictive algorithms, the process of price estimation was reduced from one week to 15 minutes. Similarly, due to the detection of the most frequently occurring errors in architects' work, the approval process for offers or building projects has also become much more efficient.

The use of BIM-based AR technologies was seen as the biggest breakthrough by LEVIATAN's management. This has helped to reduce errors, improve communications between on-site and office teams, and allowed the integration of changes in real time.

Automotive	CS 37	Fiber Network WUG in Germany – Cooperatives-built internet infrastructure for local people, enterprises and future stakeholders

Best practice principles

***P1** – Managerial capacity*	***P2** – Fostering buy-in*
***P6** – Planning*	***P7** – Cooperation*

Company description

Fiber Network WUG is a subsidiary of Nahwärme Pfofeld eG. This company is an example of a cooperative formed to speed up broadband internet connection in rural areas of Bavaria where it is not yet profitable enough for large internet providers. Firms and private persons collaborate through cooperatives to promote equal living conditions in rural areas.

Intervention

Motivation to adopt digital technologies

High-speed internet involves digging and installing fibre optic cables, which is expensive and requires construction work. This is often not cost-effective or yields low returns on investment for profit-oriented internet providers. Governmental approval of funds for public projects is also slow and inflexible. In addition, outsourcing construction of the network infrastructure (e.g. digging up roads and laying cables) would have been much more costly.

Technology adopted

A high-speed internet network was successfully constructed through a cooperative formed by local enterprises, individuals and other stakeholders. The novelty lies in its synergy with the pre-existing local heating network, based 100% on renewable energies.

Local heating networks must be controlled and monitored in order to make optimal use of the system and avoid heat losses. This requires the installation of control modules throughout the network. These modules need to constantly communicate with the main controller to exchange data. This process can be implemented either using copper lines or fibre optics lines. In this case, the latter solution was chosen, despite being four times as expensive. By being installed alongside the heating system, the solution allowed the town to obtain high-speed internet, using a pre-existing network to lay the cables without having to dig deeper or outsource the work.

As a result, every household in the town now has its own active fibre optic cable connected to the distributor in the heating system warehouse, guaranteeing a high-quality internet connection to everyone. The investment will pay for itself within eight years, compared with an estimated 15 years if the work had been outsourced.

Challenges encountered

Two main challenges were encountered:

- the infrastructure required significant monetary investment, so it was

Results and lessons learned

Several tangible outputs can be gained from this experience:

- citizens in these rural areas can now surf the internet at a speed 10 or 20 times higher than many

Automotive	CS 37	Fiber Network WUG in Germany – Cooperatives-built internet infrastructure for local people, enterprises and future stakeholders		
	Best practice principles			
		***P1** – Managerial capacity*		***P2** – Fostering buy-in*
		***P6** – Planning*		***P7** – Cooperation*

important for everyone to commit to the solution and contribute financially;

- finding an Internet provider was difficult, because no company was willing to operate the local network, even after its completion, since it was not deemed profitable. In the end, a provider leased the fibre optic network from the cooperative and had the municipality reimburse the funding gap.

city-dwellers, thus obtaining a location advantage for many enterprises;

- the network has since expanded to other rural areas in Bavaria, with an estimated turnover of EUR 1.3M in 2021, thus proving economically self-sustainable;
- the success of this experiment has convinced the local Bavarian government to take on this heating-internet network synergy, creating clear guidelines as to how such projects can be implemented, and improving funding conditions.

The main lessons to be learned are:

- the importance of fostering buy-in for digital transformation, even when this requires a significant *ex-ante* cost;
- having a clear implementation roadmap with regard to costs and benefits;
- taking advantage of cooperative efforts and seeing how they can be expanded beyond the local level.

Construction	CS 38	PORR Romania – Adopting 3D modelling technologies on construction sites		
	Best practice principles			
		***P1** – Managerial capacity*		***P2** – Fostering buy-in*
		***P4** – Skills*		***P8** – Solution*

Company description

PORR Romania is a local subsidiary of an Austrian multinational construction company that operates in 10 countries worldwide. In Romania, PORR is known for its work on large infrastructure projects such as the national railways, the Port of Constanța, and the road network.

Intervention

Motivation to adopt digital technologies

The adoption of digital technologies was mostly driven by the company's leadership, rather than being based on the necessity to address particular needs. The CEO of PORR wanted to push the boundaries of innovation at the company, with the aim of becoming a frontrunner in the use of 3D modelling technologies for construction work.

Technology adopted

The company adopted several digital technologies, aimed at the application of 3D models to construction sites. The key technologies that were introduced include:

- BIM, which is used to create 3D visualisation of the facility or building to be constructed.
- Custom-built machine control modules, developed by the navigation firm Trimble, which allow the company to transmit the 3D models developed in its office directly to the building site machinery. A dedicated BIM site engineer was employed to implement these changes.
- Drones and LIDAR scanners, which were used to provide a 3D scan of the terrain and the construction site, allowing for easy calculations of volumes dug, with low error rates.

The introduction of 3D modelling technologies in construction began as an experimental pilot project, and has since been upscaled to all of the company's construction contracts.

Challenges encountered

The main challenge to the implementation of the new technologies was resistance to switch to the new technologies on the part of sub-contractors and on-site builders. Once they saw the benefits of the technology, however, their attitudes changed.

Results and lessons learned

The company observed the following benefits:

- The introduction of machine control modules contributed to an increase in the efficiency of projects by connecting the office with the construction site.
- Drones expedited the monitoring of and calculations regarding construction projects.

Construction	CS 38	PORR Romania – Adopting 3D modelling technologies on construction sites		
	Best practice principles			
		***P1** – Managerial capacity*		***P2** – Fostering buy-in*
		***P4** – Skills*		***P8** – Solution*
	The case study highlights several best practices: • the importance of having pro-active leadership willing to push innovation boundaries and make the company an early adopter of cutting-edge technology; • the necessity to secure people with the skills required to maximise the benefits of new technologies; • the usefulness of running a pilot before upscaling and expanding practices to the entire company.			

Construction	CS 39	Norteña de Aplicaciones y Obras in Spain – Paperless construction[398]		
	Best practice principles			
		P2 *– Fostering buy-in*		***P3*** *– Strategy*
		P5 *– Financing*		***P7*** *– Cooperation*

Company description

Norteña de Aplicaciones y Obras provides specialised services in roof waterproofing. Its core team consists of a few people, making it a micro-enterprise. When it comes to digitalisation, the company relies on collaborations with multiple freelancers.

Intervention

Motivation to adopt digital technologies

Meeting market needs and remaining competitive were the biggest drivers for the company to adopt modern solutions and cater to clients' needs. In addition, daily routine of workers, such as filling in worksheets, was cumbersome and time-consuming. Norteña's CEO was motivated to make the company more competitive and efficient.

Technology adopted

The company introduced digital tools for ERP and Customer Relationship Management (CRM). These allowed workers to fill out worksheets directly on their tablets and smartphones. In addition, an integrated internal system with several modules enabled close monitoring of the company's activities, as well as:

- faster worksite incident management;
- real-time cost control of different projects per department and employee;
- digital management of invoices and payments;
- displaying all of the information on a dashboard, and real-time control of the company's finances.

Norteña also adopted several innovations targeted at improving customer experience. For example, placing QR codes on the roofs it produces; by scanning these, a client can immediately access relevant documentation or receive automatic notifications about a project's status, along with up-to-date pictures of the site.

Prior to this project, Norteña took part in activities within the ecosystem such as local conferences and forums to share its digital transformation journey. It has also been featured in the local and national press. At the same time, the management has involved the entire team in the digitalisation process, including defining the company's digital strategy.

Challenges encountered

- The implementation required major funds. Accessing public support appeared to be rather complicated and time-consuming.

Results and lessons learned

Having digitalised most of its processes, Norteña substantially enhanced its management, decision-making and service provision:

Construction	CS 39	Norteña de Aplicaciones y Obras in Spain – Paperless construction[398]		
	Best practice principles			
		***P2** – Fostering buy-in*		***P3** – Strategy*
		***P5** – Financing*		***P7** – Cooperation*
	After several attempts, the company decided to rely solely on its own funds. • At first, going paperless at the construction site proved a big challenge in terms of mindset change. • Integrating different modules and refining the communications between them was also a challenge.		• time spent by workers on paperwork went down by 80%; • waste was minimised; • turnover grew by 450% in eight years. Norteña's CEO attributes these achievements to the company's innovative mindset and 'start-up mentality'. Two success factors it emphasises are: • participation in events within the ecosystem; • the involvement and commitment of staff throughout the process.	

[398] European Commission, Executive Agency for Small and Medium-sized Enterprises (2021). Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document. Publications Office. Available at: https://data.europa.eu/doi/10.2826/120209.

Construction	CS 40	Karl Wolf GmbH & Co. KG in Germany – Single platform for clients[399]	
	Best practice principles		
		***P2** – Fostering buy-in*	***P6** – Planning*

Company description

Karl Wolf GmbH & Co. KG is a medium-sized construction company. Its operations range from classic residential construction to reconstruction, building maintenance, project development, utility and industrial construction.

Intervention

Motivation to adopt digital technologies

As a construction company in the utility sector, the company deals with a large number of different stakeholders and coordinates a large number of projects – both small and large construction sites. Stakeholders regularly need to exchange information with each other. The company realised it could use a central platform to exchange information and reduce the number of phone calls, emails and personal meetings.

Technology adopted

Looking for a suitable digital tool and being inspired by agile project management solutions from the IT and automotive industries, Karl Wolf GmbH & Co. KG adopted a solution called Kanban Board. This is a visual tool that provides an overview of the current status of tasks and projects, and assigns attributes to them such as a start date, construction site or contact person. Projects can then be marked with a status (e.g. 'site ready for client assembly', 'assembled', 'completed by contractor' or 'invoiced'). The company chose Microsoft Teams as the digital solution to implement this tool.

Challenges encountered

Since some of the company's clients are part of critical infrastructure, requirements with regard to IT security and data conformity were vital criteria in choosing suitable software without imposing a large additional cost on clients. The choice of Microsoft Teams allowed the company to gain immediate approval from the IT departments of its clients.

Results and lessons learned

Using the new platform, all stakeholders can now enter project information into a single board and access it in real time. The choice of Microsoft Teams allowed the company to avoid costly programming work, and made the solution accessible and intuitive for clients. Now, significantly more work can be done off-site.

All stakeholders were trained in how to use the tool during a kick-off meeting. This helped to avoid the need for further training in the future.

[399] European Commission (n.d.). Karl Wolf GmbH & Co. KG. Digitalisation of Construction SMEs. Available at: https://digital-construction.ec.europa.eu/best-practice/40/karl-wolf-gmbh-co-kg.

Construction	CS 41	Shay Murtagh Precast in the UK and Ireland – BIM software and 3D design				
	Best practice principles					
		***P2** – Fostering buy-in*		***P3** – Strategy*		***P4** – Skills*

Company description

Shay Murtagh Group is a full-precast company that has several factories in the UK and Ireland. It manufactures precast products, from bridge beams to architectural elements. The company is trying to implement digital technologies across the whole group.

Intervention

Motivation to adopt digital technologies

The company's owners realised that digitalisation and the revision of traditional methods of operation could bring significant added value to its supply chain and to its clients. Digitalisation covered not only the company's production, but also its entire workflow. Connecting all of the stages of production from start to finish, and exchanging data between them, was a big challenge. Digitalisation was thus seen as a potential solution.

Technology adopted

The most important tool Shay Murtagh Group has adopted is BIM software: Tekla Structures, and the Trimble suite. These are used to develop designs and demonstrate them to clients and partners. All models and information on projects and designs can be accessed via a smartphone and shared using a simple link. This has proved useful during off-site work.

The company also introduced 3D models, which allow more precise measurements to be provided to clients. In addition, clients can now access a shared online platform, accessible from either a computer or a smartphone, to view the project's status and other information at any time.

To introduce these innovative solutions, company management relied on a strategy that outlined both short- and long-term goals, as well as ways in which to regularly measure progress towards achieving them. The company revises and tailors its strategy every year, taking into account successes and failures.

Challenges encountered

Like many other companies, Shay Murtagh Group faces a lack of skilled labour necessary for digitalisation, as well as lacking the time needed for staff training.

Some non-digitalised processes are still too time-consuming. Hence, in the future, the company aims to improve communication between departments and to automate more tasks along

Results and lessons learned

The digitalisation of all procedures has allowed the company to improve and minimise its errors. Through the use of BIM software, the company was partly able to continue certain operations, such as project design, during the COVID-19 lockdown.

The company owners conclude that the start of the digitalisation process reveals a lot of further opportunities for added value, and sheds light on the processes that can be improved. Another lesson they have learned is how

Construction	CS 41	Shay Murtagh Precast in the UK and Ireland – BIM software and 3D design			
	Best practice principles				
		***P2** – Fostering buy-in*		***P3** – Strategy*	***P4** – Skills*
the workflow, as well as ensuring better quality control.			important it is to begin with a strategy and clearly defined and measurable goals, and to revise these regularly. The company representative also highlighted the importance of making sure that the staff know about the changes foreseen, and that they understand and accept the reasoning behind them.		

Construction	CS 42	Sweco in Norway – centralising calculations and 3D modelling

Best practice principles

P2 *– Fostering buy-in*	***P6*** *– Planning*

Company description

Sweco Norway is the Norwegian branch of a European engineering consultancy company. Its bridge department is developing BIM models and products for bridge construction. The company now specialises in delivering and building bridges based on 3D models, without the use of 2D drawings.

Intervention

Motivation to adopt digital technologies

The company wanted to make a shift from 2D design towards the use of 3D models. The company management was also motivated by improving quality control and keeping all calculations in one place. Its goal in adopting digital technologies was to improve the accuracy of measurements and the overall efficiency of production.

Technology adopted

Sweco Norway chose to implement parametric design – a method that uses algorithmic processes to generate design outputs. This solution was important for the company because, together with 3D modelling, it enables the creation of bridge mock-ups that can be used to identify potential problems. In addition, the company integrated several smaller calculation programs into a single piece of software with a centralised calculation function that extracts data collected on different machines with the help of API.

Challenges encountered

The challenges the company faced included:

- knowledge sharing;
- integrating parametric design into the daily workflow;
- lack of advanced software for easier access to information about each model;
- standardising digitalisation across the entire company and making sure that all staff work in the same way.

Results and lessons learned

The adoption of parametric design has helped the company to minimise resource waste due to more accurate measurements. The company has been able to obtain more accurate measurements from the very start of the project.

Due to the adoption of a remote mode of operation, the company did not experience the harsh impact of the COVID-19 pandemic on its operations.

The management emphasises the importance of knowing why an innovation is introduced and who is going to use it. These factors will determine further progress in implementation. The company also highlights the importance of demonstrating the benefits of digitalisation to all parties involved. Another option is to first test a solution out with a few of the most committed agents of change among the company's staff.