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EXECUTIVE SUMMARY

Brief overview of the analysis key findings and recommendations

1. Introduction

The regional mapping analysis within the GREENE 4.0 project aims to comprehensively understand the current state and potential for innovation in the sustainable business sector across Central European (CE) regions. The analysis focuses specifically on small and medium-sized enterprises (SMEs) in the manufacturing industry.

With SMEs forming the backbone of European industrial value creation and employment, their transformation capacities carry economy-wide implications. However, multiple bottlenecks around finances, technical know-how, policy frameworks and change management inhibit SMEs from keeping pace on green and digital transitions compared to larger corporates.

A comprehensive survey was conducted with 422 manufacturing SMEs across 7 CE countries, including Slovenia, Hungary, Germany, Austria, Czech Republic, Poland and Italy, in order to develop a holistic view of the adoption levels of green and digital technologies, as well as the key barriers inhibiting further adoption. The survey questionnaire contained sections on company details, technology usage, green manufacturing practices, supply chains, perceived usefulness, effort expectancy, facilitating conditions, ease of use, external influences, and attitudes towards change. Both quantitative data and open-ended responses were collected.

In total, the mapping analysis surveyed 422 manufacturing SMEs across the CE regions to gain representative sample coverage across company sizes, sub-sectors, and geographic areas. The analysis aimed to understand: Current adoption rates of green/digital technologies; perceived barriers, risks and uncertainties; future plans and innovation interests; required resources and supports.

Aligning with the twin goals of environmental sustainability and digital leadership aspired under initiatives like the European Green Deal, the survey provides vital signals into the dispersion of transition-enabling capabilities and supportive conditions for SMEs. It focuses on diverse manufacturing verticals - from automotive, machinery and plastics to textiles, furniture and food production. Spanning micro companies to mid-sized enterprises, the survey captures technology adoption patterns, sustainability practices, attitudes, perceived barriers and expressed needs across a representative typology. It examines interlinked dimensions like innovation ecosystems, production processes, supply chain relationships and customer influence shaping SME environments.

By recognizing regional disparities in SME contexts, adoption inhibitors and leverage points, the analysis informs evidence-based recommendations for acceleration. It showcases collaborative opportunities between solution providers, industries, and policymakers to solidify inclusive and green competitiveness.

1.1. Objectives

- Assess the present adoption levels of green manufacturing practices and digital technologies among SMEs. Understand the perceptions, attitudes, and barriers companies face in transitioning to greener and more digitally integrated business models. What solutions see widespread usage versus areas of underutilization? What adoption barriers are commonly pointed?
- Identify specific areas where innovation can be accelerated, such as production processes, supply chains, and consumer relations. Recognize financial, technical, and regulatory challenges that hinder the transition to smarter, greener factories. Understanding mindsets, attitudes and perceived challenges faced by companies of different sizes and sub-sectors towards embracing innovation. What sustainability practices or digital tools generate positive responses? Which ones are seen as too complex or risky?
- Explore opportunities for creating new regional and transnational value chains to foster collaborative innovation between manufacturing companies, technology providers, and private equity. Identifying specific areas for facilitating supply-demand pilot actions, capability enhancement, policy revisions or financing instruments based on respondent feedback. What mechanisms can generate faster change?
- Improve user acceptance and knowledge of smart manufacturing practices through tailored communication and educational initiatives. Deploy an innovative user acceptance tool to guide and facilitate the transition towards sustainable manufacturing.
- Provide actionable insights and recommendations to RIS3 authorities to influence policy-making and demonstrate the advantages of adopting green and digital technologies.
- Support companies in identifying and implementing economically viable sustainable business models that are environmentally friendly. Emphasize the role of green innovation in enhancing competitiveness. Guiding SMEs with future developed customized tools and good practices on digitally-enabled sustainability solutions suited for their scale and sector specifications. What business models align profitability with environmental gains?
- Recognize the unique industrial strengths, innovation capacities, and challenges of each region. Conduct a comparative analysis to understand diverse regional dynamics and share best practices. Recognizing zones of excellence, systemic challenges and leverage points unique to each regional industrial ecosystem by holistically analyzing barriers, capacities and change propensities
- Assessing the potential for collaborative networks between solution providers, research institutions and SME manufacturers across borders to customize offerings. How can cooperation models be structured for relevance and accessibility?

Overall, this regional mapping analysis lays the groundwork for achieving the GREENE 4.0 project's goal of boosting innovation capacity among CE manufacturing SMEs for a swift transition to sustainable and technologically advanced business models.

1.1.1. Key findings and recommendations

Here is an expanded version of the key findings and recommendations from the regional mapping analysis:

Key findings	Description
Trends in Adoption of Green and Digital Technologies	There's a positive trend in adopting green manufacturing technologies, but varying implementation levels across different practices. Surveyed SMEs showed awareness of the impending digital and circular transformation and the growing customer demand for environmentally friendly products: Positive adoption momentum seen around foundational digital technologies like cloud, CRM and ERP as well as some green solutions like renewable energy and equipment efficiency. However, emerging digital tools and environment-friendly materials remain underutilized. Implementation intensity varies across company sizes, sub-sectors and geographic clusters. Changes are incremental amongst financial limitations, technical uncertainties, and administrative complexities.
Challenges and Barriers	The primary barriers include financial constraints, legal uncertainties, and human resource challenges. These are exacerbated by the unpredictable market environment: ■ Financial constraints regarding high investment costs and long payback horizons limit adoption scales ■ Ambiguous or contradictory regulatory frameworks create compliance uncertainties. ■ Talent shortages, low green and digital literacy and change resistance impede transformation. ■ Legacy hardware compatibility issues and interface complexities affect integration. ■ Lack of information regarding applicable solutions suited for localized needs. ■ Lack of access to specialized advisory, network customized support services from expert, “test before invest.”
Perceived Usefulness and Change Acceptance	There is a general agreement on the usefulness of digital technologies and green practices in enhancing efficiency and product quality. However, there is some disagreement on the perceived complexity of implementing these technologies, with concerns about the significant efforts required for sustainable transformation: ■ General agreement on potential operational benefits from digitalization and shift towards greener materials. ■ However, skepticism exists on actual financial returns, viability beyond pilot cases. ■ Moderate overall positive disposition toward embracing sustainability and efficiency boosting solutions. ■ The likelihood of change happening is influenced by the vision of the leaders, the availability of skilled individuals, and the ability to see examples of successful change in action

Attitudes towards changes	There's a moderate likelihood of SMEs integrating or increasing green manufacturing processes in the coming years, with a slightly higher tendency towards adopting energy-efficient machinery. ■ Some SMEs are open to expanding their green manufacturing processes or adopting digital tools in the next five years, with around 30-35% expressing interest. ■ There are noticeable differences across regions. Slovenia, Poland and the Czech Republic are more likely to embrace green processes, while the Germany and Italy show a greater interest in digital tools. ■ The focus for many SMEs is on proven solutions like renewable energy and equipment efficiency, rather than innovative materials or disruptive technologies. ■ The likelihood of adoption is higher in domains where there are clear cost savings or regulatory obligations. ■ Positive responses are mainly seen among existing innovators and early adopters, while the majority may be more cautious due to barriers. ■ Challenges such as risk perceptions, conservative decision-making, long return on investment timelines, and lack of local demonstration cases hinder rapid scaling. Overall, there is some momentum, but further progress will require addressing adoption barriers, mitigating risks, and spreading the results on a larger scale.

Based on the key findings the following potential activities are recommended:

Recommendations	**Description**
Systematic integration of sustainability	Incorporate sustainability issues at all management levels, especially in medium and large companies: ■ Incorporate sustainability KPIs into strategic planning and tie executive incentives for large enterprises. ■ Create dedicated roles like Sustainability Head to coordinate environment programs and audit impacts. ■ Pursue partnerships with B2B customers, industry coalitions to integrate circular economy principles.
Development of Digital and Green Skills	Realizing and delivering customized training and mentoring programs for developing digital and green skills: ■ Assess key skills gaps through analysis of current and emerging priority technological domains. ■ Develop blended training programs, online certifications, and short-term secondments for rapid reskilling. ■ Leverage virtual mediums to maximize reach and lower barriers posed by production pressures. ■ Establish industry mentor networks to propagate skills and improve risk perceptions.

Promotion of Green and Digital solution	Demonstrate successful implementations in companies with similar operational profiles: ■ Create searchable databases of localized use cases across priority impact areas using robust frameworks. ■ Develop or provide or use virtual and augmented reality approaches to digitally demonstrate working implementations. ■ Encourage solution providers to host trial periods on key equipment and software for hands-on experience. ■ Support solution providers to engage with manufacturing companies for developing, testing, refining, and validating their solution. ■ Matching solutions and co-creation tools for co-development and demonstration of tools, including dedicated pilots focused on "test before invest."
Incentivization	Design and pilot small scale incentivization tools or programs for supporting green transition and digital transformation: ■ Introduce sustainability-linked innovation vouchers, loans, and competitive funding mechanisms. ■ Offer tax reliefs, fast-tracked licensing, and regulatory sandbox access for priority technology domains. ■ Develop public-private investment vehicles focused on infrastructure upgrades and pilot demonstrations. ■ Design and pilot green financial mechanisms combining green grants, green loans, and green equity. ■ Design and pilot a green bond mechanism for supporting SMEs green and digital transformation/investments.
Sustainability Leadership Roles	The survey findings reveal that strategic commitment from the leadership plays a pivotal role in driving the adoption of sustainability practices. To institutionalize this commitment, manufacturing SMEs can designate specialized executive positions like Chief Sustainability Officers (CSOs): ■ Manufacturing SMEs can assign senior executives as Chief Sustainability Officers (CSOs) to drive sustainability efforts and coordinate across departments. ■ CSOs can lead initiatives for material innovation, promote circular economy practices in the supply chain, engage with policymakers, and track environmental performance metrics. ■ In addition, Green Technology Officers can be appointed to stay informed about emerging solutions, conduct technology research, and manage pilot projects. ■ Dedicated leadership is crucial to embed sustainability practices within SMEs, especially considering competing priorities and limited resources. CSOs can audit the current environmental impact of operations, set targets aligned to regional/global goals, liaise with regulators, coordinate capability building, and monitor progress through robust data measurement systems. Additionally, Circular Economy Transformation Managers can be appointed to lead supply chain engagement, material innovation and transition roadmaps to closed-loop approaches.

Joint Innovation with Research Institutions	The analysis highlights gaps in availability, awareness and affordability of solutions tailored for SME manufacturing contexts. Structured innovation partnerships between industries, academia and technology developers can address this through joint development, open testbeds and capability transfer. ■ Establishing partnerships between industrial clusters, academic institutes, and technology developers can create testbeds to demonstrate sustainable digital technologies. ■ Applied research grants and regulatory sandboxes can facilitate collaboration on technology testing, customization, validation, and knowledge transfer. ■ Pre-competitive industry collaborations (matching supply-demand; open innovation partnerships; open innovation tools) allow pooling of resources, shared infrastructure, and risk mitigation before making investment commitments. ■ Showcasing successful implementations can promote the effectiveness of these solutions while SMEs can remain focused on their core operations.
Interregional knowledge and best practices sharing	While regional concentrations shape certain adoption trends, knowledge diffusion across borders carries substantial value. Initiatives for exchange of best practices, peer learning mechanisms and immersion visits between SME leadership across European cluster networks can accelerate this diffusion. ■ SME leaders can engage in best practice sharing and participate in immersion visits across European cluster networks, facilitating faster knowledge diffusion. ■ Structured peer learning mechanisms through platforms like EIT Manufacturing, CDTI, and Enterprise Europe Network can enhance access and relevance. ■ Program focus areas may include developing roadmaps for green digital technologies, exploring public-private partnership models, and creating policies tailored for SME manufacturers. ■ Establishing partnerships between leading and emerging regions can offer embedded exchange programs for sharing expertise and experiences.
Access to Finance	Availability and affordability of financing facilities remains a frequently cited barrier, especially for smaller SMEs with limited collateral or sectoral expertise among traditional financiers. Instruments like sustainability-linked loans, green bonds, crowdfunding, payment-by-results and revenue-based financing can ease access conditions to stimulate green investments. Equally important are streamlined information channels and advisory mechanisms to identify instruments suited to investment types: ■ Innovative financing instruments like sustainability-linked loans, green bonds, payment-by-results financing, and revenue-based models can incentivize investments by simplifying access.

	■ Advisory mechanisms that provide guidance on matching financing tools with investment types based on risk and return expectations are equally important. ■ Public sector interventions, such as portfolio guarantees, interest subsidies, and investment platforms, can leverage private capital and play a significant role in facilitating access to finance for SMEs. Complimenting commercial financing channels with public sector interventions like guarantees, risk sharing facilities and aggregation vehicles that provide working capital can optimize capital allocation.
Capacity building	■ Reskill workforces on digital, data and green engineering literacies via blended models involving virtual mediums. ■ Propagate awareness on viable solution use cases tailored to local contexts.
Monitoring and compliance	■ Benchmark regional and sectoral performance through digital dashboards based on identified metrics ■ Adopt balanced compliance policies that cultivate sustainability without overburdening enterprises.

2. Methodology

2.1. Survey design

The survey and interview questions focused on gaining insights across the following dimensions:

1) Company details
2) Company size and financials
3) Technology and innovation adoption rate
4) Supply chain and partnerships
5) Acceptance of green digital innovation
6) Enablers and barriers
7) Details of the respondent

Survey designed considered the UTAUT (Unified Theory of Acceptance and Use of Technology) model, a widely recognised framework for understanding technology acceptance. The UTAUT model encompasses various factors that influence user acceptance. In our case we focused on four key elements: perceived usefulness, facilitating conditions, ease of use and effort expectation, and social influence.

- Perceived usefulness:

Perceived usefulness refers to the extent to which a person believes that using a particular technology will improve their performance or work efficiency. In our survey, we wanted to find out to what extent the introduction of environmentally friendly production processes would have a positive impact on their business operations and productivity.

- Facilitating conditions:

Facilitating conditions include the extent to which individuals believe there is organisational and technical support for the adoption of a new technology. As part of our survey, we asked respondents about the existing conditions in their organisations and broader that could either facilitate or hinder the integration of green production processes.

- Ease of use (effort expectation):

Ease of use and effort expectation assess the perceived ease or difficulty of using a particular technology. In the context of adopting green production practises, we wanted to find out in our survey how easy or difficult it is for participants to adopt green practises in their operations.

- Social influence:

Social influence assesses the impact of social factors, including the opinions and feedback of others, on a person's decision to adopt a particular technology. In our survey, we investigated the role of social influence in shaping participants' attitudes and actions towards the adoption of environmentally friendly production practises.

In addition, we integrated findings from Alayon et al.'s study, "Barriers and Enablers for the Adoption of Sustainable Manufacturing by Manufacturing SMEs." This paper gave insightful viewpoints on the facilitators and barriers to Small and Medium-sized Enterprises (SMEs) adopting sustainable manufacturing methods. We hoped to broaden our knowledge and improve our survey analysis by learning about new facilitators and barriers and finding effective methods for visualizing and evaluating these dynamics. By combining the

UTAUT model with the findings of Alayon et al.'s study, we were able to identify not only constraints related to perceived usefulness, enabling conditions, ease of use, and social impact, but also a broader variety of parameters.

2.2. Target groups

The target group for the survey and mapping analysis comprises small and medium-sized enterprises (SMEs) across seven Central European countries. In total, we received 927 clicks on the survey from July 24, 2023, to November 2, 2023. Among these, surveys that aligned with the below definition of SME, provided consent for collecting personal data, were completed up to Q8, and were obtained in countries involved in the GREENE 4.0 project were considered valid. Partners reviewed the data for validity and repetition. In total, there were 422 valid surveys. The highest percentage came from Austria (43.8%, N=185); other countries were more evenly distributed, with the Czech Republic at 11.6% (N=49), Germany and Hungary each at 10.2% (N=43), Italy at 9.5% (N=40), Slovenia at 7.8% (N=33), and Poland at 6.9% (N=29).

According to the SME definition used in the survey, the target companies have:

- Less than 250 employees
- Annual turnover not exceeding EUR 50 million
- Annual balance sheet total not exceeding EUR 43 million

More than half of the companies (51.8%) reported that they primarily sell products or services to other businesses (B2B), followed by 32.3% of companies selling to both individual consumers and other businesses, and only 15% of companies primarily selling products directly to individual consumers. Geographically, the target companies are dispersed across urban and rural areas in the seven Central European countries surveyed. The majority of companies were established more than 10 years ago (85.5%).

The typology reflects a diverse mix of SMEs with variations in company size, sub-sector, business model, maturity, and geographic location. This enables the analysis to uncover insights across the regional SME landscape.

2.3. Quantitative and Qualitative Data

In our research on the acceptance factors and barriers to adopting environmentally friendly and sustainable practices among Small and Medium-sized Enterprises (SMEs), we employed a mixed-methods approach that integrated both qualitative and quantitative methodologies.

We incorporated quantitative methods through structured survey questions, systematically collecting numerical data on various aspects related to acceptance factors and barriers. The survey covered an array of key topics, including detailed information about the participating companies such as company size, financials, and company-specific details. We explored the specific green manufacturing practices employed and the technologies utilized, their supply chains and partnerships. Understanding the factors influencing user acceptance of technology, we incorporated the Unified Theory of Acceptance and Use of Technology (UTAUT) framework, exploring dimensions such as usage behavior, perceived usefulness, effort expectancy, facilitating conditions, ease of use, influence, and attitude towards change. These UTAUT factors provided a structured lens to assess the psychological and behavioral aspects impacting the adoption of sustainable practices.

Additionally, we added open-ended questions within our survey, allowing respondents to provide detailed and unstructured insights into their experiences, challenges, and motivations regarding the adoption of environmentally friendly practices. This qualitative component aimed to capture the richness of SME attitudes, offering a nuanced understanding of the factors influencing their decision-making processes.

See the whole list of indicators in Appendix A.

By combining both qualitative and quantitative findings, our study aimed to provide a holistic and comprehensive view of the factors shaping SME engagement with environmentally sustainable practices. This mixed-methods approach not only enriched the depth of our insights but also strengthened the reliability and validity of our research findings.

2.4. Sampling methodology and data collection process

The data collection process of this study followed a country-specific approach that allowed the different countries to define their own sampling procedures. The primary aim was to include as many small and medium-sized enterprises (SMEs) as possible, with limited involvement of larger companies considered important to the project. We, however, allowed for a few exceptions, in case a company was relevant also for our future collaboration together. The primary methods of data collection were face-to-face interviews and online surveys conducted via the 1ka.si platform. It the companies were interviewed in person; their data was later-on added to 1ka portal. The analyses were conducted with IBM SPSS by University of Ljubljana.

The 1ka.si platform was chosen as the tool for the online surveys because it provides a standardised and accessible platform for data collection. The local partners carefully translated the survey tool into all major national languages and then tested it thoroughly.

Throughout the data collection period, the survey was regularly monitored to ensure the integrity and quality of the data.

The survey was conducted from 24th of July 2023 to 2nd of November 2023. The partners actively participated in dissemination activities to increase industry participation. This was done through a variety of channels, including company websites, social media platforms, and personal phone calls and utilising the partners' professional networks. The multi-faceted and diversified methodology aims to maximise participation and capture a variety of opinions from SMEs and selected larger companies from multiple countries, contributing to the robustness and representativeness of the data collected.

In the analytical phase of our study, we employed frequencies and descriptive statistics (means, minimum values, maximum values, and standard deviations).

Factor analysis was a statistical approach used to check the accuracy of the estimated indicators within each domain of the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The main purpose of using factor analysis was to assess the internal structure of the data and to check the accuracy of the calculated indicators within each domain of the UTAUT (Unified Theory of Acceptance and Use of Technology) model. By examining the relationships between the observed variables, factor analysis enabled the identification of latent factors that provide insight into the underlying constructs contributing to the observed patterns. It allowed us to check whether the indicators within each domain adequately corresponded to the intended constructs, which contributed to the overall reliability and validity of our analytical results.

The results of the factor analysis reinforced the robustness of the UTAUT model, revealing distinct factors for each domain. The facilitating conditions domain exhibited three distinct factors:

- Internal Readiness and Support for Green Manufacturing
- Regulatory and External Technical Barriers to Green Manufacturing
- Regulatory Drivers on Green Manufacturing

The final list of UTAUT factors, used in this survey, therefore includes *perceived usefuleness, effort expectancy and ease of use, internal readiness, regulatory barriers, regulatory drivers and influence*.

3. Austria Analysis - key findings

3.1. Sample description

This section highlights the results of the survey conducted in Austria. The collected data provides valuable insights into the diverse array of contributing companies towards green manufacturing.

The survey was implemented within 7 CE countries through a targeted sample of companies to ensure a relevant representation of the CE business landscape. For the Austrian region, 185 responses have been secured. A noteworthy concentration of small and medium-sized enterprises has been revealed, as all participating companies boast fewer than 250 employees. Only one company didn't match the required criteria to be included in the survey, as its annual turnover exceeded 50 million euros. Half of the companies (50,8 %) are micro-enterprises with less than 10 employees and only 4,9 % employ between 100 - 250 employees. Notably to mention is, a third of the questioned companies (33,3 %) have been in existence for more than 50 years.

The predominant sector is the manufacturing industry (69 companies). 17 of those manufacture fabricated metal products and 14 basic metals. 13 companies are in professional, scientific and technical activities and 12 companies work in the information and communication sector. 6 companies operate primarily in the trade sector and do not produce themselves. 26 companies are active in the tourism sector and 14 companies work in the construction industry or are related to it.

Almost half of the respondents (44,6 %) sell products or services to both individual consumers (B2C) and other businesses (B2B). 24,5 % primarily sell to individual consumers (B2C) and for 29,3 % the primary source of sales is other businesses (B2B). The geographic markets for the Austrian companies differ slightly from the other countries represented (SI, DE, CZ, IT, PL, HU). In contrast to the other countries represented, where the majority (60,1 %) of the companies are serving the national market, the major part (57,4 %) of the surveyed Austrian enterprises are mainly serving the regional market. Also, only 40,4 % of the Austrian interviewed companies do international business which is less than the average for all participating countries (57,5 %). When addressing the international market, Germany, Hungary, and Switzerland as export/import countries have been mentioned the most.

Regarding the type of stakeholders who filled in the survey, 66 % are CEOs or directors of the enterprise and 74,3 % of the respondents have been working for the company for more than 10 years. A high level of knowledge about the company and internal structures and processes can therefore be assumed. The respondents were mainly male (71,2 %) and the most represented age ranges were 45 to 54 (32,1 %) and 55 to 64 (35,8 %).

3.2. Survey administration

This chapter provides a detailed description of the survey administration process, offering insights into the procedures and strategies implemented to collect the essential data for this study.

The survey was conducted through an online platform, with participants accessing the questionnaire via a secure link. Recruitment efforts have been deployed through two processes:

- Sending personalized invitations to a stratified sample of potential respondents.
- Using a database including representatives of relevant companies in the project region by Credit reform Austria. A preliminary filter was performed to comply with the criteria necessary for the survey. For instance, companies with only one employee were excluded, as not relevant for the study. Also, a focus on manufacturing and processing industry companies has been implemented. Furthermore, the survey

was sent to representatives from the Digital Innovation Hubs in the project region as well as start-up initiatives and networks.

The survey remained open for approximately three months. This allowed companies to respond at their convenience. The purpose of the survey was clearly communicated to strengthen the engagement. Various reminders were sent to ensure maximum participation.

As the consortium concluded the survey administration, FH Kufstein Tirol reflected on the process, seeking opportunities for improvement. In general, the contacted companies have correctly responded which leads to a successful outcome, exploitable for the project. To gather more in-depth answers, FH Kufstein Tirol could have also implemented direct contact. However, through this method, FH Kufstein Tirol would have gathered fewer answers hindering the quantitative analysis relevancy.

3.3. Preliminary findings during the survey administration

Through using a database from Credit reform Austria, the survey potentially could have reached over 20 000 companies. However, it was a notable challenge to get companies to participate, therefore only a small number of the enterprises contacted responded. The lower-than-anticipated response rate may be attributed to various factors such as time constraints and survey fatigue, highlighting the need for future studies to refine methodologies and enhance participation strategies in large-scale corporate surveys.

Moreover, companies that have already carried out (green and digital) transformations seemed more interested in the survey and answered the questions with greater accuracy. These respondents were also more likely to fill in free-text answers.

3.4. Regional Analysis key findings

3.4.1. Technology and Innovation

Table 3-1: Technologies used in companies (Austria, N=84)

	Austria		**All countries**	
	Yes	%	Yes	%
Cloud Computing	46	54,8 %	169	60,6 %
CRM (Customer Relationship Management)	43	51,2 %	154	55,2 %
ERP (Enterprise Resource Planning)	34	40,5 %	161	57,7 %
Intelligent Document Processing applications	32	38,1 %	81	29,0 %
Internet of Things (IoT) – IoT platform for management, monitoring and improvement of production flows,	17	20,2 %	67	24,0 %
Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation	7	8,3 %	30	10,8 %
Augmented Reality / Virtual Reality	1	1,2 %	10	3,6 %
Other	2	2,4 %	17	6,1 %
Total	84	100,0 %	279	100,0 %

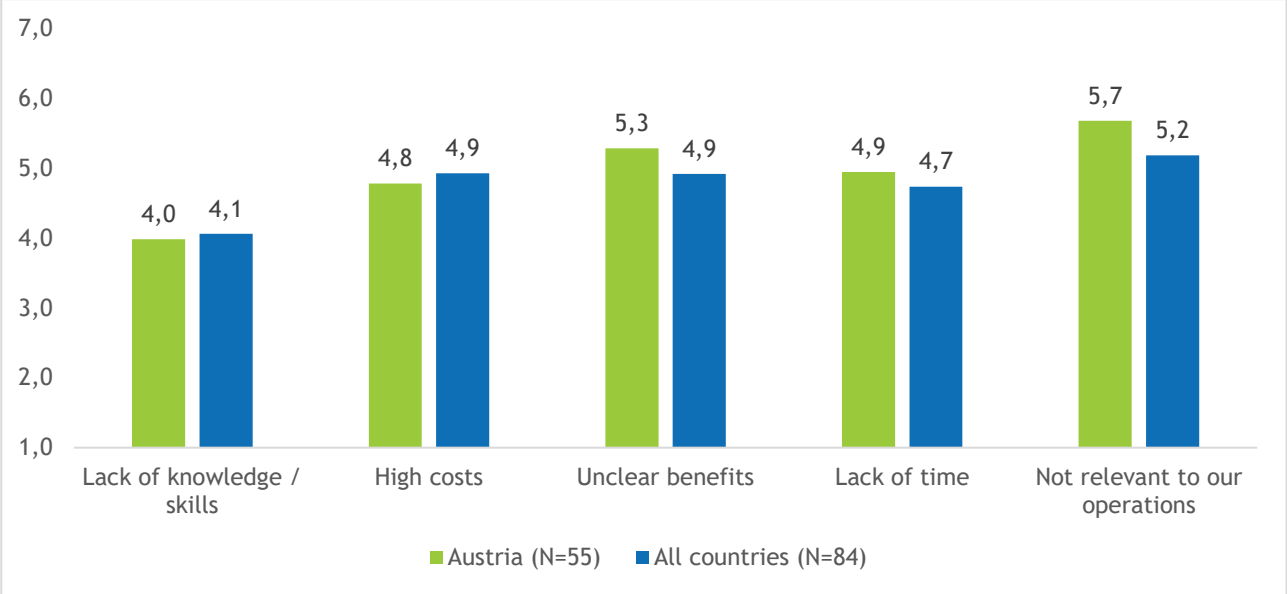
Please note that respondents had the option to select multiple responses.

In the exploration of regional dynamics within the context of technology and innovation a landscape marked by diverse advancements and unique approaches is revealed. Respondents had the option to select multiple responses. 84 responses were received around the topic of technology and innovation. Half of the companies

interviewed use technology in the form of Cloud Computing (54,8 %), CRM (Customer Relationship Management - 51,2 %), and ERP (Enterprise Resource Planning - 40,5 %). This is less than the average of all other represented countries (SI, DE, CZ, IT, PL, HU). Only in the usage of Intelligent Document Processing Applications Austrian companies (38,1 %) seem more advanced than the other participating countries (29 %). A more in-depth analysis including all selectable technologies is offered in Table 1.

The main barriers to using the above-mentioned technologies are shown in *Figure 1*. Most companies mentioned the lack of relevancy of these technologies to their operations. However, it might be correlated with one major barrier which is the misconception and lack of understanding of the benefits of integrating such technology within their processes. More than half of the respondents (strongly) agree with the statement that the benefits of using digital technologies are unclear.

Figure 3-1: Identified barriers to digital technology usage (Austria, N=55)



3.4.2. Green Manufacturing Practices

The research into the extent to which green manufacturing technologies are already widespread shows a positive picture within the Austrian ecosystem: 121 of the 185 Austrian companies responded that they use one or more of the listed green practices. The most widespread is the use of renewable energies (69,4 %), followed by the use of energy-efficient machinery and equipment (58,7 %). The least widespread in Austria are advanced process control systems with only 6,6 %, which is significantly less than in the other participating countries (average of all countries 23,7 %). Table 2 provides a more detailed overview of the utilization of all listed green manufacturing practices.

The biggest difference that can be seen in relation to the other countries is the usage of renewable energy sources and the use of recycled or sustainable materials. In both cases, Austria's results are above average. Regarding renewable energy sources only Hungary and Poland seem more advanced. In the use of recycled or sustainable materials, only German companies' results are superior. A major difference can also be seen in the utilization of advanced process control systems. With only 6 % of companies reporting using these systems, Austria's results are well below average.

Asked about green manufacturing certifications or labels, only 23 stated that they held one. In almost half of all cases (47,8 %), it is a certified environmental management system in accordance with ISO 14001.

Table 3-2: Green manufacturing technologies used in companies (Austria, N=121)

	Austria		Total	
	Count	%	Count	%
Energy-efficient machinery and equipment	71	58,7 %	205	63,9 %
Renewable energy sources (solar, wind, biomass)	84	69,4 %	198	61,7 %
Advanced process control systems	8	6,6 %	76	23,7 %
Waste recycling systems	46	38,0 %	117	36,4 %
Environmentally friendly materials in production	52	43,0 %	123	38,3 %
Lean manufacturing practices	55	45,5 %	135	42,1 %
Waste reduction strategies (e.g. composting, recycling)	54	44,6 %	135	42,1 %
Water-efficient systems (e.g. rainwater harvesting)	25	20,7 %	56	17,4 %
Sustainable packaging materials	42	34,7 %	109	34,0 %
Low VOC (Volatile Organic Compounds) finishes and glues	10	8,3 %	28	8,7 %
Use of recycled or sustainable materials	45	37,2 %	94	29,3 %
Total	121	100,0 %	321	100,0 %

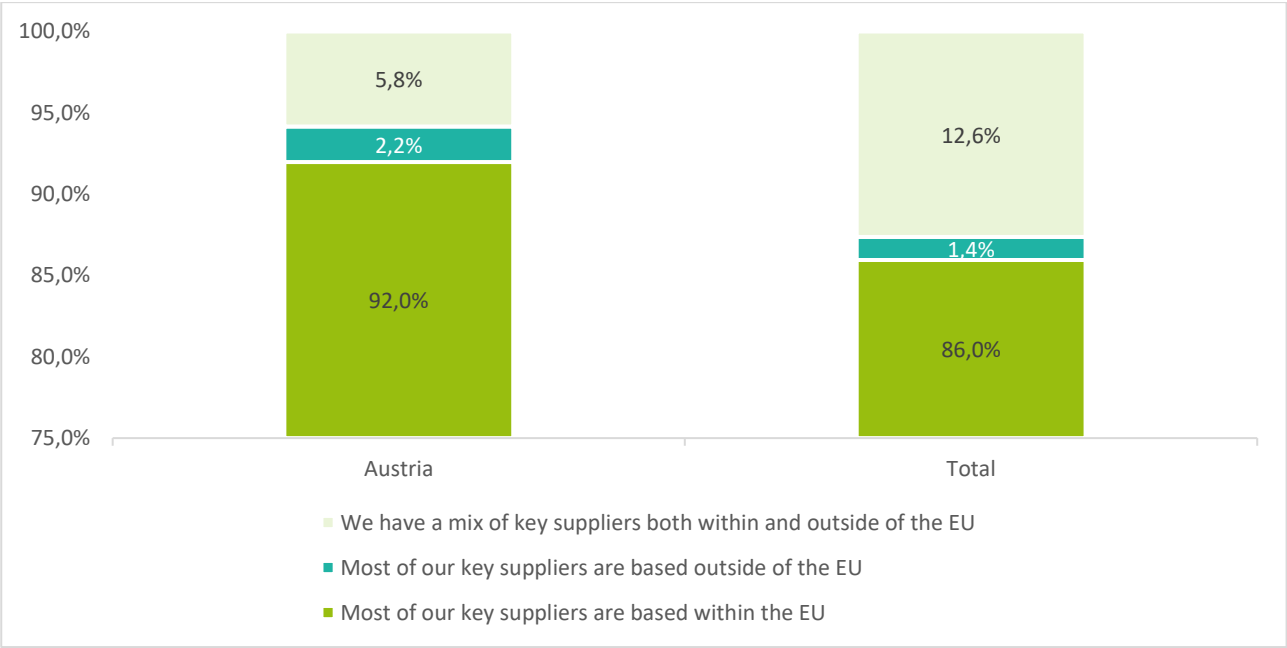
Please note that respondents had the option to select multiple responses.

3.4.3. Supply Chain and Partnerships

In terms of the geographical distribution of the supply chain, a clear pattern emerged among the Austrian companies surveyed: 92,0 % stated that most of their key suppliers are based within the EU. The three most important supplier-origin countries are Germany, Austria, and Italy. This emphasizes the importance of geographical closeness to supplier partners.

Only 14,0 % of the companies have partnerships with suppliers for testing, customizing, and buying innovative/green technologies. This is less than in the other interviewed countries (average of 17,2 %). 73,7 % of these 14 % also relate to collaboration with the aim of customizing existing technologies.

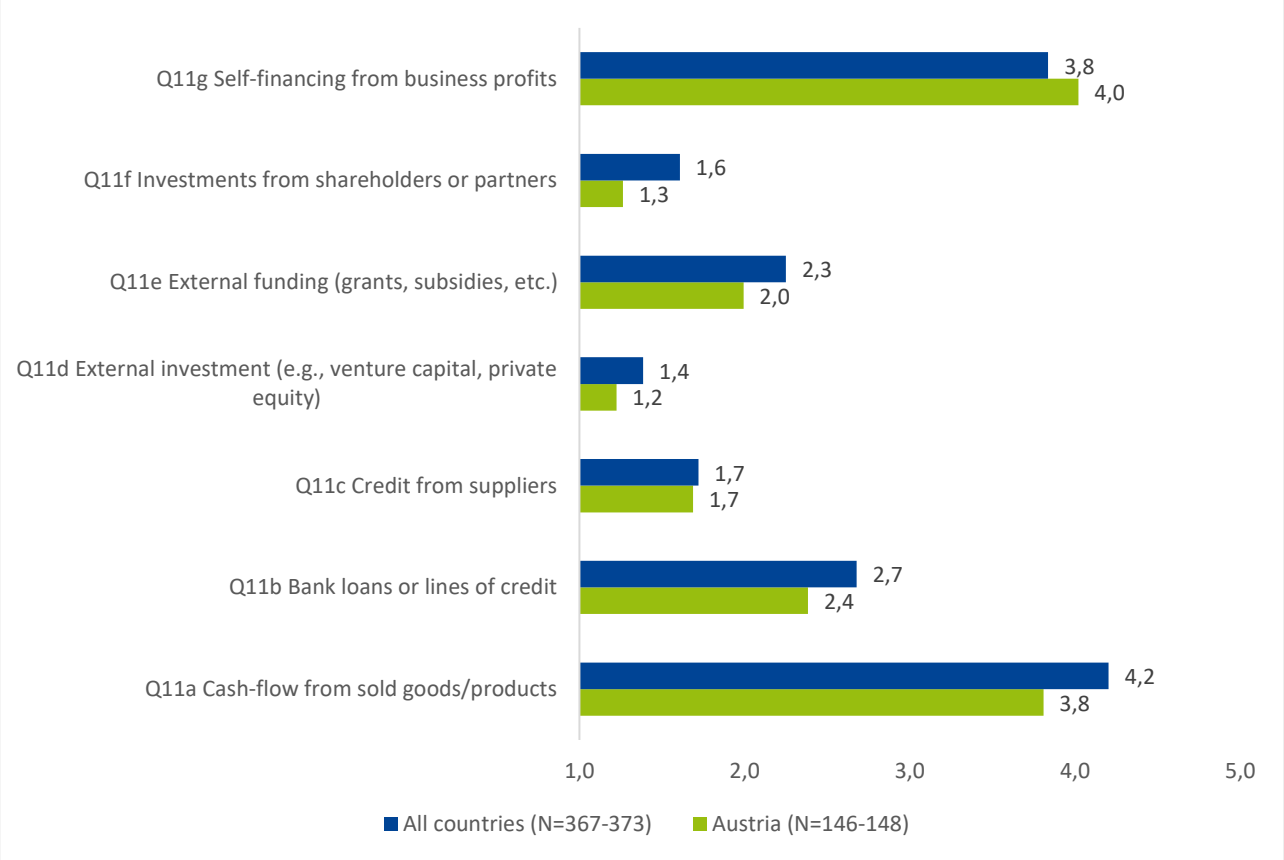
Figure 3-2: Location of key suppliers (Austria, N=137)



3.4.4. Financial Aspects

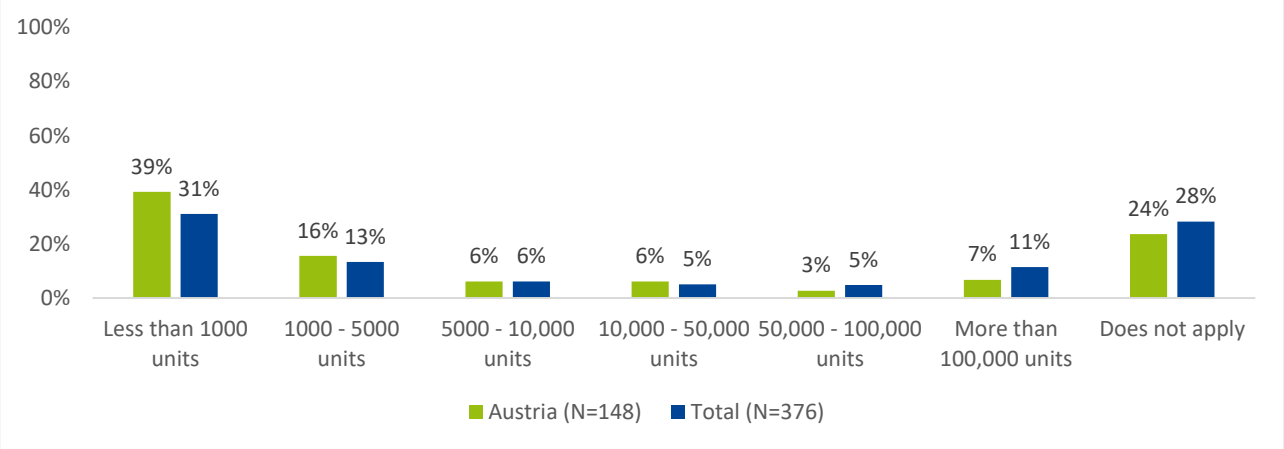
The financial dynamics that shape the economic landscape of Austria show that Austrian companies rely to a large extent on self-financing from business profits and cash flow from sold goods/products. External investments and investments from shareholders or partners play only a minor role.

Figure 3-3: Financing sources (Austria, N=146-148)



In line with the fact that mostly small companies took part in the survey, 39,2 % state that their maximum production capacity is less than 1000 units per month. Nevertheless, 15,5 % produce up to 5 000 units. The 23,6 % of "does not apply" responses are mainly from companies that do not produce themselves.

Figure 3-4: Maximum production capacity per month (Austria, N=148)



Asked about measures taken to improve production efficiency and narrow the gap between actual and potential output, more than half (64,6 %) stated that they had already invested in new equipment. The streamlining of production processes was mentioned second most frequently (44,9 %), followed by exploring new supply chain partnerships (34,0 %). In all measures, Austrian companies are clearly underperforming against the average of all countries represented, so it seems to have considerable potential for improvement.

Figure 3-5: Measures taken to improve production efficiency and narrow the gap between actual and potential output (Austria, N=147)

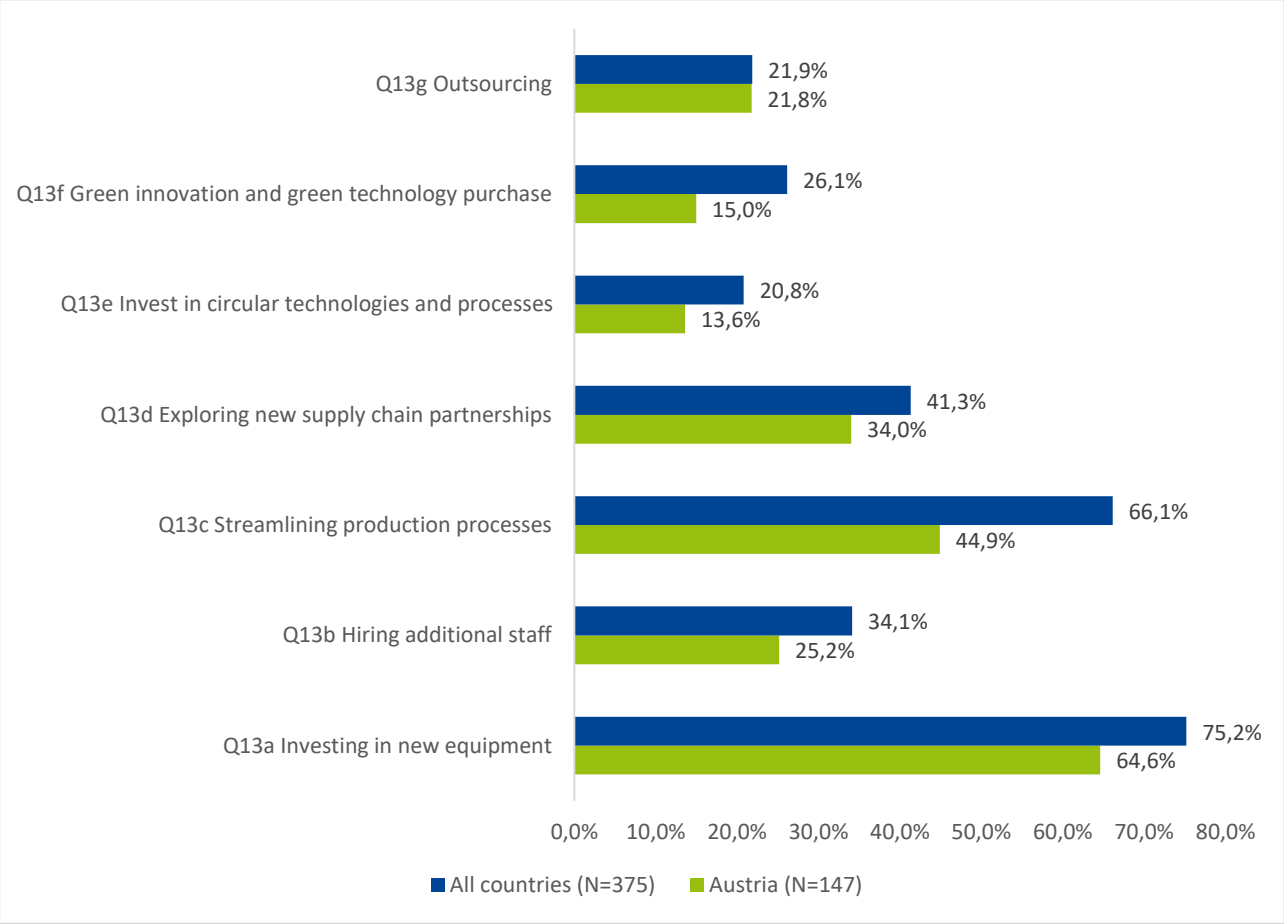
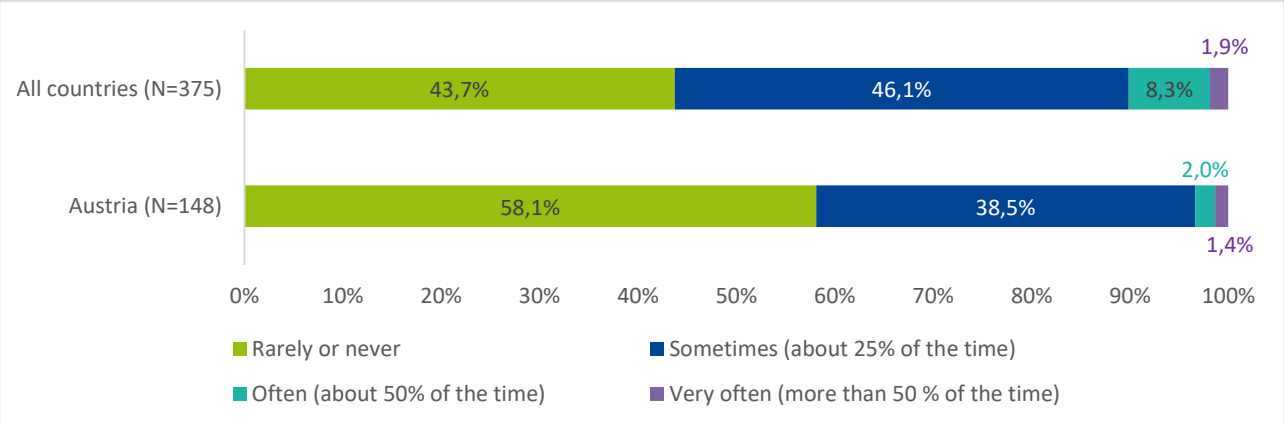


Figure 3-6: Experienced delays in receiving raw materials (Austria, N=148)



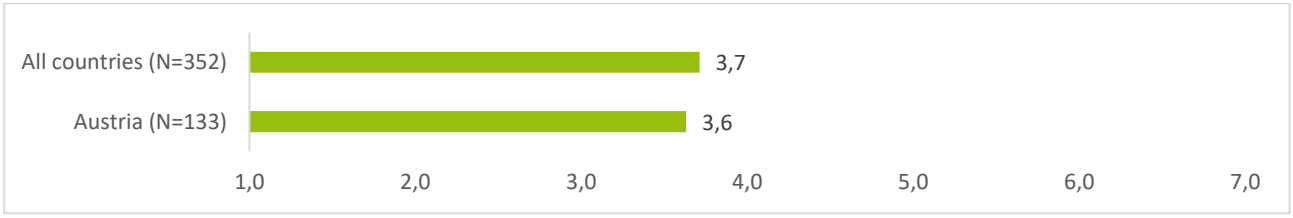
A positive picture emerges with regard to delivery delays in raw material purchasing. 58,1 % state that they have rarely or never experienced such delays. Only 3.4 % report that they often or very often receive raw

materials with a delay, compared to 10,1 % as the average for all represented countries. However, a limitation lies in the fact that almost a quarter of interviewed companies do not produce themselves.

3.4.5. Usage Behaviour

Austrian companies' self-assessment of their use of green manufacturing practices is right in the middle of the range, as is the case for all countries: The average score is 3,6 on a scale of 1 to 7.

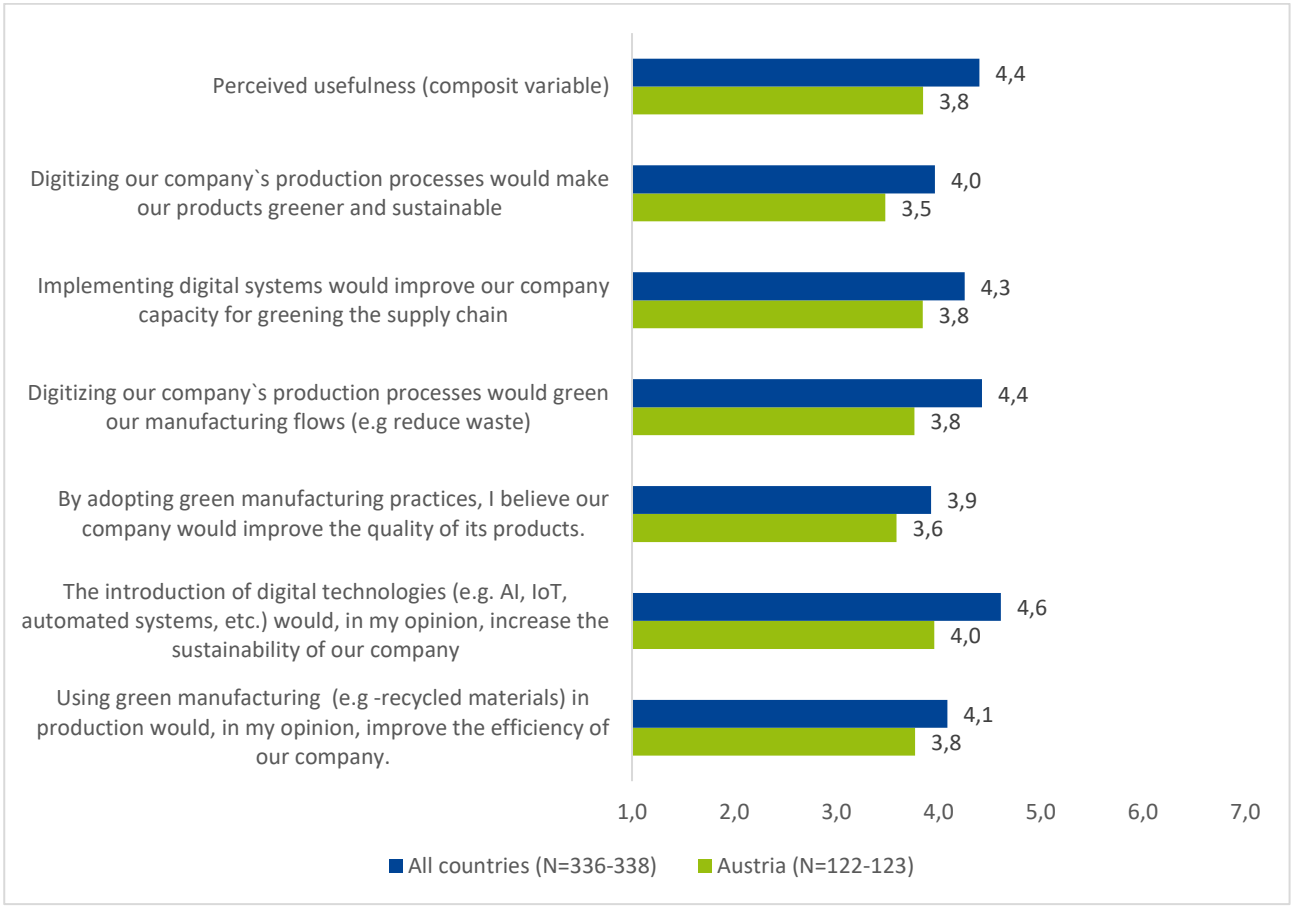
Figure 3-7: Usage behavior (Austria, N=133)



3.4.6. Perceived Usefulness

The composite variable of the perceived usefulness of green and digital technologies as well as green manufacturing practices in Austria reveals that in general Austrian companies do not sense practicality or effectiveness in implementing new digital technologies. This is not only the case for the composite variable which is a summary of all the statements but also for each individual statement. It is therefore shown that, especially in Austria, persuasive efforts are needed to demonstrate to companies that they can benefit from green technologies and sustainable manufacturing practices.

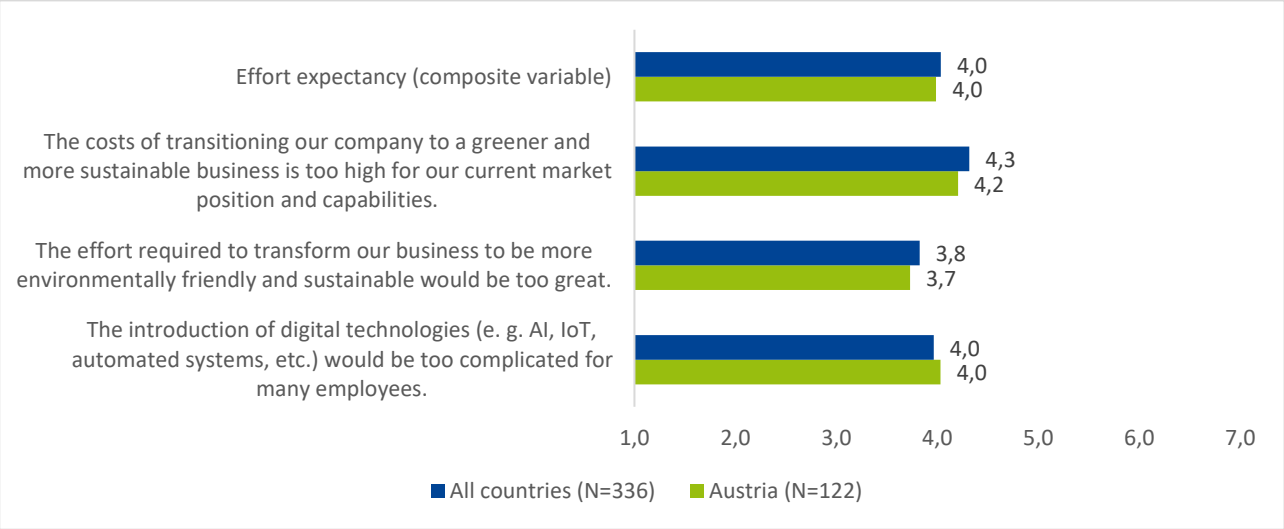
Figure 3-8: Perceived Usefulness (Austria, N=122-123)



3.4.7. Effort Expectancy and Ease of Use

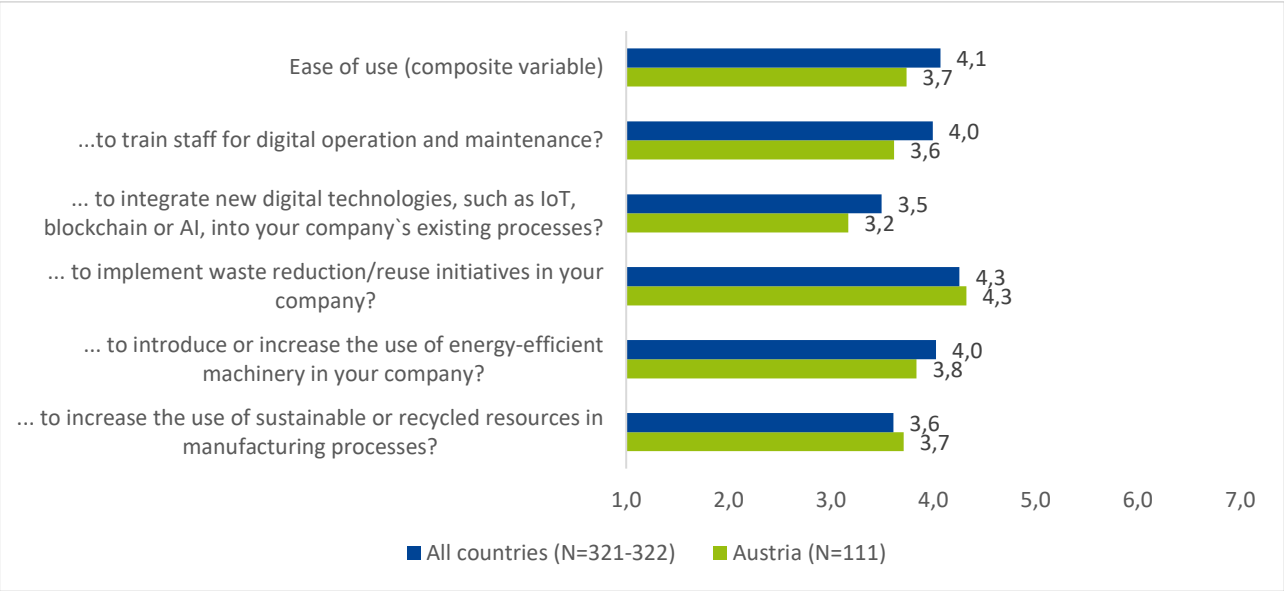
To find out how high the effort in adopting green and digital technologies is expected, the companies were asked for their agreement on the extent to which they perceive three types of challenges. The average approval rate was slightly above the mid-range, with the too-high costs of the transformation receiving the most approval, followed by the too-complicated introduction of technologies for employees and the too-great effort involved in an environmentally friendly transformation of the business. Overall, an effort expectancy of 4,0 on a scale of 1 to 7 was calculated, which corresponds to the average for all countries.

Figure 3-9: Effort Expectancy indicators and composite variable (Austria, N=122)



To measure ease of use, five indicators were used. The most difficult thing that Austrian companies consider doing right now is the integration of new digital technologies into their existing processes. The implementation of waste reduction/reuse initiatives is rated as the least challenging. Other difficulties reported by the companies surveyed mainly related to the high costs of implementation, bureaucratic/regulatory barriers, and finding appropriate solutions. Overall, a value of 3,7 was calculated for ease of use, which means a higher degree of difficulty in comparison to all countries.

Figure 3-10: Ease of use indicators and composite variable (Austria, N=110-111)



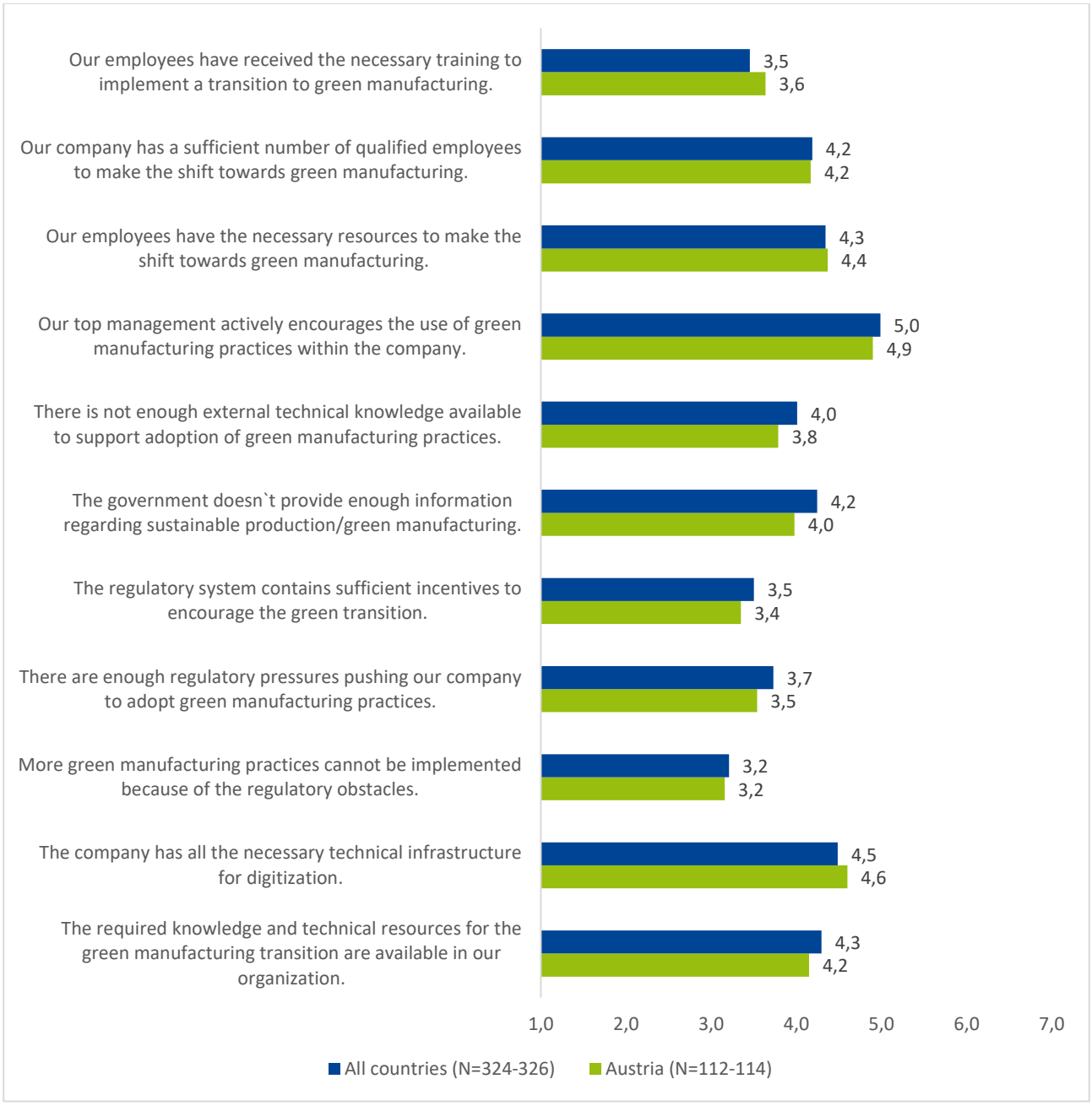
3.4.8. Facilitating Conditions

Facilitating conditions contribute to the growth and development of digital and green technologies and sustainable manufacturing practices within Austria. The availability of resources and regulatory conditions are analysed.

Most companies strongly agree that their top management actively encourages the use of green manufacturing practices within the company and that the company has all the necessary technical infrastructure for digitization. The statements that the least number of interviewed companies agree on are that more green manufacturing practices cannot be implemented because of the regulatory obstacles and that the regulatory system contains sufficient incentives to encourage the green transition.

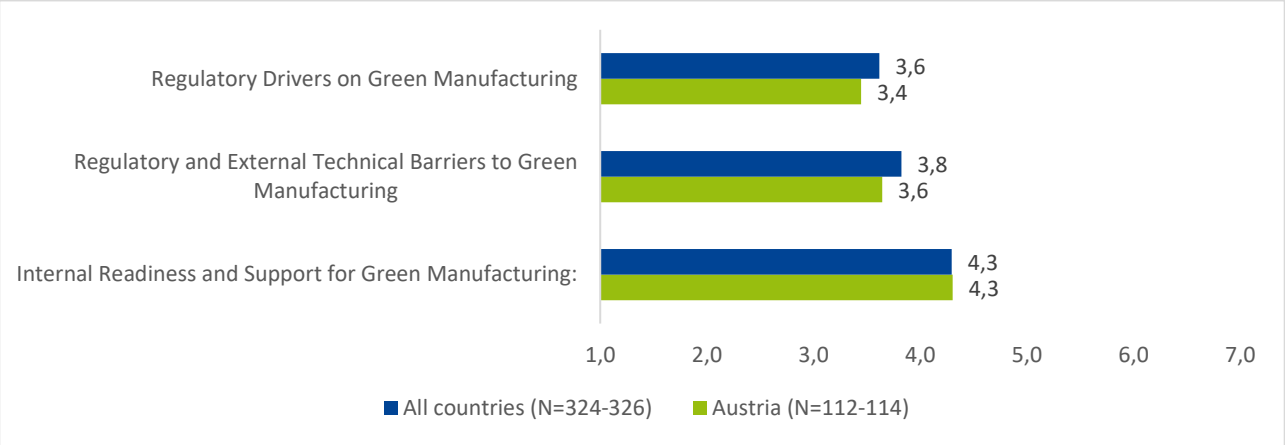
The several indicators are then categorized into three factors (see Figure 3-12).

Figure 3-11: Facilitating conditions – indicators (Austria, N=112-114)



Of the three factors that were formed, the factor "internal readiness and support for green manufacturing" was agreed with most. This factor includes the readiness of the employees and the technical infrastructure to undergo a digital and green transformation as well as the encouragement of the top management. Overall, the differences between Austria and the average of all countries are minimal.

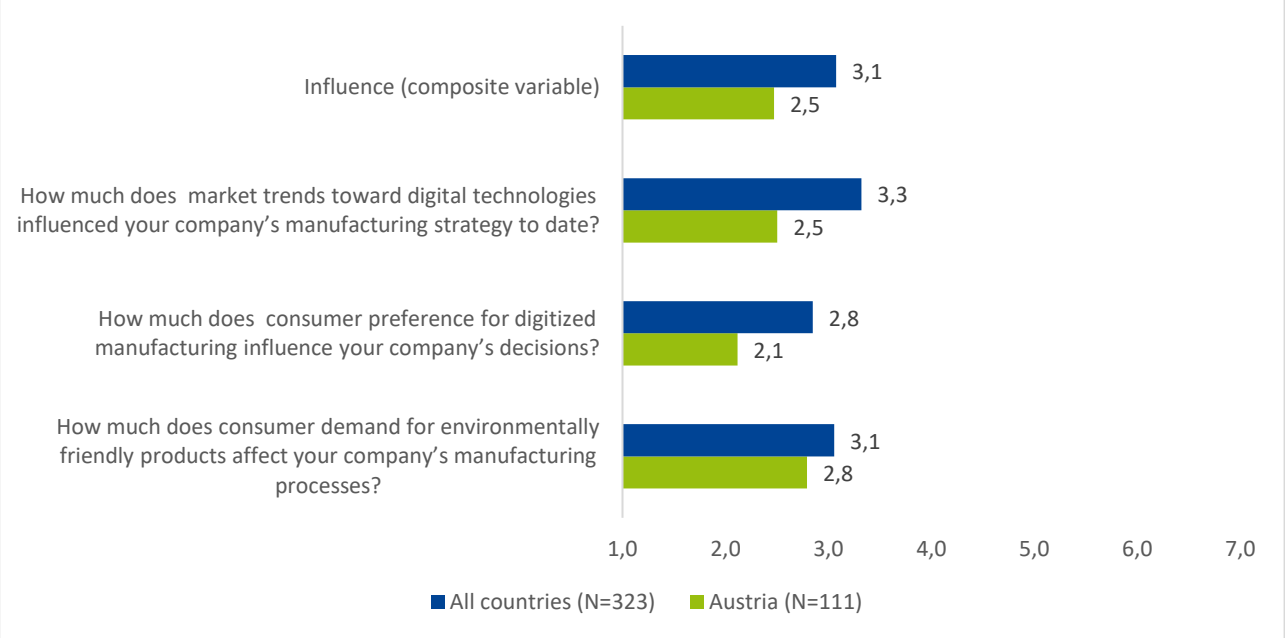
Figure 3-12: Facilitating conditions – composite variables (Austria, N=112-114)



3.4.9. Influence

The analysis regarding the influence of external factors on green and digital adoption in Austria shows that external factors don't really influence green and digital transformation. This differs greatly from the overall attitude of the other European countries. The biggest difference can be seen in companies in Italy and Poland as they perceive a much stronger influence from external factors on their business processes and decisions.

Figure 3-13: Influence indicators and composite variables (Austria, N=111)



3.4.10. Attitudes towards change

The attitude towards change among Austrian companies in adopting green manufacturing processes and digital technologies is far below average. 36,7 % of Austrian companies will unlikely integrate green manufacturing processes in the following 5 years. Whereas 75 % of Czech and Italian companies are likely to integrate or increase green manufacturing processes. This is also the case for using energy-efficient machinery and incorporating digital technologies.

Table 3-3: Attitude toward change (Austria, N=109)

	Austria		All countries	
	N	% likely or very likely	N	% likely or very likely
How likely is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	109	21,1 %	320	31,6%
How likely will you switch to energy-efficient machinery for your production in the following 5 years?	109	20,2 %	320	35,0%
How likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	109	13,0 %	320	32,0%

3.4.11. Enablers and Barriers

In the questionnaire, respondents were asked to answer three open questions. These questions addressed major drivers and biggest obstacles for companies to use green manufacturing techniques and technologies as well as the kind of support, resources or infrastructure organisations would need to successfully adopt green manufacturing practices.

Major drivers to adopt or make investments in green manufacturing practices

The answers can be categorized into 9 types of drivers:

- Environmental protection;
- Cost savings;
- Ethical responsibility;
- Attracting and satisfying customers;
- Government requirements and subsidies;
- Opportunity for innovation;
- Market and supplier context;
- Lack of employees;
- Health.

Companies set goals such as saving and protecting resources, reducing emissions and waste, producing environmentally friendly products, or circulating products. By this, they want to comply with climate targets to fight against climate change. Quotations from the surveys such as “We only have on planet earth.” and “We want to become more ecological.” show that there is an intrinsic driver for businesses as well.

Another strong motivation to adopt green manufacturing practices is financial considerations. The statement answers to the open-ended questions show that specific drivers are long-term cost advantages, increased efficiency and cost savings regarding energy, resources, etc.

Another enabler is ethical convictions at a personal level among the company management, sometimes also established as corporate principles. Responsibility towards future generations is mentioned several times in this context.

Direct customer demand or indirect sales promotion through marketing effects was also mentioned as a driver since companies acknowledge that "sustainability is a sales argument" and "responsibility for the environment is good advertising for the company".

Less mentioned, but nevertheless, also influential drivers are national and international government regulations and the opportunity for innovation, particularly with regard to the development of new products. Fewer statements also included the market and supplier context, the lack of employees, and health.

Biggest obstacles to using green manufacturing techniques and technologies

The following 8 categories were built:

- Financial costs;
- Technical barriers;
- Legal regulations;
- Lack of state financial support;
- Lack of time and human resources;
- Low internal acceptance or skills;
- Pricing;
- Quality concerns.

One major obstacle for companies is the high investment costs for the acquisition of e.g., new machinery, industrial systems or digitalisation in general. There is insufficient financial capacity for these investments and/or they are not considered profitable due to a long amortization period. Even though companies agree on the fact, that a new system is more efficient, they emphasize the fact that it remains an investment and implies paying for it. In general, competitive pressure and energy costs play an important role in financial considerations.

Another main barrier is the perceived unavailability of alternative green technologies on the market. The respondents report a lack of solutions, especially for special technical requirements for product properties.

Although legal regulations were mentioned as a driver, they are still more often seen as an obstacle, as they hinder changes and create a high level of bureaucracy. For example, one participant reports that "product authorizations are no longer valid due to changes to the formulation, and it is time-consuming and expensive to apply for new authorizations each time". Another obstacle is the uncertainty about possible state financial subsidies. It is mentioned that there is hardly accessible information on public financial subsidies and in general a lack of financial support in Austria compared to other countries.

A further challenge arises from the high time expenditure and time pressure in adopting green technologies, particularly in relation to the lack of skilled personnel resources. In addition, the low willingness and/or ability of employees or the management level to accept and implement changes is identified as an obstacle. One states for example: "Our employees would be overwhelmed if they had to enter delivery notes digitally".

Another mentioned challenge is pricing, as passing on the higher investment costs to customers would be accompanied by a decline in demand. Some companies are also concerned about a loss of product quality by using green techniques.

Needed support to successfully adopt green manufacturing practices

There were 6 types of desired support:

- Financial aid;
- Bureaucracy reduction and adaptation of legal framework;
- Technological support;
- Infrastructure expansion;
- Training and knowledge transfer;
- Environmental awareness.

The most desired form of support is long-term financial capital, especially state subsidies, tax cuts, and favourable conditions for investment loans. Also towards the attention of policy-makers is the desire to reduce bureaucracy, particularly with regard to authorization procedures, as well as for a fair and consistent mandatory design of legal framework conditions. As a concrete example the “harmonization of all imports from the Far East with our guidelines and sanctions” was mentioned.

More affordable and simple offers in the sphere of alternative green technologies, resources, products and services are seen as supportive for the implementation of green manufacturing practices. What is also required is the expansion of important infrastructures such as renewable energies and fiber optics. According to one respondent, this “would facilitate several steps towards IoT, AI, and the networking of systems”.

Finally, another major desired form of support is knowledge transfer in the form of training for employees and managers, customized advice, information material, and exchange among industry, academia, and public authorities. It is becoming clear from the responses that there are knowledge deficits in very different areas and that there is a strong desire to overcome them. What can also be seen in the context of transferring knowledge is the desire to raise environmental awareness in society (e.g. via the public media or education system), in order to encourage customers to make environmentally conscious purchasing decisions.

3.5. Summary of attitudes towards green and digital technologies

The main barriers that companies face are regulatory complexities, technological constraints, and financial limitations.

The data provides a comprehensive view of Austria’s technological landscape, revealing both strengths and challenges. In technology and innovation, widespread adoption of Cloud Computing, CRM and ERP contrasts with notable hesitation among some companies due to the perceived irrelevance and unclear benefits of digital technologies. Green manufacturing practices showcase commendable use of renewable energy and sustainable materials, yet the slower adoption of advanced process control systems indicates areas for improvement. Supply chain dynamics emphasize a strong dependence on EU-based suppliers, especially from Germany, Austria, and Italy, with fewer collaborations for testing and acquiring innovative technologies. Financially, Austrian companies interviewed heavily rely on self-financing, and while they exhibit conservative attitudes toward change, measures to improve efficiency and embrace emerging technologies remain below global averages. Addressing these challenges through targeted education, incentives, and streamlined regulations could further enhance the use of green and digital technologies in Austrian companies.

3.6. Conclusions, Recommendations, and further steps

The survey was administered to 185 companies across different sectors but primarily in manufacturing, and tourism. The majority were SMEs, with all the companies having fewer than 250 employees and having an annual turnover of less than 50 million EUR. Administered online over 3 months, the survey reached over 20 000 companies. Multiple reminders were sent to ensure maximum participation.

To overcome the barriers identified in the Austrian context regarding technology adoption and green manufacturing practices, several measures can be implemented. First, there is a need for targeted efforts to increase awareness and understanding of the benefits of digital technologies, particularly addressing misconceptions among companies. Providing educational programs and resources to enhance digital literacy and showcase practical advantages should help overcome the perceived irrelevance and lack of clarity. Additionally, fostering a culture of innovation and change within companies, potentially through leadership encouragement and training, should positively impact attitudes toward technology adoption.

In the realm of green manufacturing practices, addressing financial barriers by offering state subsidies, tax incentives, and favourable investment conditions should encourage companies to invest in environmentally friendly technologies. Reducing bureaucratic hurdles and adapting legal frameworks to support green initiatives are crucial steps. Moreover, supporting the development and availability of affordable and efficient green technologies should mitigate challenges related to technical barriers. Expanding infrastructure, especially in renewable energy sources, should further facilitate the integration of sustainable practices.

To address the identified skills gap and ease of use challenges, comprehensive training programs tailored to employees and managers should enhance their capabilities and confidence in adopting new technologies. Collaborative efforts between industry, academia, and public authorities should contribute to knowledge transfer and the development of customized solutions.

Overall, a multi-faceted approach encompassing education, financial incentives, technological support, and cultural change is essential to overcome the barriers outlined in the Austrian context.

4. Czechia Analysis - key findings

4.1. Sample description

Czechia was the second-largest contributor to the pool of questionnaires. We collected 49 valid questionnaires from companies, constituting 11.6% of the total 422 valid responses. All of these companies had fewer than 250 employees, a turnover lower than 50 million EUR, or a balance sheet below 43 million EUR. While the dominant business model for Austria and the entire sample was the combined B2C+B2B (59.2%), in Czechia, it was B2B (28.6%). Fifty percent of Czech companies were aged 21-30 years, the highest proportion, although this age group also had the highest representation in the entire sample. The smallest age group, 50+ years old, accounted for a 2.1% share, the lowest in the entire sample.

Although companies with 10-49 employees represented the highest proportion in the entire sample (36.6%) and also in Czechia (49.0%), the regional proportion was highest among the analysed regions. The share of companies with 100-250 employees was the second lowest (6.1%), with Hungary having the lowest. From a territorial perspective, Czech companies focused more on national (79.6%) and international markets (69.9%), frequently neighbouring EU countries (Germany, Poland, Slovakia). This preference is similar to the entire sample, but the proportion is higher for Czech companies and comparable to Italian companies.

The survey was processed by CEOs in 63.0%, which is 10.1 percentage points higher than the entire sample and 3.0 percentage points lower than in Austria. Most of the interviewees were men (91.3%), the highest from all countries and significantly higher than the entire sample (by 13.9 percentage points). While, on average, the prevailing age group was 45-54 years old with 35.5% (+11.6 percentage points), for Czechia, it was the group aged 35-44 years (28.3%). Similarly to other countries, interviewees had been working in the company for more than 10 years (47.8% from 46 answers; 3 were not filled out).

4.2. Survey administration

Two PPs (PP5 and PP6) were involved in the survey within the Usti region. To avoid overlapping and redundant work, PP6 took a lead role in creating lists of companies to be contacted and interviewed. A shared database of companies for PP5 and PP6 has been created. The database was processed to allow easy recording of the work of each employee involved and a record of the survey's status for each contacted company.

The main aim was to reach out to manufacturing SMEs from the NACE sector prioritized in the RIS3 strategy of the Usti Region. PP6 generated long lists of companies from NACE 21-30 (source: Register of Economic Subjects, https://www.czso.cz/csu/res/registr_ekonomickych_subjektu), including companies contained in PP6's internal CRM system (ICUK EIRA). Filters were applied for the first level of shortlisting:

- Number of employees (eliminating those with 250+ employees).
- Institutional sector (preferably 11002).

For the second level of shortlisting, we used the following criteria:

- Number of employees check (to comply with the EU definition for SME), using the MERK tool (https://www.merk.cz/) for easier identification of company relationships, turnover, and other relevant indicators.
- Check on real activity and production focus (using a desk research approach - visiting the web pages of companies). If no data was available, the company was eliminated.

The final list contained 770 companies. The eligibility check on SME status was processed among 322 companies - this activity was the most time-consuming. Out of these, 291 companies were validated as SMEs.

164 companies were contacted for the purpose of providing data for the GREENE 4.0 project. Various approaches to contacting selected companies were implemented. PP5 preferred contacting by phone, while PP6 used an email message with follow-up phone calls. After checking the relevance and completeness of the data, 49 valid questionnaires were analysed.

4.3. Preliminary findings during the survey administration

In general, companies are open to applying new digital and sustainable technologies into their operations. Some of them attempt to implement available solutions; however, they face several barriers. In some cases, legislative requirements and regulations do not permit them to experiment further. For some companies, previous negative experiences (e.g., administrative burden, changing methodologies, long waiting times for decisions) with grants and subsidies have made them hesitant to reapply. Internal capacities are limited since their strategies do not prioritize intensive R&D and innovation activities. In comparison to Austria, based on the number of questionnaires filled out, it appears that their SMEs are strategically more mature and have a general understanding that their active role is necessary in shaping and designing new measures to support digital and green transformation.

The prevailing position of SMEs can be described as economically rational. They will embrace digital and green technologies once they observe these technologies working and bringing economic value to their operations. One of the main preliminary findings was that the demand for green (sustainable) production was not driven by customer demand. Additionally, attempts had been made to use green products previously, but the characteristics of these products were not suitable as they had a negative impact on the quality of production. Therefore, programs oriented towards showcasing, increasing awareness, and transferring best practices, in combination with advisory and financial tools, might be suitable.

4.4. Regional Analysis key findings

4.4.1. Technology and Innovation

Table 4-1: Technologies used in company (Czechia, N=39)

	Czechia		All countries	
	Yes	%	Yes	%
Cloud Computing	29	74.4%	169	60.6%
CRM (Customer Relationship Management)	19	48.7%	154	55.2%
ERP (Enterprise Resource Planning)	15	38.5%	161	57.7%
Intelligent Document Processing applications	10	25.6%	81	29.0%
Internet of Things (IoT) – IoT platform for management, monitoring and improvement of production flows,	5	12.8%	67	24.0%
Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation	6	15.4%	30	10.8%
Augmented Reality / Virtual Reality	0	0.0%	10	3.6%
Other	6	15.4%	17	6.1%
Total	39	100.0%	279	100.0%

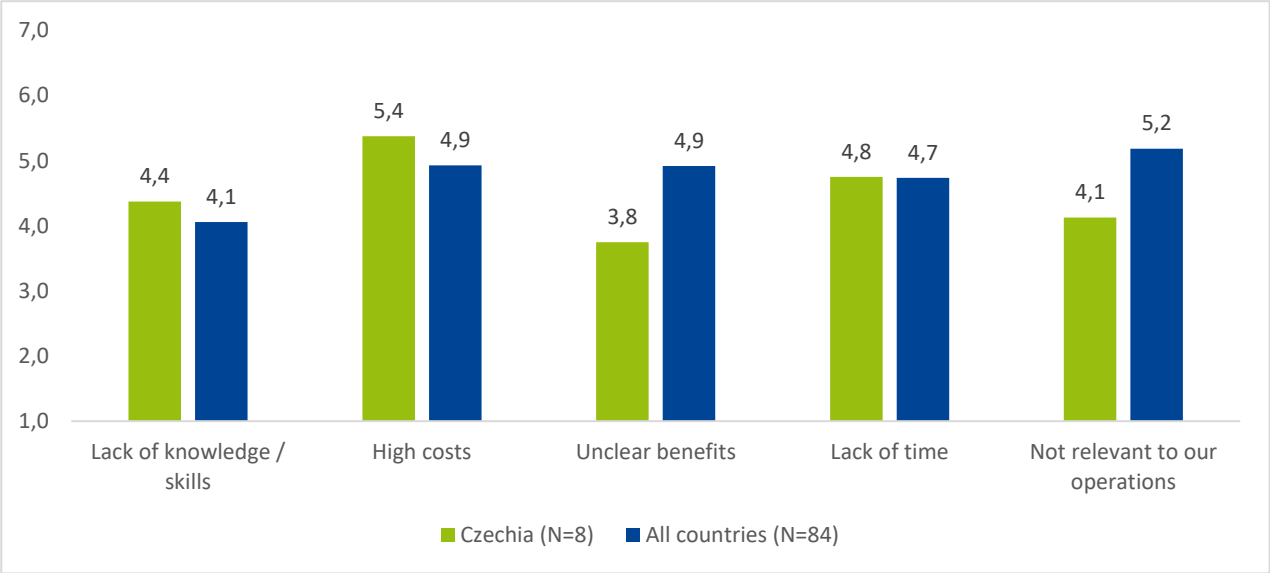
Please note that respondents had the option to select multiple responses.

Out of 49 companies with valid questionnaires, 39 declared that they already use some technologies. The top three are similar to the aggregated results, although CRM is more commonly used than ERP. Elements

of cloud computing seem to be quite common among the interviewed companies, with the proportion significantly higher than in the entire sample (+13.8 percentage points), and only Hungary having a higher share of usage. In contrast, ERP is substantially below the average (-19.2 percentage points). Similar to Slovenia, no company indicated usage of AR/VR solutions yet; however, the first contacts with AI and smart manufacturing have already been made.

Companies that still do not apply digital technologies in their operations indicate that among the key barriers, high costs have relatively higher importance than in the aggregated results. This is followed by the lack of time, with comparable importance to the whole, and a (current) lack of knowledge/skills, again with slightly higher importance than in general. The perception that the listed technologies are not relevant for them or considering benefits unclear is below the general levels.

Figure 4-1: Identifed barriers to digital technologies usage



4.4.2. Green Manufacturing Practices

Among the green manufacturing technologies used in the companies, the most frequent are energy-efficient machinery and equipment, with a proportion similar to the aggregated results. More than half of the surveyed SMEs have already implemented a waste management system. Around one-third use renewable energy sources, and a similar proportion utilizes sustainable packaging materials, reflecting their prevailing operational motivation. However, the proportion of renewable energy use is higher in the entire sample. Almost 40% of SMEs employ environmentally friendly materials in production, which is consistent with aggregate data. Advanced process control systems or lean production are underutilized, most likely due to the nature of their business.

Internal drivers for companies include a commitment to social and environmental responsibility, an aspiration to be environmentally friendly, and operational considerations where new solutions enhance economic efficiency (e.g., energy savings). Among external factors, companies cited current trends and customer needs, taking into consideration subsidies, incentives, and tax benefits.

SMEs cite various barriers hindering the adoption of green technologies. Foremost among these is financial constraint, where costs associated with implementing green solutions pose a challenge. The perception is that these costs increase product prices, and customers may be unwilling to pay a premium for environmentally friendly options. Regulatory complexities and administrative burdens represent another significant

hurdle, contributing to SMEs' hesitancy to embrace green practices. Knowledge gaps, coupled with a shortage of skilled employees and competing priorities, further impede the adoption of green technologies. Additionally, the specificities of production and technical obstacles create reluctance among SMEs to integrate environmentally friendly solutions into their operations, as some of these solutions might diminish the quality of output.

In general, only 9 companies declared they have had ISO 14001 certification. From the other relevant certifications, they mentioned ECOCERT, plastic free, FSC or related to quality – bio, QZC.

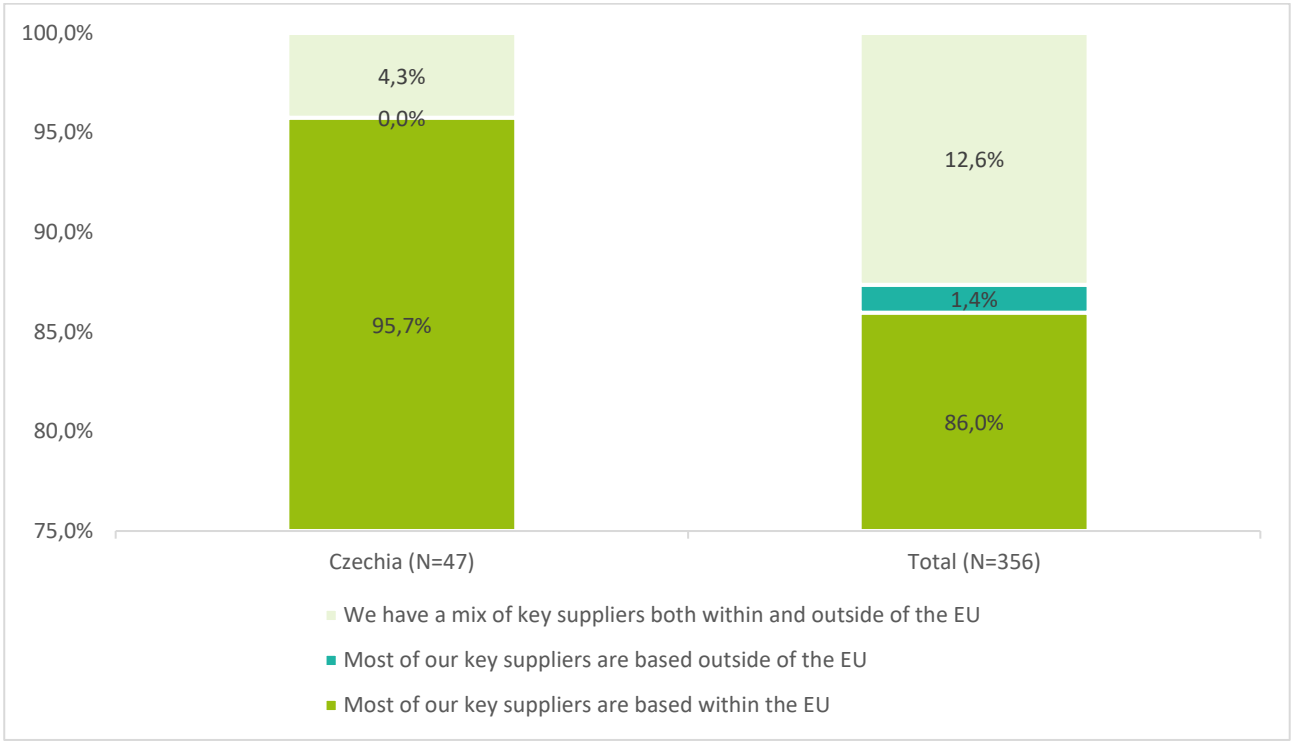
Table 4-2: Green manufacturing technologies used in company (multiple responses are possible)

	Czechia		Total	
	Count	**%**	**Count**	**%**
Energy-efficient machinery and equipment	24	61.5%	205	63.9%
Renewable energy sources (solar, wind, biomass)	14	35.9%	198	61.7%
Advanced process control systems	3	7.7%	76	23.7%
Waste recycling systems	21	53.8%	117	36.4%
Environmentally friendly materials in production	15	38.5%	123	38.3%
Lean manufacturing practices	7	17.9%	135	42.1%
Waste reduction strategies (e.g. composting, recycling)	14	35.9%	135	42.1%
Water-efficient systems (e.g. rainwater harvesting)	8	20.5%	56	17.4%
Sustainable packaging materials	14	35.9%	109	34.0%
Low VOC (Volatile Organic Compounds) finishes and glues	4	10.3%	28	8.7%
Use of recycled or sustainable materials	9	23.1%	94	29.3%
Total	39	100.0%	321	100.0%

Please note that respondents had the option to select multiple responses.

4.4.3. Supply Chain and Partnerships

Figure 4-2: Location of key suppliers (Czechia)

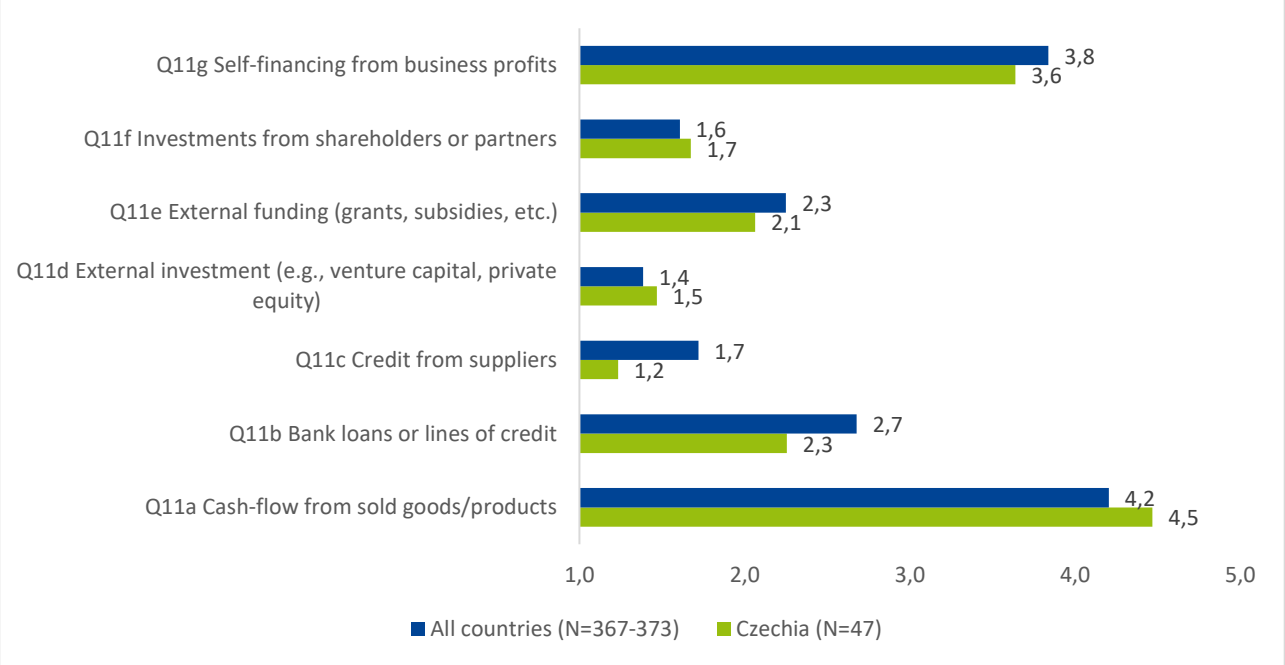


The geographical concentration of Czech companies' suppliers in EU countries is significantly higher compared to other regions and aggregated results (+9.8 percentage points), whereas in Hungary, it was much lower (-15.2 percentage points). None of the inquired companies indicated having suppliers mostly outside of the EU. The same situation was observed in Germany, Poland, and Slovenia. If there are suppliers outside of the EU territory, they are usually combined with suppliers from the EU, but still, the proportion is substantially lower (-8.4 percentage points). The suppliers from the EU frequently come from Czechia, Slovakia, or Germany. Among countries outside of the EU, companies mentioned Taiwan, Serbia, or Switzerland.

4.4.4. Financial Aspects

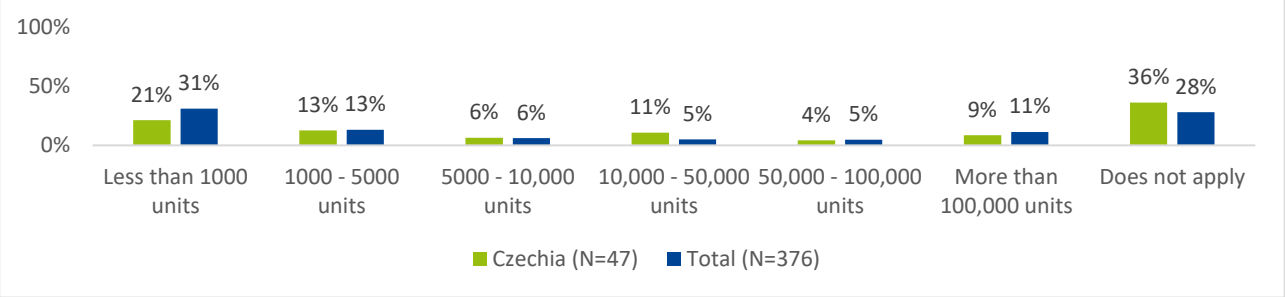
The companies surveyed rely least on financing their activities through credit from suppliers and investment both external and from shareholders. While they like to use, for example, grants and subsidies to some extent, together with bank loans, most of their activities are financed from company profits and cash flow from sales. However, both Czech and firms from other participating countries agree in their answers (Fig. 3).

Figure 4-3: Financing sources (Czechia)



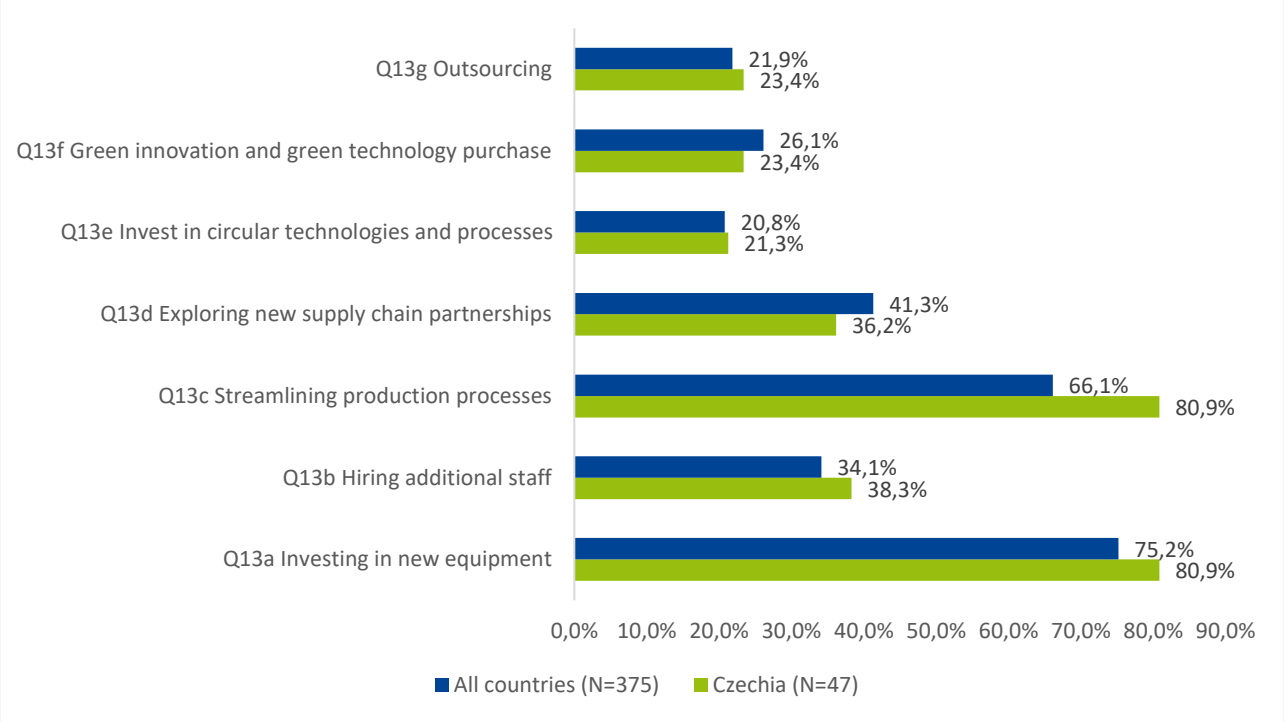
Over half of the SMEs produce less than 1000 units per month or do not even use this indicator within their production capacity. Most firms that do not set this indicator produce custom or piece production. Another example would be firms producing large metal structures, but these cannot be counted as one piece produced. A furniture firm, for example, applies a quantity of orders per m^2 of material consumed.

Figure 4-4: Maximum production capacity per month (Czechia)



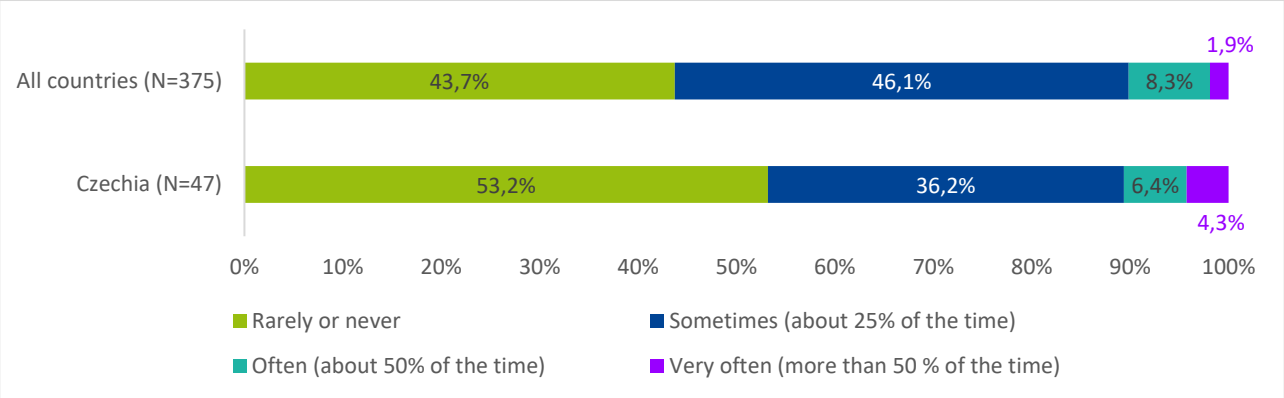
Firms most often invest in new equipment and try to streamline production processes to achieve more efficient production and reduce the gap between actual and potential output. In doing so, they have outperformed the share *of* other countries using these measures. The second category that is more widely used by Czech firms is that they are relatively often looking for new partnerships within the supply chain or that they are hiring additional employees. They make relatively little use of outsourcing opportunities or investments in circular technologies.

Figure 4-5: Measures taken to improve production efficiency and narrow the gap between actual and potential output (Czechia)



The *companies* interviewed nowadays rarely experience delays in the delivery of raw materials. Sometimes, of course, there is an unexpected event that causes a delay, but it does not happen as often as it did during the pandemic when delays were very common. Now some companies have even stocked up because of this experience.

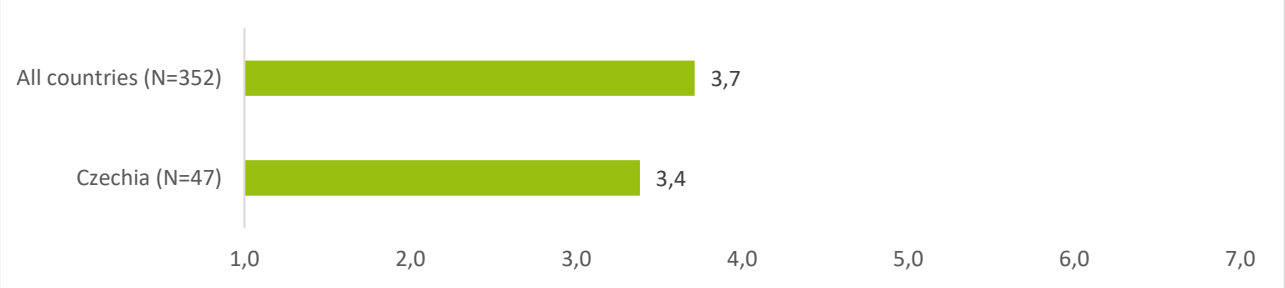
Figure 4-6: Experienced delays in receiving raw materials (Czechia)



4.4.5. Usage Behaviour

When analysing whether companies use green manufacturing practices, it was found that both Czech firms and the mean of all firms in the participating countries engage in the practices to a low to moderate extent (Fig. 7). Czech companies are therefore rather below the average in the use of these practices such as energy-efficient machinery and equipment, waste recycling systems or, for example, sustainable packaging materials.

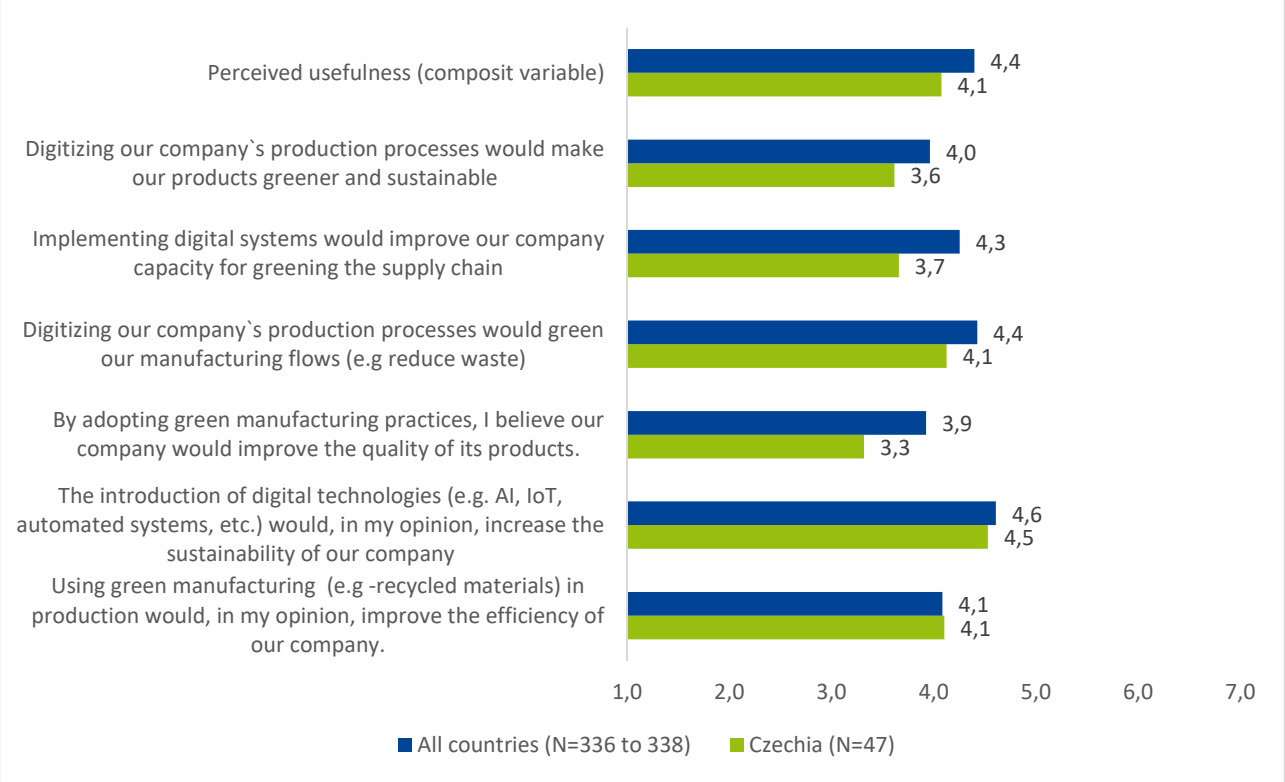
Figure 4-7: Usage behaviour by country (Czechia)



4.4.6. Perceived Usefulness

In this section, we review and describe the views of companies on the usefulness of green and digital technologies. As mentioned above, until now companies have not used green practices much in their production. But how do they evaluate green technologies in terms of their usefulness? In Figure 8 you can see the statements presented, for which companies were asked to indicate the extent to which they agree or disagree. Respondents disagreed to some extent with three of the statements presented and were rather neutral on others. The only statement that shifted to a more agreeing view is that the introduction of digital technologies (e.g. AI, IoT, automated systems, etc.) would increase the sustainability of their company.

Figure 4-8: Perceived usefulness indicators and composite variable (Czechia)



When compared to values from all countries, Czech companies have a more disagreeing view. First of all, when evaluating the introduction of digital systems, they do not think that it would improve their company's ability to increase the greening of the supply chain, and further, that the digitalisation of production processes would not make their products greener and more sustainable.

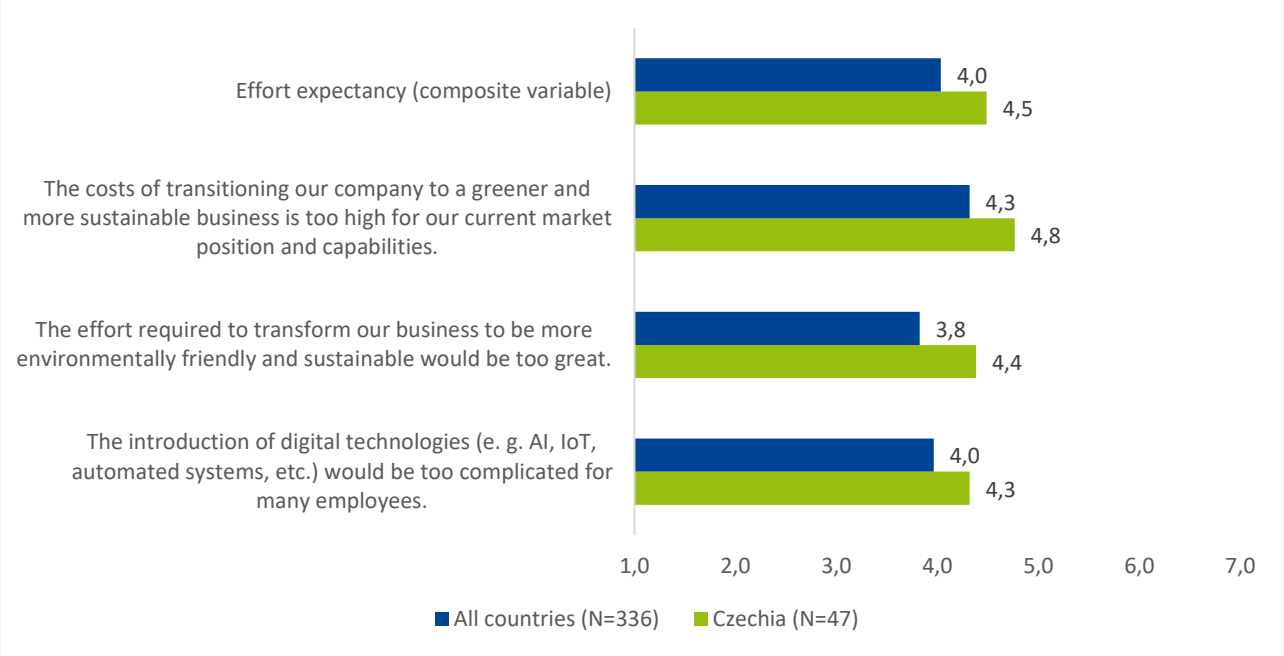
In general, however, Czech companies do not have a strong opinion and are rather neutral towards green and digital technologies. They therefore do not see a clear benefit arising from this.

4.4.7. Effort Expectancy and Ease of Use

In terms of how companies perceive the efforts in adopting green and digital technologies, Czech companies are much more critical than companies in other countries.

Both the cost, the difficulty of implementation for current employees, and the general effort to switch to these technologies are perceived rather negatively and to some extent companies agree with these presented statements (Fig. 9). Some companies explained the potential complexity for employees due to different nationality, older age, employment of the disabled, or simple reluctance to take these measures.

Figure 4-9: Effort Expectancy indicators and composite variable (Czechia)



It would be somewhat difficult for Czech companies to introduce green and digital technologies. The easiest step to introduce these technologies is generally perceived to be to train employees, then try to reduce waste or reuse it immediately (Fig. 10).

They perceive the introduction of energy-efficient machines neutrally on average, but in the sample there are companies that have either already purchased such machines at the beginning of their business to avoid subsequent further investments, or companies for which it is now financially unsustainable to completely replace the machines with more environmentally friendly ones.

We also found out from some respondents that they thought their production was so energy intensive that no energy efficient machines could be on the market or that it would not be worthwhile to purchase them.

4.4.8. Facilitating Conditions

Factor analysis yielded 3 factors:

FACTOR 1: Internal Readiness and Support for Green Manufacturing:

This factor pertains to the internal preparedness of an organization for the transition towards green manufacturing practices. It encompasses the availability of resources, qualified personnel, knowledge, and technical infrastructure within the organization. Additionally, it considers the active encouragement and support

from top management, along with the provision of necessary training for employees, ensuring the internal ecosystem is conducive to embracing green manufacturing.

Includes statements:

- Q34b Our employees have the necessary resources to make the shift towards green manufacturing.
- Q34c Our company has a sufficient number of qualified employees to make the shift towards green manufacturing.
- Q33a The required knowledge and technical resources for the green manufacturing transition are available in our organization.
- Q34a Our top management actively encourages the use of green manufacturing practices within the company.
- Q34d Our employees have received the necessary training to implement a transition to green manufacturing.
- Q33b The company has all the necessary technical infrastructure for digitization.

When evaluated, it was found that the highest scoring item under this factor was "Our top management actively encourages the use of green manufacturing practices within the company." As in other countries, the Czech Republic achieved an average value of 5.0. Such a high positive rating may also reflect the fact that the respondents belong to top management and to a certain extent evaluated themselves. In most of the items that fall under this factor, the Czech Republic achieved very similar values compared to other countries. Only for the item "The required knowledge and technical resources for the green manufacturing transition are available in our organisation" the values for the Czech Republic were one tenth of a point higher. In contrast, one of the lowest values was achieved by both the Czech Republic and the other countries for the item "Our employees have received the necessary training to implement a transition to green manufacturing". However, respondents very often spontaneously added during the interviews for this item that implementing training in this area is not a big problem at all. Companies usually provide training and further education to their employees in areas that are relevant. Green technologies are in most cases not 'on the agenda'. Therefore, employees are not trained in this area on a widespread basis. If training is already taking place, it is only for selected job roles. It can be concluded that this first factor has received a relatively positive evaluation overall. The "people" factor seems to be in "good shape" both in the Czech Republic and in other countries.

FACTOR 2: Regulatory and External Technical Barriers to Green Manufacturing

This factor revolves around the external influences that organizations encounter when attempting to adopt green manufacturing practices, namely lack of government information, other regulatory obstacles and limited external technical knowledge.

Includes statements:

- The government doesn`t provide enough information regarding sustainable production/green manufacturing.
- There is not enough external technical knowledge available to support adoption of green manufacturing practices.
- More green manufacturing practices cannot be implemented because of the regulatory obstacles.

In a deeper analysis of the factor "Regulatory and External Technical Barriers to Green Manufacturing", the values found were mostly in the neutral range and did not differ much from other countries in the Czech Republic. Only for the item "More green manufacturing practices cannot be implemented because of the regulatory obstacles" was the value in the Czech Republic 3 tenths of a point lower, which is a positive finding in this case. Respondents in the Czech Republic are more likely to say that they "disagree to some extent" with the statement, meaning that they do not feel the regulatory barriers significantly. However, it is clear that regulation will not be a serious problem in other countries either. For the item "The government doesn`t provide enough information regarding sustainable production/green manufacturing", the results for

the Czech Republic, like those for the other countries, are in the average range, i.e. "neither agree nor disagree". This finding may indicate that companies do not expect information on sustainable production/green production from the government. At least this was loosely commented on by some respondents in the interviews. For the third item surveyed under this factor, i.e. "There is not enough external technical knowledge available to support adoption of green manufacturing practices", the neutral rating in the Czech Republic was also similar to other countries. In this case, respondents often spontaneously stated that they chose a neutral answer choice because they did not really know whether there was enough or not enough external technical knowledge, as they had not yet asked for it.

FACTOR 3: Regulatory Drivers on Green Manufacturing

This factor centers around the influence of regulatory frameworks on motivating and facilitating organizations to adopt green manufacturing practices.

Includes statements:

- Q33d There are enough regulatory pressures pushing our company to adopt green manufacturing practices.
- Q33e The regulatory system contains sufficient incentives to encourage the green transition.

In the case of "Regulatory Drivers on Green Manufacturing", the analysis was based on two items, one of which measured "strength of pressure" ("There are enough regulatory pressures pushing our company to adopt green manufacturing practices") and the second item "strength of pull" - motivation ("The regulatory system contains sufficient incentives to encourage the green transition"). While the 'strength of pressure' was rated 4 across countries, i.e. mostly neutral ('neither agree nor disagree'), the 'strength of pull', i.e. motivation, was rated slightly negative (3.5). Thus, according to respondents, the regulatory systems are rather not containing sufficient incentives to promote the green transition. In this question, the Czech Republic answered in line with other countries. However, the interviews revealed that there are very significant differences by sector. In agriculture, the incentive system in the Czech Republic is very detailed and support for green technologies is strong. Farmers have already learned to work with the system and are actively using it. Therefore, a high degree of organic production is visible in agriculture.

When comparing the three factors, it may visually appear that "Internal Readiness and Support for Green Manufacturing" are the best, as they have the highest values. However, such an interpretation would be misleading because, each factor was saturated with several items and some items were worded positively and others negatively. The last factor "Regulatory Drivers on Green Manufacturing" contained one positive item ("the system contains sufficient incentives...") and one negative item ("regulatory requirements force companies to..."). The arithmetic averages then show completely incomparable data and it is not possible to make a correct analysis from these figures.

Figure 4-10: Facilitating conditions – indicators (Czechia)

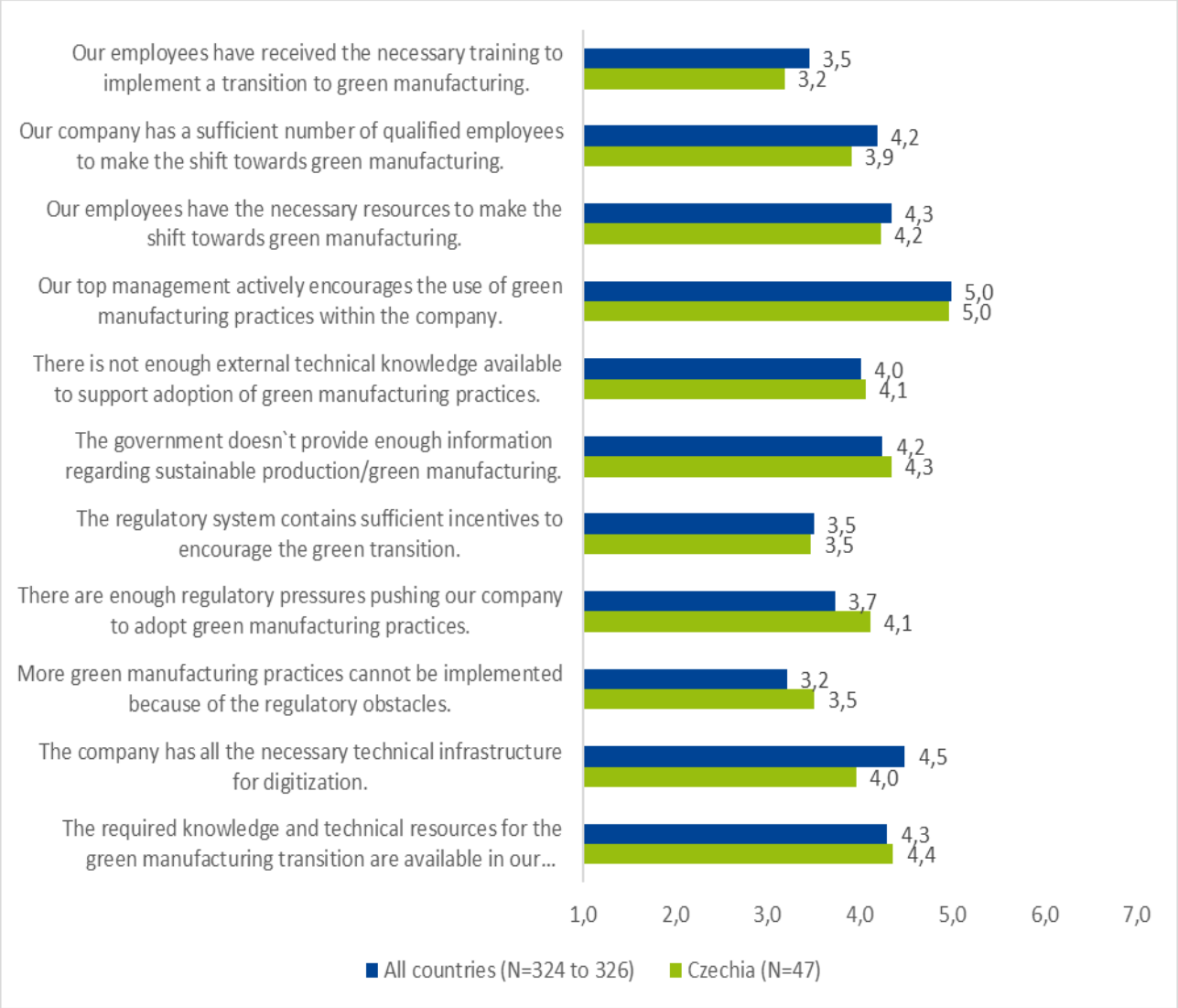
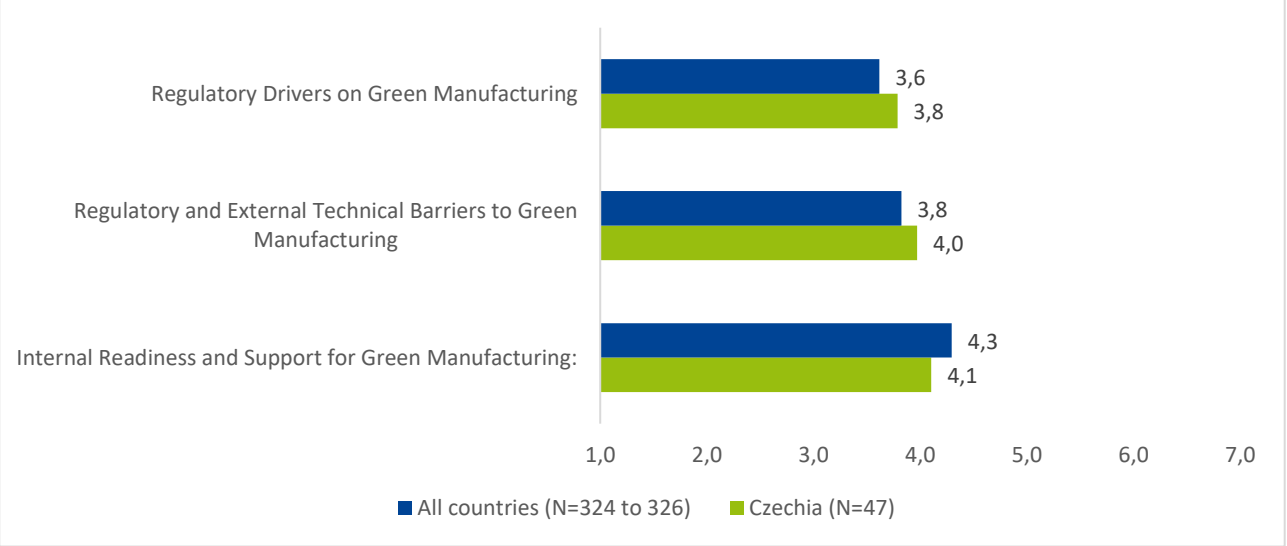


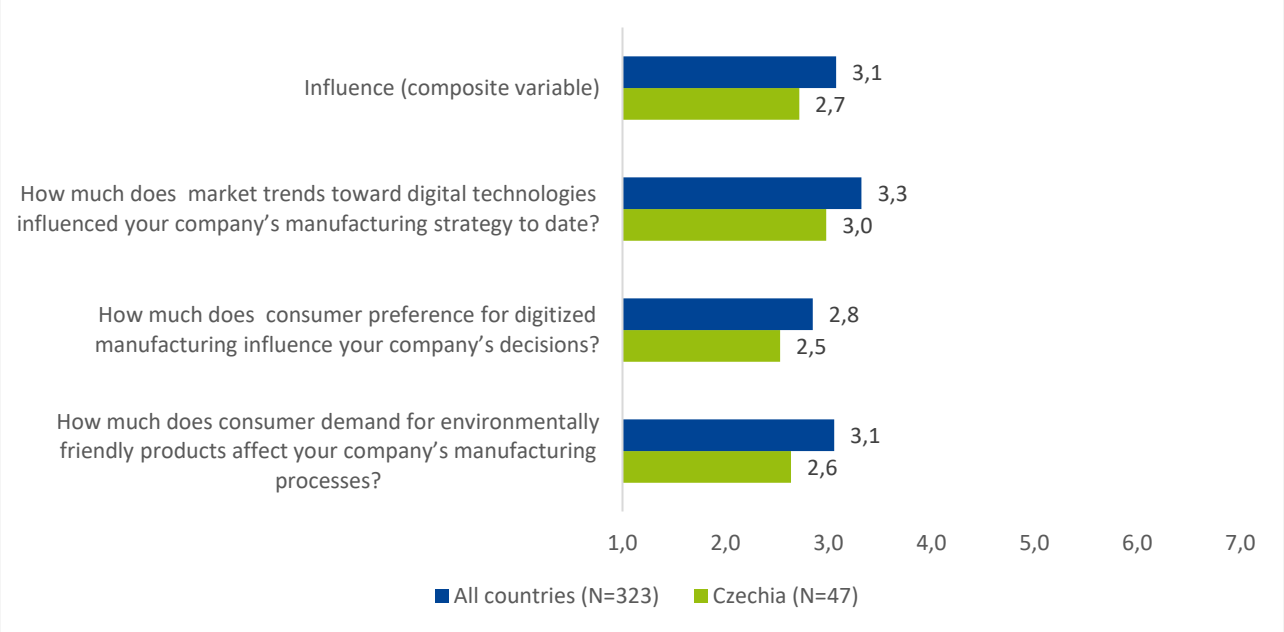
Figure 4-11: Facilitating conditions - composite variables (Czechia)



4.4.9. Influence

When analysing external factors, i.e. customer demand, it was found that in general this pressure is weak. Across the countries surveyed, respondents reported experiencing consumer demand to a small extent (value 3.1) and in the case of the Czech Republic, even to a very small extent (value 2.7). There appears to be very little difference between consumer demand for environmentally friendly products and consumer preferences for digitalised production. Consumers do not care about the degree of digitisation among manufacturing firms. Nor can they judge the level of digitalisation in a firm well enough from the consumer's position. They are not interested in this issue and therefore do not exert any pressure in this area. They are more interested in environmentally friendly products, even if these products can affect their health or quality of life. It can therefore be assumed that in the context of this research, more interest and thus more pressure was recorded by those companies that produce products of this type (i.e. agriculture, cosmetics, pharmaceuticals, etc.). And since the overall proportion of firms of this type was small, the overall effect of these variables is also low.

Figure 4-12: Influence indicators and composite variable (Czechia)



4.4.10. Attitudes Toward Change

At the end of the survey, respondents predicted how likely it was that their company would introduce or increase green processes, switch to energy-efficient machinery or incorporate digital technologies into production processes within 5 years. As Figure 14 shows, around a third of respondents - both across countries and within the Czech Republic - predict some degree of likelihood of implementation. Slightly higher optimism is found in the case of the switch to energy-efficient machines. This finding is logical. For businesses, the economic benefits are the first priority, and these are evident in the case of energy-efficient machines. Managers always primarily consider the economic return on investment. Another thing is that there are already a number of machines on the market today that are energy efficient. Managers can already choose from specific offers, calculating different options. In contrast, in the case of artificial intelligence, blockchain and IoT-enabled devices, there is currently little concrete idea among SMEs about how they could use these technologies.

It would probably be incorrect to conclude that a third of SMEs are planning to adopt green technologies or artificial intelligence in the next five years, despite the fact that the table shows such figures. The way in which respondents were selected needs to be taken into account. A large percentage of the companies

contacted did not participate in the survey. They did not respond to the questionnaire sent to them, and in the eventual follow-up telephone contact, they refused to participate when they were told what the topic of the research was, because they were not interested in the issue. Thus, the research sample was not selected randomly, and it is not possible to generalize to the entire population of SMEs even in the case of the forecast.

And in the companies that participated in the research, it was sometimes noticeable that the manager or director answers rather as he would like or as he thinks he is expected to answer (the issue of so-called Socially Desirable Answers in face-to-face interviews). All these factors need to be taken into account in the final prediction of future changes.

Table 4-3: Attitude toward change (Czechia)

	Czechia		All countries	
	N	% likely or very likely	N	% likely or very likely
How likely is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	16	34%	320	31,6%
How likely will you switch to energy-efficient machinery for your production in the following 5 years?	18	38,3%	320	35,0%
How likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	15	31,9%	320	32,0%

4.4.11. Enablers and Barriers

Market demand - this is currently very low. There are exceptions only for certain sectors (agriculture, food, cosmetics, pharmaceuticals), i.e. for products that are directly consumed by consumers and can affect their health or quality of life. "Saving" or being environmentally friendly is rather declarative, i.e. customers talk about it, but when they make their purchasing decisions, they buy a product that is cheaper rather than one that is more environmentally friendly. Companies behave similarly. In the case of public procurement, the price of a good/service also plays a primary role, not its environmental friendliness. Thus, the state as a customer not only does not create demand for environmental friendliness, but legislatively puts it ahead of price.

Economic reasons - example - if recycled goods are cheaper, choose recycled. But not primarily because it saves the environment, but because it is cheaper and their final price will be lower and they will remain competitive.

Environmental responsibility - some companies state that they want to adopt green practices and go digital because it will save the environment. If there are no financial benefits associated with this attitude, another motive is apparent in the background - for example, the company's image, differentiating itself from competitors in corporate strategy.

Available subsidies - given that the respondents were often people with a background in economics, they are not very friendly towards subsidies in general. Yet, subsidies were often mentioned in this context. Not only because subsidies work well in some sectors (agriculture), but also because small and medium-sized firms do not have as easy access to foreign financial resources as large and multinational firms. The form of subsidy would not have to be direct, but other solutions would be acceptable (reduction of the income tax base, etc.).

4.5. Summary of attitudes towards green and digital technologies

- Green technologies are considered more expensive, the economic benefits are not always obvious.
- SMEs are not economically strong. The economic intensity of green technologies is high and often difficult to implement technologically.
- Investing in green technologies is a risk for entrepreneurs - they invest significant funds in new technologies, the cost is reflected in the final product and it becomes uncompetitive.
- Consumer demand is relatively low. Consumers prefer price over ecology. However, in international supply chains, the situation is slightly different.
- Negative impact on quality. Some of the sustainable solutions decrease quality parameters of goods or services provided and required by customers.
- Digitalisation - currently many SMEs do not have a concrete idea of how they could use these technologies in their business
- Companies mentioned problems due to finances, where subsidies are required, which are very time-consuming due to bureaucracy.
- Use of the existing subsidy system (e.g., Green Savings - photovoltaics, rainwater harvesting etc.) is only possible for businesses that operate in their own properties. However, a large number of these businesses are in rented premises and cannot benefit from subsidies.
- Some of the ecological proposals for production are not applicable in specific operations due to legislation and or other conditions. For hazardous waste, other recovery or processing for reuse is impossible at this time.
- The public interest in organic products is rather declarative (the price of the product is the decisive factor in purchasing, not its environmental friendliness) or the market segment willing to pay a premium is relatively small.
- The behaviour of companies is very similar. Only one respondent in the research reported that a German client (B2B) demands and prefers the environmental performance of the product. The position of companies is rather conservative and economically pragmatical. Despite a positive approach to environmental and social responsibility, they want to see a positive impact on economic efficiency.
- Employees do not seem to be the main problem in the implementation of digitalisation and green systems. There was neither a general resistance to nor fear of new technologies. The fact that employees are not yet trained in this area is primarily related to the fact that companies do not yet have this need and employees do not use these skills.
- Lack of strategic approach and internal capacity. Since the companies frequently do not have a specific strategy for sustainable innovation, they also lack general awareness about best practices and economic benefits of digital technologies and green production.
- Once decided, the management strongly supports the green transition.
- Regarding Technology and Innovation, elements of cloud computing seem to be quite common among the interviewed companies, AI and automation slowly gets into awareness, however usage of AR/VR was not present in the sample.
- Usage of green solutions is based on responsibility and economic rationality. Despite some companies considering changing old machinery as very costly and complicated, the majority of inquired companies already use energy-efficient machinery and equipment. Popular is the usage of waste recycling systems. Renewable energy sources might be used more.
- Companies use reinvested profits or cash-flow from sold products as a primary source of financing. They use loans, grants or other financial tools to a lesser extent.
- SMEs are a bit hesitant or sceptical regarding their expectations about potential positive impacts of digital technologies and green production on business. Despite that, the introduction of AI and other digital technologies was considered as the most promising from analysed options.
- They also expect higher effort and costs related to transition.

4.6. Conclusions, Recommendations and Action plan

4.6.1. Conclusion

In terms of how companies perceive the efforts in adopting green and digital technologies, Czech companies are much more critical than companies in other countries. SMEs are primarily addressing issues other than green technology adoption and digitalisation, frequently of operational character. In the case of the introduction of machines and technologies that are both environmentally friendly and bring economic benefits (at least in the medium term), their activity is much greater than in the case of digitalisation, for example, where they often have no concrete idea of how they could use the new technologies and no time to devote to it.

In the case where a new company is being created as a “greenfield" i.e., building a business from the ground up or undergoing a complete overhaul, it orders new "green" technologies. For a large part of existing companies, the introduction of green practices is out of the question because the old machines do not allow it.

4.6.2. Recommendation

In the area of digitalization - involvement of young people who have considerable knowledge about new technologies. For example, bachelor's theses in some fields of study could be handled as concrete projects in companies - on the basis of an internship in which they would learn about the operation of the company, they would suggest what technologies could be used, how much it would cost and what the benefits would be.

In the field of green technologies - measures to be divided according to the size of the company (small companies and medium-sized companies separately - the differences are noticeable). Measures should then be set up in several areas: subsidies (or similar alternative - e.g. in the form of income tax reduction), change in legislation (e.g. in tenders the ecological criterion should have a higher weight than it currently has; possibility to draw subsidies even in the case of renting real estate - e.g. rent rebate, etc.)

Increasing the awareness and adoption capacity by a) supporting peer to peer sharing of best practices, b) creating or enhancing existing mentoring or acceleration programs for faster implementation under the guidance of experiencde managers, CEOs, owners (e.g. Platinn program).

4.6.3. Action Plan

The following simplified draft of an action plan contains types of actions based on results and recommendations. It should be considered as a starting point for discussion with stakeholders, ideally in the form of a co-creation process with the participation of quadruple helix representatives. Otherwise, the plan might lack authenticity, a critical level of identification, ambition connected to feasibility, and actively self-defined (co-)ownership.

Table 4-4: Action plan

Priority Area	Measure	Responsibility	Preparation time
Enhancing knowledge (among young professionals)	Specific internship program	UJEP + ICUK + selected companies	6-12 months
Financing	Adjustment of subsidies for rented spaces (to use renewable energy)	MMR + MŽP	12-24 months
Awareness and capacity	Specific P2P best practice sharing program	ICUK + other IC + selected companies	12 – 18 months
Awareness and capacity	Specific mentoring program	ICUK + other IC	12 -18 months

5. Germany Analysis – key findings

5.1. Sample description

Within Germany, a total of 43 SMEs were surveyed. 42 of these companies employ fewer than 250 persons; one company employs more staff than that but has an annual turnover of less than 50 million Euros. One other company has an annual turnover exceeding 50 million Euros but employs fewer than 250 persons. The remaining 41 companies fulfil all three applicable criteria for being considered an SME. 23 of the surveyed companies self-identified as belonging to the Manufacturing sector; of those 23, 13 are active in manufacture of machinery and equipment, and 9 in the manufacture of other fabricated metal products. As most of the surveyed companies are located in the eastern part of Germany, and Saxony in specific, this sectoral focus is a reflection of the strength of these industrial branches in this part of the country. 28 of the specific company representatives filling out the survey chose to share some personal details; of those 28, 16 self-identified as CEOs. Age brackets 35-44 (9) and 45-54 (10) were the most common, with one respondent in the 65-74 bracket and none in 25-34. 24 of the respondents which filled out this section of the questionnaire were male, 4 were female. 12 respondents have been working at their current companies for more than 10 years, and 8 between 5 and 10 years.

5.2. Survey administration

The majority of the applicable datasets was input autonomously and without supervision. In order to publicize the survey, we used multiple direct and indirect information channels, which included mass mailings, newsletters of partner organizations and projects, and the local press. Additionally, some companies with which we had pre-existing contacts were contacted on an individual basis through email and phone. Of this more limited range of companies, 5 were selected for personal interviews, which included filling out the survey together and was accomplished both in presence (2) and online (3). The aim of these interviews was to gain some additional insights on both the structure of the survey itself and on the specific challenges and priorities of these companies. These 5 datasets are included in the overall set evaluated in this analysis.

5.3. Preliminary findings during the survey administration

The response rate to the initial mail campaign was low. After sending the survey out to ca. 600 company addresses, we received no more than 20 usable response datasets. This aligns with previous experiences we have had regarding online surveys and was in line with our expectations. We were able to attain additional responses in the following weeks by utilizing other channels, as outlined in 3.2. As concerns the 5 in-person interviews, the most striking issue highlighted by the respondents was a lack of easily accessible and independent expert knowledge on digitization and the green economy. Lack of qualified personnel and financing issues were also mentioned in one way or another by all 5 interview partners. Regarding the structure of the survey itself, no significant points of criticism were made.

5.4. Regional Analysis key findings

5.4.1. Technology and Innovation

Relative to the international average, we find significantly lower rates of adoption in the categories CRM, IoT, and AI. Intelligent Document Processing applications are in higher use than by average, as are ERP systems. There are several possible reasons for these differences, but we believe the most plausible to be a) composition of the German sample relative to the mean, and b) differences in understanding of the technologies mentioned / term ambiguity. For example, “Cloud Computing” may to one respondent only need to refer to the storage of files on an off-site server to fulfil this criterion, while another may think it

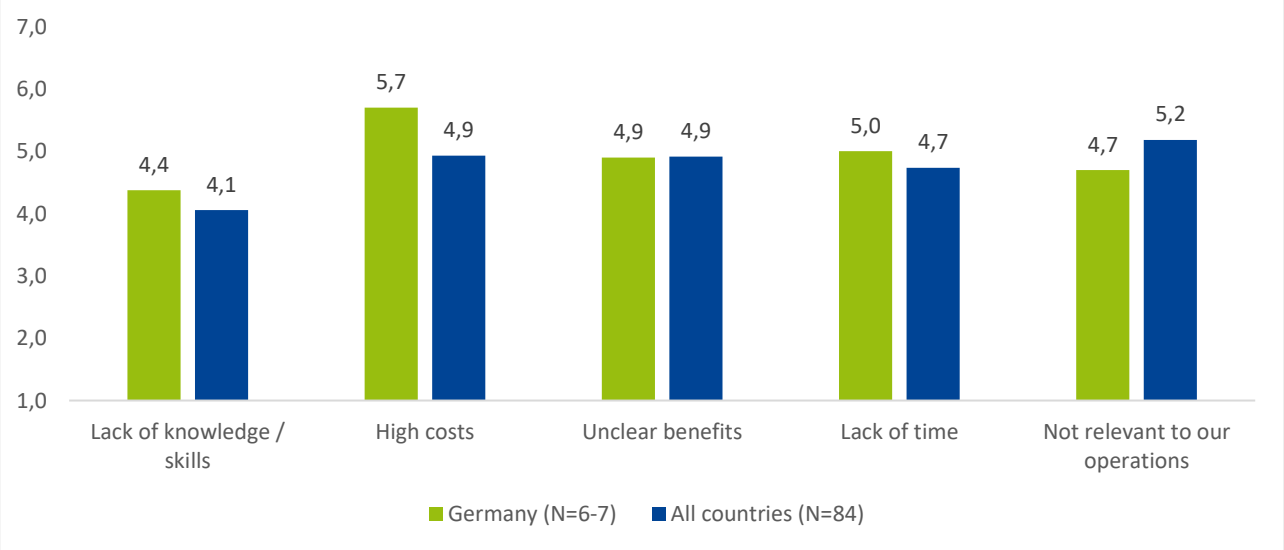
necessary to actually run applications on a remote PC for it to be considered computing in a cloud. This type of ambiguity is hard to avoid and harder to retroactively verify when designing a survey, which means that it introduces a degree of uncertainty. Nonetheless, the differences in percentage values are high enough to conclude that within the sample of surveyed German SMEs, the adoption rate of digital technologies is somewhat lower than the CE (central European) average. In Figure 1, we also see that the cost factor for the German companies is a higher barrier than the average, while fewer respondents than the average actually assessed these technologies as not relevant to their operations.

Table 5-1: Technologies used in company (Germany, N=31)

	Germany		All countries	
	Yes	**%**	**Yes**	**%**
Cloud Computing	17	54,8%	169	60,6%
CRM (Customer Relationship Management)	10	32,3%	154	55,2%
ERP (Enterprise Resource Planning)	20	64,5%	161	57,7%
Intelligent Document Processing applications	13	41,9%	81	29,0%
Internet of Things (IoT) - IoT platform for management, monitoring and improvement of production flows,	2	6,5%	67	24,0%
Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation	2	6,5%	30	10,8%
Augmented Reality / Virtual Reality	1	3,2%	10	3,6%
Other	1	3,2%	17	6,1%
Total	31	100,0%	279	100,0%

Please note that respondents had the option to select multiple responses.

Figure 5-1: Identified barriers to digital technologies usage



5.4.2. Green Manufacturing Practices

In this question, we see a high degree of adoption in the "Energy-efficient machinery and equipment" category, although the breadth of possible interpretations of this term should be acknowledged; energy-efficient equipment could reasonably be considered to be something as relatively simple as LED-based lighting, to a replacement of a great portion of the actual machines used in the production process for more efficient

counterparts. Most categories are roughly equivalent to the CE average. One discrepancy is the low prevalence of waste recycling systems, which we hypothesize may be explained by a comparatively higher quality of the public waste management services in Germany, which could make such systems less critical, especially in the context of SMEs. The category "Low VOC finishes and glues" is somewhat industry-specific and may be higher for the German sample because of our choice of companies.

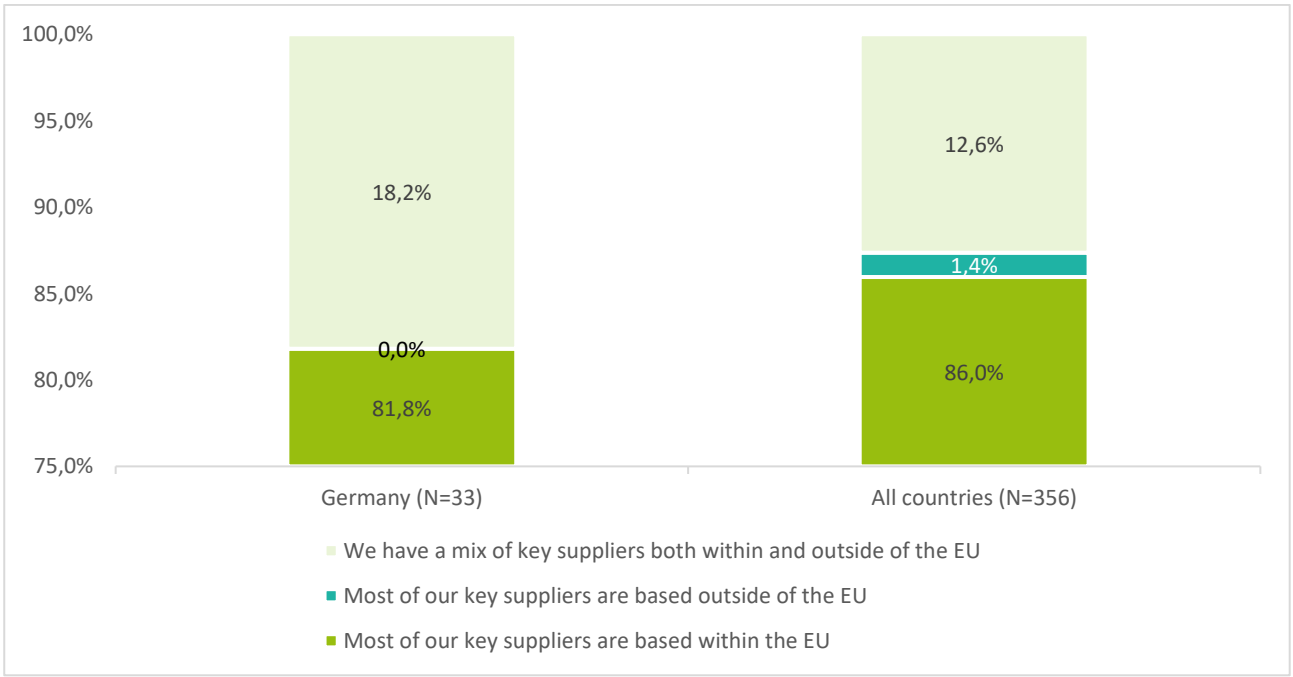
Table 5-2:Green manufacturing technologies used in company (multiple responses are possible)

	Germany		Total	
	Count	%	Count	%
Energy-efficient machinery and equipment	23	71,9%	205	63,9%
Renewable energy sources (solar, wind, biomass)	16	50,0%	198	61,7%
Advanced process control systems	7	21,9%	76	23,7%
Waste recycling systems	4	12,5%	117	36,4%
Environmentally friendly materials in production	13	40,6%	123	38,3%
Lean manufacturing practices	17	53,1%	135	42,1%
Waste reduction strategies (e.g. composting, recycling)	10	31,3%	135	42,1%
Water-efficient systems (e.g. rainwater harvesting)	9	28,1%	56	17,4%
Sustainable packaging materials	11	34,4%	109	34,0%
Low VOC (Volatile Organic Compounds) finishes and glues	5	15,6%	28	8,7%
Use of recycled or sustainable materials	18	56,3%	94	29,3%
Total	32	100,0%	321	100,0%

Please note that respondents had the option to select multiple responses.

5.4.3. Supply Chain and Partnerships

Figure 5-2: Location of key suppliers (Germany)



For both Germany and CE overall, we see that the large majority of surveyed SMEs has most of their key suppliers within the EU, with only a small minority of 18,2% and 12,6% respectively indicating that they also depend on suppliers outside the EU, which may, of course, also refer to Switzerland, Norway, or the United Kingdom. Firms with key suppliers that operate exclusively overseas are not a factor, which is to be expected for SMEs. It would be interesting to be able to compare these figures to values from 2019, before the COVID-19 pandemic.

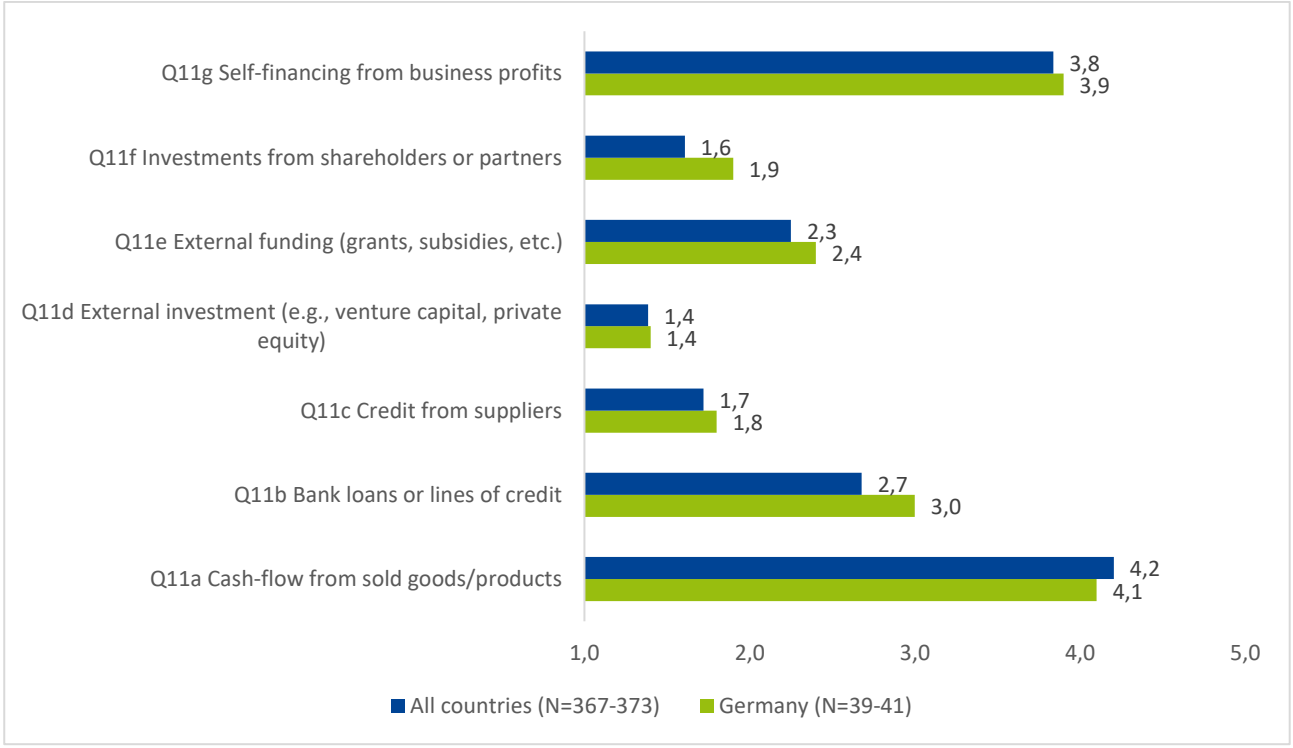
5.4.4. Financial Aspects

For both Germany and CE overall, the most important financing sources by a significant margin are cash-flow from sold goods and products, as well as self-financing from business profits – two sources which are, of course, interrelated. Bank loans and external funding in the form of state aid are also important, though external investment almost plays no role at all. This can in part be explained by rising interest rates, although the more significant reason is that many SMEs, which are often family-run businesses, are wary of making deals with venture capitalists on principal.

Production capacity, in the CE average and even more so in the German sample alone, was overwhelmingly either quantified in the >1000 unit/year range, or deemed to be not applicable. The reason for this is that the output of many SMEs isn't simply the end of an assembly line. Many companies, especially so in mechanical engineering and machine building, create a low number of specifically tailored (and high turnover/unit) products. A large portion of the mass component production sector has moved to lower income countries during the past decades, which explains the observed results.

Regarding measures taken to improve production efficiency, the most popular for the German sample are "Investing in new equipment", "Streamlining production processes", and "Hiring additional staff", though notably, "Exploring new supply chain partnerships" is also highly rated, which can be assumed to be a result of pandemic-era disruptions. A notable divergence to the CE average is that "Hiring additional staff" is much less of a priority here; this could be indicative of a relatively higher shortage of skilled workers in Germany, which forces companies to pursue new employees more proactively.

Figure 5-3: Financing sources (Germany)



Less than a third of the surveyed SMEs experience delays in receiving raw materials only rarely or not at all, which is far lower than the 43,7% of companies in the CE average. The percentage of companies experiencing delays often is also elevated. The reason for this may be that within the companies in the German sample, the products are relatively more complex due to the given sectorial focus, and an increase in the number and variety of components will naturally lead to more complex and easily disturbed supply chains.

Figure 5-4: Maximum production capacity per month (Germany)

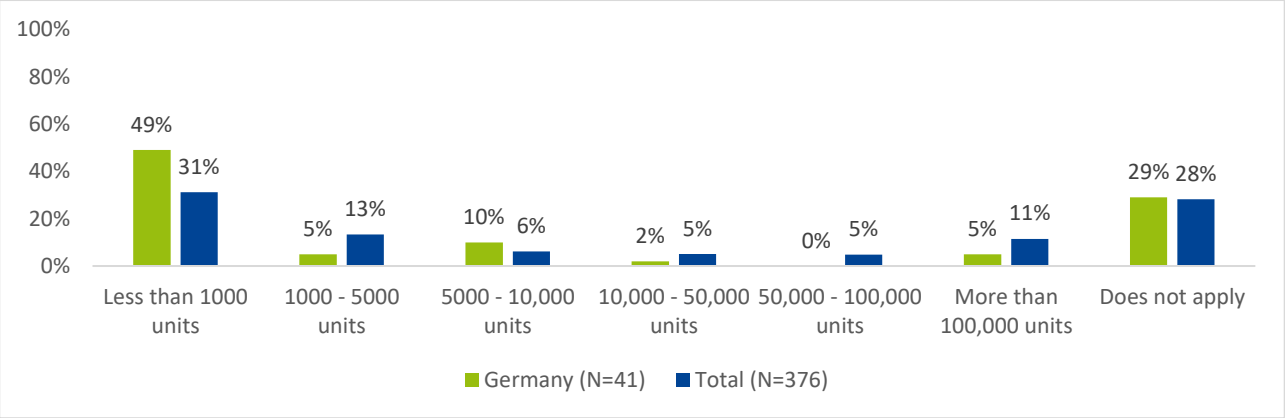


Figure 5-5: Measures taken to improve production efficiency and narrow the gap between actual and potential output (Germany)

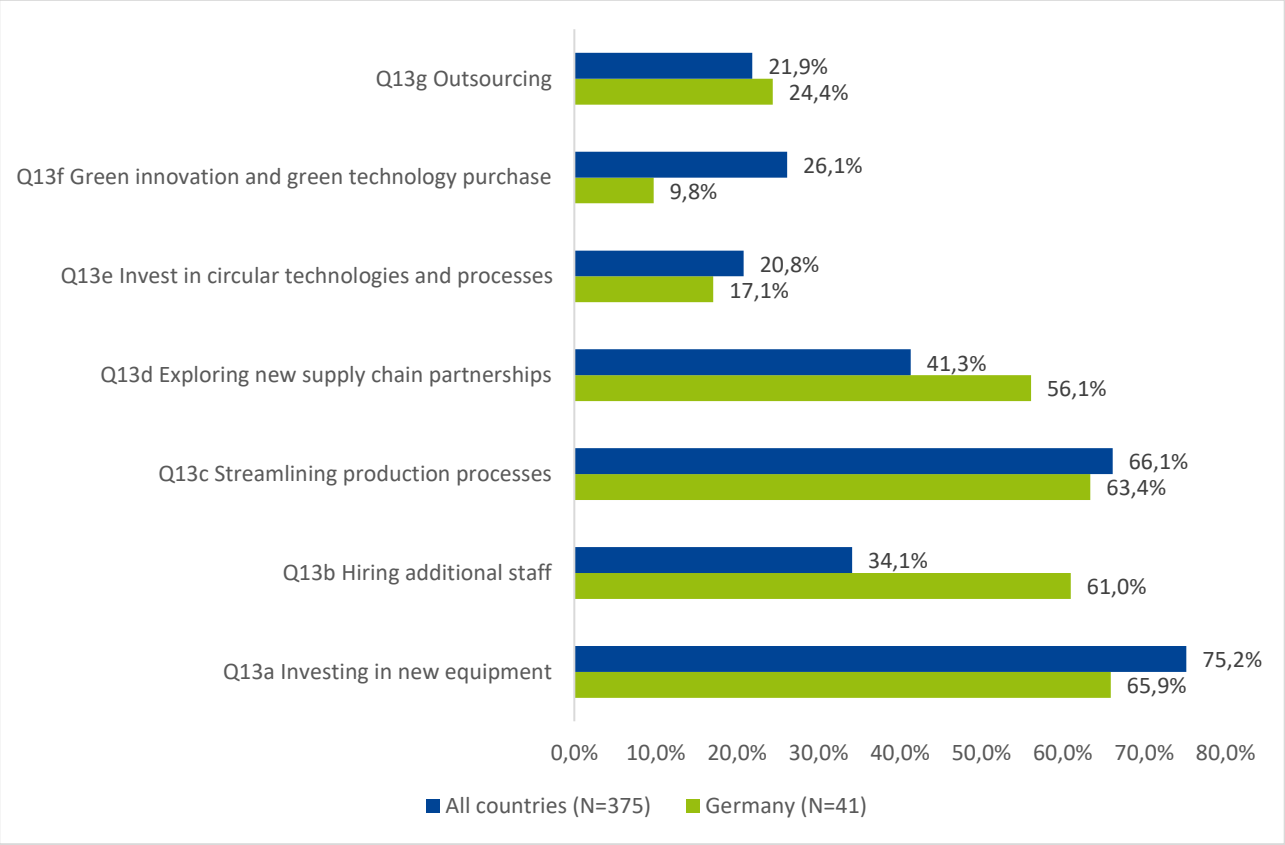
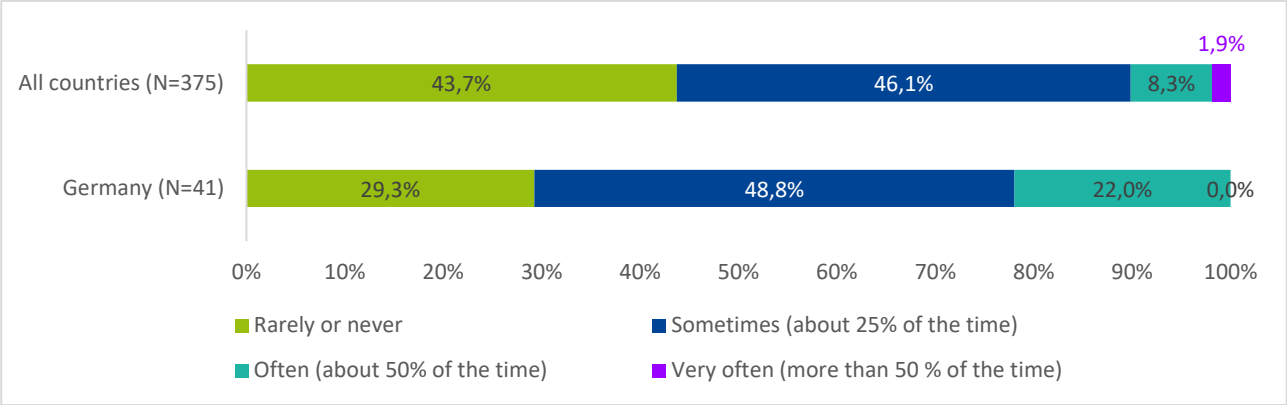


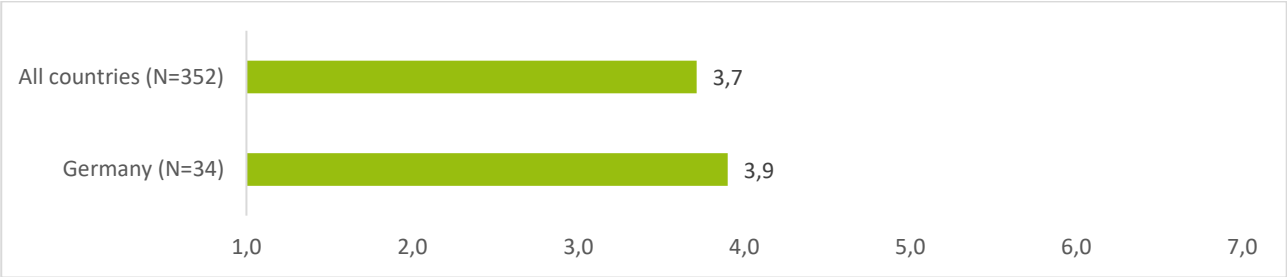
Figure 5-6: Experienced delays in receiving raw materials (Germany)



5.4.5. Usage Behaviour

On the adopted scale of 1 (not at all) to 7 (already implemented), the average value for the German dataset was 3,9. This is slightly but not significantly higher than the CE average.

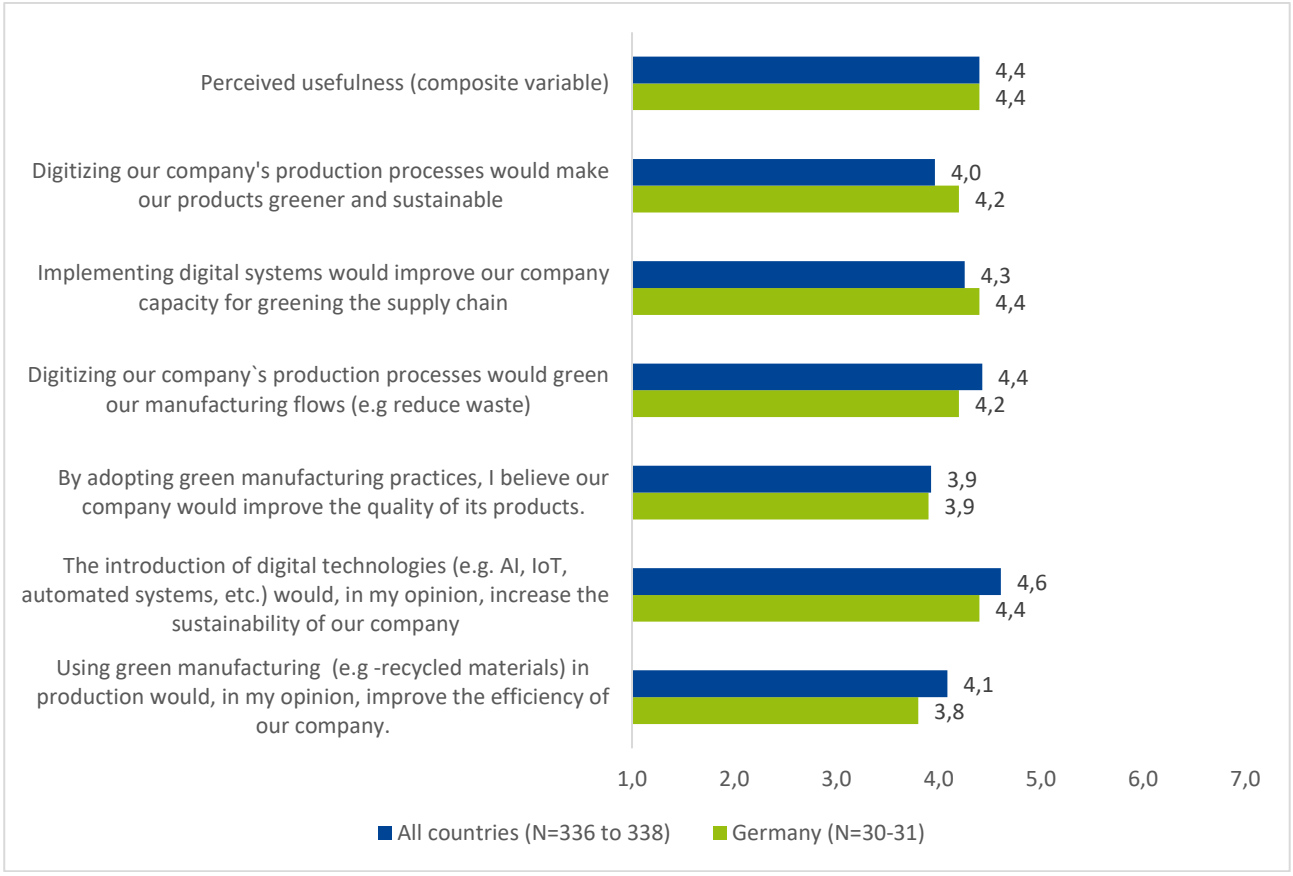
Figure 5-7: Usage behaviour by country



5.4.6. Perceived Usefulness

In spite of the fact that we observed earlier that the adoption of digital technologies within the group of surveyed German companies lags behind the CE average in certain categories, the perceived usefulness of digitization is equal to the CE average. Across the board, both for Germany and CE overall, we observe cautiously but not exuberantly optimistic attitudes toward digital technology, in the range of 3,8 to 4,6 out of 7. This is indicative of the fact that while the hypothetical benefits of properly implemented digital systems are clear to most company executives, actually achieving this is a challenge of a size specific to individual SMEs. A company fighting to stay afloat generally doesn't have the capacity to green its production.

Figure 5-8: Perceived usefulness indicators and composite variable (Germany)



5.4.7. Effort Expectancy and Ease of Use

As alluded to in the previous section, while the average effort expectancy expressed is largely ambivalent, the situation can vary drastically from one company to another. Figure 9 does not fully express this variance, but the answers to the open-ended questions near the end of the survey and the insights gleaned from our in-person interviews go further in shedding light on the issues at hand. A recurring theme for our German companies was that while state aid is always welcomed, smaller SMEs in particular often find themselves ill-equipped to successfully execute their own, individual digital transformation, which leaves them no choice but to rely on external corporations that firstly act in their own best interest. And while very little can be done to quickly ameliorate the general lack of skilled IT workers to enable small companies to build up in-house capabilities, more options for receiving independent expert advice would be appreciated by all interviewees. The average values in Figure 10 are actually consistently higher for Germany than for CE overall, but executing on production greening initiatives, which are often not essential to the continuing ability of a company to operate, remains a question of available resources.

Figure 5-9: Effort Expectancy indicators and composite variable (Germany)

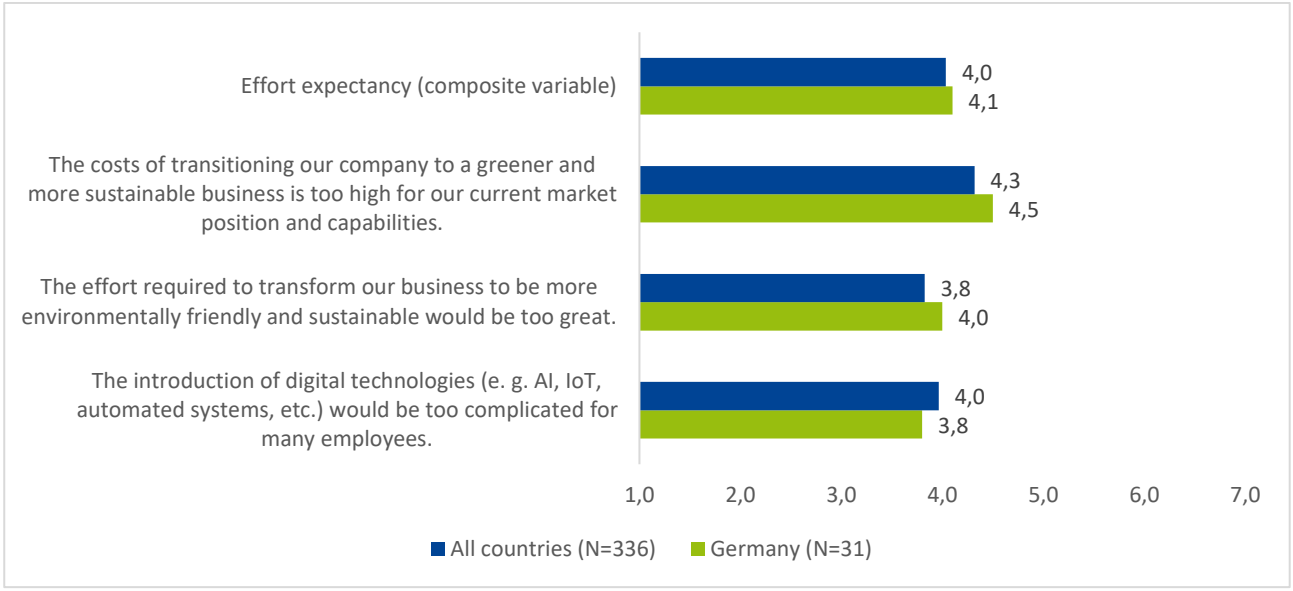
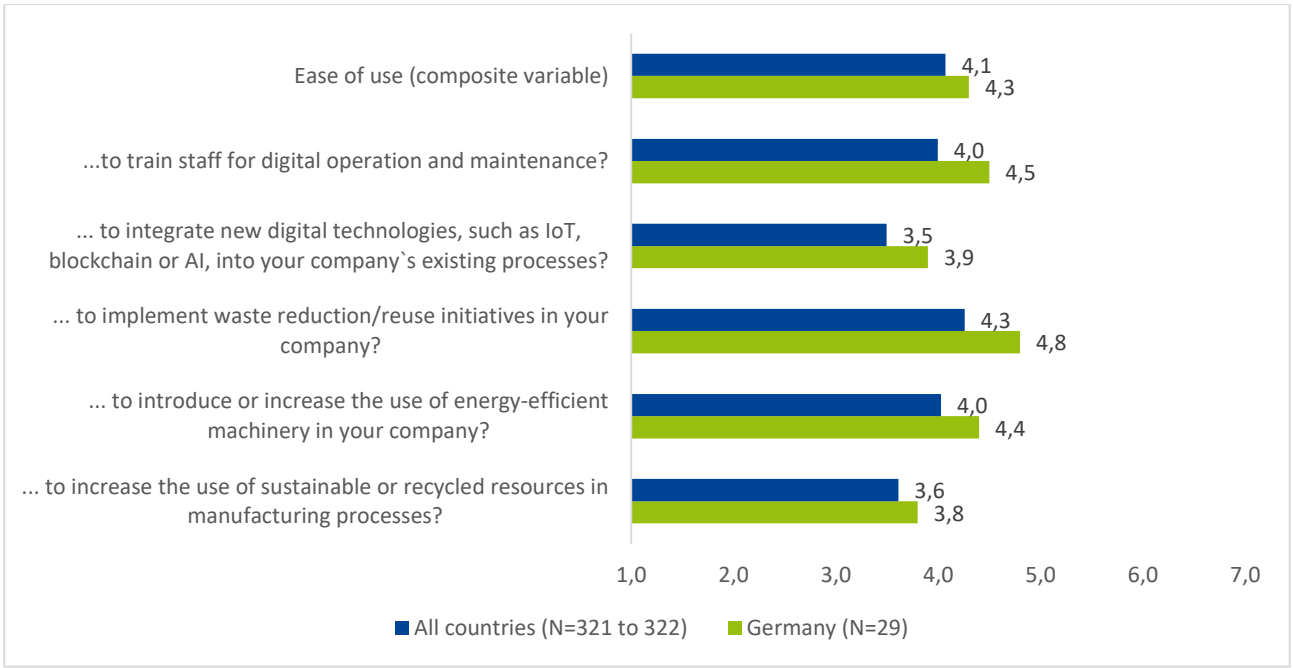


Figure 5-10: Ease of use indicators and composite variable (Germany)



5.4.8. Facilitating Conditions

For the German dataset, the overall picture is quite positive here; highlightable in particular are the internal readiness factors “Our top management actively encourages the use of green manufacturing practices”, “The company has the necessary technical infrastructure”, and “The required knowledge and technical resources are available”, all of which were rated close to 5 out of 7. Overall, the composite variable for internal readiness reaches a comparatively high value of 4,6. It should, of course, be noted that the majority of respondents are themselves inarguably top management, which will naturally tend to bias them in their own favour. In a similar vein, attitudes shift markedly for the second group of factors, regarding regulatory and external technical barriers. Here, respondents find themselves in agreement with the negative theses

of there not being enough external technical knowledge and not enough information provided by the government, although the impact of actual regulatory obstacles to the implementation of green manufacturing is rated quite modestly (2,8, compared to 3,2 for the CE average. Correspondingly, the composite variable for this group of factors is lower, at 4,1. Factor group 3, regarding regulatory incentives, yields similarly muted results; both regulatory incentives and pressures receive only a middling satisfaction score at 3,4 each. It should therefore be once again stressed that the received responses, in this section even more so than in general, represent the subjective point of view of company representatives, and heavily skew in favour the upper management layer. There is still ample value in more detailedly evaluating the received responses, but the existing biases should be taken into account.

Factor analysis yielded 3 factors:

FACTOR 1: Internal Readiness and Support for Green Manufacturing:

This factor pertains to the internal preparedness of an organization for the transition towards green manufacturing practices. It encompasses the availability of resources, qualified personnel, knowledge, and technical infrastructure within the organization. Additionally, it considers the active encouragement and support from top management, along with the provision of necessary training for employees, ensuring the internal ecosystem is conducive to embracing green manufacturing.

Includes statements:
- Q34b Our employees have the necessary resources to make the shift towards green manufacturing.
- Q34c Our company has a sufficient number of qualified employees to make the shift towards green manufacturing.
- Q33a The required knowledge and technical resources for the green manufacturing transition are available in our organization.
- Q34a Our top management actively encourages the use of green manufacturing practices within the company.
- Q34d Our employees have received the necessary training to implement a transition to green manufacturing.
- Q33b The company has all the necessary technical infrastructure for digitization.

FACTOR 2: Regulatory and External Technical Barriers to Green Manufacturing

This factor revolves around the external influences that organizations encounter when attempting to adopt green manufacturing practices, namely lack of government information, other regulatory obstacles and limited external technical knowledge.

Includes statements:
- The government doesn’t provide enough information regarding sustainable production/green manufacturing.
- There is not enough external technical knowledge available to support adoption of green manufacturing practices.
- More green manufacturing practices cannot be implemented because of the regulatory obstacles.

FACTOR 3: Regulatory Drivers on Green Manufacturing

This factor centres around the influence of regulatory frameworks on motivating and facilitating organizations to adopt green manufacturing practices.

Includes statements:
- Q33d There are enough regulatory pressures pushing our company to adopt green manufacturing practices.
- Q33e The regulatory system contains sufficient incentives to encourage the green transition.

Figure 5-11: Facilitating conditions – indicators (Germany)

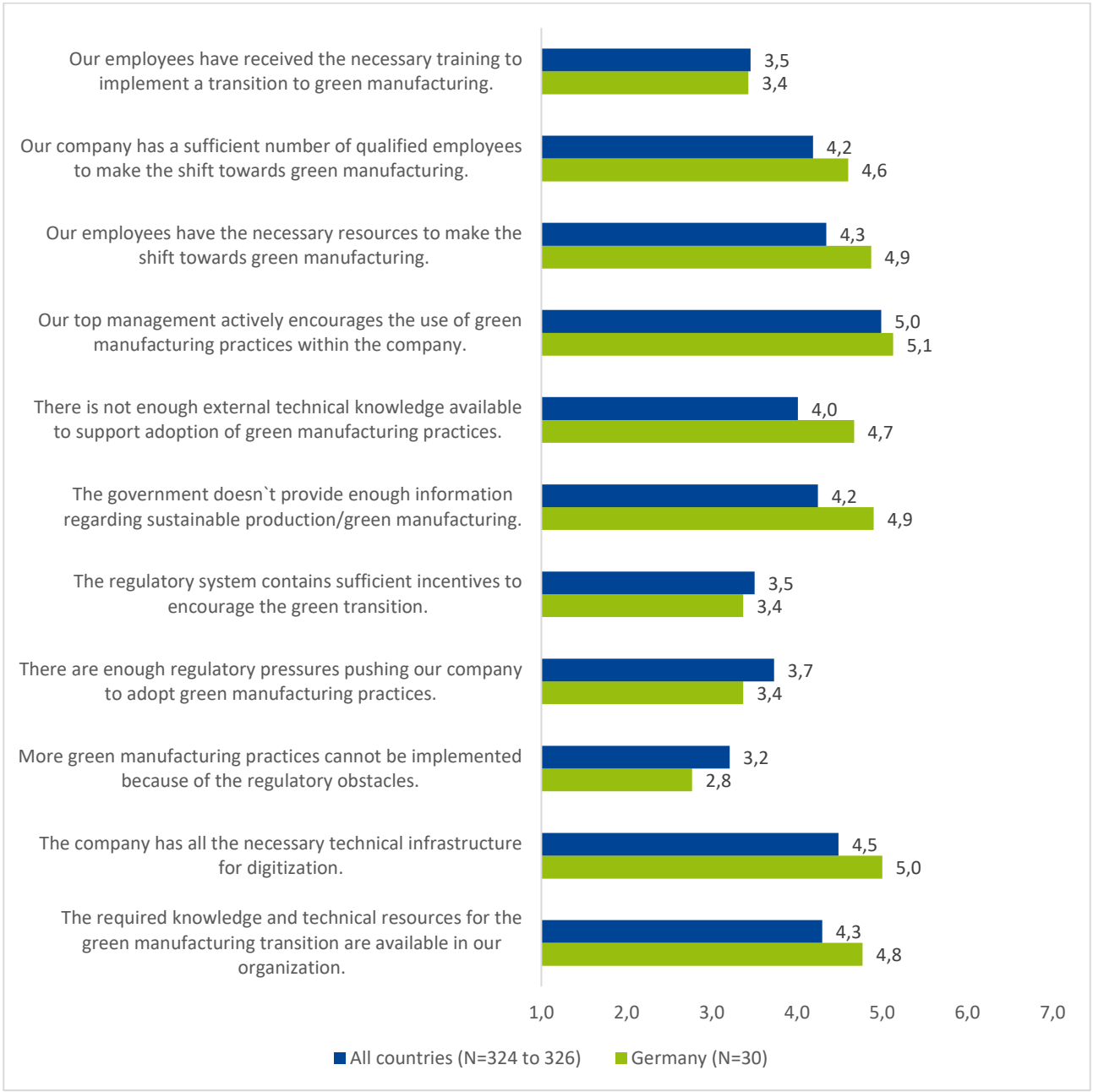
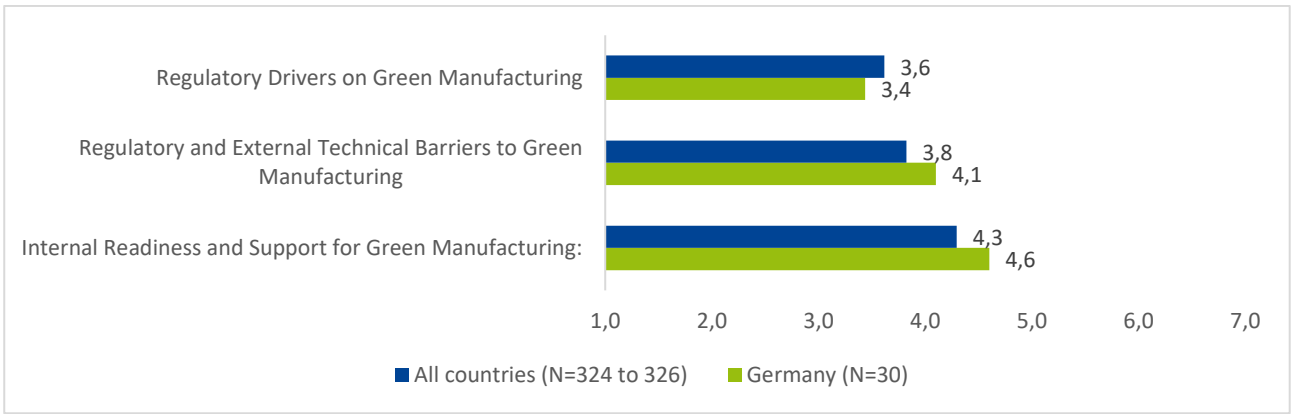


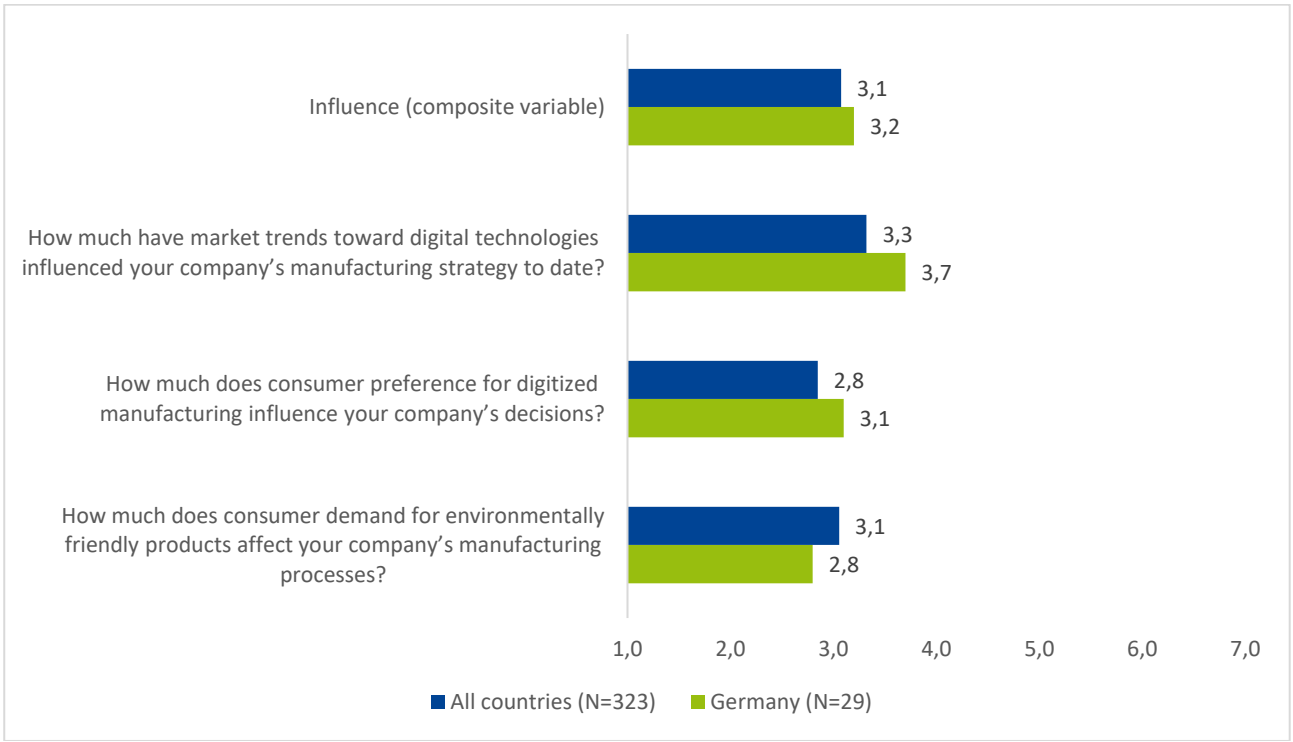
Figure 5-12: Facilitating conditions - composite variables (Germany)



5.4.9. Influence

As illustrated in Figure 13, consumer preference for a digitized manufacturing process slightly outweighs demand for environmentally friendly products, in an inversion of the CE average. It can be hypothesized that this may be due to the prevalence of B2B-only firms in the German dataset, and specifically the mechanical engineering sector. For large companies (automotive firms etc.), reliability and timely commissioning of any specialized equipment would be considerably more crucial than any environmental considerations, be they related to energy consumption or the utilized materials. Conversely, fully digitized production environments have only upsides for customers in this field, especially with respect to documentation and the ongoing maintenance. We believe that the elevated figure rating the importance of market trends (3,7) is also a result of this circumstance, as many clients in the sector at this point don't just see digitized production as an advantage, but as a prerequisite. What this means for the implementation of specifically green production processes is that many SMEs may be hesitant to implement them, unless they can be credibly assured that doing so won't result in any competitive disadvantage.

Figure 5-13: Influence indicators and composite variable (Germany)



5.4.10. Attitudes Toward Change

Percentages of positive responses for all three questions are slightly more than ten percent below the CE average, which is significant. There are several possible explanations for this. One is that the surveyed companies in Germany have a generally more pessimistic outlook and/or struggle financially, and therefore can't or won't invest in manufacturing solutions. Another is that the sectorial focus on mechanical engineering and machine building firms has skewed the results relative to the average, in which responses from these specific subsectors are not as proportionally dominant. It should however be noted, that the Czech dataset has a sectorial focus comparable to the German one, and its values in this category align more closely with and at times exceed the average. It is also conceivable that the number of responses is too low to draw generalized conclusions in this manner.

Table 5-3: Attitude toward change (Germany)

	Germany		All countries	
	N	% likely or very likely	N	% likely or very likely
How likely is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	29	20,7%	320	31,6%
How likely will you switch to energy-efficient machinery for your production in the following 5 years?	29	24,1%	320	35,0%
How likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	29	20,7%	320	32,0%

5.4.11. Enablers and Barriers

Question 1: What are the major drivers for your business to adopt or make investments in green manufacturing practices? Please consider the benefits to the environment, the economy, and the market, in addition to any additional benefits you anticipate.

For Germany, most frequently mentioned by far is the possibility of reducing operating costs in general and energy and material costs in specific. Customer demands and requirements for a greener production share a second place with environmental idealism ("because it's the right thing to do"). Regulatory pressures were only mentioned by two respondents. Some respondents also expressed that they fundamentally see green manufacturing as something that doesn't apply to them, either because they claimed to see no advantages or because they don't use much or any energy-intensive equipment.

Question 2: What do you think are the biggest obstacles or challenges to using green manufacturing techniques and technologies in your company? Please consider technical, financial, regulatory barriers, market challenges and any additional barriers you anticipate.

Most significant by a wide margin are financing issues, followed by a lack of staff. One respondent noted that while the advantages of green technology in many areas are undisputed, those positive effects often take years to manifest themselves to a degree that will have a significant positive impact on their bottom line. A minority of respondents formulated answers to the effect that they feel that they have already done anything they sensibly can for now. Another point was that some customers still associate recycled materials with lower quality products.

Question 3: What kind of support, resources or infrastructure do you think your organization would need to successfully adopt green manufacturing practices? Please provide details about training, technology, finance, or other types of support.

State subsidies are frequently mentioned, as is a desire for less bureaucracy and more readily available expert advice, both related to digitization as such and to aid programmes in specific – smaller SMEs in particular are often totally unfamiliar with these environments. Reliable public infrastructure and external offers for advanced training are another two points.

5.5. Summary of attitudes towards green and digital technologies

Fundamentally, we can conclude that there is a wide range of companies present in the German sample, that brings with it a wide range of perspectives. On the one hand, we have large SMEs with nearly more than 250 employees, which over the years have made themselves capable of serving even bigger customers, including internationally, with complex and constantly evolving demands. While there's always room for improvement, this end of the SME range is certainly less susceptible to falling behind on digitization, due to their greater resources and inherent capacity to handle change. On the other end of the spectrum, we have a large pool of small SMEs, often family-run, often direct suppliers to the aforementioned larger enterprises. This range of smaller firms is much more likely to be driven to extinction by falling behind on market trends toward digitization, which would be disastrous for the health of the local economic structure and increase dependence on overseas suppliers, in a time where everyone is trying to achieve the opposite. All the large problem areas, be they related to financing, lack of staff, or lack of expertise, weigh more heavily the smaller a company is. Combine this with internal structures that are often inflexible, or dominated by a family patriarch archetype CEO, and it should be more than obvious why so many small business in particular are in urgent need of support in tackling the challenges that lie ahead. For many it is already a question of sink or swim.

5.6. Conclusions, Recommendations and Action plan

There is little that can be directly done with regards to improving the financial situation of any company on the transnational level, let alone within this project. The same applies to the lack of qualified staff; German CEOs can complain all day long, but their colleagues to the east often have it even worse, as their prospective employees make their way to Germany to fill positions here. What can be done, however, is improve the situation around availability of experts and good information. To that end, the GREENE 4.0 project should work toward establishing transnational knowledge bases, which enable company representatives not only to contact their respective local advisory offices, but to actively seek a direct, cross-border exchange of information with their European colleagues. Creating such a platform in a way that is not only functional but will be used and accepted even and especially by the most vulnerable economic entities will be a challenge. We believe, however, that the present analysis represents a more than adequate starting off point, as well as a knowledge reservoir as the project develops onward.

6.Hungary Analysis - key findings

6.1. Sample description

The aims were SMEs from various industries, according to the NACE classification. With 42 of the 43 organisations employing fewer than 250 people, it indicates that the survey's primary concentration is on this subset of businesses. This composition exemplifies a concentrated effort to capture the perspectives and characteristics of small businesses from a variety of industries. IFKA had several previous programmes that helped us to get the proper information about SMEs that fit into the partnership's survey. IFKA chose SMEs from the Green National Champions Programme (https://znb.ifka.hu/) and the Hungarian Multinational Programme (https://mmp.ifka.hu/). During the interview process we reached out to over 180 companies. Out of 180, 63 SMEs started to fill out the survey, and 40-43 (depending on the questions) have been validated.

Given the emphasis on SMEs and the broad industry coverage, the poll is most likely designed to uncover insights and trends particular to smaller businesses across industries. This method can give a more detailed picture of the issues, opportunities, and commonality faced by tiny enterprises across industries.

Details like turnover, operational issues, development forecasts, and even particular questions about the unique characteristics of managing smaller enterprises might be significant in the survey's company information section. These specifics may aid in drawing connections between a company's size, industry, and the issues or possibilities it faces.

The data gathered from such a sample might be useful for policymakers, industry stakeholders, and the SME community since it may highlight underlying patterns or requirements shared by numerous industries within the SME landscape.

6.2. Survey administration

Part A of the survey might involve questions about company size, industry, turnover, and other basic demographic details. Our method of administration was involving a combination of online surveys, phone interviews, and even in-person visits to certain companies to ensure a representative sample.

Approximately 70% of the interviews were completed over the phone, and/or finished online. The other 30% performed in-person. The mutual relationship between the SMEs and the IFKA officials was the key reason for personal visits. We used a table of SMEs from previous IFKA programmes (Green National Championship Programme, Hungarian Multi Programme,) because some IFKA representatives visited these SMEs yearly to check whether they were complying with the rules based on the project they had previously applied to, so there was a strong personalconnection between IFKA officials and the companies in question.

6.3. Preliminary findings during the survey administration

Based on our measurements we reached out to approximately 180 companies that fell into the category we were seraching. The relatively high response rate (24%) from these smaller enterprises might indicate their willingness to engage in such surveys, suggesting a vested interest in sharing their perspectives.

We noticed certain common pain points: Even during the early stages of survey administration, certain common challenges or pain points across industries or among SMEs of different sizes might have emerged. mainly in the open question part of the survey. These initial insights could hint at overarching issues that could be further explored in the analysis phase.

6.4. Regional Analysis key findings

6.4.1. Technology and Innovation

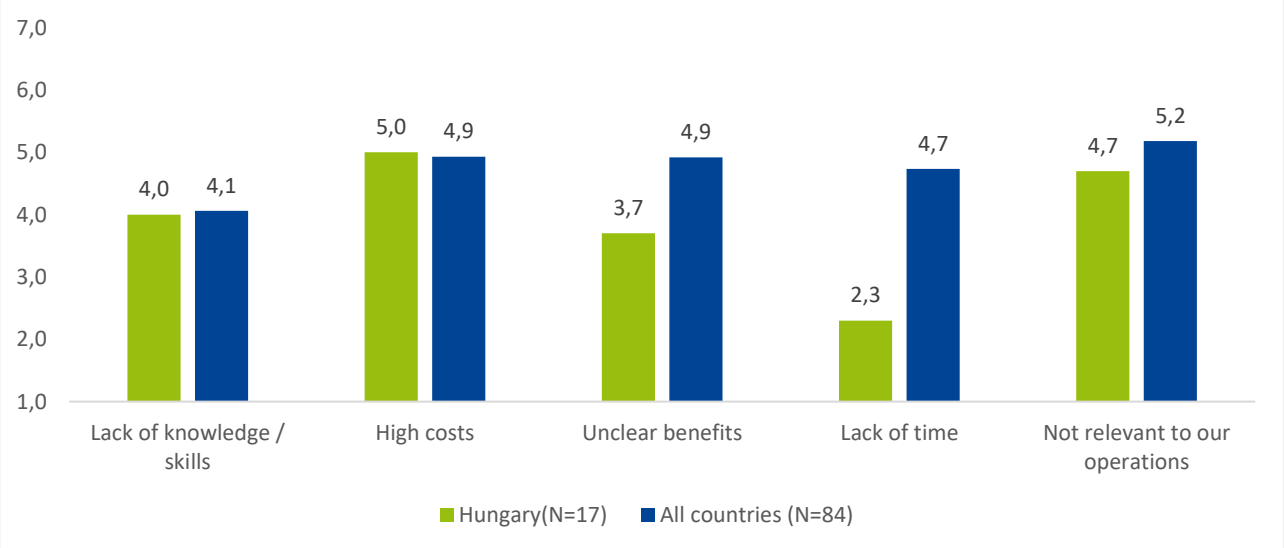
As IFKA included the SMEs in the survey in previous programmes, we knew that a significant number of companies are interested in industries that need to have a certain technological advantage (heavy industry, textile industry, packaging), so as we expected, they have to be keen on technology and innovation. However, the latest technologies are not necessary in the everyday lives of these companies (AI, virtual reality).

Table 6-1: Technologies used in company (Hungary, N=43)

	Hungary		All countries	
	Yes	%	Yes	%
Cloud Computing	30	69,8%	169	60,6%
CRM (Customer Relationship Management)	21	48,8%	154	55,2%
ERP (Enterprise Resource Planning)	30	69,8%	161	57,7%
Intelligent Document Processing applications	8	18,6%	81	29,0%
Internet of Things (IoT) - IoT platform for management, monitoring and improvement of production flows,	14	32,6%	67	24,0%
Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation	3	6,9%	30	10,8%
Augmented Reality / Virtual Reality	1	2,3%	10	3,6%
Other	0	0,0%	17	6,1%
Total	43	100,0%	279	100,0%

Please note that respondents had the option to select multiple responses.

Figure 6-1: Identifed barriers to digital technologies usage



The Hungarian example in terms of lack of knowledge brings the average results as any other country in the survey. The same applies to the second question of high costs. Some modern technologies, especially cutting-edge ones, can be complex to understand and implement. This complexity might make it challenging for individuals or organizations to immediately recognize their benefits without proper guidance or expertise. Based on the data IFKA gathered respondents mentioned that implementing new technologies often

requires an initial investment in terms of resources, time, and sometimes financial commitment. It might be difficult to ascertain the return on investment until the technology is fully integrated and operational particularly in the heavy indsutry.

6.4.2. Green Manufacturing Practices

Tabela 6-1: Green manufacturing tehcnologies used in company (multiple responses are possible)

	Hungary		Total	
	Count	%	Count	%
Energy-efficient machinery and equipment	35	89,7%	205	63,9%
Renewable energy sources (solar, wind, biomass)	32	82,1%	198	61,7%
Advanced process control systems	20	51,3%	76	23,7%
Waste recycling systems	13	33,3%	117	36,4%
Environmentally friendly materials in production	12	30,8%	123	38,3%
Lean manufacturing practices	17	43,6%	135	42,1%
Waste reduction strategies (e.g. composting, recycling)	20	51,3%	135	42,1%
Water-efficient systems (e.g. rainwater harvesting)	7	17,9%	56	17,4%
Sustainable packaging materials	14	35,9%	109	34,0%
Low VOC (Volatile Organic Compounds) finishes and glues	2	5,1%	28	8,7%
Use of recycled or sustainable materials	1	2,6%	94	29,3%
Total	39	100,0%	321	100,0%

Please note that respondents had the option to select multiple responses.

The most affordable thing to use is energy-efficient machinery and equipment. Energy-efficient machinery is engineered to use power more effectively, often by incorporating advanced technologies that reduce energy waste during operation. The respondents from Hungary mentioned these machines as a priority to introduce in their companies due to the high energy prices because of the economic circumstances and the war in our neighbourhood.

The goal is ultimately to save costs, not really the environmental impact.

The second most important thing was long-term durability, which could potentially reduce maintenance costs and increase the lifespan of equipment.

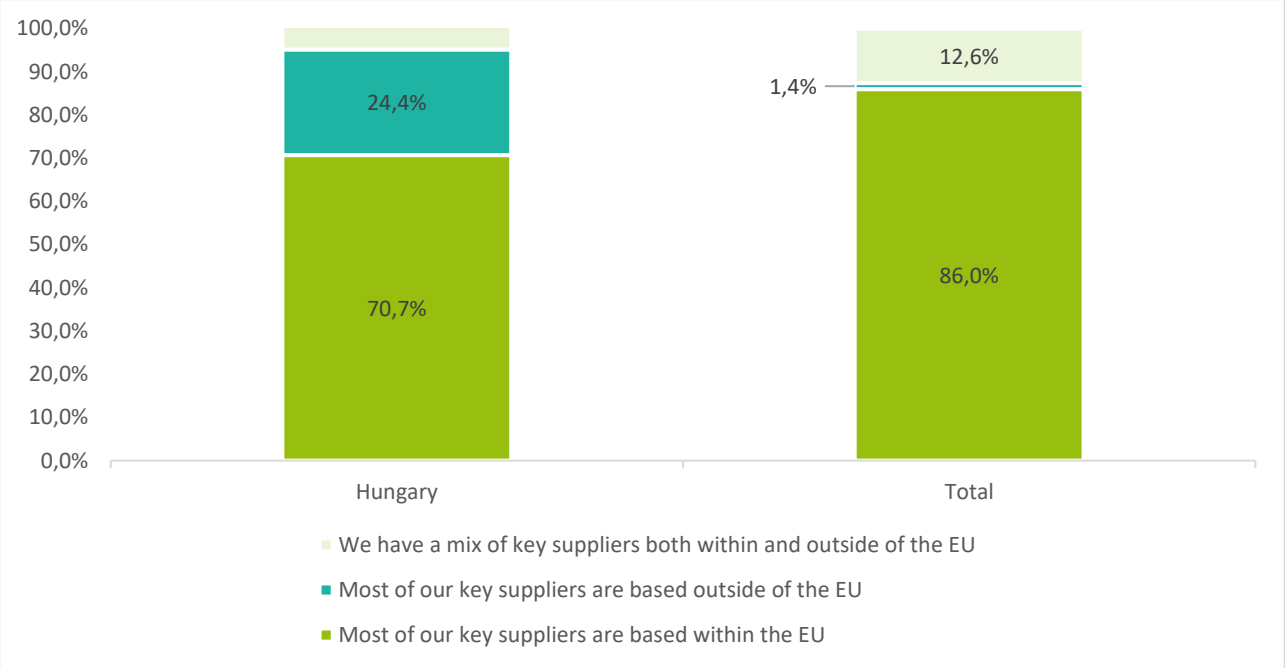
More than 80% of the companies are using some sort of renewable energy source. In recent years, the Hungarian government has introduced several possibilities in the form of governmental aid for companies to reduce costs with the introduction of mostly solar-powered energy sources. The government offers incentives and support for solar panel installation through feed-in tariffs and grants. Although Hungary's topography might limit extensive hydropower options, some SMEs situated near water bodies or streams might explore micro-hydro systems to generate renewable electricity (food product manufacturing).

More than half of the companies are using some kind of automated technology. Accoring to the respondents, especially in manufacturing and production, are incorporating advanced control systems. These systems use technologies like SCADA (Supervisory Control and Data Acquisition), PLC (Programmable Logic Controllers), and DCS (Distributed Control Systems) to automate processes, optimize production, and improve efficiency.

Hungary's progression in advanced process control and waste recycling systems demonstrates a commitment to sustainable practices and environmental stewardship. Further investments in technology, infrastructure, and awareness campaigns can drive continued improvements in these areas. However, the legislative environment is not concrete enough in some cases.

6.4.3. Supply Chain and Partnerships

Figure 6-2: Location of key suppliers (Hungary)



There are several industrial clusters and regions where significant supplier networks are present.

Several respondents mentioned Győr (northwest of Hungary), home to Audi's manufacturing plant and supplier park. Győr has a dense network of automotive suppliers due to Audi's presence, and the upcoming BMW plant in Debrecen is expected to attract a cluster of automotive suppliers to this region.

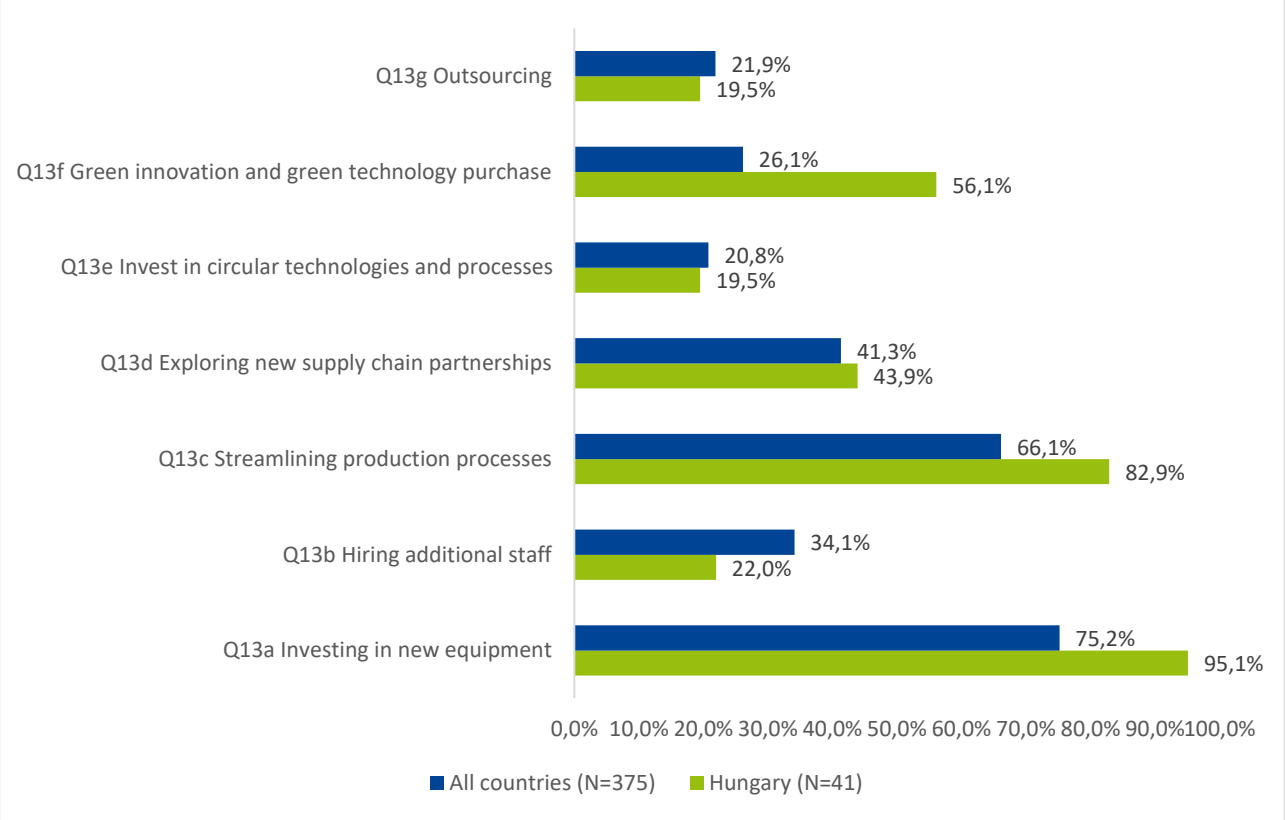
In terms of electronics and technology, the capital city houses various technology and electronics suppliers, particularly in software development, IT services, and electronics manufacturing. The largest city in the Northwest is known for its electronics industry. Miskolc hosts suppliers specialising in electronics components and assembly.

Outside Hungary, the respondents mentioned mostly the neighbouring countries (70% of the key suppliers are based within the EU). Austria and Romania are at the top, but mostly in the metal industry and rubber and plastic products, the main supplier is in Serbia, which is outside the EU. Most probably, that is why it is over 24%. The manufacturing industry requires non-European suppliers as well, so our respondents mentioned South Korea, Japan, and China as well.

6.4.4. Financial Aspects

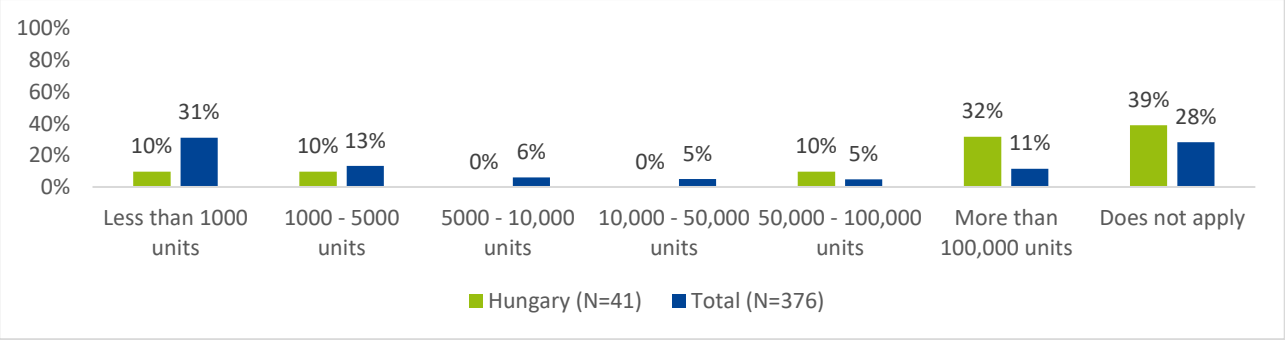
95% answered with probably the most common answer from banks or financial institutions: to invest in new machinery or equipment. These loans might have specific terms tailored for equipment financing. This includes the leasing of heavy machinery to acquire equipment without significant upfront costs. Financial institutions or specialised leasing companies offer financing options for equipment purchases.

Figure 6-3: Financing sources (Hungary)



The second largest group of answers was the streamlining of production processes to improve efficiency, reduce waste, and enhance productivity. Integration of digital technologies like data analytics and ERP systems for real-time monitoring, predictive maintenance, and better decision-making in the manufacturing processes. These two answers are totally in line with survey average.

Figure 6-4: Maximum production capacity per month (Hungary)

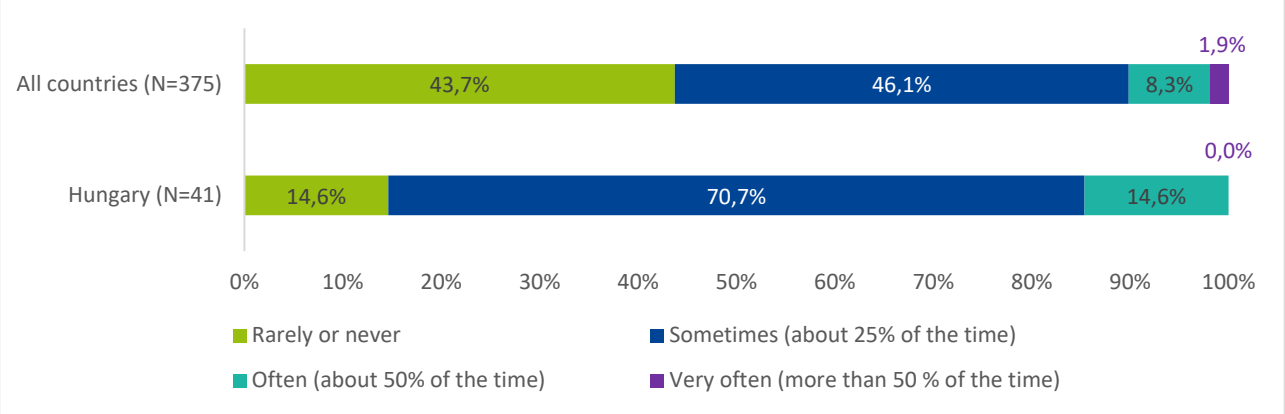


The results show that there are two peak points in this graph. The first one does not applicable to Hungary. According to the responses provided, this is why the interviewees' manufacturing facilities are not necessary for mass production. In terms of heavy industry, we received several responses indicating that these machines are personalised to the buyer's preferences and can be constructed in several months.

Another typical response was that the product palette is so diverse that it cannot even be measured.

The second highest peak point exceeds 100,000 units. These responses are from plastic producers and electrical equipment makers.

Figure 6-5: Experienced delays in receiving raw materials (Hungary)

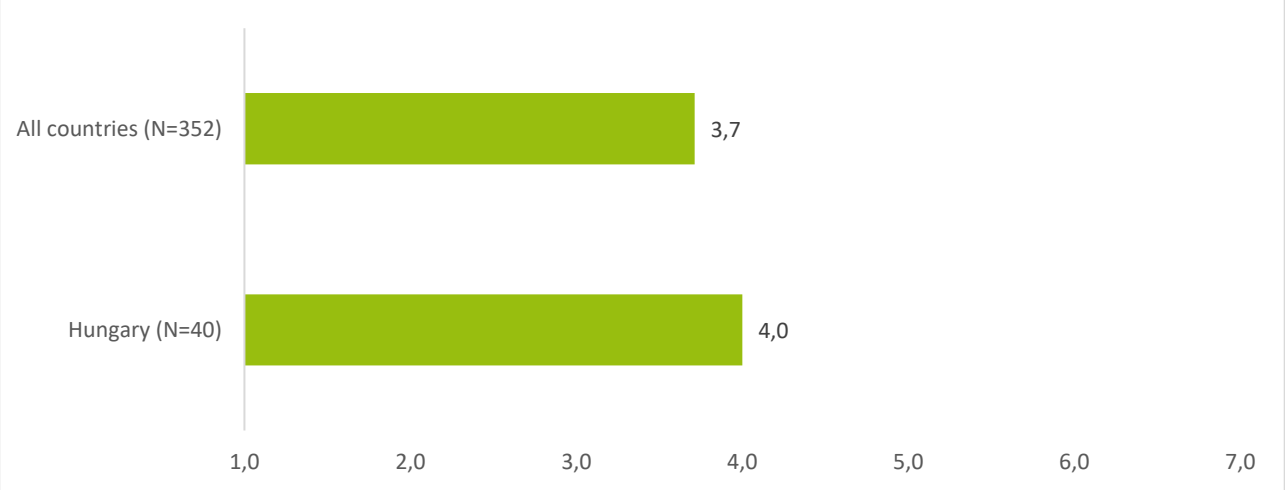


Delays in getting raw materials can have a substantial impact on production plans and operations. Addressing these delays necessitates a methodical strategy, but according to the answers, it is not very common in the SMEs asked. According to our interviews face-to-face or by phone, the employees mentioned that delays might occur during transit, at customs checkpoints, or due to logistical challenges. If delays are due to regulatory issues or customs, they often engage with governmental bodies to streamline processes.The other solution they have mentioned is identifying backup suppliers or substitute raw materials in case of prolonged delays.

6.4.5. Usage Behaviour

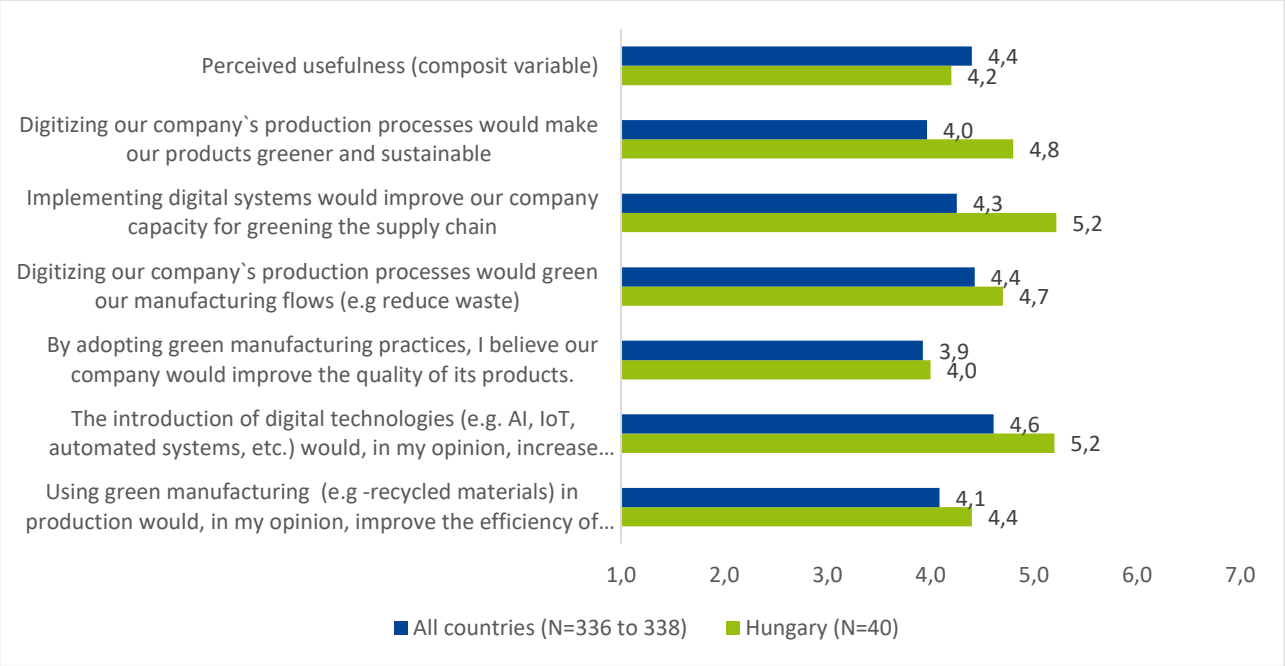
As mentioned before, Hungarian SMEs who have filled out the survey are interested in green manufacturing practices to implement energy-efficient machinery and equipment to reduce overall energy consumption in production facilities and also to introduce lean methodologies to optimise processes, reduce waste, and improve efficiency. Four interviewees mentioned during the phone interviews that they are pursuing the ISO 14001 certification to gain environmental management certifications to demonstrate commitment to eco-friendly practices, but most importantly, to collaborate with industry peers, clusters, research institutions, and associations to share best practices and innovations in green manufacturing.

Figure 6-6: Usage behaviour by country (Hungary)



6.4.6. Perceived Usefulness

Figure 6-7: Perceived usefulness indicators and composite variable (Hungary)



Overall, the answers are higher than the average of all countries.

Companies believe that digital technology may help them improve operational efficiency, optimise operations, and boost productivity through automation and data-driven insights.

The answers show that some SMEs in Hungary perceive green technologies as cost-saving measures in the long run, despite potential higher initial investments, through reduced energy bills, waste management, and regulatory compliance. The SMEs in question have recognised that consumers prefer eco-friendly products and services, and they consider green technology as a method to improve brand image and satisfy market needs. What's very important is that there's a recognition of the need for upskilling employees, especially in the manufacturing industry, to effectively use digital tools and manage green initiatives within the organisation because we hear from the telephone interviews and in the open question part of the survey that underskilled employees in the market are a great barrier to further.

6.4.7. Effort Expectancy and Ease of Use

The overall experience of the questioned SMEs is that employees are underskilled to use cutting-edge digital technologies. The SMEs realised that one possibility is to investigate governmental incentives, grants, or support programmes aimed at facilitating and encouraging sustainable business practices. Funding for this is currently not tolerated by the market, but is already expected by Western European customers.

As mentioned before in the financial aspects part SMEs in question sometimes have a unique, typically high-value equipment with different manufacturing processes, so the digital technology to be used would also need to be diverse, requiring very significant financial resources and organisational restructuring.

Their experience is that sometimes it is not worth it to step into a greener and more sustainable business because it takes too much time to refund the costs of greening technologies. The viability of a sustainable business model, including potential cost savings and enhanced brand reputation, is too low.

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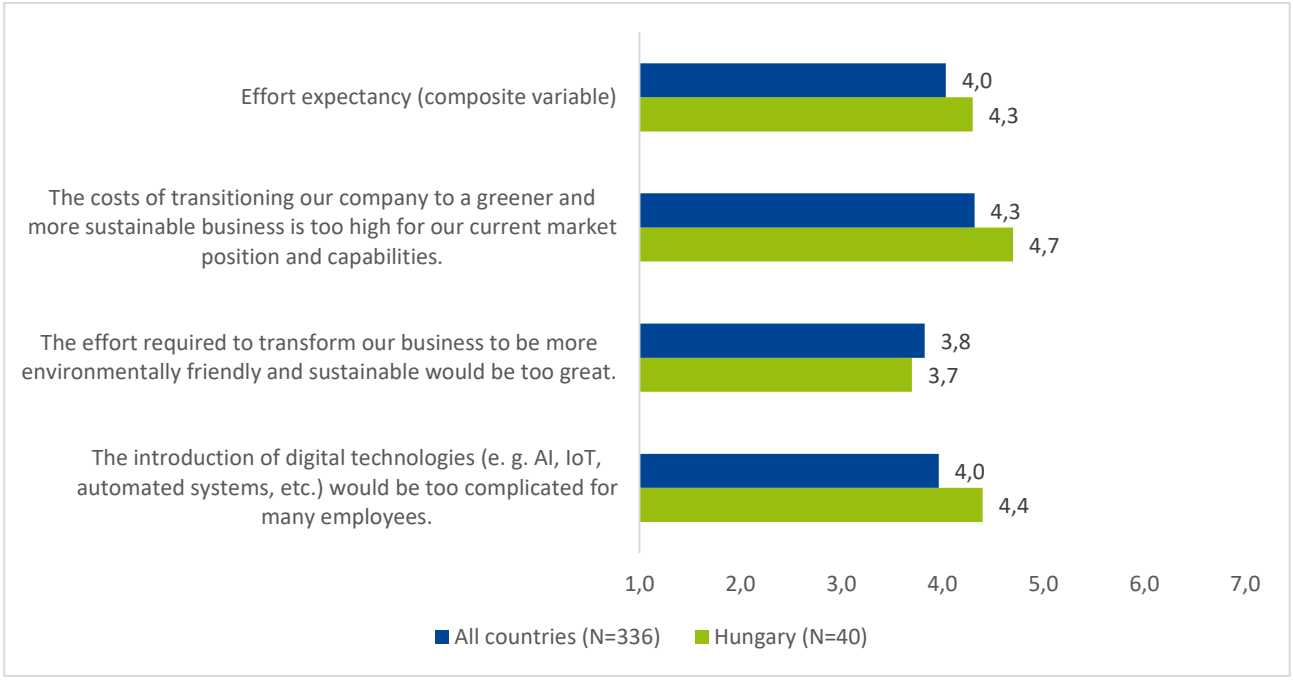
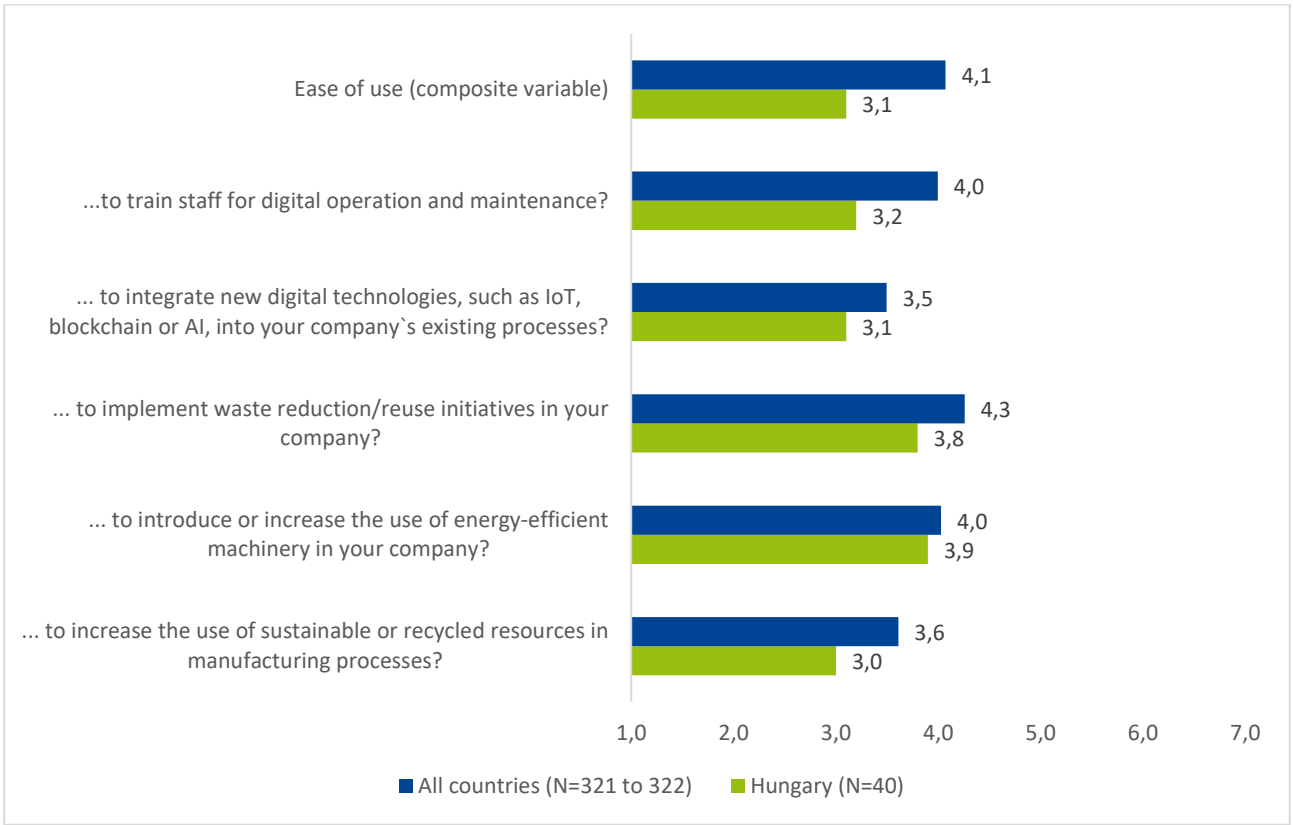
Figure 6-8: Effort Expectancy indicators and composite variable (Hungary)



If we want to sum up in one sentence the essential problem for any development is financing. The uncertain economic situation and the industrial downturn are currently not conducive to green investment. Hectic, unpredictable changes in energy prices making it even harder to consider green developments.

Figure 6-9: Ease of use indicators and composite variable (Hungary)



The most difficult variable for companies, according to the results, is transitioning to sustainable or recycled resources. It often involves adjustments in supply chains, product redesign, and supplier collaborations, which can pose moderate challenges but are feasible with strategic planning and supplier partnerships. As we can see from the results, this is the lowest rate that Hungary has compared to the other countries.

The second most challenging part is integrating these advanced technologies, which often involves significant technological changes, employee training, and substantial planning, making it moderately to considerably challenging, especially without prior experience or expertise. As we have seen, employee training is one of the toughest challenges an SME can face currently because it needs personnel who are willing to take part in the training and be able to receive and further use the information they get. Also, this leads us to the next question about digital systems: Employee adaptation to digital systems might require training and adaptation time, but it's relatively more feasible than the previous, with proper training and user-friendly interfaces.

Incorporating energy-efficient machinery may require initial investment and restructuring, but it's moderately feasible with access to suitable equipment and resources.

6.4.8. Facilitating Conditions

FACTOR 1: Internal Readiness and Support for Green Manufacturing:

This factor pertains to the internal preparedness of an organization for the transition towards green manufacturing practices. It encompasses the availability of resources, qualified personnel, knowledge, and technical infrastructure within the organization. Additionally, it considers the active encouragement and support from top management, along with the provision of necessary training for employees, ensuring the internal ecosystem is conducive to embracing green manufacturing.

Includes statements:

- Q34b Our employees have the necessary resources to make the shift towards green manufacturing.
- Q34c Our company has a sufficient number of qualified employees to make the shift towards green manufacturing.
- Q33a The required knowledge and technical resources for the green manufacturing transition are available in our organization.
- Q34a Our top management actively encourages the use of green manufacturing practices within the company.
- Q34d Our employees have received the necessary training to implement a transition to green manufacturing.
- Q33b The company has all the necessary technical infrastructure for digitization.

FACTOR 2: Regulatory and External Technical Barriers to Green Manufacturing

This factor revolves around the external influences that organizations encounter when attempting to adopt green manufacturing practices, namely lack of goverment information, other regulatory obstacles and limited external technical knowledge.

Includes statements:

- The government doesn`t provide enough information regarding sustainable production/green manufacturing.
- There is not enough external technical knowledge available to support adoption of green manufacturing practices.
- More green manufacturing practices cannot be implemented because of the regulatory obstacles.

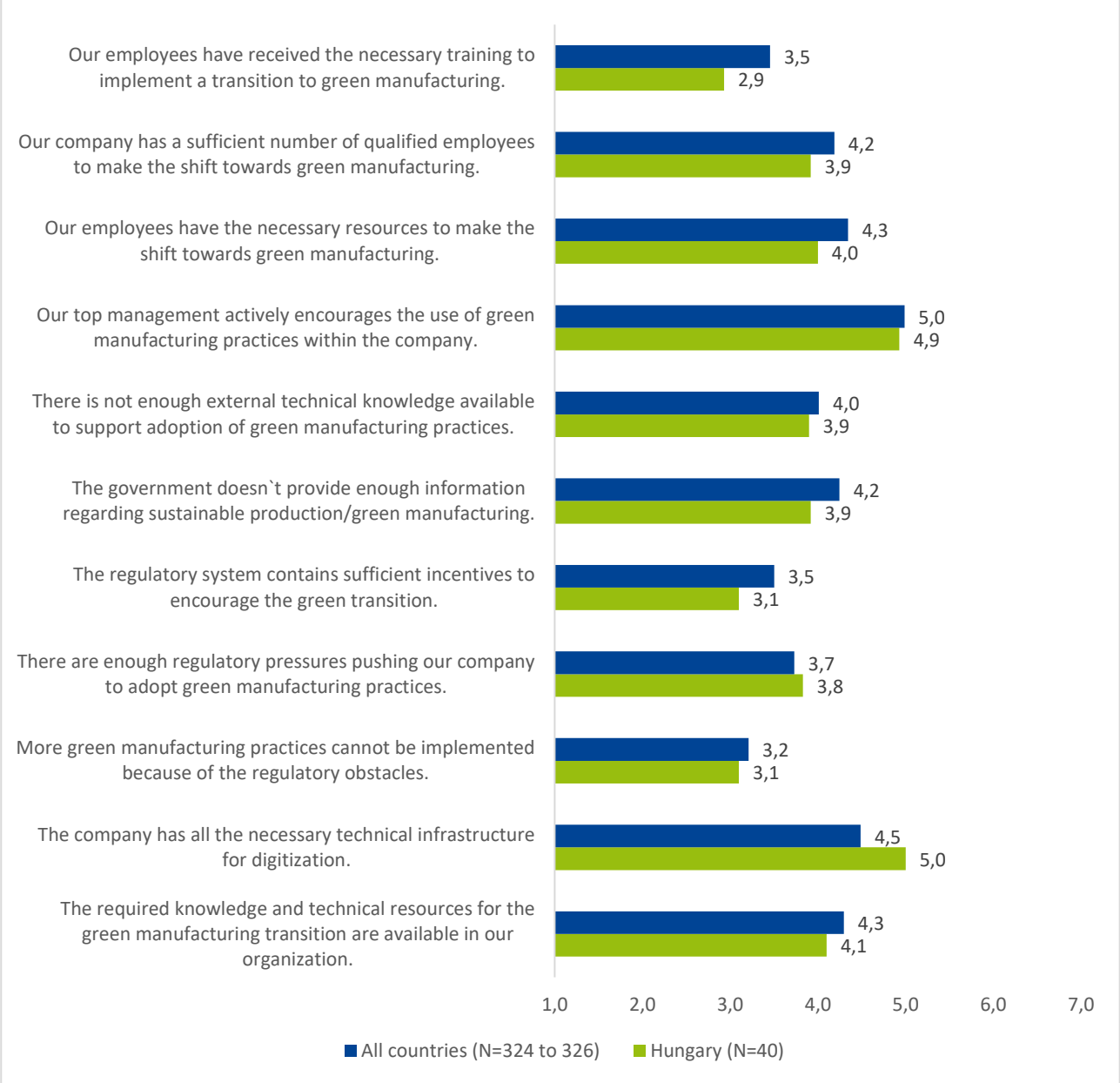
FACTOR 3: Regulatory Drivers on Green Manufacturing

This factor centers around the influence of regulatory frameworks on motivating and facilitating organizations to adopt green manufacturing practices.

Includes statements:

- Q33d There are enough regulatory pressures pushing our company to adopt green manufacturing practices.
- Q33e The regulatory system contains sufficient incentives to encourage the green transition.

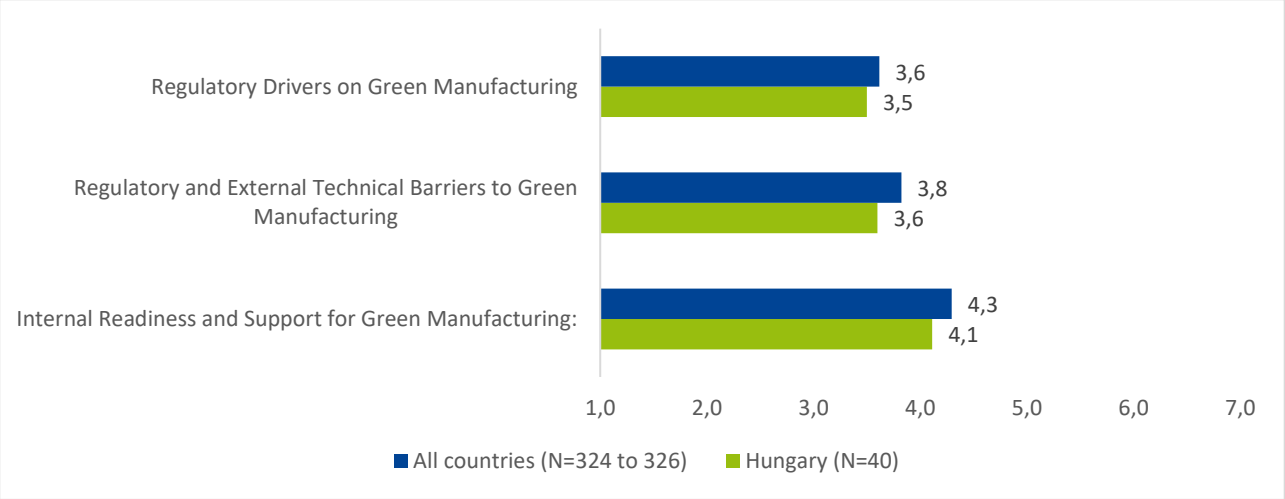
Figure 6-10: Facilitating conditions - indicators (Hungary)



Overall, the organisations polled do not believe their personnel have gotten the necessary training to undertake a move to green manufacturing. The first step would be to get financing or budgets particularly designated for green projects, which would allow for investment in sustainable technology, equipment, or materials. Three firms acknowledged senior management's active encouragement and assistance, such as dedication to sustainability objectives, contributing resources, and setting an example.

The goal would be to build a workplace culture that prioritises sustainability by promoting staff participation and green initiative ideas. This implies that if staff have avenues for feedback and recommendations on green practises, a culture of continual development may be fostered. Internal preparation and support for green manufacturing demand a comprehensive strategy, which necessitates not only the availability of resources and infrastructure, but also a culture shift and commitment at all levels of the organisation. Encouragement, education, and a supportive environment are critical for adopting and effectively shifting to sustainable manufacturing practises.

Figure 6-11: Facilitating conditions - composite variables (Hungary)

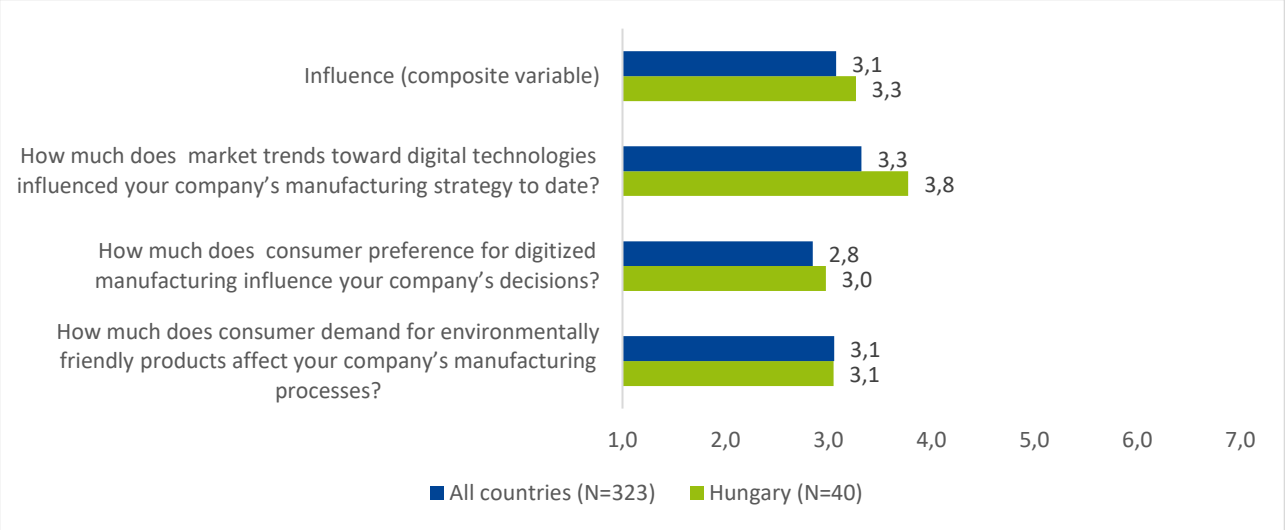


Overall, there are no major disparities in regulatory experiences among the SMEs surveyed. Meeting environmental regulatory standards may incur considerable expenses, particularly for smaller or resource-constrained enterprises.

According to the SMEs polled, confusing or contradictory legislation addressing incentives, subsidies, or tax breaks for green projects may deter businesses from engaging in sustainable practises. Collaboration among enterprises, governments, and stakeholders can assist to reduce these hurdles and develop an environment suitable to green manufacturing in Hungary.

6.4.9. Influence

Figure 6-12: Influence indicators and composite variable (Hungary)



Consumer demand for ecologically friendly products frequently has a considerable impact on manufacturing processes, resulting in changes in material procurement, production methods, and packaging.In terms of the latter, it is frequently stated that Western European nations have the aim and need to have suppliers who influence industrial processes towards digitalization but also green technology. Market trends favouring digital technologies frequently affect manufacturing strategy by pushing investments in IoT, AI, or automation to improve productivity, optimise processes, and remain competitive, but as previously stated in the paper, financial assistance is required to overcome this challenge.

6.4.10. Attitudes Toward Change

Table 6-2: Attitude toward change (Hungary)

	Hungary		All countries	
	N	% likely or very likely	N	% likely or very likely
How likely is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	40	45,0%	320	31,6%
How likely will you switch to energy-efficient machinery for your production in the following 5 years?	40	42,5%	320	35,0%
How likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	40	50,0%	320	32,0%

The possibility of green manufacturing process integration or increasing adoption over the next five years is determined by how these elements connect with the company's strategic strategy, resources, and commitment to sustainability. If the benefits of green practises are perceived to exceed the hurdles and the firm actively prioritises sustainability, it is more likely to integrate or grow green manufacturing processes within its operations but as we can see only less than half of the companies answered this, and it is significantly lower comparing to all countries.

Companies that prioritise sustainability, foresee long-term benefits in energy efficiency, and have the resources to invest in new machinery are more likely to make such a transition. It's a strategic decision influenced by various economic, environmental, and operational considerations, but first of all, in the next five years, regulatory changes need to happen despite economic conditions and unexpected events such as war, natural disasters, pandemics, etc. This is even lower than the previous questions because it is strictly on the machinery, and it can be seen that in the near future, such things as green machinery are not likely to be purchased.

Companies committed to digital transformation, having a tech-forward culture, and having the resources to invest in these technologies are more likely to integrate them to enhance their manufacturing processes and gain a competitive edge. It's a strategic decision influenced by various technological, financial, and operational considerations, but according to the answers, these technologies are easier to purchase and also to operate, and these software and IT devices are easier to get, not to mention tailored heavy machinery that can arrive after 1 year of waiting due to supply chain issues, for example.

6.5. Summary of attitudes towards green and digital technologies

- Main barriers identified.
- Public perception and company perception
- Outline some key challenges encountered by interviewed companies regarding their process for digital transformation and green transition (not barriers, but the challenges are mainly related to their internal ecosystem and business competition – for example – staff low skills, staff resistance to change etc)
- Key indicators analysis results – analyse and breakdown of response by key indicators of survey sections.

Main Barriers Identified: Among the companies that filled out the questionnaire, we can see there are plenty of similarities. It depends on the companies' main profile whether the cost implications or the technological disadvantage cause more trouble, but what they have in common is the need for financial support and skilled labour.

Cost Implications: Using digital and green technology comes with a hefty upfront cost.

Lack of Infrastructure: Inadequate technology readiness and infrastructure for widespread adoption

Regulatory Difficulties: The integration of these technologies is impacted by complicated and dynamic rules.

Perception and Awareness: Businesses and the general public have a limited grasp of the advantages and realities of implementing digital and green technology.

If we are talking about the differences between public perception, it frequently lacks comprehension or knowledge of the possible advantages, which causes hesitancy or scepticism.

Should we choose to group the questions on importance and occurrence the most relevant is cost saving to recognize the potential for long-term cost savings through energy efficiency, waste reduction, and streamlined processes. This answer is intertwined with the next one because the help of capitalization on growing consumer demand for eco-friendly products and services, foresees a potential market expansion. In fact it is a demand from the Western-European suppliers and partners to integrate green technology and practices into the manufacturing process. To do this, companies need to request financial assistance or incentives to offset the high initial investment costs to access affordable and efficient green technologies suitable for their operations, but there is always a question of uncertainty regarding the immediate returns on investments made in green manufacturing techniques. On the government's side, there is an evaluation of how well companies comply with evolving environmental regulations and loosen the strictness and hazy wording. The government should also measure the success of training programmes to enhance staff skills and foster adaptability.

Hungary, lowering financial costs is the most important part, and just after that comes the green mentality and the emerging need to deliver green products and techniques that are better for the environment. The challenges these companies have to face are surprising not very heterogeneous. Resistance to change among staff is due to fear of job displacement or a lack of skills for technological shifts. The staff possesses inadequate skills for effectively leveraging digital tools and implementing green technologies. The first priority is to learn about green manufacturing practices ("good practices"). Green manufacturing technologies that can be seen in action can serve as inspiration, and partnerships can be formed. Employee training can be essential, as the actions and attitudes of employees are key to achieving sustainability outcomes in the green transition. The other challenge companies are facing is specialised expertise in managing and maintaining green technologies. Sometimes digitalization and using cutting-edge digital tools can be a challenge for some of the employees.

6.6. Conclusions, Recommendations and Action plan

The next steps for these companies to underline their strategy must start with a cost-benefit analysis to assess the economic feasibility and return on investment of adopting green and digital technologies.

On the government's side, there is an evaluation of how well companies comply with evolving environmental regulations and loosen the strictness and hazy wording. The government should also measure the success of training programmes to enhance staff skills and foster adaptability.

In the summary we want to highlight how financial, infrastructural, and regulatory barriers remain pivotal in the adoption of green and digital technologies. Internally, challenges primarily revolve around workforce

readiness, competitive adaptation, skill enhancement, and seamless technology integration. Key indicators focus on financial viability, regulatory adherence, staff readiness, and competitive benchmarks to monitor the success and progression of these transitions.

To keep up with the trends, the importance of guidance and training is essential. The drainage of skilled workers to neighbouring western countries is also a key issue. Whoever has the comprehensive skills for implementing and managing green technologies has an offer from a country that Hungary can't compete with salary-wise. Overall, in Hungary, SMEs are struggling to keep the workforce, not just in close proximity but in the country.

7. Italy Analysis - key findings

7.1. Sample description

The target group of the Italian companies surveyed is reasonably uniform since they are SMEs with fewer than 250 employees. 95% of these have an annual turnover not exceeding EUR 50 million and their annual balance sheet not exceeding 40 million EUR.

95% of the organizations have a B2B Business Model.

The respondents are all Italian nationals, and 51% are between 45 and 54 years old and have worked for the company for over 15 years.

There was a good diversification of profiles interviewed, including 24% CEO, 19% CTO and the remainder profiles ranging from production manager, quality manager, innovation manager, marketing, and other technical profiles.

7.2. Survey administration

80% of the surveys were conducted by meeting the person to be interviewed in the company or via a remote call.

This method was more effective in limiting errors in the compilation or misunderstandings and not limiting ourselves to the answer but arguing a few questions that we found stimulating.

The remaining 20% were filled in directly by the person concerned after our introduction to the survey.

7.3. Preliminary findings during the survey administration

Respondents were weary of submitting another questionnaire on a subject that still needs to be implemented in the company. However, they were proactive towards the survey by going beyond the pure question and willing to be further contacted by the project partners for future collaboration opportunities.

7.4. Regional Analysis key findings

Most of the respondents are located in the north of Italy (Lombardy and Veneto Regions), where manufacturing is the core of economic development. Accordingly, in the past years, companies have invested in digital technologies to decrease operational costs and increase efficiency. The digitalisation level of these companies is quite good compared to the rest of the country.

Green manufacturing is still not a priority; however, companies are becoming aware of its importance due to external pressure (market, policy, etc.).

7.4.1. Technology and Innovation

Digital technology adoption is quite good if compared to the whole sample; in particular, technologies for managing processes (e.g., ERP, CRM) are widespread, while disruptive technologies such as Artificial Intelligence and Augmented Reality still need to be digested. Few companies have already implemented them, but most of the respondents stated that their adoption is premature.

Other mentioned technologies are Additive Manufacturing, Cybersecurity and Robotics. The latter, in particular, is of high interest for companies willing to automate their processes.

Tabela 7-1: Technologies used in Company (Italy, N=38)

	Italy		All countries	
	Yes	**%**	**Yes**	**%**
Cloud Computing	23	60,5%	169	60,6%
CRM (Customer Relationship Management)	26	68,4%	154	55,2%
ERP (Enterprise Resource Planning)	33	86,8%	161	57,7%
Intelligent Document Processing applications	12	31,6%	81	29,0%
Internet of Things (IoT) – IoT platform for management, monitoring and improvement of production flows,	20	52,6%	67	24,0%
Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation	7	18,4%	30	10,8%
Augmented Reality / Virtual Reality	6	15,8%	10	3,6%
Other	7	18,4%	17	6,1%
Total	38	100,0%	279	100,0%

Please note that respondents had the option to select multiple responses.

7.4.2. Green Manufacturing Practices

Tabela 7-2: Green manufacturing tehcnologies used in company (multiple responses are possible)

	Italy		Total	
	Count	**%**	**Count**	**%**
Energy-efficient machinery and equipment	17	50,0%	205	63,9%
Renewable energy sources (solar, wind, biomass)	18	52,9%	198	61,7%
Advanced process control systems	23	67,6%	76	23,7%
Waste recycling systems	17	50,0%	117	36,4%
Environmentally friendly materials in production	11	32,4%	123	38,3%
Lean manufacturing practices	17	50,0%	135	42,1%
Waste reduction strategies (e.g. composting, recycling)	13	38,2%	135	42,1%
Water-efficient systems (e.g. rainwater harvesting)	3	8,8%	56	17,4%
Sustainable packaging materials	11	32,4%	109	34,0%
Low VOC (Volatile Organic Compounds) finishes and glues	2	5,9%	28	8,7%
Use of recycled or sustainable materials	12	35,3%	94	29,3%
Total	34	100,0%	321	100,0%

Please note that respondents had the option to select multiple responses.

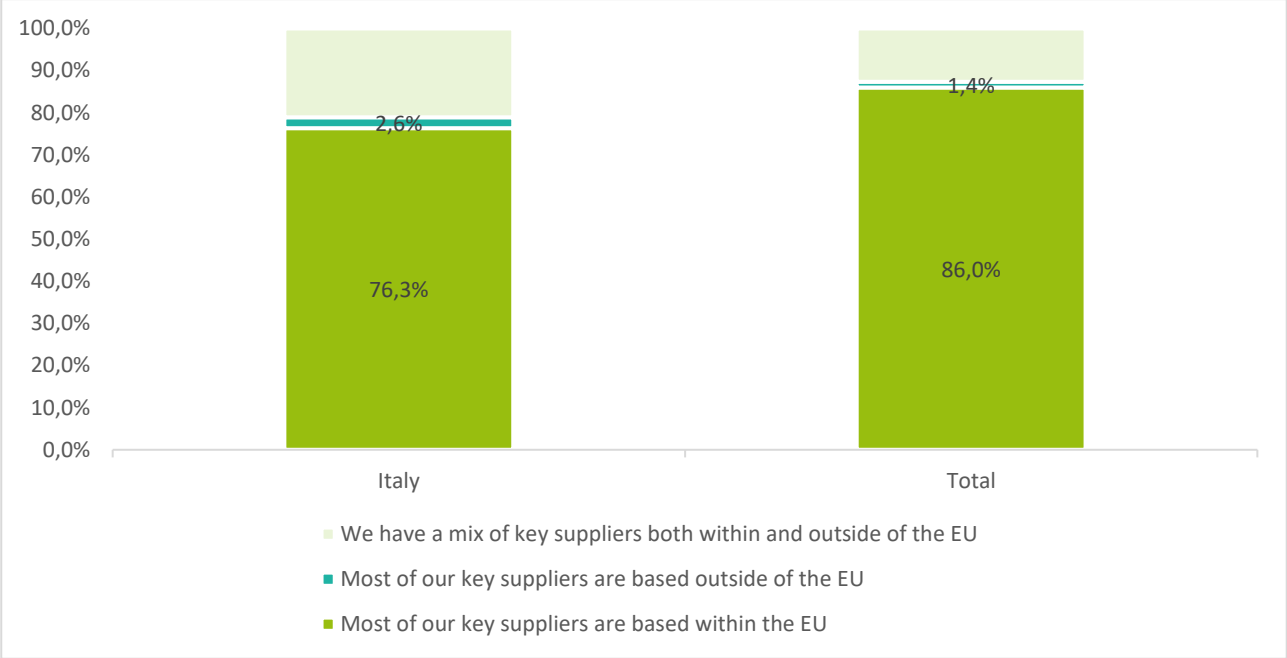
Respondents stated that they use Advanced Process Control Systems, Energy-efficient machinery and equipment, Renewable energy sources and lean manufacturing practices in their companies. However, they still need to apply green approaches over the entire supply chain process, e.g. Water-efficient systems or Sustainable packaging materials, Use of recycled or sustainable materials, and an effective disposal strategy for waste components and materials.

7.4.3. Supply Chain and Partnerships

Most of the key suppliers are located in Italy, and 21% of the respondents rely on both national and international suppliers. The latter are mainly located in Germany, France and Switzerland within Europe, while Cina and USA are outside Europe.

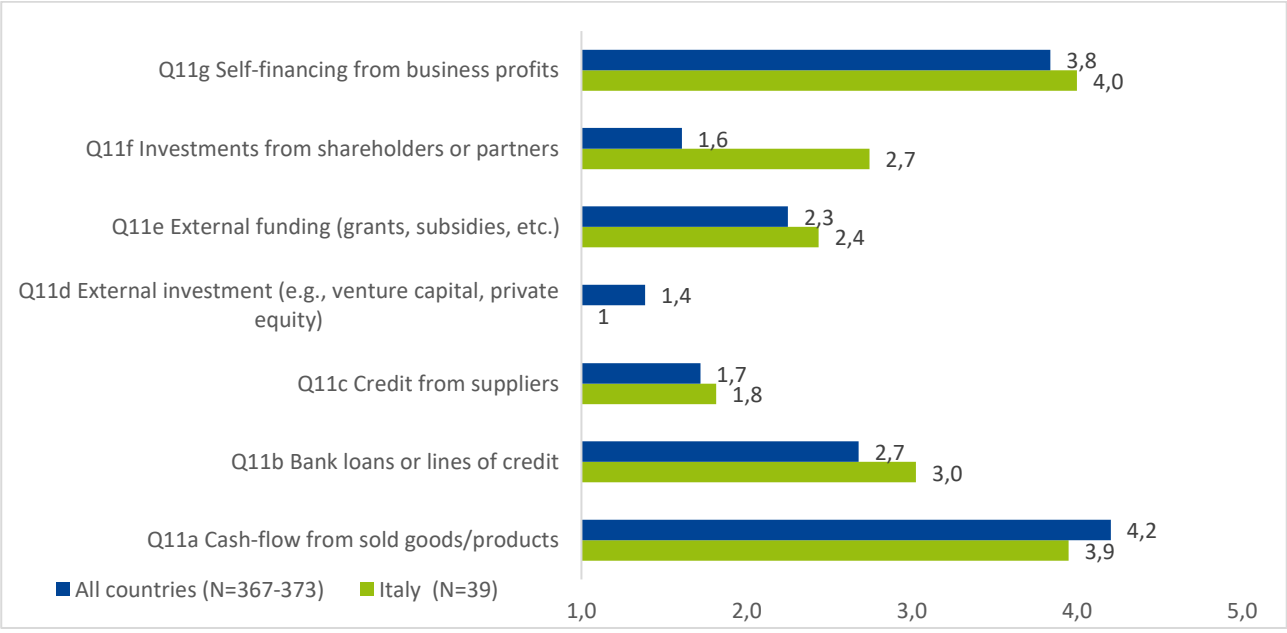
Half of the respondents stated they have partnerships with their suppliers, in particular for joint R&D projects.

Figure 7-1: Location of key suppliers (Italy)



7.4.4. Financial Aspects

Figure 7-2: Financing sources (Italy)



Companies mainly finance their operation with internal resources: business processes and revenues cash flows. Some of them leverage also shareholders, banks and other external funding (such as R&D project financing).

The internal capacity highly varies according to the peculiarity of the production. For most companies, the monthly capacity is less than 1.000 units or "not applicable" at all because the production refers to special assembly lines or tailored machines that take months to be ready.

The target measures for improving production efficiency address streamlining and optimization of processes, also through the adoption of lean manufacturing approaches. 77% affirmed they are investing in new equipment and more efficient machines.

Figure 7-3: Maximum producton capacity per month (Italy)

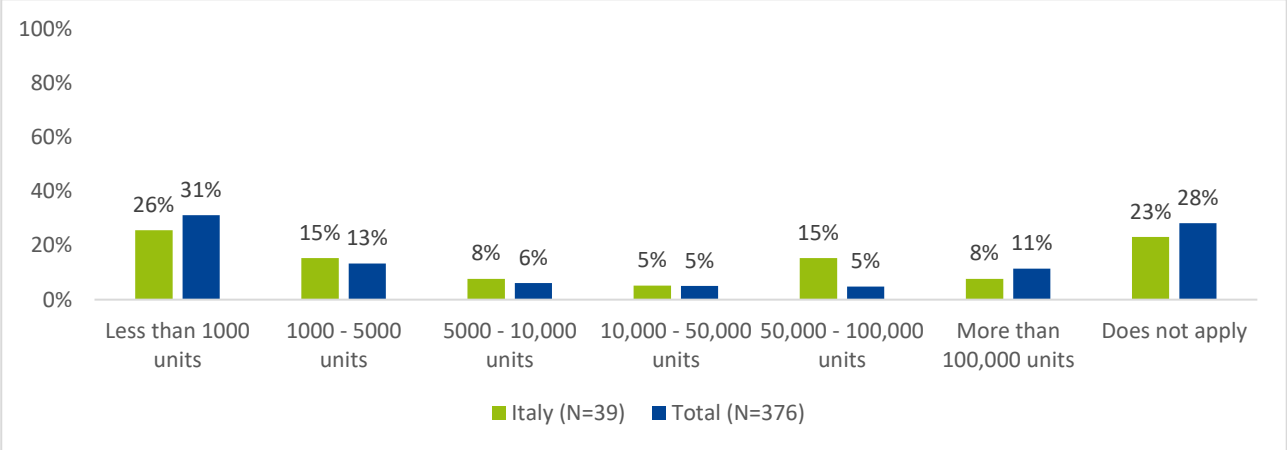
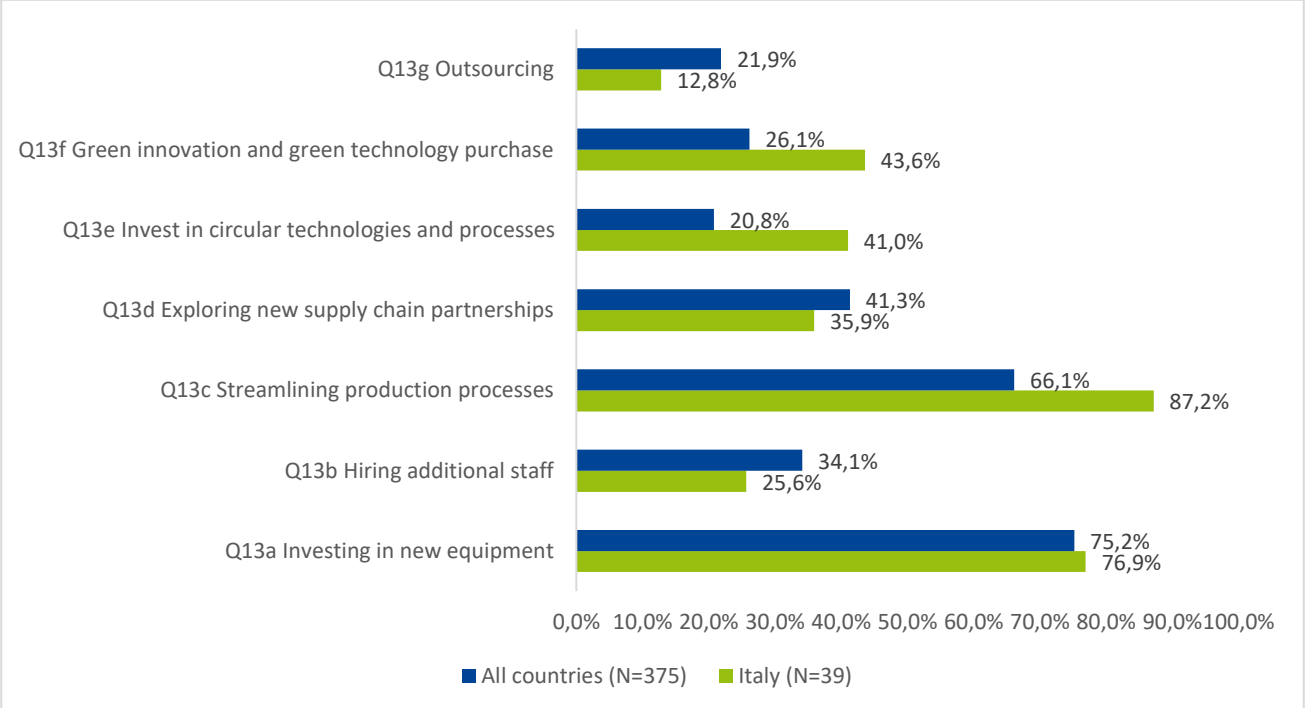
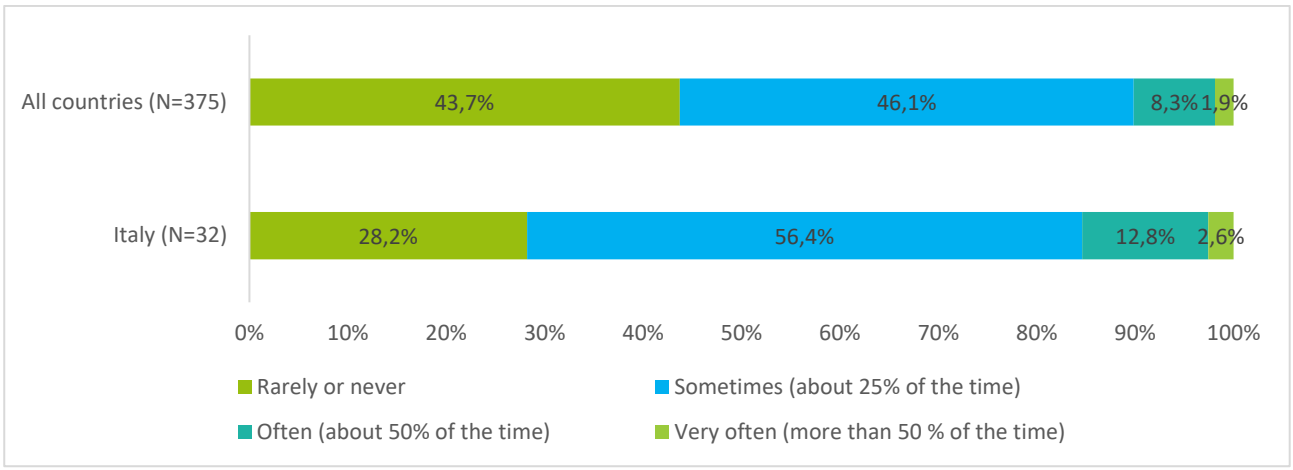


Figure 7-4: Measures taken to improve production efficiency and narrow the gap between actual and potential output (Italy)



Most companies face delays in receiving raw materials despite the fact that most of the suppliers are local or national.

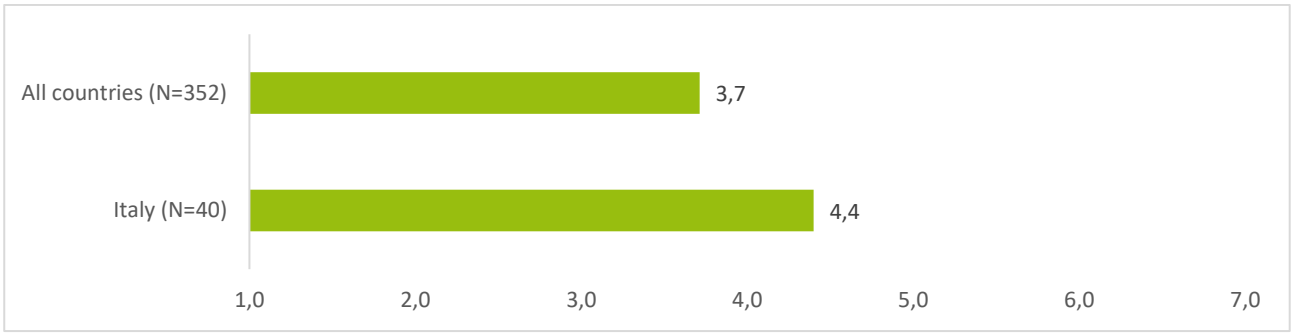
Figure 7-5: Experienced delays in receiving raw materials (Italy)



7.4.5. Usage Behaviour

Italian respondents are quite optimistic about the perceived usage of green manufacturing practices, with a mean value of 4,4 out of 5, compared with the 3.7 average of the whole sample. Indeed, most of the companies affirmed that they have already implemented or are investing, especially in renewable sources (such as solar panels) and in energy efficiency activities.

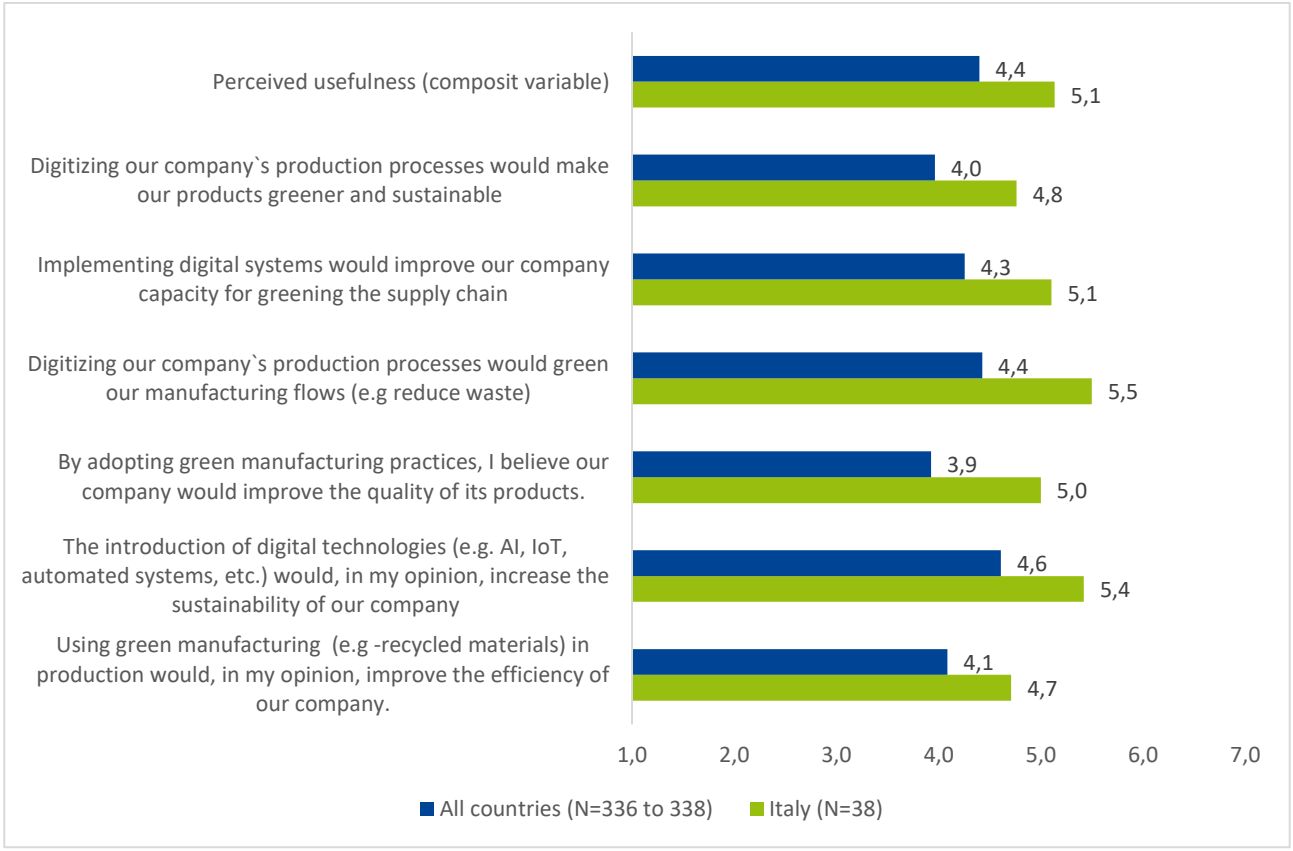
Figure 7-6: Usage behaviour by country



7.4.6. Perceived Usefulness

Respondents are quite sure about the usefulness of adopting digital technologies, which would both increase the sustainability of the company and would also support the green transformation. They are also optimistic about the benefits of green practices that would improve the quality of their products. It is not clear whether green manufacturing would improve the company's efficiency.

Figure 7-7: Perceived usefulness indicators and composite variable (Italy)



7.4.7. Effort Expectancy and Ease of Use

The main challenges against the adoption of digital and green technologies refer to the cultural propensity and the lack of resources, in particular, human resources.

Cultural barriers are the first to be addressed at all organisational levels. Indeed, many respondents stated that for the company, “green manufacturing is still not a priority”. The current economic scenario forces companies to focus on day-by-day and urgent activities; therefore, investments for the middle-long term are always postponed. On the other hand, if the top management highly believes in the twin transition and includes these projects in the business strategy, the company easily embarks on this journey.

Some companies must also deal with the specific products and the related supply chain: most of the time, supply chain leaders impose terms and conditions that have to be followed, whether they are aligned with the twin transition or not.

Figure 7-8: Effort Expectancy indicators and composite variable (Italy)

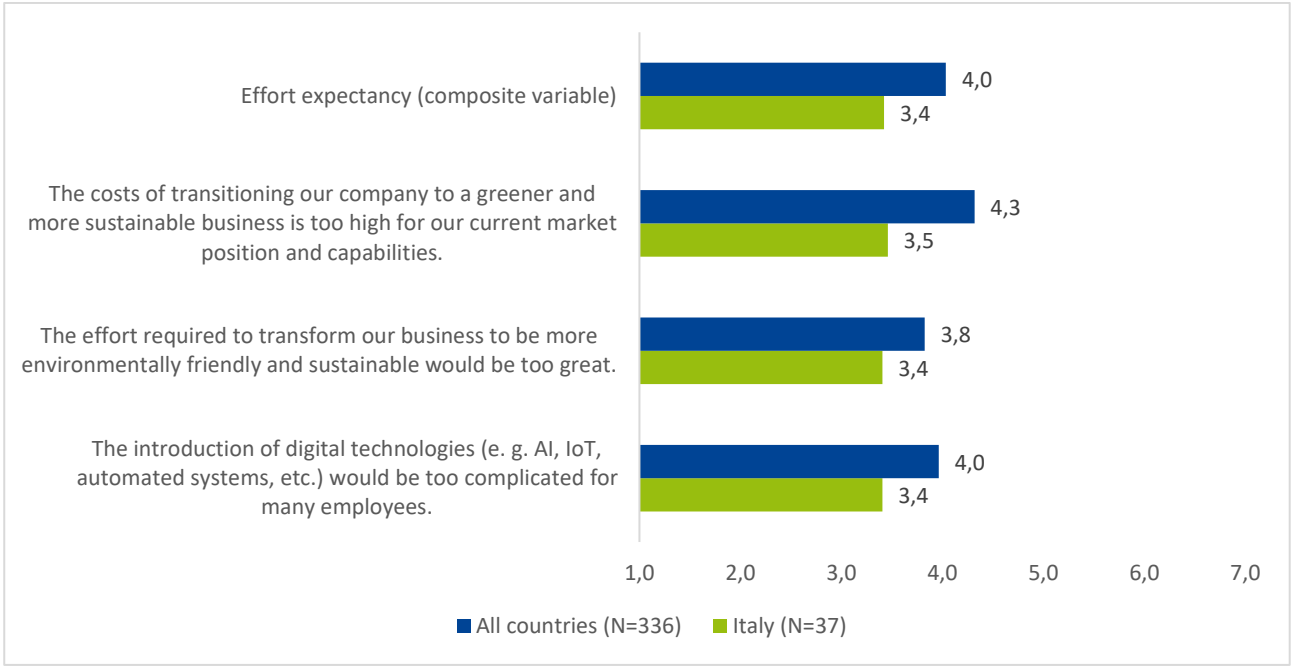
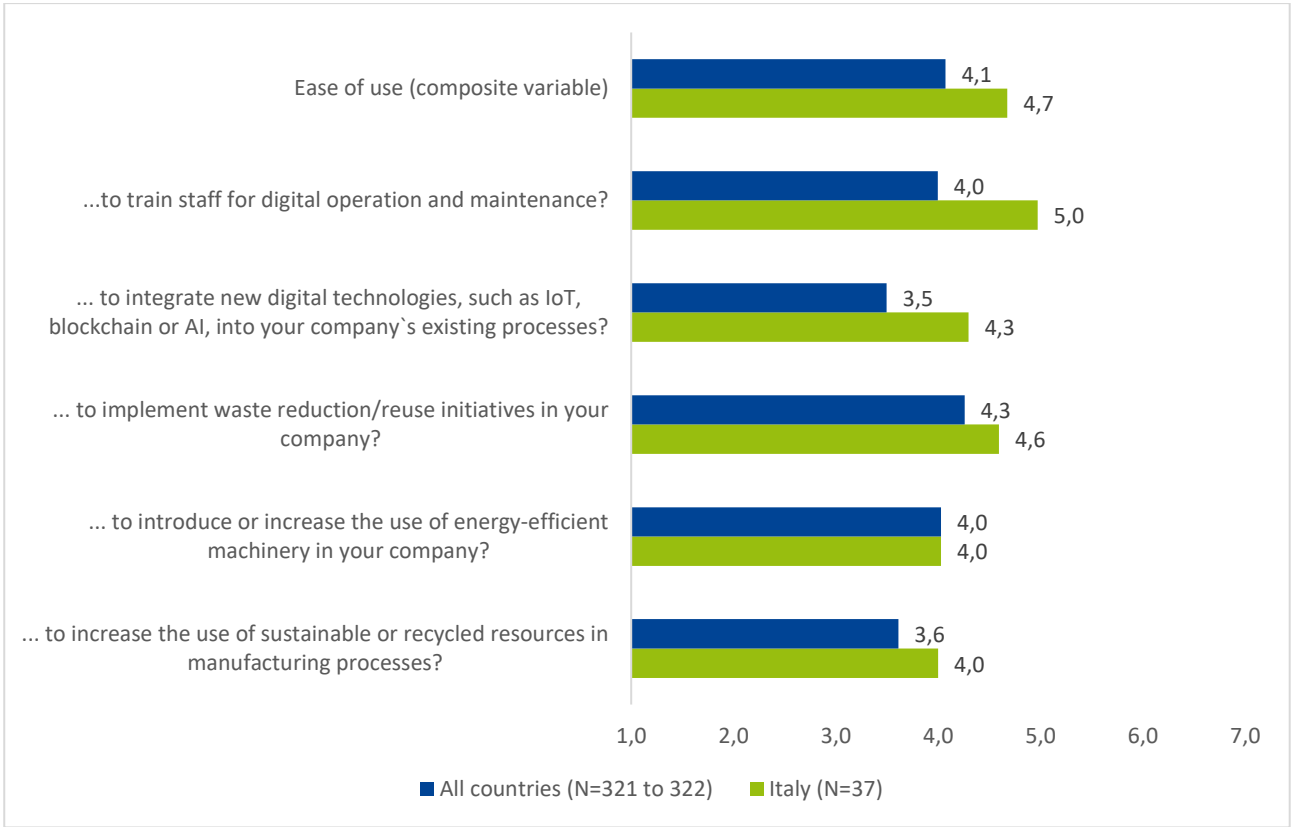


Figure 7-9: Ease of use indicators and composite variable (Italy)



7.4.8. Facilitating Conditions

Italian companies demonstrate a clear and good internal readiness towards the transition towards green manufacturing practices, confirming to have a top management actively oriented in promoting green manufacturing practices as well as knowledgeable employees with the necessary resources to embrace the transition. However, external technical knowledge is still not enough and strategic partnerships are needed. Also the government direction is not clear, and not enough information regarding sustainable production/green manufacturing are provided or, sometimes, policy and regulations are not aligned with companies' needs. Coherent incentives from the government are required to support companies.

Figure 7-10: Facilitating conditions – indicators (Italy)

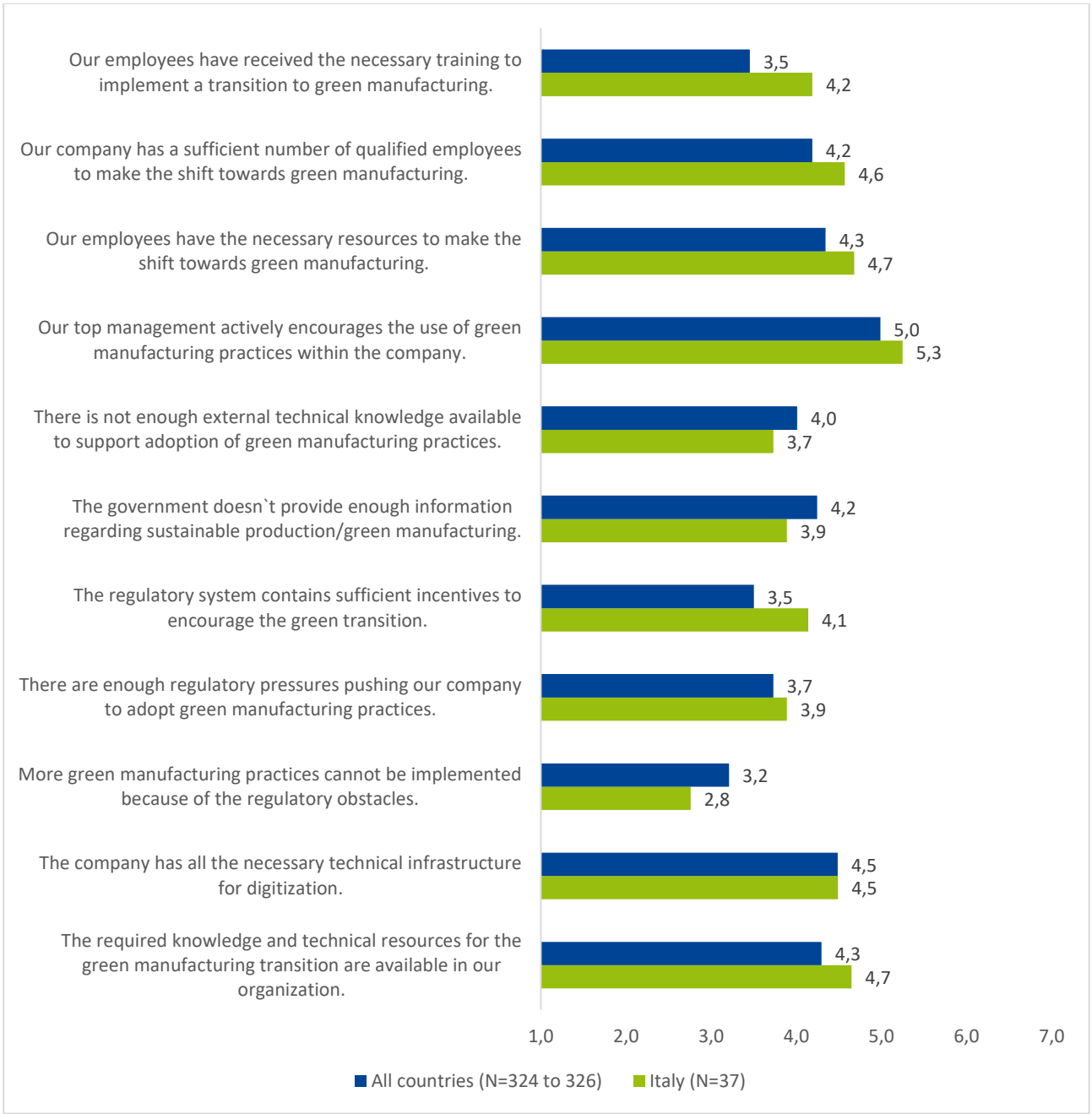
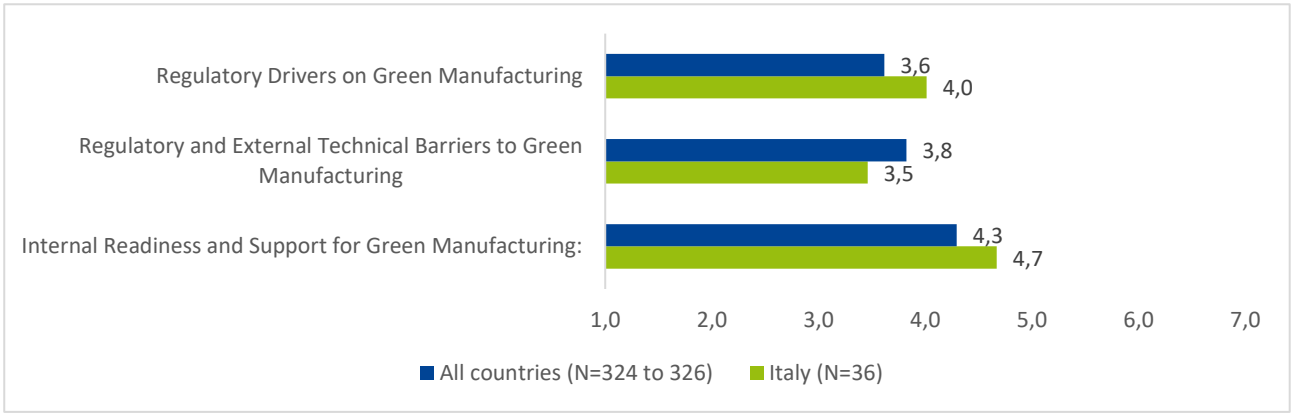


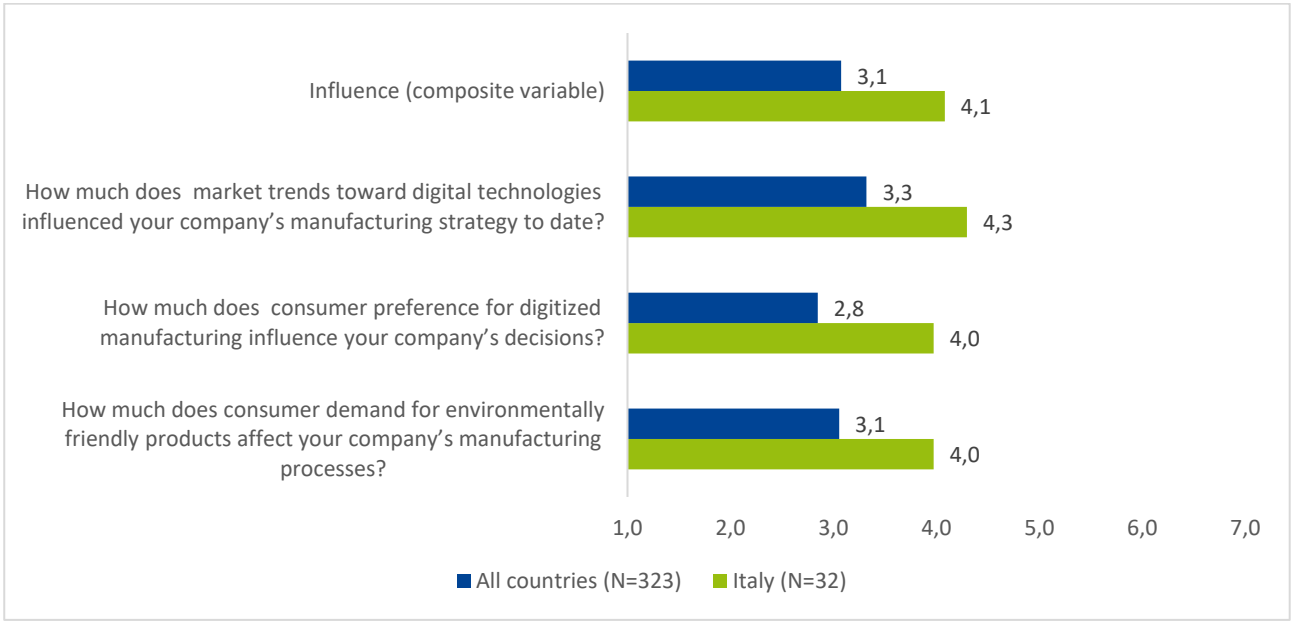
Figure 7-11: Facilitating conditions - composite variables (Italy)



7.4.9. Influence

External factors highly influence the adoption of digital and green technologies. In particular, consumers play a significant role by driving market trends and expressing preferences for innovative products and services. Moreover, to remain competitive, businesses monitor market trends and adopt digital technologies that give them an edge.

Figure 7-12: Influence indicators and composite variable (Italy)



Only 33% of the respondents are likely to integrate or increase green manufacturing processes into their production operations in the following five years, and 11% affirmed to have already implemented them. However, 58% stated they switched to energy-efficient machinery for their production in the following five years. The 47% will incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following five years.

7.4.10. Attitudes Toward Change

Only 33% of the respondents are likely to integrate or increase green manufacturing processes into their production operations in the following five years, and 11% affirmed to have already implemented them. However, 58% stated they switched to energy-efficient machinery for their production in the following five years. The 47% will incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following five years.

Figure 7-13: Attitude toward change (Italy)

	Italy		All countries	
	N	% likely or very likely	N	% likely or very likely
How likely is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	36	33,3%	320	31,6%
How likely will you switch to energy-efficient machinery for your production in the following 5 years?	36	58,3%	320	35,0%
How likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	36	47,2%	320	32,0%

7.4.11. Enablers and Barriers

Companies may adopt or invest in green manufacturing for various reasons driven by economic, environmental, and social factors. In particular, the most mentioned drivers are:

- Market and customer demand: Many markets have specific standards and certifications related to environmental sustainability. Moreover, consumers are becoming more environmentally conscious, and there is a growing demand for sustainable and eco-friendly products. Companies that adopt green manufacturing can enhance their brand reputation and appeal to environmentally conscious consumers.
- Environment: consumers and employees are becoming sensitive to environmental issues and, therefore, are always more careful in adopting observant practices. This also fosters the top management to introduce environmental-friendly perspectives.
- Cost savings: green manufacturing often involves adopting energy-efficient technologies and processes. By reducing energy consumption, companies can achieve cost savings in the long run through lower utility bills and operational expenses.
- Regulatory compliances: Governments and regulatory bodies are increasingly imposing stricter environmental regulations. Companies may adopt green manufacturing practices to comply with these regulations and avoid penalties or legal issues.

While there are clear benefits to adopting green manufacturing practices, several barriers may impede companies from investing in or fully embracing sustainability initiatives. The main challenges include:

- Upfront costs and uncertain ROI: Implementing green manufacturing technologies and processes often requires significant upfront capital investment. Many companies, especially smaller ones, may need help to allocate resources for these initial costs, even though the long-term benefits may be substantial. Moreover, the uncertainty regarding the financial returns and payback periods for green investments can be a significant barrier. Companies may be reluctant to invest in sustainability measures if they are unsure about such initiatives' economic viability and ROI.
- Cultural mindset and short-term focus: The surrounding financial and economic scenario forces companies to focus on short-term profits that are prioritized concerning other business goals over long-term sustainability initiatives. The pressure to meet quarterly financial targets can hinder commitment to green manufacturing.

- Technology gap and limited access to green technologies: Adopting green manufacturing involves using new technologies and methodologies. Companies may need help finding skilled personnel or training their existing workforce to implement and manage these technologies effectively. Moreover, some industries may have limited access to state-of-the-art green technologies. The availability and affordability of sustainable solutions can vary, making it difficult for certain companies to adopt these technologies.

7.5. Summary of attitudes towards green and digital technologies

- Main barriers identified.
- Public perception and company perception
- Outline some key challenges encountered by interviewed companies regarding their process for digital transformation and green transition (not barriers, but the challenges are mainly related to their internal ecosystem and business competition – for example – staff low skills, staff resistance to change etc)
- Key indicators analysis results – analyse and breakdown of response by key indicators of survey sections.

7.6. Conclusions, Recommendations and Action plan

Italian companies are willing to adopt green manufacturing practices driven by market demand, environmental consciousness, cost savings, and regulatory compliance. These practices can enhance brand reputation, appeal to eco-friendly consumers, and result in long-term cost reduction through energy-efficient technologies. However, barriers such as upfront costs, uncertain return on investment, a short-term profit focus, and a technology gap may impede companies from fully embracing sustainability initiatives. Overcoming these challenges requires addressing financial concerns, shifting cultural mindsets towards long-term goals, and providing support for acquiring and implementing green technologies.

8. Poland Analysis - key findings

8.1. Sample description

The survey targeted 29 manufacturing companies in the SME sector, representing various industries, including manufacturing, information and communication, and professional, scientific, and technical activities (technical and technological design, research, development for industry/manufacturing/energy/waste/circular economy). Among them, there were companies engaged in automation, robotics, Industry 4.0, automotive, metal industry, construction, IT, mattresses and furniture production, medical technology, foundry, agricultural, food processing and more.

Most of the surveyed companies (96.6%) employed fewer than 250 persons, with varying numbers of employees in different size categories. Dominance of companies (39.3%) have a workforce ranging from 100 to 250 employees. The age distribution of the companies ranged from up to 10 years to more than 50 years. The highest percentage (41.4%) falls into the category of companies aged between 21 and 30 years, indicating a significant presence of established companies in this range. Additionally, all companies have turnovers lower than 50 million euros.

In terms of business models, 55.2% identified as B2B (Business to Business), while 13.8% were B2C (Business to Consumer), and 31% operated with both B2B and B2C models.

Geographically, the companies had diverse market reach, with 79.3% operating nationally and 82.8% internationally, including markets in Europe (Austria, Germany, Czech Republic, Slovakia, Hungary, Norway, Denmark, Estonia, France, Greece, Romania, Croatia, United Kingdom, Lithuania, Latvia, Portugal, Netherlands, Italy, Spain, Sweden, Switzerland, Norway, Slovenia, Finland, Russia, Montenegro, Albania, Ukraine, Scotland, Iceland, Ireland, Luxembourg) North America (United States, Canada), Asia (Thailand), and Africa. Only 3.4 percent of companies indicated cross-border markets.

8.2. Survey administration

The survey was conducted from August to October 2023, using both digital and paper formats. In the first step, the survey, created and translated into Polish, was sent to manufacturing companies within the ecosystem of the Krakow Technology Park. The distribution to companies was often preceded by telephone contact from KPT. Additionally, promotional activities were carried out to encourage companies to complete the survey. The survey was promoted on the social media channels of the Krakow Technology Park, the Chamber of Industry and Commerce in Krakow, and regional chambers gathering manufacturing entrepreneurs. Regional events attended by entrepreneurs were also utilized for promotion, such as a conference on the Circular Economy in Brzesko or a meeting with entrepreneurs in Mielec, where the project team invited companies from the Podkarpackie region to fill out the survey. Each respondent completed the survey independently.

8.3. Regional Analysis key findings

During interactions with companies, several key aspects were observed. Companies demonstrated genuine interest in the project topic and were open to sharing their experiences. However, the distant prospect of gaining access to the knowledge base discouraged some companies. Companies hoped for immediate benefits and sought specific plans for the coming months along with tangible advantages. Companies preferred completing the survey online. Many respondents often found the survey to be too lengthy. Various data collection methods were employed, including personal interviews, online surveys, telephone conversations, and remote filling out after preparatory discussions.

In summary, entrepreneurs perceived the survey as overly lengthy, necessitating the use of diverse methods, including personal contacts and persuasion, to encourage their participation. While many companies showed interest in obtaining additional information about the GREENE 4.0 project, some may have been reserved on certain issues or unaware of all the benefits associated with the technological solution.

8.3.1. Technology and Innovation

Table 8-1: Technologies used in company (Poland, N=26)

	Poland		All countries	
	Yes	**%**	**Yes**	**%**
Cloud Computing	7	26,9%	169	60,6%
CRM (Customer Relationship Management)	20	76,9%	154	55,2%
ERP (Enterprise Resource Planning)	18	69,2%	161	57,7%
Intelligent Document Processing applications	2	7,7%	81	29,0%
Internet of Things (IoT) – IoT platform for management, monitoring and improvement of production flows,	4	15,4%	67	24,0%
Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation	3	11,5%	30	10,8%
Augmented Reality / Virtual Reality	1	3,8%	10	3,6%
Other	0	0%	17	6,1%
Total	26	100,0%	279	100,0%

Please note that respondents had the option to select multiple responses.

The results indicate high utilization of CRM (76.9%) and ERP technologies (69.2%) in region.

Technologies related to document processing or IoT are relatively underrepresented. Intelligent Document Processing applications are relatively rarely used in region (7.7%). This may indicate that companies have not fully recognized the potential of this technology yet. The use of IoT is relatively low - 15.4%). AI is relatively underrepresented, both in Poland (11.5%) and overall (10.8%). Introducing this technology may require further education and adaptation. AR/VR technologies are even less popular, indicating a low percentage of companies using them, both in Poland (3.8%) and overall (3.6%).

In region, Cloud Computing is used by 26.9% of companies, indicating moderate but significant utilization of this technology. In CE region the share increases to 60.6%, suggesting widespread adoption.

There is potential for education and promotion of modern technologies, especially those related to document processing or the Internet of Things.

Remark: number of answers for question 17 was quite low for Poland (N = 2), so we do not add chart or interpretation.

8.3.2. Green Manufacturing Practices

Table 8-2: Green manufacturing technologies used in company (multiple responses are possible)

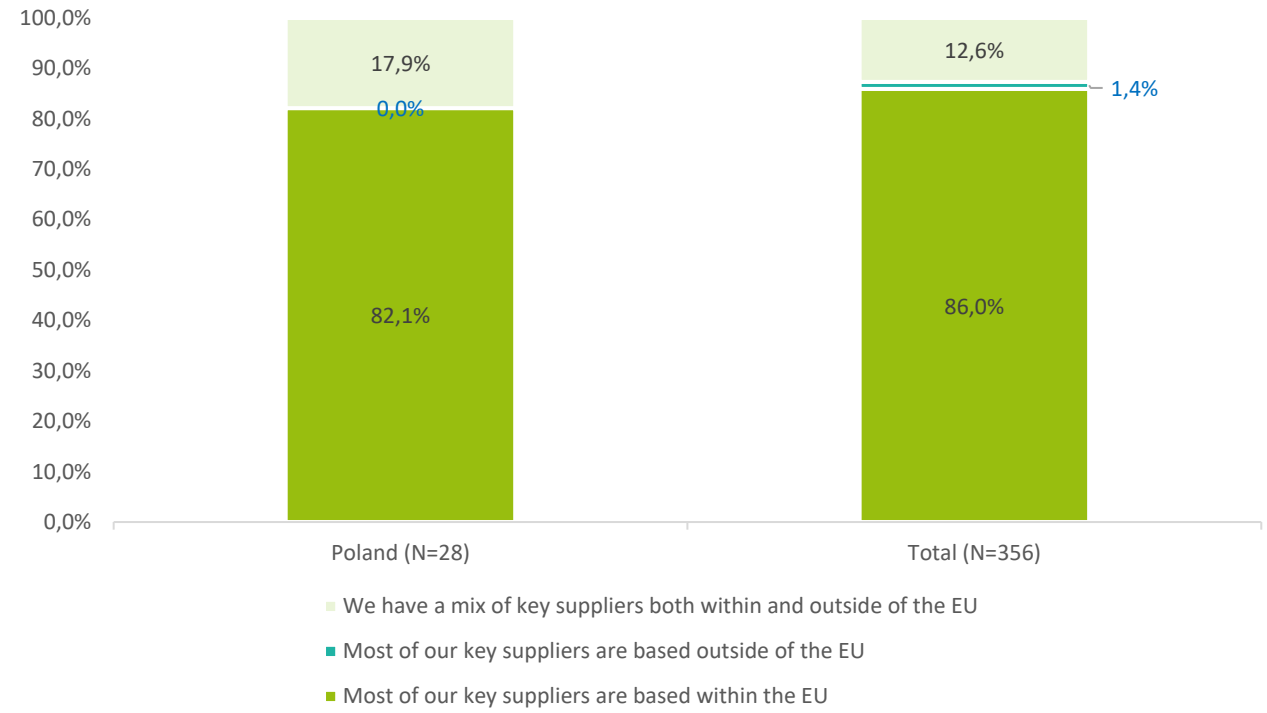
	Poland		Total	
	Count	%	Count	%
Energy-efficient machinery and equipment	16	57,1%	205	63,9%
Renewable energy sources (solar, wind, biomass)	21	75%	198	61,7%
Advanced process control systems	7	25%	76	23,7%
Waste recycling systems	7	25%	117	36,4%
Environmentally friendly materials in production	6	21,4%	123	38,3%
Lean manufacturing practices	11	39,3%	135	42,1%
Waste reduction strategies (e.g. composting, recycling)	10	35,7%	135	42,1%
Water-efficient systems (e.g. rainwater harvesting)	2	7,1%	56	17,4%
Sustainable packaging materials	7	25%	109	34,0%
Low VOC (Volatile Organic Compounds) finishes and glues	1	3,6	28	8,7%
Use of recycled or sustainable materials	8	28,6	94	29,3%
Total	28	100,0%	321	100,0%

Please note that respondents had the option to select multiple responses.

Majority usage in both region and overall reflects a positive trend toward energy-efficient machinery and equipment. Renewable energy sources (solar, wind, biomass) show widespread usage in region, suggesting a strong emphasis on sustainable energy practices – photovoltaics became very popular in Poland in recent years. Advanced process control systems are not widely adopted but show notable implementation in region. Waste recycling systems exhibit moderate usage, with a higher percentage in the overall responses. Environmentally friendly materials in production have more widespread adoption in the overall responses compared to Poland. Lean manufacturing practices demonstrate significant implementation in Małopolska region. Waste reduction strategies (e.g.composting, recycling) show active engagement, slightly higher in the overall responses. Water-efficient systems (e.g., rainwater harvesting) have limited adoption, especially in Poland. Sustainable packaging materials exhibit moderate usage, with a slightly higher percentage in the overall responses. Low VOC (Volatile Organic Compounds) finishes and glues have relatively low usage, indicating potential for improvement in adopting environmentally friendly materials.

8.3.3. Supply Chain and Partnerships

Figure 8-1: Location of key suppliers (Poland)



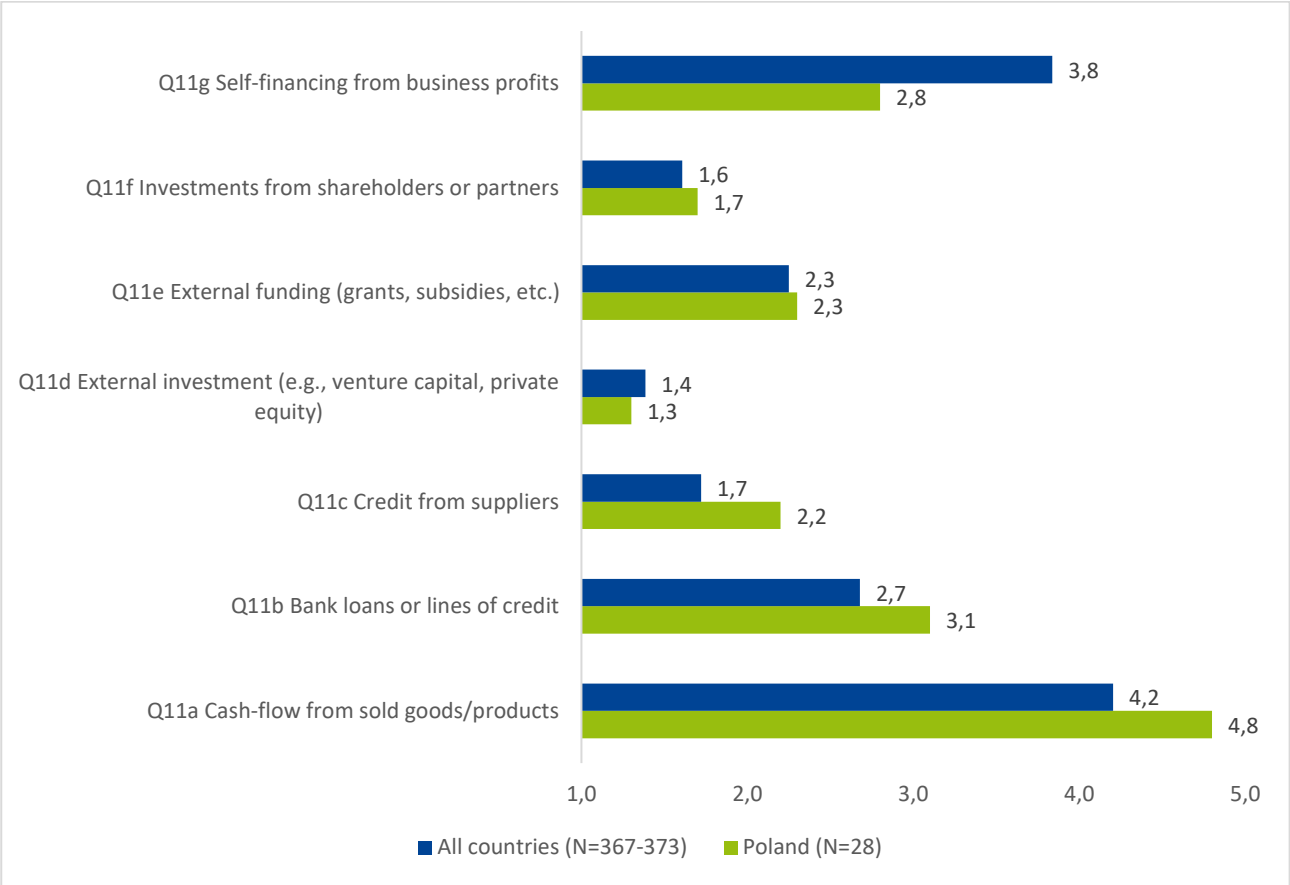
The majority of respondents' key suppliers are based in the European Union (82.1%). However, there is a group of companies (17.9%) that utilizes a mixed supplier base, including entities both within and outside the EU. Most commonly identified countries from the EU were Germany (5 answers), Netherlands (5 answers), Czech Republic (3 answers), Great Britain (3 answers). Most importan suppliers outside EU is China (3 answers).

The results indicate that a majority of companies (64.3%) do not have partnerships with suppliers, including startups, for testing, customizing, and purchasing innovative/green technologies. However, there is a notable portion of respondents (25%) who have such partnerships. Additionally, a small percentage (10.7%) responded as "Do not know," suggesting a level of uncertainty or lack of awareness about existing partnerships. The results suggest that among companies with partnerships with suppliers (including startups) for testing, customizing, and buying innovative/green technologies, the nature of these partnerships varies. A significant percentage of respondents (71.4%) reported engaging in joint roadmaps and projects with their suppliers. This indicates a collaborative effort to plan and execute initiatives related to innovative or green technologies. The majority of companies (85.7%) indicated that they are involved in purchasing new technology solutions from their suppliers. This suggests a proactive approach to acquiring and integrating innovative technologies into their operations. A substantial portion of respondents (71.4%) reported customizing existing technologies in collaboration with their suppliers. This reflects a tailored approach to adapting technologies to better suit the specific needs of the companies.

While a lower percentage, 28.6% of companies mentioned testing their suppliers' technologies in their operations. This may indicate a cautious approach, where companies assess the effectiveness of technologies before widespread implementation. Overall, the results suggest a diversity of engagement with suppliers, encompassing joint planning, purchasing, customization, and, to a lesser extent, testing of technologies in the companies' operations.

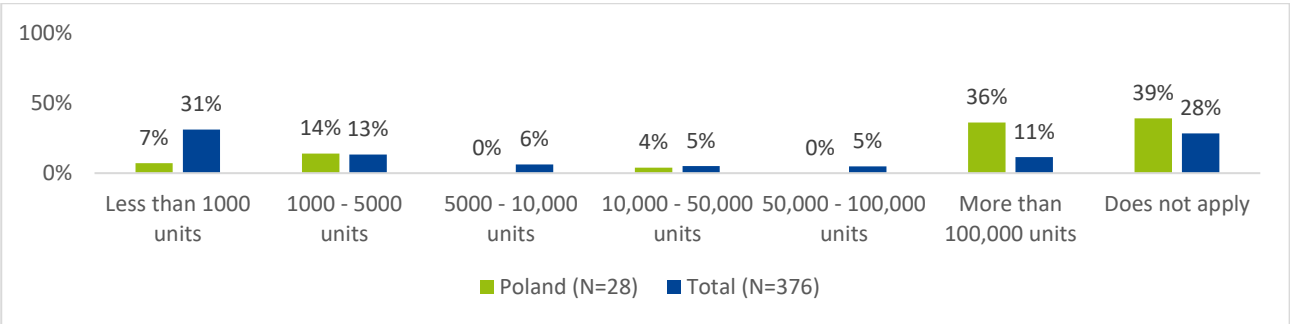
8.3.4. Financial Aspects

Figure 8-2: Financing sources (Poland)



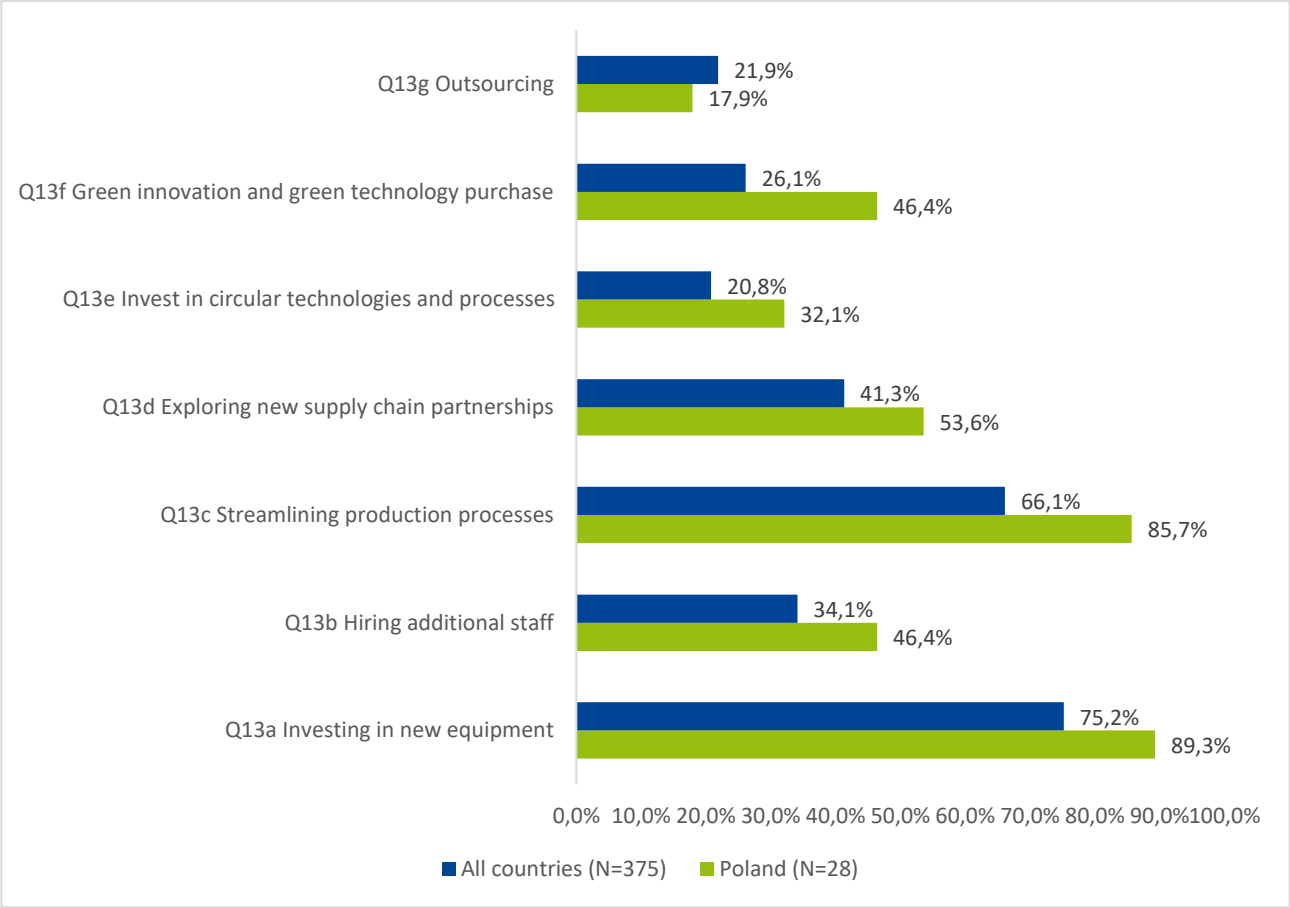
Responses indicate that cash flows from sold goods/products, bank loans and self-financing from business profits are among the more significant sources of financing.External investments (e.g., venture capital, private equity) are the least popular among manufacturing companies in both Małopolska and other coutries.

Figure 8-3: Maximum producton capacity per month (Poland)



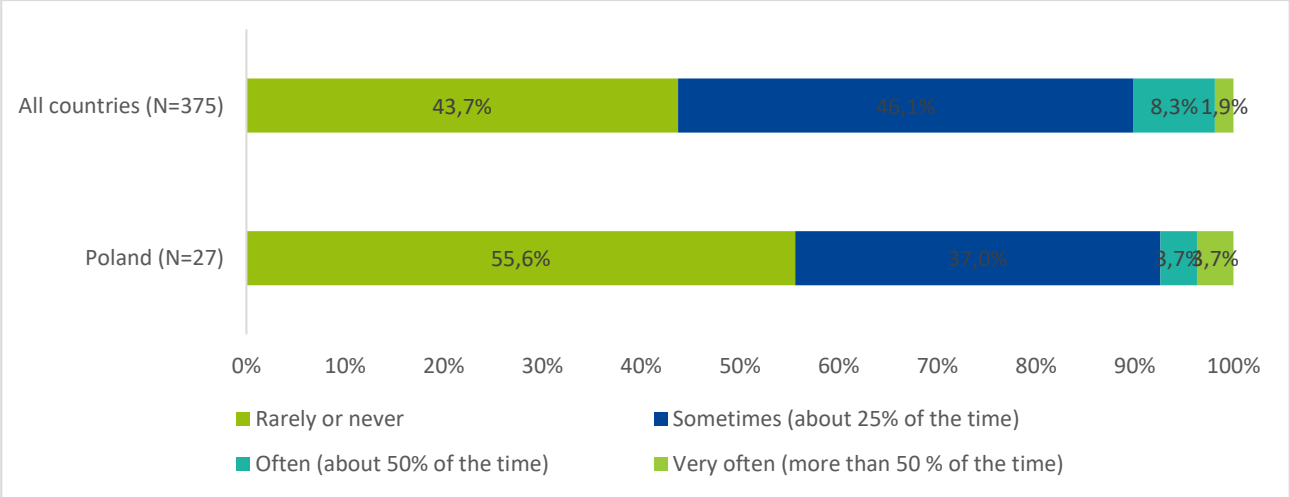
The responses of the companies illustrate their diversity in terms of production capacity, both in terms of quantity and the nature of their activities.

Figure 8-4: Measures taken to improve production efficiency and narrow the gap between actual and potential output (Poland)



Regarding efforts to increase production efficiency and reduce the gap between actual and potential productivity, companies engaged in activities such as investing in new equipment (89.3%), streamlining production processes (85.7%), and, to significant extent exploring new supply chain partnerships (53.6%). Hiring additional staff on the same level as green innovation and green technology purchase (46.4 %). Some companies (32.1%) also invested in circular technologies and processes to contribute to a circular economy.

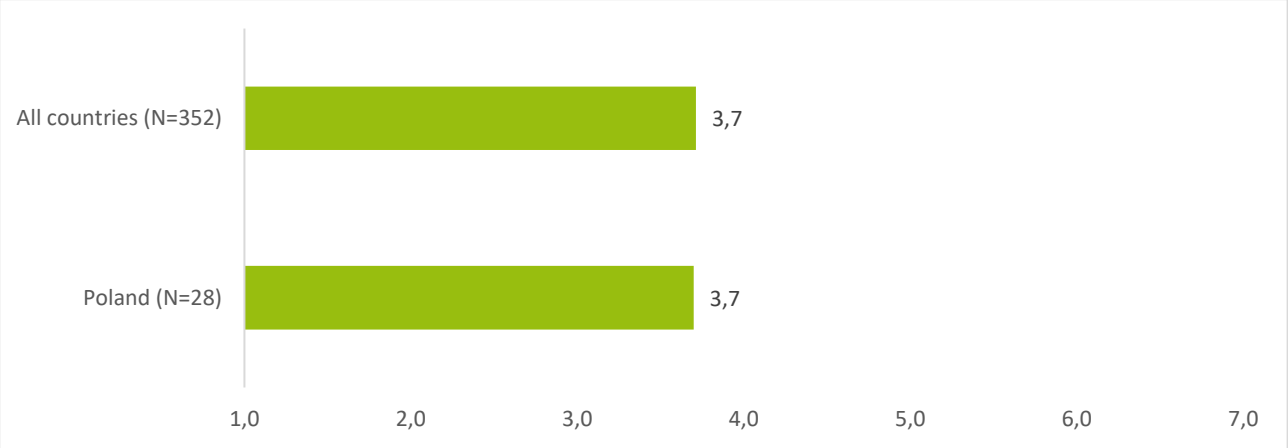
Figure 8-5: Experienced delays in receiving raw materials (Poland)



In Małopolska region, most respondents (55.6%) rarely or never experience delays in receiving raw materials. This percentage is slightly higher than the average for all countries (43.7%). About 37% of Polish companies experience occasional delays (37%). Only a small percentage of surveyed companies often or very often experience delays (7,4%), which is lower than the average for other countries (10.2%).

8.3.5. Usage Behaviour

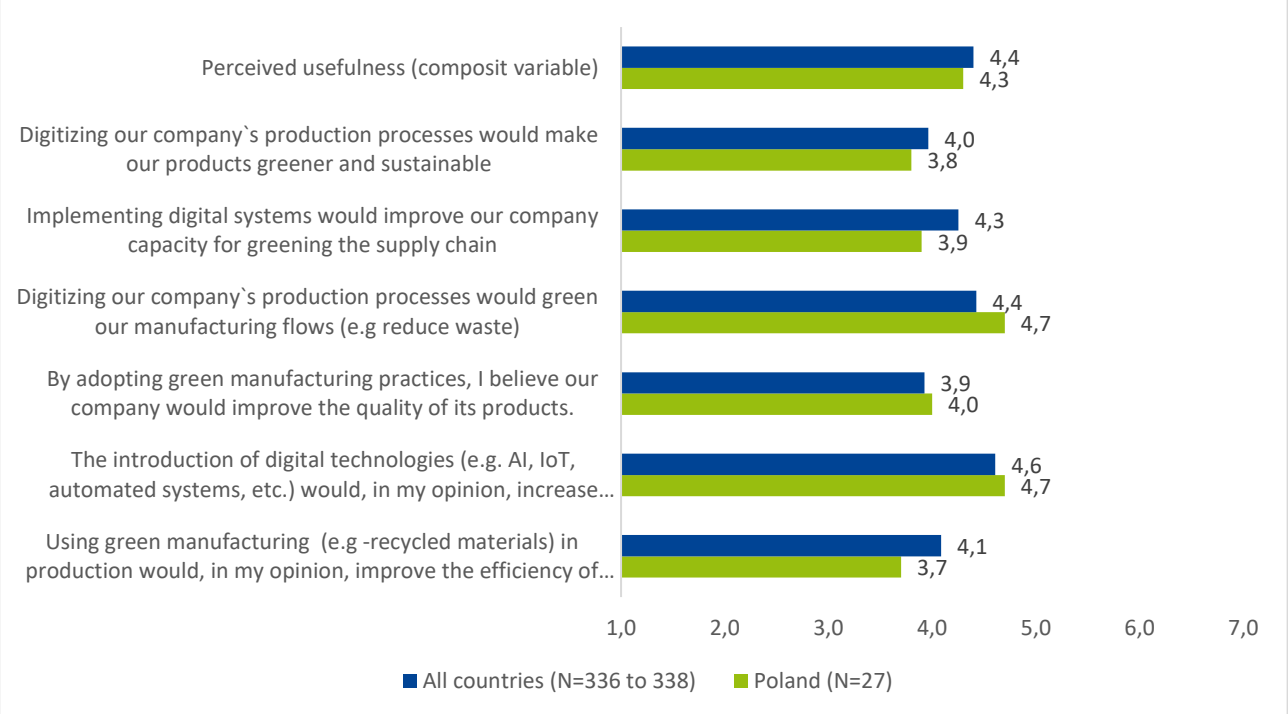
Figure 8-6: Usage behaviour by country



Usage of green technologies in Małopolska region is on par with usage with other surveyed regions and countries.

8.3.6. Perceived Usefulness

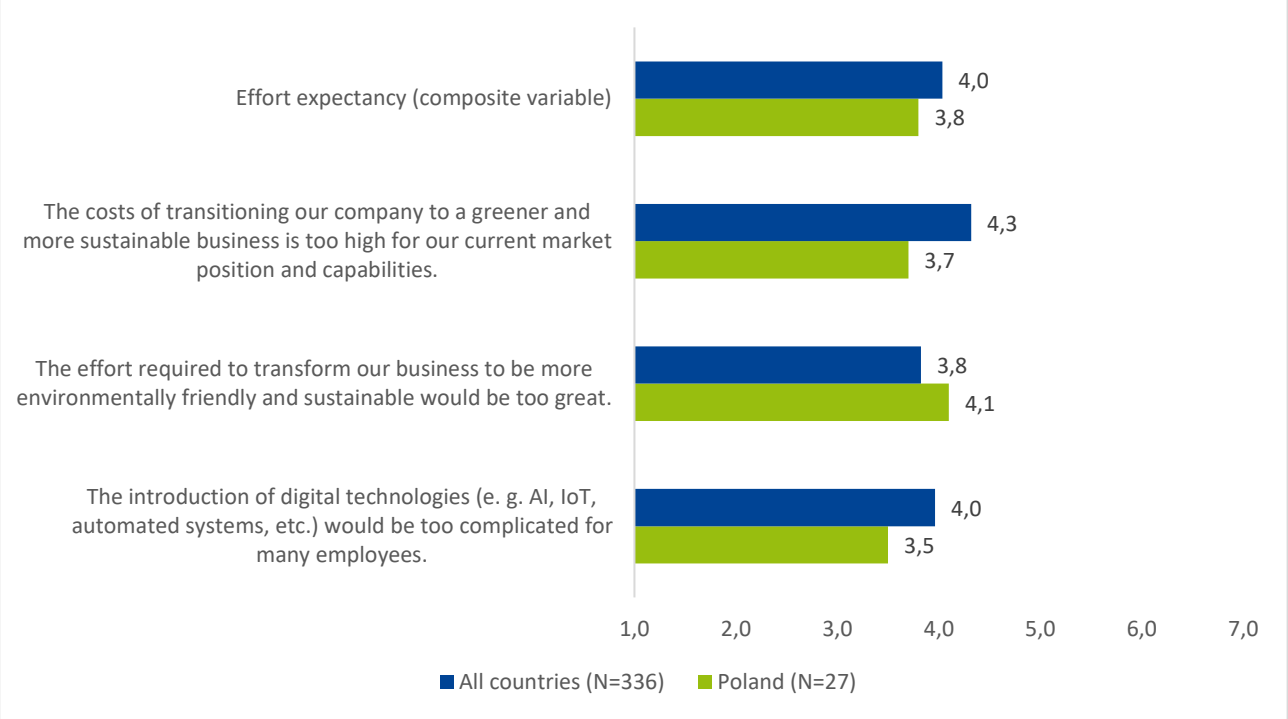
Figure 8-7: Perceived usefulness indicators and composite variable Poland



There is a moderate level of agreement (4,3) that incorporating green manufacturing practices could enhance efficiency, with slightly higher agreement in CE region (4,4). Respondents generally agree that the implementation of digital technologies would contribute to the sustainability of their companies (4,4), with a slightly higher agreement in Poland (4,7). There is a moderate level of agreement (3,9) that integrating green manufacturing practices would positively impact product quality, with slightly higher agreement in Poland (4,0). Overall, respondents perceive digital technologies and green manufacturing practices as useful, with slightly higher perceived usefulness for all countries (4,4).

8.3.7. Effort Expectancy and Ease of Use

Figure 8-8: Effort Expectancy indicators and composite variable (Poland)

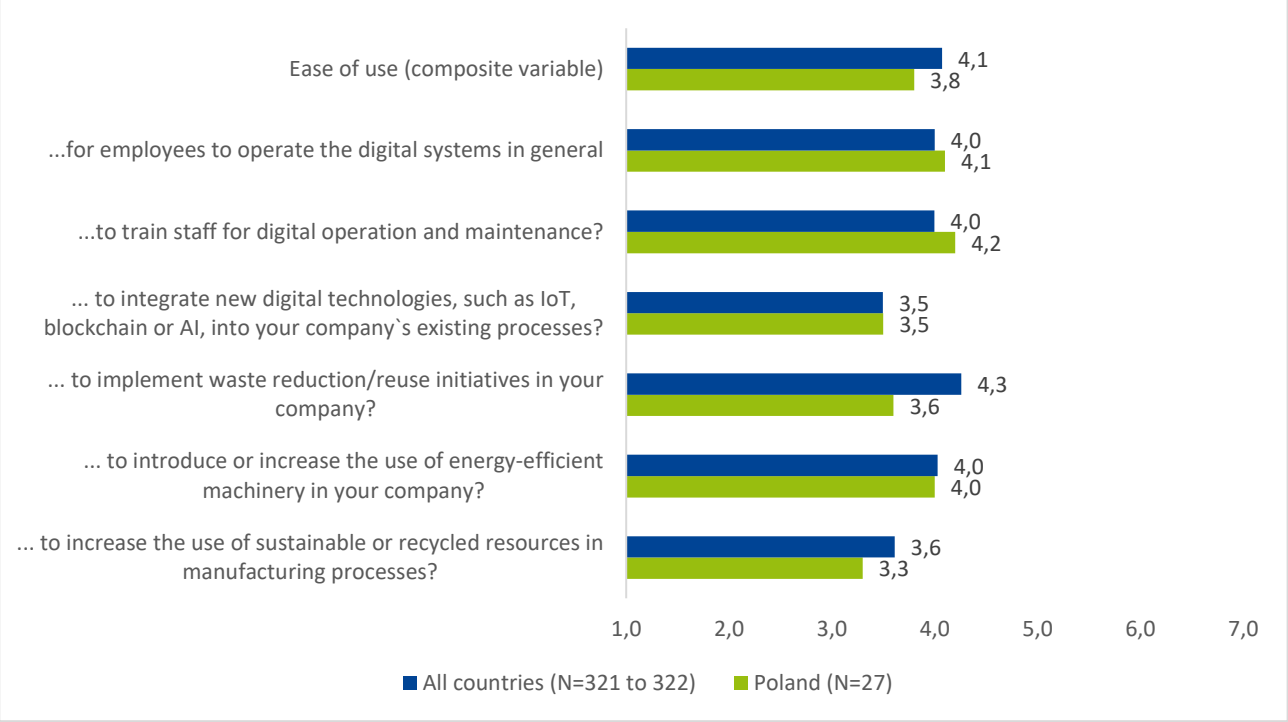


There is a slight disagreement in both Małopolska region and other countries surveyed regarding the perceived complexity of introducing digital technologies. However, respondents in Poland (3,5) express a slightly lower level of concern compared to the average (4,0).

Respondents in MAłopolska region show a moderate level of agreement (4,1) that the effort required for environmental and sustainable transformation would be significant.

There is a difference in perception, with respondents in Poland expressing a lower level (3,7) of concern about the costs of transitioning to a greener business compared to the average (4,3.). In CE region, there is a higher level of agreement that costs may be a significant barrier.

Figure 8-9: Ease of use indicators and composite variable (Poland)



Respondents in Małopolska region find it moderately difficult (3,3) to increase the use of sustainable or recycled resources in manufacturing processes. The difficulty level is slightly higher in the all countries surveyed context (3,6). There is a moderate level of agreement that introducing or increasing the use of energy-efficient machinery is perceived as moderately challenging, with similar perceptions in both Poland (4,1) and overall (4,0). There is a moderate level of agreement that it is moderately challenging for employees to operate digital systems in general (4,0), with slightly higher perceived difficulty in Poland (4,2). The composite variable "ease of use" reflects a higher level of agreement in CE region (4,1) compared to Małopolska region (3,9%).

8.3.8. Facilitating Conditions

Factor analysis yielded 3 factors:

FACTOR 1: Internal Readiness and Support for Green Manufacturing:

This factor pertains to the internal preparedness of an organization for the transition towards green manufacturing practices. It encompasses the availability of resources, qualified personnel, knowledge, and technical infrastructure within the organization. Additionally, it considers the active encouragement and support from top management, along with the provision of necessary training for employees, ensuring the internal ecosystem is conducive to embracing green manufacturing.

Includes statements:

- Q34b Our employees have the necessary resources to make the shift towards green manufacturing.
- Q34c Our company has a sufficient number of qualified employees to make the shift towards green manufacturing.
- Q33a The required knowledge and technical resources for the green manufacturing transition are available in our organization.
- Q34a Our top management actively encourages the use of green manufacturing practices within the company.

- Q34d Our employees have received the necessary training to implement a transition to green manufacturing.
- Q33b The company has all the necessary technical infrastructure for digitization.

FACTOR 2: Regulatory and External Technical Barriers to Green Manufacturing

This factor revolves around the external influences that organizations encounter when attempting to adopt green manufacturing practices, namely lack of government information, other regulatory obstacles and limited external technical knowledge.

Includes statements:
- The government doesn`t provide enough information regarding sustainable production/green manufacturing.
- There is not enough external technical knowledge available to support adoption of green manufacturing practices.
- More green manufacturing practices cannot be implemented because of the regulatory obstacles.

FACTOR 3: Regulatory Drivers on Green Manufacturing

This factor centres around the influence of regulatory frameworks on motivating and facilitating organizations to adopt green manufacturing practices.

Includes statements:
- Q33d There are enough regulatory pressures pushing our company to adopt green manufacturing practices.
- Q33e The regulatory system contains sufficient incentives to encourage the green transition.

There is a low level of agreement that the necessary knowledge and technical resources for transitioning to green manufacturing are available within the organization. Respondents moderately agree that the company possesses the required technical infrastructure for digitization. There is a moderate level of agreement that regulatory obstacles hinder the implementation of additional green manufacturing practices. Respondents agree that there are sufficient regulatory pressures encouraging the adoption of green manufacturing practices. There is a moderate level of agreement that the regulatory system provides adequate incentives for the transition to green practices. Respondents strongly agree that the government lacks in providing sufficient information on sustainable production and green manufacturing. There is a moderate level of agreement that external technical knowledge to support green manufacturing practices is lacking. Respondents strongly agree that top management actively encourages the use of green manufacturing practices. There is a moderate level of agreement that employees have the necessary resources for transitioning to green manufacturing. There is a moderate level of agreement that the company has a sufficient number of qualified employees for transitioning to green manufacturing. There is a low level of agreement that employees have received sufficient training for the transition to green manufacturing.

Respondents in Poland perceive slightly higher regulatory and external technical barriers to green manufacturing compared to the global average. There is a moderate level of agreement that regulatory drivers are influencing green manufacturing, with a slightly higher agreement in Poland compared to the global average. There is a moderate level of internal readiness and support for green manufacturing, both in Poland and globally.

Figure 8-10: Facilitating conditions - indicators (Poland)

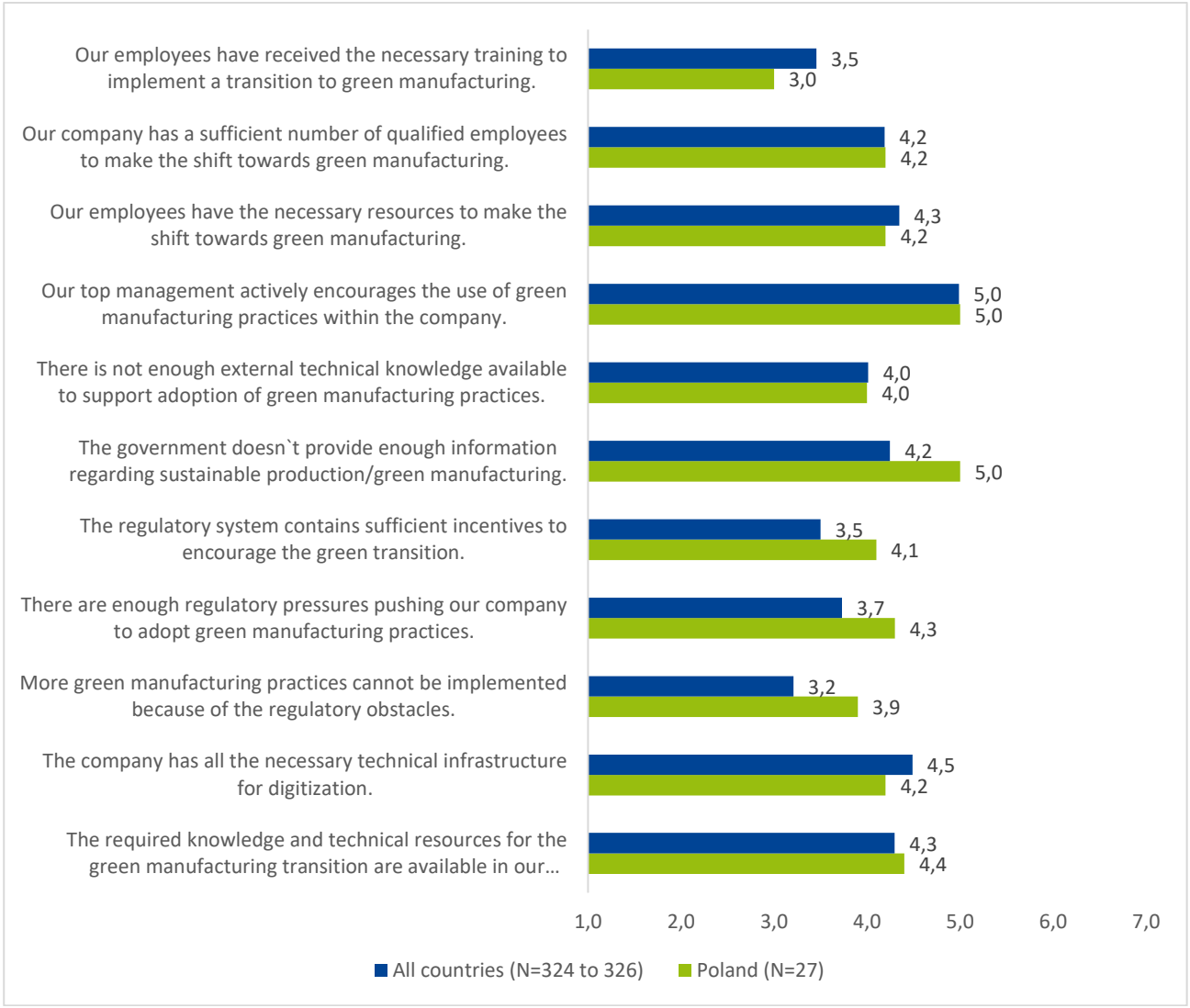
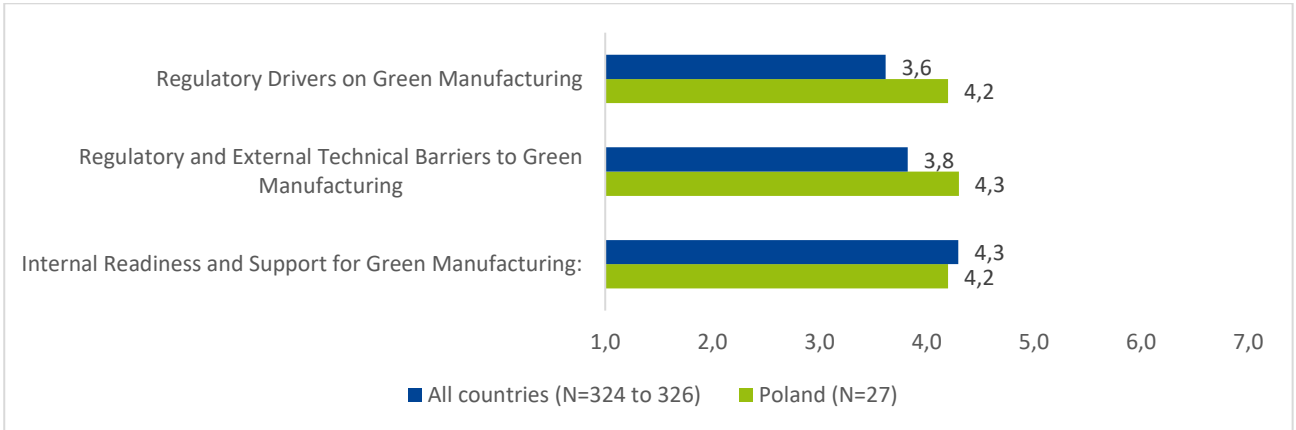
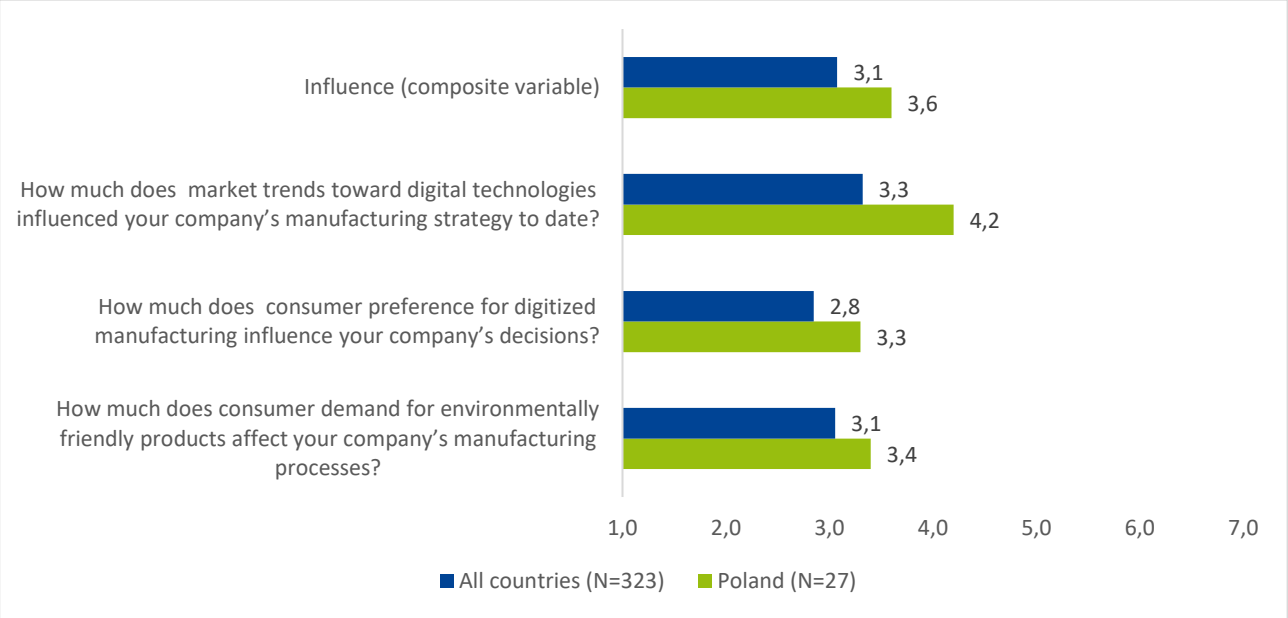


Figure 8-11: Facilitating conditions - composite variables (Poland)



8.3.9. Influence

Figure 8-12: Influence indicators and composite variable (Poland)



Consumer demand for environmentally friendly products and digitized manufacturing has a moderate influence on manufacturing processes in Poland, slightly higher than the global average.

Market trends toward digital technologies have some influence on the manufacturing strategy in Poland, surpassing the global average. The composite variable indicates a moderate overall influence on manufacturing processes in Poland, slightly higher than the global average.

8.3.10. Attitudes Toward Change

Table 8-3: Attitude toward change (Poland)

	Poland		All countries	
	N	% likely or very likely	N	% likely or very likely
How likely is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	27	29,6%	320	31,6%
How likely will you switch to energy-efficient machinery for your production in the following 5 years?	27	37%	320	35,0%
How likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	27	33,3%	320	32,0%

There is a moderate level of likelihood that companies in Małopolska region will integrate or increase green manufacturing processes in the next 5 years (29,6%), which is slightly lower than average (31,6%). The likelihood of incorporating digital technologies into manufacturing processes is moderate (33,3%). There is a relatively higher likelihood that companies in Małopolska will switch to energy-efficient machinery (37%)in the next 5 years compared to CE average (35%).

8.3.11. Enablers and Barriers

Most important barrier identified during survey was lack of financial resources: companies do not have enough money for starting green and digital transition. External financing (such as grants) is difficult to obtain. Implementation costs are too high. Being green is also considered to be risky – each investment requires time, and it is difficult to make such decision without confidence in results ("*In essence, the biggest obstacle is market instability and unpredictability. Every investment requires a return period, and in times of uncertainty, it is more difficult to make purchasing decisions. There are also limitations arising from energy regulations (limitations on the size of photovoltaic installations that are inadequate for industrial needs")*.

Legal issues are also considered to be problematic – regulations are constantly changing, some of them are mutually exclusive.

Human resources: IT staff required for digital transition is available but expensive. Training regular workers is also difficult without external support.

Companies stated that "being green" (generally speaking) is well received by customers and good for public image. Some of them even expressed concern for the natural environment. We may assume, however, that the second follows from the first and that manufacturers perceive green transformation – to some extent – as a way to attract customers. Simultaneously, there have been claims that customers draw their attention only to price and ignore means of production.

Companies mentioned that more experienced staff might be reluctant to accept green and digital transformation – i.e., changing the way work is carried out for many years. Some sectors, like automotive, have very specific requirements regarding quality and, even more importantly, security. This also applies to products based on traditional recipes, like food – there might be not so much space for innovation and digitalization. Some of them fear that adopting green technologies will increase unit costs – and competitors, using traditional methods, will gain an advantage.

8.4. Summary of attitudes towards green and digital technologies

8.4.1. Technology and Innovation

The results indicate high utilization of CRM (76.9%) and ERP technologies (69.2%) in region.

Technologies related to document processing or IoT are relatively underrepresented. Intelligent Document Processing applications are relatively rarely used in region (7.7%). This may indicate that companies have not fully recognized the potential of this technology yet. The use of IoT is relatively low - 15.4%). AI is relatively underrepresented, both in Poland (11.5%) and overall (10.8%). Introducing this technology may require further education and adaptation. AR/VR technologies are even less popular, indicating a low percentage of companies using them, both in Poland (3.8%) and overall (3.6%).

In region, Cloud Computing is used by 26.9% of companies, indicating moderate but significant utilization of this technology. In CE region the share increases to 60.6%, suggesting widespread adoption.

8.4.2. Green Manufacturing Practices

The majority of respondents' key suppliers are based in the European Union (82.1%). However, there is a group of companies (17.9%) that utilizes a mixed supplier base, including entities both within and outside the EU. Most commonly identified countries from the EU were Germany (5 answers), Netherlands (5 answers), Czech Republic (3 answers), Great Britain (3 answers). Most importan suppliers outside EU is China (3 answers).

8.4.3. Financial Aspects

Responses indicate that cash flows from sold goods/products, bank loans and self-financing from business profits are among the more significant sources of financing. External investments (e.g., venture capital, private equity) are the least popular among manufacturing companies in Małopolska.

Regarding efforts to increase production efficiency and reduce the gap between actual and potential productivity, companies engaged in activities such as investing in new equipment (89.3%), streamlining production processes (85.7%), and, to significant extent exploring new supply chain partnerships (53.6%). Hiring additional staff on the same level as green innovation and green technology purchase (46.4 %). Some companies (32.1%) also invested in circular technologies and processes to contribute to a circular economy.

In Poland, the majority of respondents (55.6%) rarely or never experience delays in receiving raw materials. This percentage is slightly higher than the average for all countries (43.7%). About 37% of Polish companies experience occasional delays (37%).Only a small percentage of surveyed companies often or very often experience delays (7,4%), which is lower than the average for other countries (10.2%).

8.4.4. Perceived Usefulness

There is a moderate level of agreement in Małopolska (4,3) that incorporating green manufacturing practices could enhance efficiency, with slightly higher agreement in CE region overall (4,4). Respondents generally agree that the implementation of digital technologies would contribute to the sustainability of their companies (4,7). There is a moderate level of agreement (4,0%) that integrating green manufacturing practices would positively impact product quality. Overall, respondents perceive digital technologies and green manufacturing practices as useful, with slightly higher perceived usefulness for all countries (4,4).

8.4.5. Effort Expectancy and Ease of Use

There is a slight disagreement in both Poland and all countries surveyed regarding the perceived complexity of introducing digital technologies. However, respondents in Poland (3,8) express a slightly lower level of concern compared to the average (4,0).

Respondents in Poland show a moderate level of agreement (4,1) that the effort required for environmental and sustainable transformation would be significant.

Respondents in Poland express some concern regarding level of concern compared to the average (4,0).

Respondents in Poland show a moderate level of agreement (4,1) that the effort required for environmental and sustainable transformation would be significant.

There is a notable difference in perception, with respondents in Poland expressing a lower level (3,7) of concern about the costs of transitioning to a greener business compared to the global average (4,3). In CE region, there is a higher level of agreement that costs may be a significant barrier.

8.4.6. Attitudes Toward Change

There is a moderate level of likelihood that companies in Małopolska region will integrate or increase green manufacturing processes in the next 5 years (29,6%), which is slightly lower than average (31,6%). The likelihood of incorporating digital technologies into manufacturing processes is moderate (33,3%). There is a relatively higher likelihood that companies in Małopolska will switch to energy-efficient machinery in the next 5 years (37%).

8.5. Conclusions, Recommendations and Action plan

The results of the survey suggest a positive trend in the adoption of green manufacturing technologies, but there are varying levels of implementation across different practices. Companies demonstrated genuine interest in the project topic and were open to sharing their experiences. Respondents are aware of the upcoming digital and circular transformation. They also realize that environmental issues are increasingly recognized by their customers, who pay attention to ensuring that the final product is environmentally friendly. The uncertain economic situation in the market is also a driving force for change. On the other hand, companies see many challenges associated with this, mainly arising from the high costs of implementing the transformation. As it was said before, main obstacles are financial, legal and organizational issues. In most cases providing direct financial support is not possible - resources on an appropriate scale are available only to governments. Based on the survey results and discussions with companies, the following actions can be recommended to support the processes of digital and circular transformation among companies in the Małopolska region. Among them are:

- Systematic incorporation of sustainability issues at all management levels, and in medium and large companies, integration of environmental action strategies, including CE and ESG principles (Environmental, Social and Governance), with the company's overall strategy.
- Development of green competencies ("green skills") among employees. As survey showed in the Małopolska region there is a potential for education and promotion of modern technologies, especially those related to document processing or the Internet of Things
- Demonstration and promotion of green and digital solutions implemented in companies with a similar profile of operations
- Appointment of individuals responsible for "greening the company" to the company's boards – this could be an "environmental policy officer" or a circular economy manager, and at the middle management level, for example, a green-tech leader or waste manager.
- Involvement of research institutes and the entire research, development, and innovation sector in the awareness-building process.
- Opportunity to gain experience through participation in a study visit, for example, to a business with a similar profile of activities in another country.
- Financial support for these activities from both public and private sources

As Greene 4.0 we would like to connect manufacturers with solution providers – we may extend the scope to include also consulting companies that are willing to advice manufactures how to get funding (governmental projects exist) and provide with knowledge about current legal status.

9. Slovenia Analysis - key findings

9.1. Sample description

The sample used for the survey in Slovenia comprises a diverse range of companies in the manufacturing sector. The key characteristics of the companies surveyed include:

- **Size:** All of the interviewed companies fall within the SME category, with less than 250 employees, aligning with the SME definition used in the survey.
- **Financials:** Companies surveyed have annual turnovers not exceeding EUR 50 million and annual balance sheet totals not exceeding EUR 43 million, as per the survey criteria. This ensures a representation of companies with varying financial scales.
- **Industry sectors:** The survey covers various sub-sectors within the manufacturing industry, including industrial machinery, electronics, metal, plastic and rubber production, food and beverage and textiles. This diversity allows for insights into different facets of the manufacturing landscape.
- **Business models:** The target companies exhibit diverse business models, including B2B, B2C, and a mix of both. The majority of interviewed companies in Slovenia follow a Business-to-Business (B2B) model (48.5%), followed by companies engaged in both B2C and B2B activities (39.4%).
- **Company age:** The surveyed companies in Slovenia have a relatively balanced distribution across different age groups, with a notable presence in the 11 to 20 years range (33,3%).
- **Number of employees:** The majority of surveyed companies in Slovenia have fewer than 10 employees (50.0%), indicating a prevalence of micro and small-sized enterprises.
- **Geographic dispersion:** Geographically, the companies are dispersed across urban and rural areas in Slovenia and operate at the national and international levels, indicating a global orientation in their geographic markets.

9.2. Survey administration

The survey administration for the GREENE 4.0 project involved a multifaceted and targeted approach to ensure comprehensive coverage and diverse participation. The methodologies employed included:

- **Promotional campaign:** A strategic promotional campaign was executed through social media platforms and the project website. This digital outreach aimed to maximize visibility and attract participation from a broad audience.
- **Intermediary engagement:** Collaborative efforts were made by reaching out to over 20 intermediaries, with wide outreach to companies, such as Chambers of Commerce, Business incubators, European Digital innovation hubs and Enterprise Europe Network in Slovenia. These intermediaries played a crucial role in amplifying the survey to their networks, enhancing the survey's reach and credibility.
- **Telephone interviews:** our experts conducted telephone interviews with selected companies. This direct and personal approach allowed for in-depth conversations and a higher level of engagement. Often companies asked for a personal assistance and expressed interest to meet also online or in person.
- **Personal interviews:** Some companies were approached for personal interviews, adding a qualitative dimension to the survey. These interviews allowed for nuanced insights and a deeper understanding of individual company perspectives.
- **Online Meetings:** online meetings were conducted as part of the outreach strategy. This facilitated real-time interactions, addressing queries, and emphasizing the importance of survey participation.

9.3. Preliminary findings during the survey administration

Throughout the survey administration process in Slovenia, several noteworthy preliminary findings emerged, offering valuable insights into the state of sustainable and digital practices among small and medium enterprises (SMEs) in the region. The survey encountered challenges due to the simultaneous distribution of two parallel questionnaires stemming from other EU-projects. This parallel approach created confusion among companies, impacting the data collection process. Since Slovenia is a small country, it was challenging to gather a sufficient, diverse, and representative sample.

Furthermore, companies in Slovenia expressed limited awareness regarding green business models, EU-level regulations, and the business cases supporting the twin transition (digital and green). This lack of awareness highlights a potential gap in knowledge and understanding among businesses in the region. Companies exhibited a need for centralized and accessible information, expressing a clear interest in a centralized information platform. This portal, envisioned as a comprehensive resource hub, would consolidate relevant information, expert insights, and innovations related to green business practices and digital transformation. This indicates a potential gap in the availability of easily accessible information on green business practices and the twin transition.

Companies articulated a need for expert guidance and information on innovative practices. The survey revealed a desire for access to expertise that can facilitate the adoption of green technologies and digital solutions. This underscores the importance of knowledge dissemination and support mechanisms for companies seeking to navigate the twin transition effectively.

The preliminary findings in Slovenia emphasize the importance of addressing awareness gaps and providing accessible resources for companies to navigate the twin transition successfully. The interest in a one-stop-shop portal signals an opportunity to create a centralized platform that caters to the specific informational needs of businesses in the region, fostering a more informed and sustainable business landscape.

9.4. Regional Analysis key findings

9.4.1. Technology and Innovation

The technological landscape in Slovenian companies reflects a dynamic interplay between traditional and emerging solutions. Table 1 shows the adoption trends of various technologies, offering insights into how Slovenian businesses utilize these tools to enhance their operations.

The adoption of cloud computing stands out significantly in Slovenia, with 70.8% of companies leveraging this technology. This surpasses the overall average adoption rate of 60.6%, indicating a relatively higher embrace of cloud solutions among Slovenian businesses. This trend suggests a recognition of the benefits associated with cloud computing in enhancing flexibility, scalability, and collaboration.

Both Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) systems exhibit robust adoption in Slovenian companies, with 62.5% and 45.8%, respectively. These figures indicate a strategic use of technology for managing customer relationships and streamlining enterprise-wide processes. The widespread adoption aligns with global trends in leveraging integrated systems for efficient business operations.

Moderate adoption is observed in Intelligent Document Processing (16.7%) and Internet of Things (IoT) technologies (20.8%) in Slovenian companies. While not yet pervasive, these technologies signify a growing interest in automation and connectivity for improved business processes. The moderate adoption rates suggest a cautious but forward-looking approach among companies in Slovenia.

Slovenian companies report a lower adoption rate of Artificial Intelligence (AI) at 8.3%, compared to the overall adoption rate of 10.8%. This discrepancy highlights a relatively slower integration of AI technologies

in Slovenian business operations. However, the overall adoption rate suggests that AI adoption is still in the early stages across surveyed countries.

Slovenian companies currently show no adoption of Augmented Reality (AR) or Virtual Reality (VR) technologies. This aligns with the low overall adoption rate of 3.6%. The absence of adoption in Slovenia indicates that immersive technologies have yet to gain traction, possibly due to specific industry requirements or a perceived lack of immediate relevance.

In summary, Slovenian companies demonstrate a strong inclination toward cloud computing and foundational business systems like CRM and ERP. While emerging technologies such as Intelligent Document Processing and IoT show promise with moderate adoption, there is room for growth, especially in the areas of Artificial Intelligence and Augmented/Virtual Reality. Understanding these adoption patterns provides valuable insights for stakeholders and policymakers aiming to support the integration of advanced technologies within the Slovenian business landscape.

Table 9-1: Technologies used in company (Slovenia, N=24)

	Slovenia		All countries	
	Yes	%	Yes	%
Cloud Computing	17	70,8%	169	60,6%
CRM (Customer Relationship Management)	15	62,5%	154	55,2%
ERP (Enterprise Resource Planning)	11	45,8%	161	57,7%
Intelligent Document Processing applications	4	16,7%	81	29,0%
Internet of Things (IoT) – IoT platform for management, monitoring and improvement of production flows,	5	20,8%	67	24,0%
Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation	2	8,3%	30	10,8%
Augmented Reality / Virtual Reality	0	0,0%	10	3,6%
Other	1	4,2%	17	6,1%
Total	24	100,0%	279	100,0%

Please note that respondents had the option to select multiple responses.

When exploring the reasons behind the non-adoption of digital technologies, the survey reveals valuable insights, illustrated in Figure 1 below:

Slovenian companies, scoring 4.4 on average, indicate a moderate agreement that a lack of knowledge or skills poses a barrier to technology adoption. This emphasizes the importance of fostering digital literacy and providing educational resources to enhance the workforce's capabilities.

The perceived high costs associated with technology adoption are a significant concern for Slovenian companies, reflected in their average score of 5.0. Mitigating cost barriers through incentives, subsidies, or shared resources could encourage more widespread adoption.

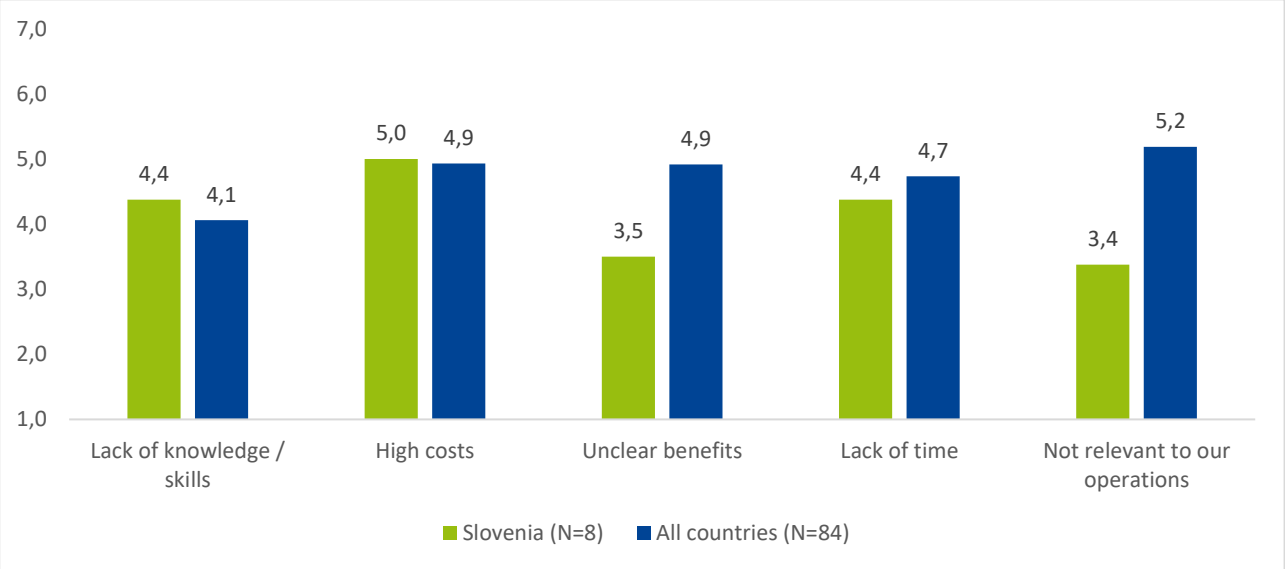
Slovenian companies, with an average score of 3.5, express a somewhat lower concern about the unclear benefits of digital technologies. This suggests a potential opportunity for clearer communication on the tangible advantages and outcomes of adopting these technologies.

The average score of 4.4 indicates a moderate agreement among Slovenian companies regarding the barrier of insufficient time for technology adoption. This underscores the need for streamlined and user-friendly solutions that integrate seamlessly into existing workflows.

With an average score of 3.4, Slovenian companies lean towards disagreeing that digital technologies are not relevant to their operations. This suggests a general recognition of the applicability of these technologies, although targeted education may further highlight their relevance in specific contexts.

These findings illuminate the technological landscape in Slovenia, emphasizing both the strides made in adopting certain digital solutions and the challenges that need to be addressed to foster broader integration.

Figure 9-1: Identifed barriers to digital technologies usage



9.4.2. Green Manufacturing Practices

Green manufacturing practices are gaining traction among Slovenian companies, as evidenced by the adoption of various environmentally friendly technologies. The data below, sourced from Table 2, provides insights into the prevalence of these practices:

A significant 67.9% of Slovenian companies are investing in energy-efficient machinery and equipment. This reflects a commendable commitment to reducing energy consumption and minimizing environmental impact, contributing to the overarching goal of sustainable manufacturing.

46.4% of Slovenian companies are harnessing renewable energy sources such as solar, wind, and biomass. This signifies a notable recognition of the importance of transitioning towards cleaner energy alternatives, aligning with broader sustainability objectives.

28.6% of Slovenian companies employ advanced process control systems. This adoption showcases a strategic focus on optimizing manufacturing processes for efficiency and resource conservation, demonstrating a commitment to greener and more sustainable operations.

A substantial number of companies, 32.1%, actively implement waste recycling systems, while 50.0% engage in waste reduction strategies like composting and recycling. This dual approach emphasizes a comprehensive commitment to minimizing the environmental footprint through responsible waste management.

50.0% of Slovenian companies are incorporating environmentally friendly materials into their production processes, reflecting a conscious effort to choose sustainable inputs. Additionally, 39.3% embrace lean manufacturing practices, showcasing a commitment to resource optimization and waste reduction throughout the production lifecycle.

While only 7.1% have implemented water-efficient systems like rainwater harvesting, 35.7% are adopting sustainable packaging materials. These practices underscore a holistic approach to environmental responsibility, addressing not only energy and waste but also water conservation and responsible packaging.

A notable 14.3% of Slovenian companies use low VOC (Volatile Organic Compounds) finishes and glues, contributing to improved air quality and reduced environmental impact. Additionally, 3.6% incorporate recycled or sustainable materials, emphasizing a commitment to circular economy principles.

Slovenian companies are actively integrating green manufacturing practices into their operations, showcasing a multifaceted approach that encompasses energy efficiency, waste management, sustainable materials, and responsible resource consumption. This positive trend aligns with global sustainability goals and positions Slovenian industries as responsible contributors to a greener and more sustainable future.

Table 9-2: Green manufacturing tehcnologies used in company (multiple responses are possible)

	Slovenia		Total	
	Count	%	Count	%
Energy-efficient machinery and equipment	19	67,9%	205	63,9%
Renewable energy sources (solar, wind, biomass)	13	46,4%	198	61,7%
Advanced process control systems	8	28,6%	76	23,7%
Waste recycling systems	9	32,1%	117	36,4%
Environmentally friendly materials in production	14	50,0%	123	38,3%
Lean manufacturing practices	11	39,3%	135	42,1%
Waste reduction strategies (e.g. composting, recycling)	14	50,0%	135	42,1%
Water-efficient systems (e.g. rainwater harvesting)	2	7,1%	56	17,4%
Sustainable packaging materials	10	35,7%	109	34,0%
Low VOC (Volatile Organic Compounds) finishes and glues	4	14,3%	28	8,7%
Use of recycled or sustainable materials	1	3,6%	94	29,3%
Total	28	100,0%	321	100,0%

Please note that respondents had the option to select multiple responses.

9.4.3. Supply Chain and Partnerships

In the context of supply chain dynamics and collaborative innovation, Slovenian companies display distinctive patterns in their key supplier relationships and partnerships for testing, customizing, and procuring innovative or green technologies. The majority of Slovenian companies (84.4%) rely on key suppliers within the European Union (EU). This inclination towards EU-based suppliers aligns with regional collaboration and adherence to common regulatory standards. A smaller portion (15.6%) maintains a diversified approach, leveraging a mix of suppliers both within and outside the EU (see Figure 2).

When it comes to fostering partnerships with suppliers, including startups, for testing, customizing, and procuring innovative or green technologies, Slovenian companies exhibit varying degrees of engagement: a notable 21.9% express uncertainty about their participation, while 6.3% actively engage in partnerships for testing, customizing, and acquiring innovative or green technologies. However, a predominant 71.9% indicate a lack of such partnerships.

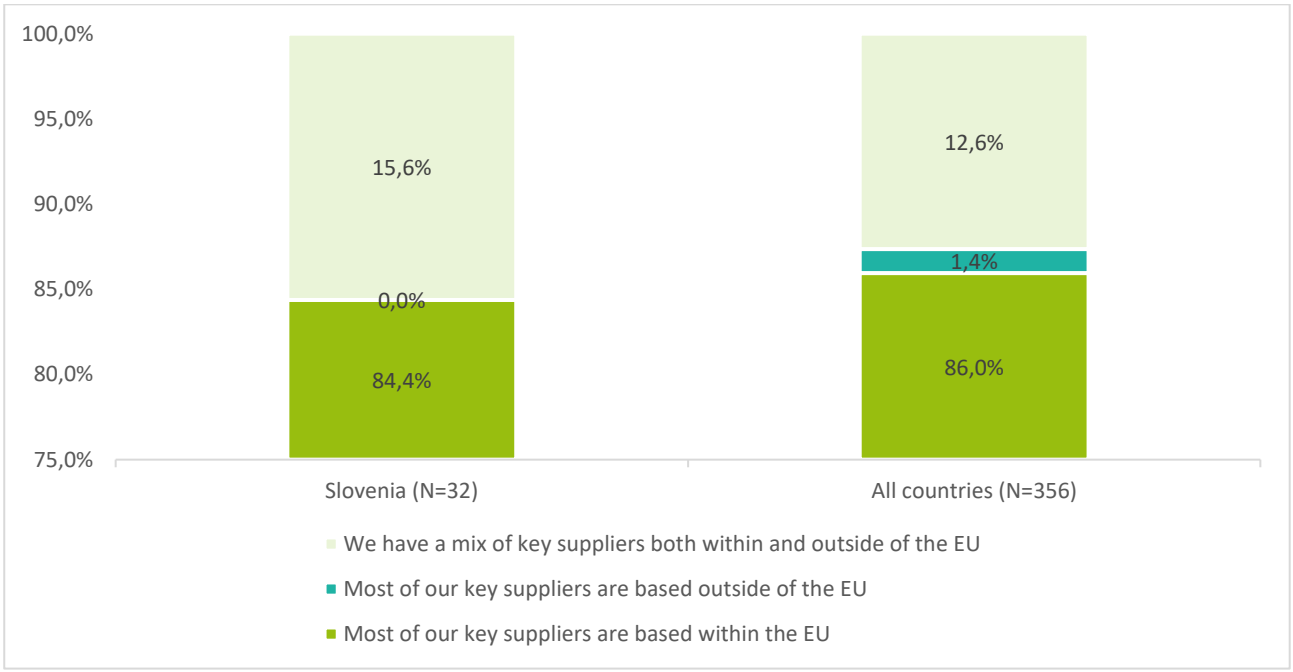
The nature of existing partnerships reveals diverse collaborative efforts among companies that confirm their engagement. Joint Research and Development (R&D) projects stand out, with 50.0% of Slovenian companies involved in partnerships participating in this endeavour. This represents 60.7% of all companies engaged in

joint R&D projects. Additionally, 100.0% of Slovenian companies in partnerships purchase new technology solutions from their suppliers, constituting 50.8% of all companies with such partnerships. All companies in partnerships (100.0%) are involved in customizing existing technologies with their suppliers, making up 59.0% of all companies in such collaborations. The testing of suppliers' technologies in operations is a widespread practice, with all Slovenian companies in partnerships (100.0%) participating and representing 44.3% of all companies engaged in partnerships.

Notably, no companies in the Slovenian subset provided information on other forms of collaboration, while other collaborative efforts constitute 6.6% of all companies involved in partnerships on a broader scale.

In summary, Slovenian companies predominantly source key supplies within the EU, signalling a robust commitment to regional collaboration. While a significant portion currently lacks partnerships for testing or acquiring innovative/green technologies, those who do engage in joint R&D, technology acquisition, customization, and testing as integral elements of their collaborative endeavours. These insights shed light on the dynamics of supply chain relationships and collaborative innovation within the Slovenian business landscape.

Figure 9-2: Location of key suppliers (Slovenia)



9.4.4. Financial Aspects

When examining the financing sources for operations, Figure 3 shows that Slovenian companies reveal notable reliance on various channels. Cash-flow from sold goods/products stands out as a significant source, with a score of 4.7 in Slovenia compared to the overall average of 4.2. Conversely, reliance on bank loans or lines of credit is lower in Slovenia (2.8) than the overall average (2.7). Credit from suppliers is minimally relied upon, with a score of 1.5 in Slovenia and 1.7 overall. External investment and funding options, such as venture capital, private equity, and grants, are less frequently utilized by Slovenian companies, each scoring 1.5 and 2.5, respectively. Investments from shareholders or partners and self-financing from business profits both exhibit moderate reliance, with scores of 1.6 and 3.8, respectively.

Figure 9-3: Financing sources (Slovenia)

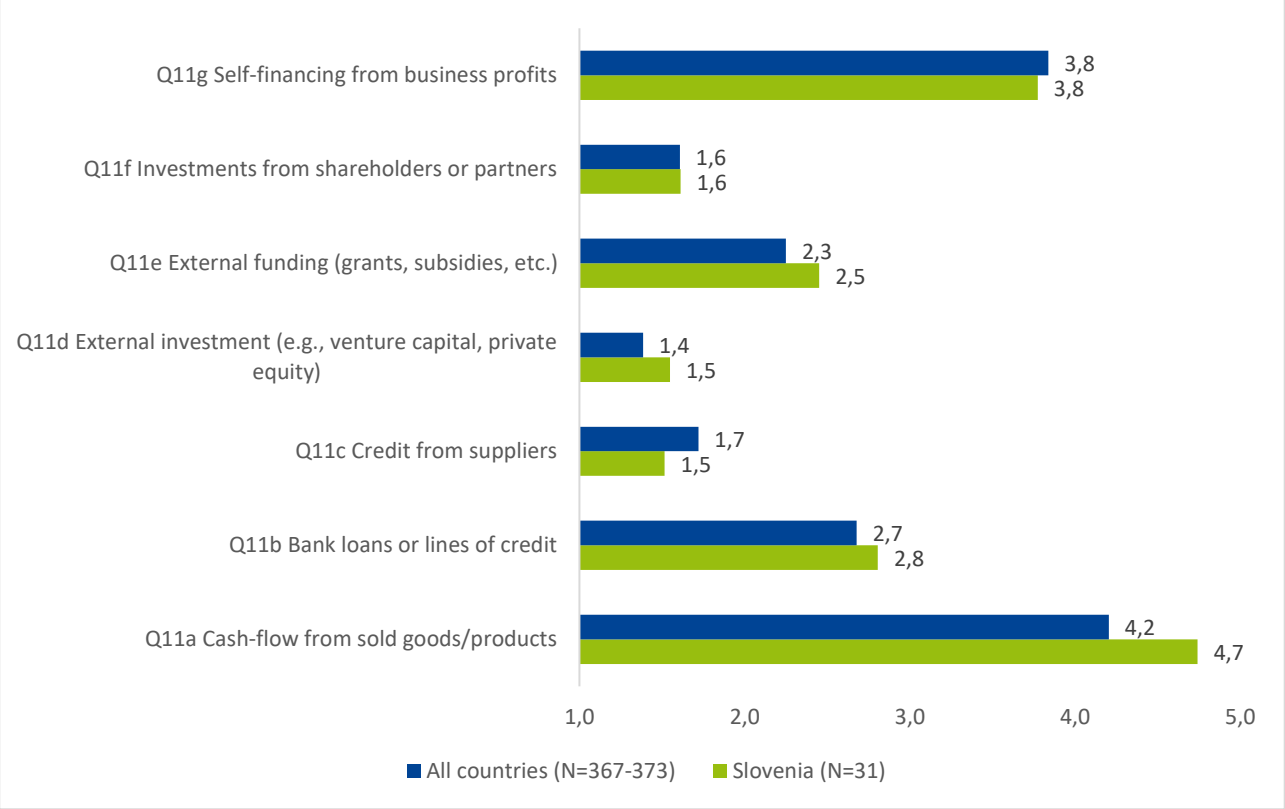
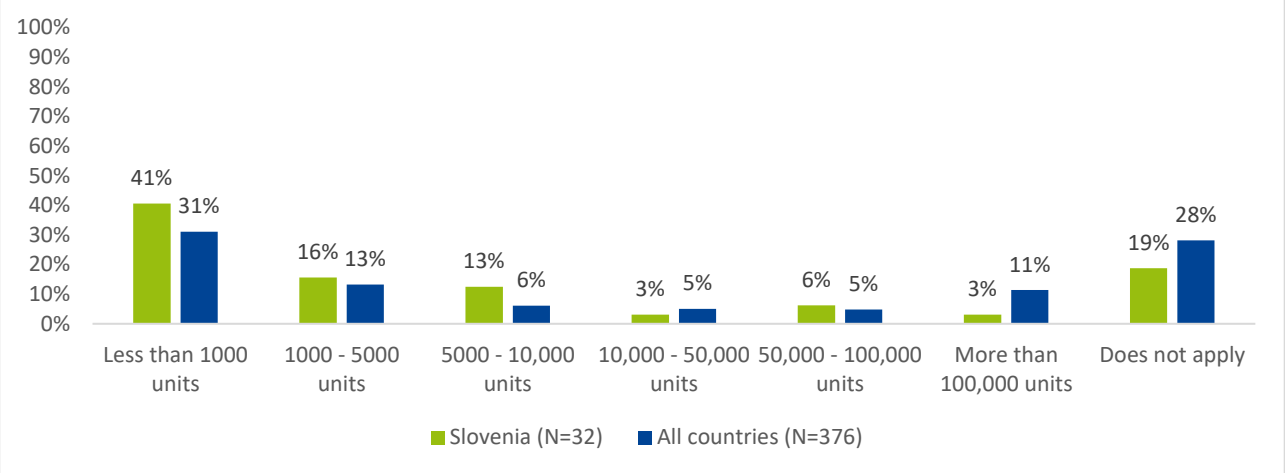


Figure 4 exhibits that regarding production capacity, Slovenian companies display varied scales. The majority (41%) have a production capacity of fewer than 1000 units, while 19% indicate that the question does not apply to their operations. This distribution contrasts with the overall data, where 31% have a production capacity of fewer than 1000 units, and 28% state that the question does not apply.

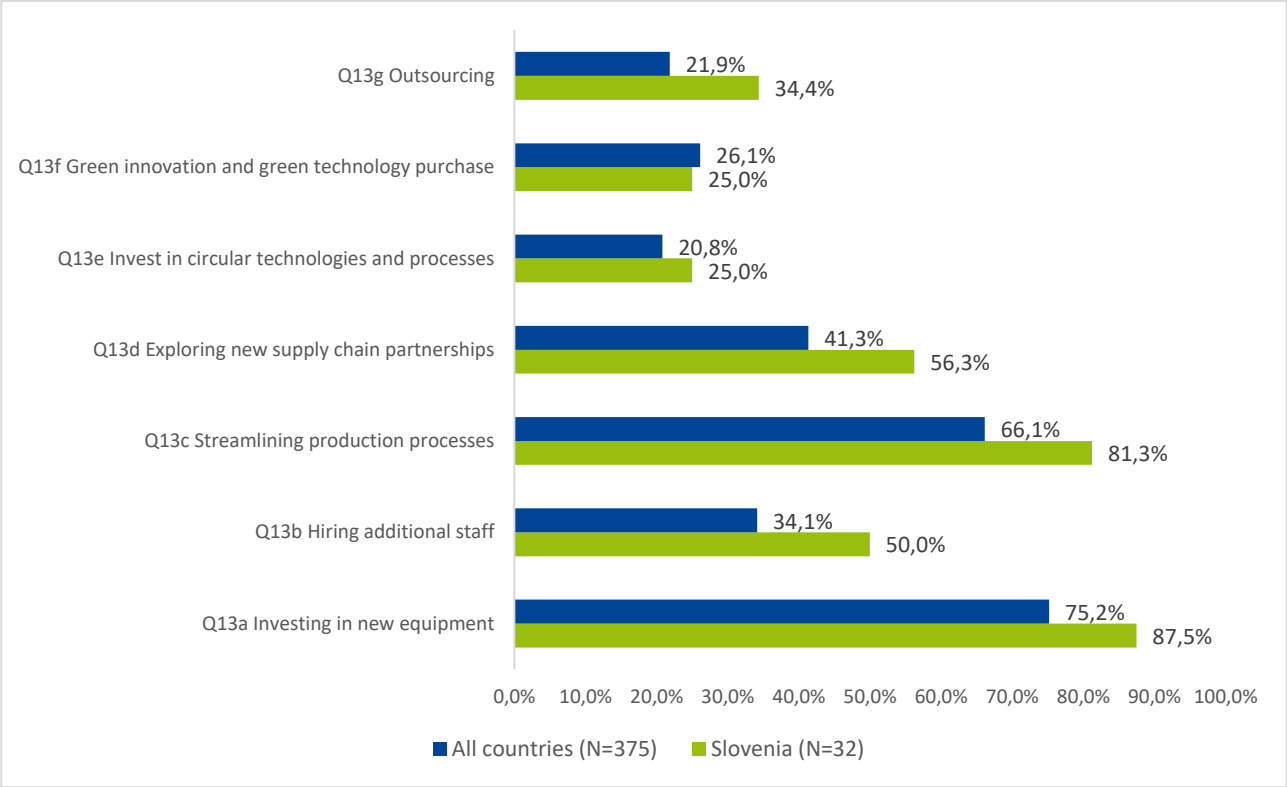
Figure 9-4: Maximum producton capacity per month (Slovenia)



In the realm of strategic initiatives, Slovenian companies express a high propensity for investing in new equipment (87.5%), streamlining production processes (81.3%), and hiring additional staff (50.0%). Exploring new supply chain partnerships, investing in circular technologies and processes, and pursuing

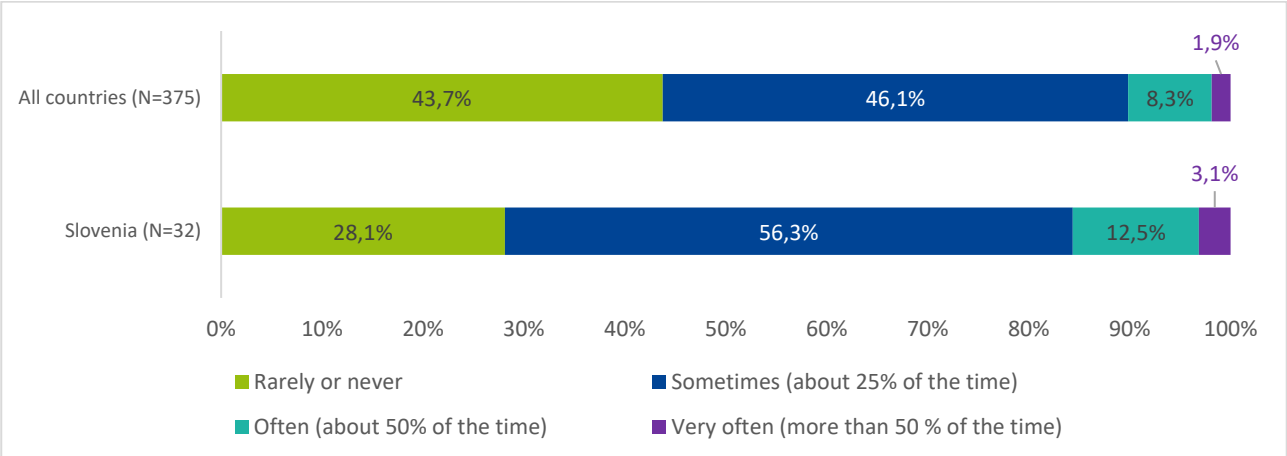
green innovation and technology purchase are also notable strategic considerations for Slovenian companies. This is evident in Figure 9-5 below.

Figure 9-5: Measures taken to improve production efficiency and narrow the gap between actual and potential output (Slovenia)



When it comes to the frequency of delays in receiving raw materials, Slovenian companies differ from the overall pattern. A majority (56.3%) in Slovenia experience delays sometimes (about 25% of the time), while 28.1% rarely or never encounter delays. The overall distribution shows that 43.7% rarely or never experience delays, and 46.1% experience delays sometimes. Rare or very often instances of delays are less common in Slovenia (3.1%) compared to the overall average (10.2%).

Figure 9-6: Experienced delays in receiving raw materials (Slovenia)



Overall, the financing and operational strategies of Slovenian companies reflect a blend of reliance on traditional sources, strategic investments, and considerations unique to the country's industrial landscape. The data provides insights into the financial resilience and operational dynamics of companies in Slovenia within the broader context of the surveyed countries.

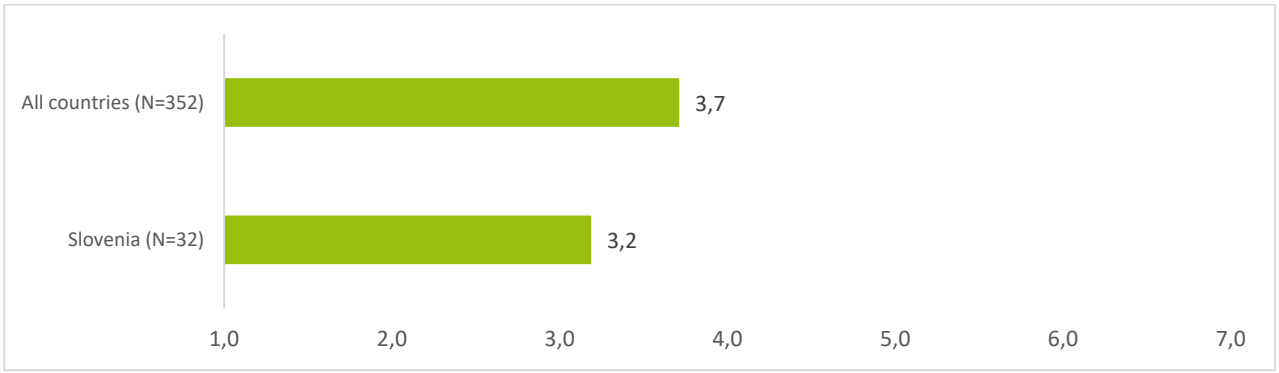
9.4.5. Usage Behaviour

In evaluating the adoption of green manufacturing practices, Slovenian companies provide valuable insights (Figure 8-7). On a scale of 1 (not at all) to 7 (to an extremely large extent), Slovenian companies estimate their usage of green manufacturing practices at 3.2. This places them slightly below the overall average of 3.7 across all surveyed countries.

When comparing this estimation to the previously presented data on green manufacturing technologies used by Slovenian companies, a comprehensive picture emerges. The majority of companies in Slovenia employ energy-efficient machinery and equipment (67.9%) and utilize renewable energy sources (46.4%). Additionally, waste reduction strategies (50.0%) and the use of environmentally friendly materials in production (50.0%) are prevalent.

The data suggests that while Slovenian companies have embraced certain green manufacturing technologies, the self-assessment of their overall usage falls slightly below the global average. This preliminary finding sets the stage for a deeper exploration of the factors influencing green manufacturing practices in Slovenia and the potential for further integration within the industrial landscape.

Figure 9-7: Usage behaviour by country



9.4.6. Perceived Usefulness

Slovenian companies express a moderate agreement (4.7) that incorporating green manufacturing practices, such as using recycled materials, would enhance the efficiency of their operations. This sentiment aligns with the overall average across surveyed countries (4.1).

There is a strong consensus among Slovenian companies (5.7) that the introduction of digital technologies (e.g., AI, IoT, automated systems) would significantly contribute to the sustainability of their operations. This positive attitude surpasses the global average (4.6), indicating a heightened recognition of the potential benefits.

Companies affirm (4.7) that adopting green manufacturing practices would enhance the quality of their products. This aligns with the overall global sentiment (3.9) and highlights a shared understanding of the positive correlation between green practices and product quality.

Respondents in Slovenia express a positive inclination (5.1) toward the idea that digitizing production processes would contribute to greening manufacturing flows, including waste reduction. This surpasses the global average (4.4), indicating a strong belief in the potential positive impact of digitalization on sustainability.

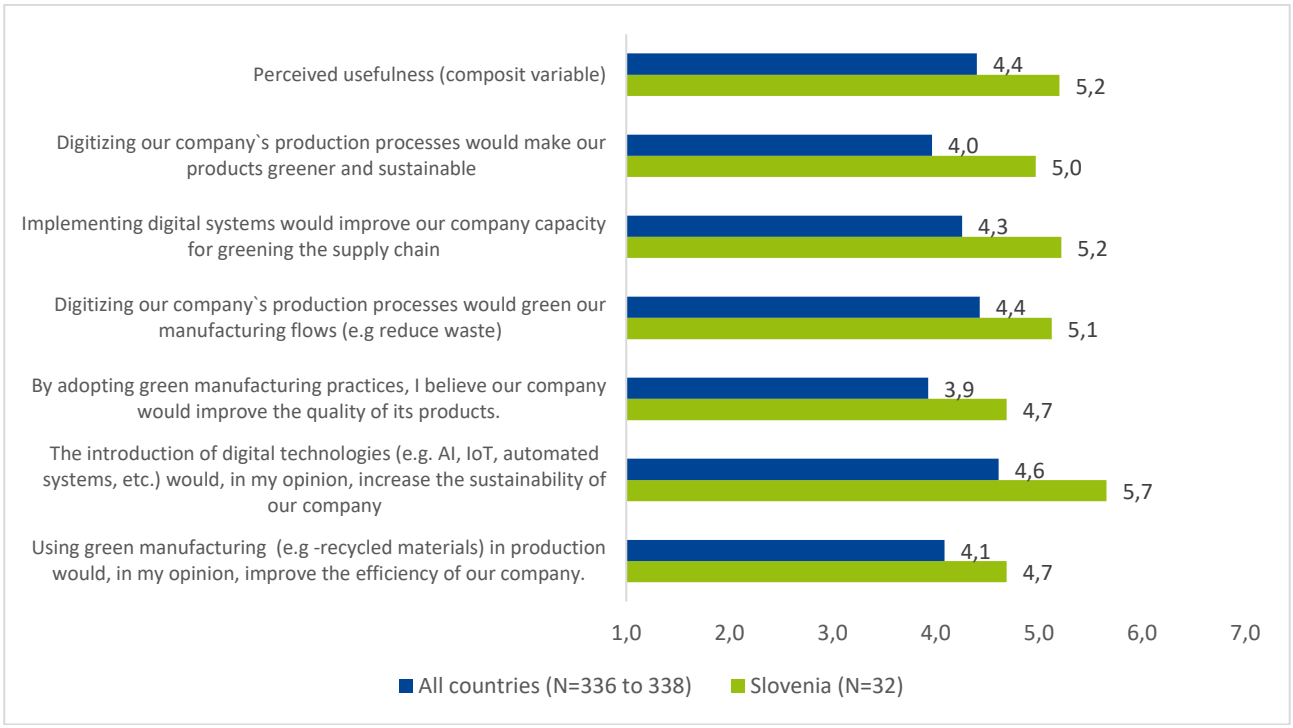
Companies exhibit a positive stance (5.2) toward the belief that implementing digital systems would enhance their company's capacity to green the supply chain. This surpasses the global average (4.3), suggesting a heightened awareness of the role of digitalization in sustainable supply chain management.

Slovenian companies strongly agree (5.0) that digitizing production processes would result in greener and more sustainable products. This perception is higher than the global average (4.0), indicating a robust belief in the transformative potential of digitalization for product sustainability.

The composite variable reflecting the perceived usefulness of integrating green manufacturing practices and digital technologies receives a high rating of 5.2 in Slovenia, surpassing the global average of 4.4. This underscores a strong belief in the overall utility and benefits of adopting these practices.

In summary, Figure 8 depicts that Slovenian companies exhibit a positive and forward-looking attitude toward the integration of green manufacturing practices and digital technologies, with perceptions consistently surpassing the global averages. This signals a readiness and openness to embrace sustainable and technologically advanced approaches in their operations.

Figure 9-8: Perceived usefulness indicators and composite variable (Slovenia)



9.4.7. Effort Expectancy and Ease of Use

Slovenian companies, in alignment with global sentiments, exhibit a moderate level of concern (3.9) regarding the perceived complexity of introducing digital technologies like AI, IoT, and automated systems. This shared apprehension emphasizes potential challenges associated with adopting advanced digital tools.

A general consensus (3.7) is observed among Slovenian businesses regarding the perceived effort required to make their operations more environmentally friendly and sustainable. This sentiment aligns closely with the global average of 3.8, indicating a universal acknowledgment of challenges linked to environmentally conscious transformations.

When considering the costs associated with transitioning to greener and more sustainable practices, Slovenian companies express a higher level of agreement (4.8) compared to the global average of 4.3. This heightened concern underscores the financial considerations that businesses in Slovenia associate with sustainability initiatives.

In terms of a composite variable measuring overall effort expectancy, which encapsulates perceived challenges in adopting both digital technologies and environmentally sustainable practices, Slovenian companies

rate it at 4.1. This slightly surpasses the global average of 4.0, indicating a nuanced caution among Slovenian businesses about the expected effort involved in this transformative journey.

In summary, Figure 8-9 below shows that Slovenian companies, akin to their global counterparts, share concerns about the complexity of adopting digital technologies and the financial implications of transitioning to environmentally sustainable practices. These perceptions reflect common challenges and considerations within the international business landscape.

Figure 9-9: Effort Expectancy indicators and composite variable (Slovenia)

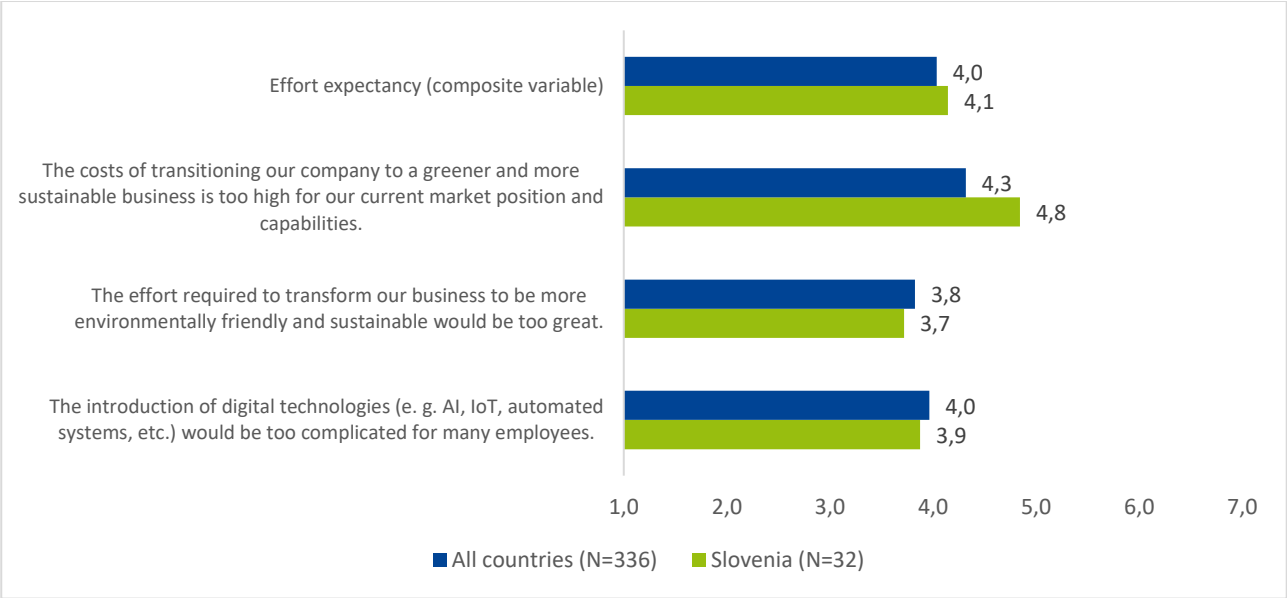


Figure 10 shows that Slovenian companies are navigating various challenges in their quest for sustainability and digital transformation. Perceptions of difficulty vary across key dimensions:

Incorporating sustainable practices, increasing energy efficiency, and implementing waste reduction initiatives pose moderate challenges, scoring 4.3, 4.5, and 4.5, respectively. These findings indicate a balanced acknowledgment of the complexities involved in adopting environmentally friendly practices.

Likewise, integrating new digital technologies and training staff for digital operations are perceived with moderate difficulty, scoring 4.4 and 4.6. This suggests a pragmatic understanding of the challenges associated with the digital transition.

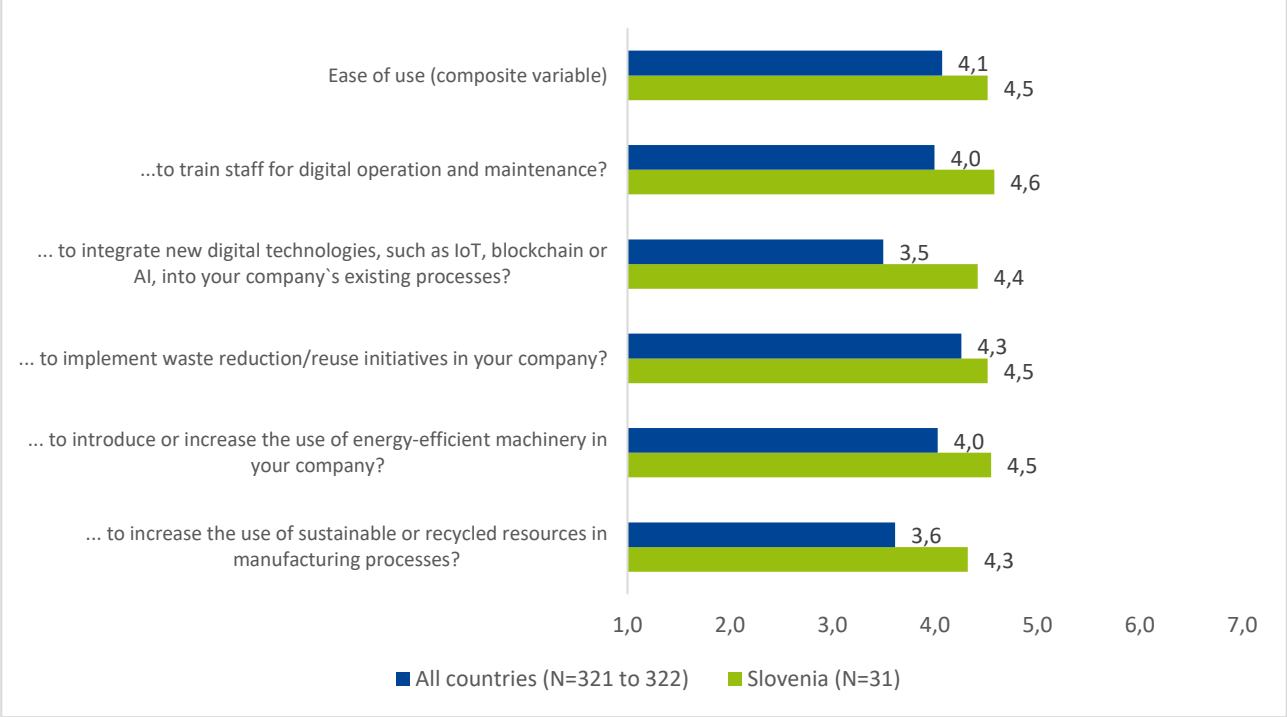
The composite variable measuring overall ease of use across these dimensions stands at 4.5 for Slovenia, slightly above the global average of 4.1. Slovenian companies foresee a moderate level of ease in navigating the challenges linked to sustainable and digital transformations.

In addition, specific challenges related to these transitions were highlighted by Slovenian respondents:

- Diverse functions within companies may vary in their readiness for the adoption of digital/greener technologies, contingent on employee education, technological processes, and material-information flows.
- The specificity of the industry poses challenges, such as the predominant use of plastic in insulating materials and the difficulty in replacing certain components due to the insulating functions of plastics and rubber.
- Accessibility to non-refundable funds for the green transition, as well as workforce-related considerations, were highlighted as challenges.
- Some companies in Slovenia currently do not engage in the adoption of green technologies, and specific investment is required for equipment and employee training.

- The diverse nature of production companies in Slovenia, catering to custom orders, may limit the innovativeness of operations to align with green practices.
- Challenges include issues related to the use of sustainable materials, such as recycled polyester and polyamide, which present processing difficulties, impacting energy consumption and production efficiency.
- The textile industry in Slovenia is at the initial stages of transitioning to a more environmentally friendly and digital era. Challenges include fragmented industry structures, small company sizes, limited financial resources, and a lack of awareness about digital tools.

Figure 9-10: Ease of use indicators and composite variable (Slovenia)



9.4.8. Facilitating Conditions

Factor analysis yielded 3 factors:

FACTOR 1: Internal Readiness and Support for Green Manufacturing:

This factor pertains to the internal preparedness of an organization for the transition towards green manufacturing practices. It encompasses the availability of resources, qualified personnel, knowledge, and technical infrastructure within the organization. Additionally, it considers the active encouragement and support from top management, along with the provision of necessary training for employees, ensuring the internal ecosystem is conducive to embracing green manufacturing.

Includes statements:

- Q34b Our employees have the necessary resources to make the shift towards green manufacturing.
- Q34c Our company has a sufficient number of qualified employees to make the shift towards green manufacturing.
- Q33a The required knowledge and technical resources for the green manufacturing transition are available in our organization.
- Q34a Our top management actively encourages the use of green manufacturing practices within the company.

- Q34d Our employees have received the necessary training to implement a transition to green manufacturing.
- Q33b The company has all the necessary technical infrastructure for digitization.

FACTOR 2: Regulatory and External Technical Barriers to Green Manufacturing

This factor revolves around the external influences that organizations encounter when attempting to adopt green manufacturing practices, namely lack of goverment information, other regulatory obstacles and limited external technical knowledge.

Includes statements:
- The government doesn`t provide enough information regarding sustainable production/green manufacturing.
- There is not enough external technical knowledge available to support adoption of green manufacturing practices.
- More green manufacturing practices cannot be implemented because of the regulatory obstacles.

FACTOR 3: Regulatory Drivers on Green Manufacturing

This factor centers around the influence of regulatory frameworks on motivating and facilitating organizations to adopt green manufacturing practices.

Includes statements:
- Q33d There are enough regulatory pressures pushing our company to adopt green manufacturing practices.
- Q33e The regulatory system contains sufficient incentives to encourage the green transition.

As Figures 8-11 and 8-12 below point out, the analysis of resource availability and regulatory conditions reveals three distinct factors influencing the transition to green manufacturing.

Factor 1: Internal Readiness and Support for Green Manufacturing: In Slovenia, respondents express a moderately positive outlook regarding their organization's internal readiness for green manufacturing. They believe that the necessary knowledge and technical resources for the transition are available (4.1) and that the company possesses the required technical infrastructure for digitization (4.0). However, there is a perception that regulatory obstacles hinder the implementation of additional green manufacturing practices (3.5). On the regulatory front, respondents feel there is a lack of sufficient pressure (3.4) and incentives (3.5) to drive the green transition. Moreover, the government's communication on sustainable production and green manufacturing needs improvement (4.6). Despite these challenges, top management is seen as actively encouraging green practices (5.0), and employees are deemed to have the necessary resources (4.1), qualifications (4.1), and training (3.5) for the shift towards green manufacturing.

Factor 2: Regulatory and External Technical Barriers to Green Manufacturing: This factor captures the perceived barriers related to regulations and external technical knowledge. Slovenian respondents indicate a relatively positive sentiment (4.2) concerning their internal readiness and support for green manufacturing practices, but they also acknowledge barriers in the form of regulations and the availability of external technical knowledge (4.2).

Factor 3: Regulatory Drivers on Green Manufacturing: The third factor revolves around the regulatory drivers influencing green manufacturing. In Slovenia, respondents recognize a moderate level of regulatory influence, with a score of 3.4. This suggests that while regulatory factors play a role, they may not be perceived as highly influential in driving the green manufacturing transition.

In summary, Slovenian companies recognize internal readiness and support for green manufacturing, acknowledge barriers in the form of regulations and external technical knowledge, and perceive moderate regulatory drivers for the transition. These insights provide a nuanced understanding of the factors shaping the landscape of green manufacturing in Slovenia.

Figure 9-11: Facilitating conditions – indicators (Slovenia)

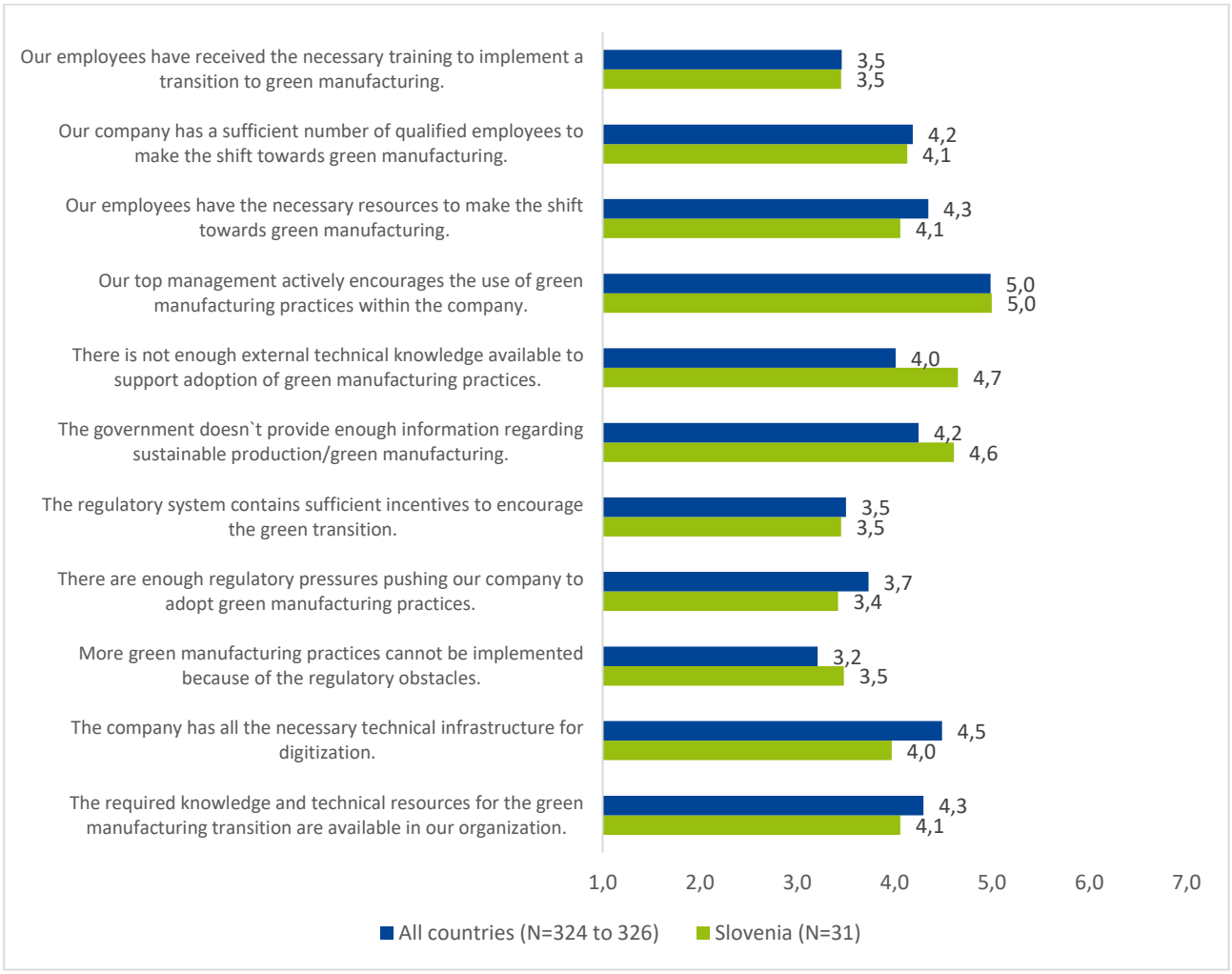
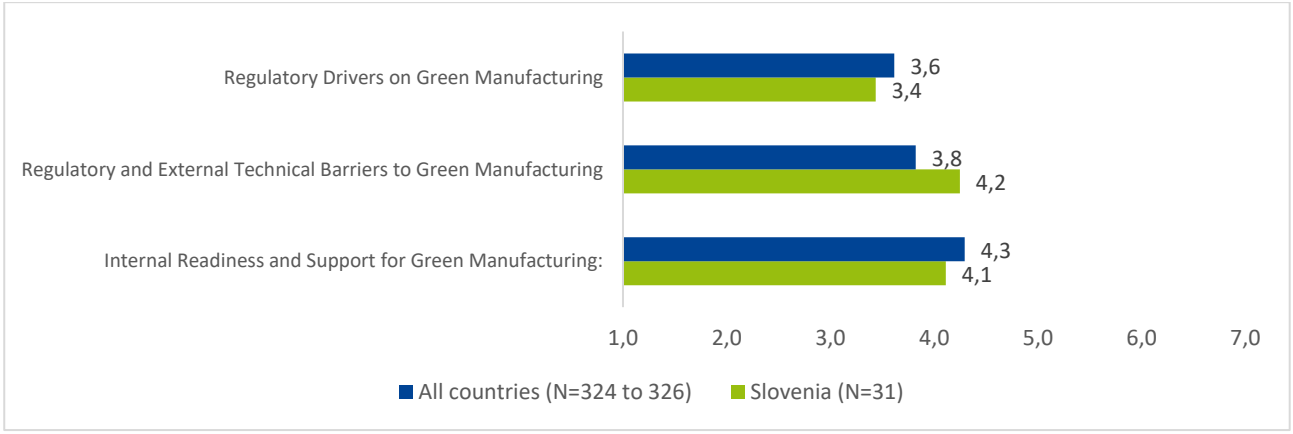


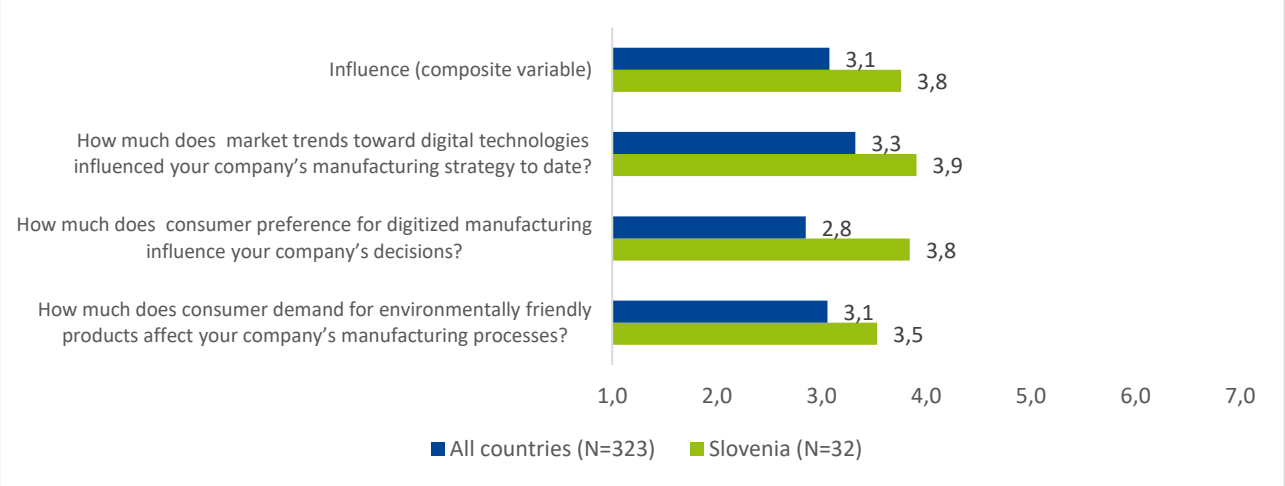
Figure 9-12: Facilitating conditions - composite variables (Slovenia)



9.4.9. Influence

In Slovenia, the influence of consumer demand for environmentally friendly products on manufacturing processes is rated at 3.5, indicating a moderate impact (see Figure 13). Similarly, consumer preference for digitized manufacturing holds a rating of 3.8, emphasizing a noticeable but not overwhelming influence on companies' decisions. Furthermore, the survey indicates that market trends toward digital technologies have a relatively stronger influence, with a rating of 3.9 in Slovenia. This suggests that companies in Slovenia are somewhat more responsive to broader market trends in digital technologies when shaping their manufacturing strategies. The composite variable for overall influence stands at 3.8, reinforcing the collective impact of these consumer-centric factors on manufacturing considerations.

Figure 9-13: Influence indicators and composite variable (Slovenia)



9.4.10. Attitudes Toward Change

As evident in Figure 14 Slovenian companies are willing to embrace sustainability, energy efficiency, and digital transformation in their manufacturing processes over the next five years, surpassing the global average. In Slovenia, a substantial 56.3% of companies express a likelihood (score 5 to 8) of integrating or increasing green manufacturing processes within the next five years. On a global scale, this percentage is notably lower, standing at 31.6%.

Table 9-3: Attitude toward change (Slovenia)

	Slovenia		All countries	
	N	% likely or very likely	N	% likely or very likely
How likely is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	32	56,3%	320	31,6%
How likely will you switch to energy-efficient machinery for your production in the following 5 years?	32	53,1%	320	35,0%
How likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	32	65,6%	320	32,0%

Slovenian companies exhibit a strong inclination toward adopting energy-efficient machinery, with 53.1% expressing a likelihood (score 5 to 8) of making this transition within the next five years. The global average for this intention is 35.0%. Slovenian companies lead in the intention to incorporate digital technologies into their manufacturing processes, with a significant 65.6% expressing a likelihood (score 5 to 8) within the next five years. The global average for this intention is notably lower, at 32.0%.

In summary, Slovenian companies demonstrate a proactive stance, with a majority expressing a strong likelihood of integrating green practices, adopting energy-efficient machinery, and incorporating advanced digital technologies into their manufacturing processes. This indicates a noteworthy commitment to sustainability and technological advancement within the Slovenian business landscape, outpacing the global average.

9.4.11. Enablers and Barriers

Slovenian businesses cite a diverse range of drivers influencing their decision to adopt or invest in green manufacturing practices. The motivations span various dimensions, incorporating environmental, economic, and market considerations.

Key factors include the anticipation of potential tax burdens for companies deemed potential polluters, higher energy prices prompting the need for technologies supporting waste reuse, and the influence of both European and national regulations. Market competition and the perceived positive environmental impact are identified as drivers that contribute to greater market realization.

Cost reduction emerges as a significant motivator, coupled with a strong commitment to environmental protection. This includes initiatives such as the reuse of waste materials, particularly carbon fibers, driven by both cost considerations and adherence to stringent waste disposal regulations. The potential taxation for non-environmentally friendly companies and the market-driven acceptance of products underscores the interplay between economic and market forces.

Technological advancements also play a role, with businesses expressing a preference for tools and equipment with lower energy consumption. Additionally, the incorporation of new and cost-effective technologies is considered, taking into account legislative compliance.

In the agricultural sector, a focus on diversification and sustainability, particularly in the production of pumpkin oil, aligns with the increasing demand for healthy, locally produced, and organic food.

However, financial constraints pose a challenge for some businesses, impacting their ability to invest in green manufacturing practices. Nevertheless, a strong sense of responsibility towards the environment is identified, with businesses anticipating increased sales as a result.

Optimization of processes, lean production, and economic savings are mentioned as part of the overall strategy, reflecting an awareness of market dynamics favouring price over quality. The responsiveness to customer demands and industry trends, the industry's orientation towards green practices, and the desire to align with this trend further contribute to the multifaceted approach adopted by Slovenian businesses.

Government support, both financial and strategic alignment with company goals, is recognized as a facilitator for the adoption of green practices. Finally, considerations related to competitiveness, customer value, and waste reduction showcase a holistic approach adopted by Slovenian businesses, reflecting a balance between economic pragmatism, environmental responsibility, and responsiveness to market dynamics.

9.5. Summary of attitudes towards green and digital technologies

- Main barriers identified.
- Public perception and company perception
- Outline some key challenges encountered by interviewed companies regarding their process for digital transformation and green transition (not barriers, but the challenges are mainly related to their internal ecosystem and business competition – for example – staff low skills, staff resistance to change etc)
- Key indicators analysis results – analyse and breakdown of response by key indicators of survey sections.

9.6. Conclusions, Recommendations and Action plan

9.6.1. Key findings

The financial landscape in Slovenia reveals a predominant reliance on self-financing from business profits and cash flow from sold goods, indicating a preference for internal funding sources. However, the survey indicates a lesser inclination towards external financing options, such as bank loans or credit from suppliers. Additionally, the production capacity in Slovenia leans towards a significant percentage (41%) of companies producing less than 1000 units per month. In terms of investment and innovation, Slovenian companies express a clear intent to invest in new equipment and streamline production processes. Delays in receiving raw materials, reported as sometimes (56.3%), suggest a potential area for improvement in the supply chain.

The adoption of green manufacturing practices in Slovenia, as estimated on a scale of 1 to 7, is moderate at 3.2, slightly below the overall average of 3.7. However, there is a positive sentiment towards digitization, with high agreement that it would enhance efficiency (5.7) and sustainability (4.6). Respondents also agree on the potential of green manufacturing practices to improve product quality (4.7). Despite these positive indicators, concerns exist regarding the complexity of introducing digital technologies (3.9) and the perceived high costs of transitioning to greener practices (4.8). However, companies in Slovenia see varying degrees of ease in adopting sustainable practices, with the highest perceived ease in increasing the use of sustainable or recycled resources (4.5). The major drivers for green practices include regulatory conditions, internal readiness, and external technical support, with positive responses in Slovenia for internal readiness (4.1). Consumer demand for environmentally friendly products has a moderate influence (3.5), while consumer preference for digitized manufacturing has a higher impact (3.8).

Looking ahead, a majority of Slovenian companies express a likelihood of integrating or increasing green manufacturing processes (56.3%) and adopting energy-efficient machinery (53.1%) in the next 5 years.

Recommendations arising from these findings include enhancing financial strategies by encouraging diversification in financing sources and exploring opportunities for external investment. Innovation and production optimization should focus on continuing investments in new equipment, streamlining processes, and addressing delays in raw material procurement. In the realm of green manufacturing and digitization, efforts should be directed at promoting awareness of the benefits of green practices and developing comprehensive training programs for digital technology adoption. Addressing concerns requires the implementation of support mechanisms for overcoming perceived barriers. Additionally, exploring cost-sharing initiatives or subsidies for green transitions can be instrumental in facilitating a smoother and more widespread adoption of environmentally friendly practices.

9.6.2. Action Plan for Sustainable Industrial Practices

Financial Diversification Incentives:

- Conduct a comprehensive review of financial policies to identify areas for incentivizing green investments.
- Explore the introduction of tax benefits and subsidies for companies engaging in sustainable manufacturing practices.

Innovation and Production Optimization:

- Facilitate industry-wide forums for the exchange of best practices in production optimization.
- Encourage the establishment of innovation hubs to drive technological advancements in sustainable manufacturing.

Promoting Green Manufacturing Practices and Digitization:

- Launch awareness campaigns to highlight the environmental and economic benefits of sustainable manufacturing.

- Develop and implement training programs to enhance digital literacy and skills among the workforces.
- Establish a digital resource platform to provide companies with tools and guidelines for adopting eco-friendly practices.

Facilitating Sustainable Practices Transition:

- Create a user-friendly online platform providing accessible resources and guidelines for adopting green processes.
- Collaborate with educational institutions to integrate sustainability into relevant curricula.

Enhancing Internal and External Drivers:

- Provide resources for employee training and development to enhance internal readiness.
- Establish platforms for companies to gather consumer feedback and preferences, aligning production with market demands.

Government Collaboration and Coordination:

- Establish a cross-functional task force comprising representatives from relevant government agencies to coordinate sustainable industrial initiatives.
- Encourage collaboration between public and private sectors in implementing sustainable practices.

10. GREENE 4.0 – key conclusions, recommendations, and further steps

Regional Mapping Analysis was conducted based on a dedicated customized survey run in seven countries in Central Europe, including Slovenia, Hungary, Germany, Austria, the Czech Republic, Poland, and Italy. The surveys were administered to 422 small and medium-sized manufacturing enterprises (SMEs) and covered various aspects of their operations. The goal of the surveys was to understand the adoption levels of green and digital technologies, sustainability practices in supply chains, sustainable business models, digitization, green production processes, distribution channels, logistics, and customer relationships.

The primary objectives were to assess the current adoption levels of environmentally friendly manufacturing practices and digital technologies among SMEs, understand their perceptions, attitudes, and barriers to transitioning to more sustainable and digitally integrated business models. The analysis also aimed to identify specific areas for accelerating innovation, such as improving production processes, supply chains, and customer relations, while recognizing the financial, technical, and regulatory challenges that hinder the transition to smarter and greener factories. Additionally, the analysis aimed to understand and explore opportunities for creating new regional and transnational value chains to foster collaborative innovation between manufacturing companies, technology providers, and private equity.

The analysis highlighted the need for an improved regional innovation ecosystem to encourage and expedite the transition to more sustainable and digitally integrated business models. It gathered insights into the perceptions, practices, and innovation potential of manufacturing SMEs in Central Europe, emphasizing the importance of addressing barriers to adopting green and digital technologies. The study's extensive coverage across different company sizes, sub-sectors, and geographic areas provides a comprehensive understanding of the current state and the potential for innovation in the sustainable business sector.

10.1. Key findings

Uneven adoption of green and digital technologies is seen across Central European SMEs. Primarily foundational technologies are used widely (e.g. cloud computing, CRM, ERP), while newer technologies (e.g. AI, IoT, blockchain) are used less. Implementation of green practices varies in areas such as renewable energy, waste management, process efficiency, etc. Barriers to further adoption include financial constraints, regulatory complexities, technical knowledge gaps, and scarcity of skilled talent. There is a trend towards relatively low acceptance rates for green innovations, particularly in relation to individual factors. On a scale of 1 to 7, the countries do not exceed level 5 for any factor, but generally position themselves around average values between 3 and 4. Nevertheless, the perceived benefits of green innovations are consistently rated positively, which indicates a fundamental willingness on the part of users to adopt environmentally friendly practises. Impact-related factors proved to be the least significant for the companies surveyed. Instead, the focus shifts to regulatory barriers and lack of framework conditions, suggesting that legal restrictions and lack of supporting factors play a more central role in the adoption of green innovations. This is also confirmed when we summarise and compare the open issues in the countries, with environmental protection, financial constraints and regulatory influences being the most important topics. Regulatory factors in particular play a decisive role, as companies are influenced by both EU and national laws.

Policymakers, industry leaders, academia and other stakeholders need to collaborate to address these roadblocks. Companies recognize value of green/digital tech but are wary of costs, change management challenges, and ROI. Awareness campaigns, proof of concepts, and success stories must counter these misconceptions. Strategic priorities, resources, and readiness of SMEs shape their approaches to sustainability/digital transformation; larger SMEs have greater capacity to experiment with new solutions. Regional dynamics matter; knowledge-sharing across borders can help productive development. Holistic policy frameworks with

financial incentives, upgraded infrastructure, streamlined regulations, and institutional coordination are needed to systematically address innovation gaps in SMEs. Collaboration between public/private sectors is essential.

Key recommendations and next steps for GREENE project include: (1) Develop educational programs, resources, etc. to enhance awareness/skills; (2) Create support mechanisms (mentoring, funding, regulation guidance); (3) Encourage technology partnerships, piloting of solutions, knowledge exchange; (4) Advocate for policy revisions, administrative coordination; (5) Curate use cases, guides, forums to provide tailored advice on transitioning to sustainable business models; (6) Develop indicators/monitoring mechanisms to track progress in sustainability/digitization metrics. GREENE project can use these recommendations to roll out tangible programs, resources, and policy guidance to support SMEs' twin transition.

10.1.1. Main barriers

No.	BARRIERS	Description
1	Technology Adoption Gaps	Significant disparities exist in the adoption levels of foundational and emerging technologies among SMEs, both between countries and enterprise segments. For instance, while cloud computing is widely used in certain regions like Slovenia, other technologies such as IoT, AI, and immersive technologies are underutilized across most SMEs. This discrepancy also extends to company size and export orientation, with larger, export-focused SMEs demonstrating greater technology integration. This indicates uneven digital capacity across the industrial fabric. Despite perceived barriers like high costs, unclear benefits, and a lack of skills and relevance, SMEs generally recognize the usefulness of digital tools.
2	Varied Green Practices	The implementation of green solutions among SMEs is dispersed, with renewable energy and equipment efficiency seeing substantial adoption. However, areas such as water conservation, VOC reduction, and circular approaches lag behind. Compliance-driven solutions tend to dominate over market-driven sustainability initiatives. Adoption approaches also vary due to geographic, cultural, and policy differences. For example, Germany and Austria lead in waste and materials practices, while Hungary and Poland show promise in renewables and efficiency. However, advanced control systems are underutilized in most regions. Financing and payback concerns, supply chain complexities, inadequate information, and technical readiness pose additional obstacles. Nevertheless, climate consciousness and the potential for long-term savings drive positive sentiment among SMEs.
3	Uneven Innovation Capacity	Innovation capacity among SMEs depends on factors such as enterprise size, age bracket, international exposure, and sector. Larger, established, and export-intensive SMEs tend to innovate more actively due to greater resources and market pressures. In contrast, micro firms face limitations in terms of innovation capabilities. Supply chain partnerships, R&D investments, and strategic commitment toward sustainability also vary significantly across regions, shaping the innovation ecosystem. For instance, Germany and Italy lead in joint innovation projects with suppliers. Structural factors, including the dominance of smaller SMEs in the industrial fabric, legacy infrastructure, and risk aversion, tend to

		hinder radical innovation. Incremental improvements often dominate transformative changes.
4	Supply Chain Dynamics and Sustainable Sourcing Priorities	An overwhelming majority of SME manufacturers surveyed (86%) source most of their raw materials and supplies from within the European Union (EU). This intra-EU reliance is particularly high in countries like Germany, Austria, and the Czech Republic, where it exceeds 90%. In Hungary, Poland, and Slovenia, the dependency on EU suppliers ranges from 60% to 80%, while the integration of non-EU suppliers is relatively low at 15%. This trend indicates a "China+1" realignment, which emerged during the pandemic as companies aimed to reduce import exposure and increase supply chain visibility, logistics reliability, and working capital optimizations. SMEs are increasingly preferring local or neighboring suppliers within the EU to enhance their supply chain resilience. SMEs are also placing greater importance on sustainable sourcing practices when selecting suppliers. Around 28% of SMEs actively consider environmental records, emissions performance, renewable energy usage, and waste management practices when evaluating potential partners. Some SMEs are even willing to pay modest premiums to work with suppliers that demonstrate strong sustainability practices. This focus on sustainability is particularly pronounced among mid-sized SMEs (50-250 employees) that have export-oriented operations. These companies face heightened expectations from industrial customers in Western Europe regarding demonstrating supply chain commitments to environmental, social, and governance (ESG) criteria. As a result, the adoption of sustainable sourcing practices is progressively trickling down to smaller suppliers in local tiers.
5	Market Responsiveness and Competitive Advantages	European consumers are increasingly demanding organic, natural, and environmentally friendly products across various industries such as food, garments, and personal care. This consumer shift is driving manufacturers to overhaul their formulations and supply networks to align with sustainable practices. Even in business-to-business (B2B) industries like packaging equipment, there is a rising demand for solutions that contribute to reducing plastic waste, using recyclable materials, and offering carbon labeling. Meeting these requirements and aligning with customer mandates is crucial for companies seeking to maintain a competitive advantage. However, pursuing sustainable initiatives in supply chain design and partnership choices remains challenging due to financial and skills limitations. SMEs need improved access to advisory services that can assist with identifying, auditing, integrating, and building capabilities among green suppliers locally.
6	Assimilation Challenges	Integrating new technologies into SMEs can be challenging, especially for those dealing with immediate issues:

		■ Operational Integration: Adopting technologies like sensors and industrial robots without internal engineering teams can be difficult. It involves designing interfaces, managing legacy hardware compatibility issues, and developing skills in data analytics. ■ Process Redesign: To maximize the potential of new technologies, companies need to incorporate them into core workflows. This requires iterative testing, protocol refactoring, and reinforcement learning. It can stretch the capacity of SMEs. ■ Capability Scaling: As technology usage expands across the organization, additional capabilities like data governance, OT/IT convergence, platform engineering, vendor management, and cybersecurity become necessary. Developing these capabilities can be challenging but essential for successful integration. ■ Revenue Transitioning: Disruptive innovations like servitization business models, data monetization, and circular remanufacturing can lead to revenue decline in existing product lines. SMEs need to carefully manage revenue transition while balancing short-term health and long-term goals.
7	Financial Strategies and Capacity Utilization	SMEs face financial barriers when adopting new technologies: ■ Risk Aversion: SMEs predominantly rely on internal cash flows and operating profits to fund their working capital and investments. There is a general aversion to taking on debt, which can hinder their ability to invest in new technologies. ■ Focus on Flexible Production Models: Many SMEs operate with flexible production models, often producing fewer than 1000 units monthly. This allows for customization and faster changeovers but puts strain on fixed costs. ■ Strategic Investment Priorities: SMEs prioritize investments in new equipment and production optimization to improve productivity and reduce overhead costs. However, investments in technologies like data utilization and waste reduction may receive less attention due to financial limitations.
8	Market Influences and Consumption Trends	SMEs face challenges in meeting market demands for sustainability and technology adoption.: ■ Low Eco-sensitivity in Purchase Behavior: Despite increasing awareness of climate change, consumers' preference for environmentally friendly products does not always translate into actual purchases. Higher prices for sustainable products and the availability of cheaper alternatives hinder consumer demand. ■ Minimal Influence of Digitization on Purchase Decisions: Technology adoption levels do not significantly influence customer procurement decisions. Digitization is not a primary factor for customers beyond basic quality and support expectations.

	However, evolving EU regulations, export market expectations, and supply chain requirements indirectly drive baseline technology adoption, particularly in areas like traceability tools.

10.1.2. Main enablers

No.	ENABLERS	Description
1	Incentives and awards	Incentives play a crucial role in motivating SMEs to adopt sustainability and technology practices: ■ Non-fiscal Incentives: Integrate sustainability criteria into public procurement frameworks to guarantee offtake for compliant products and solutions. Give preference to solutions qualifying for certified labels and eco-innovation badges. Encourage industry associations and large anchor companies to recognize sustainable practices through preferred vendor programs, spotlight awards, and innovation challenges. ■ Skills and Awareness Initiatives: Implement industrial digital literacy programs to provide training on sensors, connectivity, data analytics, and platform engineering. Establish green engineering institutes to offer hands-on exposure to integration approaches for automation, waste management, and energy systems. Promote change management guidance involving shopfloor participation and offer executive leadership programs for skill development. ■ Pilot small scale incentivization tools or programs for supporting green transition and digital transformation: sustainability-linked innovation vouchers, loans, competitive funding mechanisms. ■ Tax reliefs, fast-tracked licensing, and regulatory sandbox access for priority technology domains. ■ Public-private investment vehicles focused on infrastructure upgrades and pilot demonstrations. ■ Green financial mechanisms combining green grants, green bonds green loans, and green equity.
2	Networked Innovation Models/Platforms	Collaborative approaches foster innovation in sustainability and technology adoption: ■ Applied Research Translation: Facilitate tripartite partnerships between public infrastructure, academia, and industry consortiums to support concept-to-test phase research. Delink applied research activity from immediate profit goals. ■ Test Infrastructure Access: Leverage European Digital Innovation Hub (EDIH) networks to enable rapid prototyping of product and process innovations using shared test facilities and pilot lines for technologies like additive manufacturing and robotics. ■ Sustainability Incubation: Nurture early-stage ventures focused on circularity, emission reduction, and alternate materials through dedicated incubators. Provide regulatory advice, customer access, and capability augmentation to support the growth of these ventures. The coordination of knowledge, infrastructure, capital, and policy flows through purpose-built institutional frameworks will help

		overcome limitations faced by individual SMEs. These initiatives will contribute to the broader vision of a globally competitive and sustainable industrial value creation led by resilient SMEs.
3	Supporting collaborative mechanisms for identification, assessment, testing, validation and demonstration of green and digital technologies	■ Identify promising technology solutions through competitive scouting and assessment. ■ Incubate ventures with innovative sustainability offerings tailored for SME context. ■ Sub-Sector Use Cases Validation: Conduct detailed benchmarking of sustainability solutions at the granular industry level to assess issues, payback timelines, and optimization needs given variances in operational matrices. ■ Incubate ventures with innovative sustainability offerings tailored for SME context. ■ Showcase implementations via case studies, site visits and results dissemination. ■ Maturity Stage Customization: Study the specific transformation challenges and risk considerations faced by startups, micro entities, and professionally managed SMEs at different stages of development. This will help identify the necessary support at each stage. ■ Regional Infrastructure Audits: Undertake comprehensive mapping of infrastructure availability within localized industrial clusters. Assess the existence, accessibility, and service quality of shared testbeds, waste exchanges, renewable energy networks, and other relevant infrastructure.
4	Policy Frameworks and Infrastructure	To stimulate the adoption gaps and support SMEs in sustainability and technology adoption, policy interventions can significantly act as enablers for diminishing the barriers and facilitate green transition and digital transformation. Policy tools which can act as enablers: ■ Financing and De-risking: Create investment subsidy pools and leverage public guarantees to partially fund pilot projects on automation, data analytics, and waste-to-value use cases. Explore emerging financing models like revenue-based financing and payment-by-results to manage variability. Provide higher capital cost subsidies, investment tax credits, and accelerated depreciations to enhance viability. ■ Compliance Flexibility: Introduce regulatory sandboxes and revision allowances to balance compliance requirements with the challenges faced by smaller manufacturers during the initial years of substantial modernization investments. Promote adoption roadmaps and staged development approaches through policy guidelines and unified standards, gradually transitioning from punitive measures to incentives. ■ Institutional Support: Enhance the availability and coordination of existing advisory mechanisms for factory modernization to maximize awareness and simplify access through inte-

		grated digital platforms and streamlined application procedures. Expand technology translation assistance through industry research collaborations.
5	Strategic Commitment and Innovation	SMEs with clear leadership vision and strategic mandates toward sustainability and technology adoption outperform their peers in terms of innovation. The following trends were observed: ■ SMEs that align executive incentives with sustainability goals tend to have higher utilization levels of renewable energy, efficient equipment, and waste recycling practices. By tying leadership incentives to sustainability outcomes, these companies demonstrate a stronger commitment to environmental responsibility. ■ Companies with dedicated positions such as Chief Digital Officers or Heads of Sustainability are more likely to pilot initiatives involving data analytics, IoT sensors, and automation. Having individuals in these roles helps drive innovation and fosters a culture of technological advancement and sustainability. ■ Firms that invest in research and development (R&D), develop technology roadmaps, and prioritize internal capability building processes are more successful in adopting tools like cloud computing and industrial internet solutions. These investments demonstrate a strategic commitment to innovation and support the integration of advanced technologies. ■ Companies integrated into global value chains face increased pressure from customers and competitors to demonstrate supply chain transparency and traceability. As a result, they prioritize solutions that enable them to trace the origin of their products and ensure compliance with sustainability standards. ■ Startups and younger SMEs tend to be more agile in adopting technology compared to larger, more established companies. These smaller entities have a higher risk appetite and are more willing to experiment with new technologies and innovative approaches. Overall, the propensity for change and innovation within SMEs is strongly influenced by leadership orientation, growth ambitions, and external accountability. SMEs with clear strategic vision and a commitment to sustainability and technology adoption are more likely to embrace innovation and drive positive change within their organizations.

10.1.3. Implications

To address the adoption gaps and foster innovation, there is a need for cooperative efforts spanning policy, finance, technical expertise, and commercial buy-in. Differentiated measures and assistance frameworks tailored to micro segments should be developed, focusing on vulnerable links in value chains. Knowledge sharing networks, satellite incubation/acceleration structures, and clustered competence centers can enhance the diffusion of capabilities to lagging areas and different-sized SMEs.

Harmonizing and upgrading regulatory standards, administrative processes, and infrastructure with sustainability and digitalization goals through coordinated public-private efforts is crucial. Demonstrators, result dissemination, and participative goal-setting methods can improve risk perceptions, trust, and co-ownership between stakeholders.

To address the innovation capacity gaps, targeted interventions are needed. Multilayered approaches should include policy reforms, industry networks, and public R&D institutions. Digital literacy programs, shared test infrastructure, streamlined funding access, and programs promoting employee participation in automation decisions can address barriers and accelerate adoption.

In terms of green manufacturing practices, energy efficiency and waste management solutions have gained momentum among SMEs. Investments in energy-efficient equipment and waste management systems have been relatively high. However, adoption of renewable energy and sustainable materials varies based on regional factors, customer acceptance barriers, and lack of financial incentives. Process optimization, certification, and standards adoption present challenges due to suboptimal skills, limited technical support, and compliance complexities.

Financial limitations, regulatory complexities, lack of knowledge and skills, and unclear benefits are critical barriers to technology and green practices adoption. Strategies to overcome these barriers should include improved access to risk capital, simplified regulatory processes, skilling initiatives, and clear demonstration of economic and operational benefits.

Addressing technology adoption gaps, promoting green practices, and enhancing innovation capacity require a collaborative approach from various stakeholders. Tailored interventions, knowledge sharing, and alignment of regulatory frameworks with sustainability and digitalization goals are essential to foster a culture of innovation and accelerate the adoption of technology and sustainable practices among SMEs.

10.1.4. Addressing barriers and leveraging enablers

To facilitate the adoption of green production methods and digital technologies among SMEs, it is crucial to address barriers and leverage enablers.

Addressing Barriers:

- Resistance to Change: Overcoming resistance to change is critical. This can be achieved through education, transparent communication, and addressing fears and misconceptions.
- Financial Concerns: SMEs often face limited financial resources. Mitigating cost concerns by providing financial analyses, support mechanisms, and demonstrating long-term return on investment can make green and digital technologies more financially feasible.
- Awareness and Knowledge Gaps: Bridging the knowledge gap through targeted informational campaigns will help SMEs understand the benefits and applicability of green and digital technologies.
- Technical Challenges: Tackling technical barriers requires providing the necessary skills, training, and infrastructure support to enable effective implementation of new technologies.

Leveraging Enablers:

- Governmental and Financial Support: Utilizing incentives like grants, tax benefits, and tailored financing options can alleviate financial burdens and encourage SMEs to invest in green initiatives.
- Collaborative Networks and Partnerships: Building partnerships with technology providers and experts facilitates access to resources, knowledge, and best practices, supporting the adoption of green and digital technologies.
- Policy Frameworks and Regulations: Leveraging supportive policy frameworks and regulations creates an encouraging environment for adopting sustainable practices.
- Innovation and R&D: Investing in research and development helps develop affordable and efficient green technologies, making them more accessible to SMEs.
- Cultural Shifts: Promoting a culture that values sustainability and innovation encourages businesses to integrate green and digital technologies into their core operations.
- Matching Supply with Demand: Matching innovative green and digital solutions with the specific needs and demands of manufacturing SMEs ensures they have access to suitable technologies and innovations.

By addressing these barriers and leveraging enablers, SMEs can overcome challenges and embrace green and digital technologies more effectively. The adoption of green and digital technologies among small and medium-sized enterprises is essential for addressing environmental challenges, driving economic benefits, maintaining competitiveness, and securing long-term viability. By implementing targeted measures, policies, and incentives, we can facilitate the transition and create a more sustainable and digitally advanced business landscape for SMEs.

10.1.5. Recommendations

Based on the key findings from the regional mapping analysis we provide a consolidated list of key recommendations and action plan:

Key Recommendations

- Assign sustainability leadership roles: Appoint executives like Chief Sustainability Officers and Green Technology Officers to drive the adoption of environmentally friendly solutions.
- Propagate digital and green skills: Launch reskilling programmes on technology topics via blended models to maximize reach across employee groups.
- Demonstrate solution implementation: Create searchable databases of localized use cases across priority impact areas for manufacturing SMEs.
- Incentivize adoption: Introduce sustainability-linked innovation vouchers, regulatory sandboxes and competitive funding mechanisms.
- Enable joint innovation: Facilitate collaboration between industrial clusters, academic institutes and technology developers through shared testbeds.
- Share inter-regional knowledge: Encourage experience sharing and immersion visits for SME leadership across European cluster networks.
- Enhance access to finance: Promote innovative instruments like sustainability-linked loans and revenue-based financing to ease access conditions.
- Benchmark performance: Track regional and sectoral progress through digital dashboards aligned to identified metrics.
- Appoint sustainability executives: Assign leadership roles like Chief Sustainability Officers and Circular Economy Transformation Managers.
- Reskill for smart factories: Upskill workforces on digital, data and green engineering skills via flexible mediums.

Recommendations	Description
Systematic integration of sustainability	Incorporate sustainability issues at all management levels, especially in medium and large companies: ■ Incorporate sustainability KPIs into strategic planning and tie executive incentives for large enterprises. ■ Create dedicated roles like Sustainability Head to coordinate environment programs and audit impacts. ■ Pursue partnerships with B2B customers, industry coalitions to integrate circular economy principles.
Development of Digital and Green Skills	Realizing and delivering customized training and mentoring programs for developing digital and green skills: ■ Assess key skills gaps through analysis of current and emerging priority technological domains. ■ Develop blended training programs, online certifications, and short-term secondments for rapid reskilling. ■ Leverage virtual mediums to maximize reach and lower barriers posed by production pressures. ■ Establish industry mentor networks to propagate skills and improve risk perceptions.
Promotion of Green and Digital solution	Demonstrate successful implementations in companies with similar operational profiles: ■ Create searchable databases of localized use cases across priority impact areas using robust frameworks. ■ Develop or provide or use virtual and augmented reality approaches to digitally demonstrate working implementations. ■ Encourage solution providers to host trial periods on key equipment and software for hands-on experience. ■ Support solution providers to engage with manufacturing companies for developing, testing, refining, and validating their solution. ■ Matching solutions and co-creation tools for co-development and demonstration of tools, including dedicated pilots focused on “test before invest.”
Incentivization	Design and pilot small scale incentivization tools or programs for supporting green transition and digital transformation:

	■ Introduce sustainability-linked innovation vouchers, loans, and competitive funding mechanisms. ■ Offer tax reliefs, fast-tracked licensing, and regulatory sandbox access for priority technology domains. ■ Develop public-private investment vehicles focused on infrastructure upgrades and pilot demonstrations. ■ Design and pilot green financial mechanisms combining green grants, green loans, and green equity. ■ Design and pilot a green bond mechanism for supporting SMEs green and digital transformation/investments.
Sustainability Leadership Roles	The survey findings reveal that strategic commitment from the leadership plays a pivotal role in driving the adoption of sustainability practices. To institutionalize this commitment, manufacturing SMEs can designate specialized executive positions like Chief Sustainability Officers (CSOs): ■ Manufacturing SMEs can assign senior executives as Chief Sustainability Officers (CSOs) to drive sustainability efforts and coordinate across departments. ■ CSOs can lead initiatives for material innovation, promote circular economy practices in the supply chain, engage with policymakers, and track environmental performance metrics. ■ In addition, Green Technology Officers can be appointed to stay informed about emerging solutions, conduct technology research, and manage pilot projects. ■ Dedicated leadership is crucial to embed sustainability practices within SMEs, especially considering competing priorities and limited resources. CSOs can audit the current environmental impact of operations, set targets aligned to regional/global goals, liaise with regulators, coordinate capability building, and monitor progress through robust data measurement systems. Additionally, Circular Economy Transformation Managers can be appointed to lead supply chain engagement, material innovation and transition roadmaps to closed-loop approaches.
Joint Innovation with Research Institutions	The analysis highlights gaps in availability, awareness and affordability of solutions tailored for SME manufacturing contexts. Structured innovation partnerships between industries, academia and technology developers

	can address this through joint development, open testbeds and capability transfer. ■ Establishing partnerships between industrial clusters, academic institutes, and technology developers can create testbeds to demonstrate sustainable digital technologies. ■ Applied research grants and regulatory sandboxes can facilitate collaboration on technology testing, customization, validation, and knowledge transfer. ■ Pre-competitive industry collaborations (matching supply-demand; open innovation partnerships; open innovation tools) allow pooling of resources, shared infrastructure, and risk mitigation before making investment commitments. ■ Showcasing successful implementations can promote the effectiveness of these solutions while SMEs can remain focused on their core operations.
Interregional knowledge and best practices sharing	While regional concentrations shape certain adoption trends, knowledge diffusion across borders carries substantial value. Initiatives for exchange of best practices, peer learning mechanisms and immersion visits between SME leadership across European cluster networks can accelerate this diffusion. ■ SME leaders can engage in best practice sharing and participate in immersion visits across European cluster networks, facilitating faster knowledge diffusion. ■ Structured peer learning mechanisms through platforms like EIT Manufacturing, CDTI, and Enterprise Europe Network can enhance access and relevance. ■ Program focus areas may include developing roadmaps for green digital technologies, exploring public-private partnership models, and creating policies tailored for SME manufacturers. ■ Establishing partnerships between leading and emerging regions can offer embedded exchange programs for sharing expertise and experiences.
Access to Finance	Availability and affordability of financing facilities remains a frequently cited barrier, especially for smaller SMEs with limited collateral or sectoral expertise among traditional financiers. Instruments like sustainability-linked loans, green bonds, crowdfunding, payment-by-results and revenue-based financing can ease access conditions to stimulate green investments. Equally important are streamlined information channels and advisory mechanisms to identify instruments suited to investment types:

	■ Innovative financing instruments like sustainability-linked loans, green bonds, payment-by-results financing, and revenue-based models can incentivize investments by simplifying access. ■ Advisory mechanisms that provide guidance on matching financing tools with investment types based on risk and return expectations are equally important. ■ Public sector interventions, such as portfolio guarantees, interest subsidies, and investment platforms, can leverage private capital and play a significant role in facilitating access to finance for SMEs. Complimenting commercial financing channels with public sector interventions like guarantees, risk sharing facilities and aggregation vehicles that provide working capital can optimize capital allocation.
Capacity building	■ Reskill workforces on digital, data and green engineering literacies via blended models involving virtual mediums. ■ Propagate awareness on viable solution use cases tailored to local contexts.
Monitoring and compliance	■ Benchmark regional and sectoral performance through digital dashboards based on identified metrics. ■ Adopt balanced compliance policies that cultivate sustainability without overburdening enterprises.

10.1.6. Action plan

- Set up online sustainability academy and leadership assimilation cohorts
- Launch innovation vouchers and regulatory easing for priority technology domains
- Structure European cluster network for inter-regional best practice exchange
- Introduce green financing tools like sustainability-linked loans and green bonds
- Develop searchable databases of localized use cases across applications
- Facilitate joint innovation supply-demand platform between companies, academia and startups
- Benchmark sectoral and regional performance on key process and technology metrics
- Advise SMEs through instruments for personalized solution recommendations
- Propagate participative decision structures for smoother assimilation of new solutions
- Showcase implementations for improving risk perceptions through dissemination channels

Measures/Actions	Description
Enhancing Skills and Knowledge	■ Conduct training needs analysis across target SME segments to identify specific skills gaps and topics for educational programs. ■ Develop blended capacity building programs covering technical, business and sustainability subjects. Include modules on data analytics, IoT, change management etc. ■ Leverage online platforms, coaching structures and industry mentors for flexible skill development channels adapted to SME environments. ■ Foster satellite skills hubs via partnerships with regional vocational institutes to propagate programs. ■ Curate tailored green technology literacy programs for management executives focused on viable use cases and peer learning
Support Mechanism	■ Create centralized helpdesk for query resolution and guidance on adopting green/digital solutions. ■ Develop playbooks and interactive tools that assist SMEs in identifying applicable solutions. ■ Provide consultants to undertake technology audits and opportunity assessment. ■ Offer grant writing assistance and coordination support to access public funding. ■ Assist companies in baseline measurements and progress monitoring on relevant KPIs
Commercialization and Deployment	■ Identify promising technology solutions through competitive scouting and assessment. ■ Support pilot testing and validation of solutions via regulatory sandboxes and demonstrations ■ Incubate ventures with innovative sustainability offerings tailored for SME context. ■ Catalyze industry consortiums for pre-competitive collaboration on priority technology areas. ■ Showcase implementations via case studies, site visits and results dissemination.
Policy Frameworks and Infrastructure	■ Advocate for harmonizing sustainability regulations and incorporating digital readiness criteria.

	■ Promote inter-agency coordination mechanisms to synchronize administrative processes. ■ Explore public-private partnership models for upgrading infrastructure suited to SME capacities. ■ Introduce competitive innovation vouchers and green investment matching schemes. ■ Develop regional indices to track green/digital transitions across industrial clusters
Access to finance support tools/mechanism	■ Innovative financing instruments like sustainability-linked loans, green bonds, payment-by-results financing, and revenue-based models can incentivize investments by simplifying access. ■ Advisory mechanisms that provide guidance on matching financing tools with investment types based on risk and return expectations are equally important. ■ Public sector interventions, such as portfolio guarantees, interest subsidies, and investment platforms, can leverage private capital and play a significant role in facilitating access to finance for SMEs.
Promotion of Green and Digital solution	Demonstrate successful implementations in companies with similar operational profiles: ■ Create searchable databases of localized use cases across priority impact areas using robust frameworks. ■ Develop or provide or use virtual and augmented reality approaches to digitally demonstrate working implementations. ■ Encourage solution providers to host trial periods on key equipment and software for hands-on experience. ■ Support solution providers to engage with manufacturing companies for developing, testing, refining, and validating their solution. ■ Matching solutions and co-creation tools for co-development and demonstration of tools, including dedicated pilots focused on “test before invest.”
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- Design and pilot green financial mechanisms combining green grants, green loans, and green equity.
- Design and pilot a green bond mechanism for supporting SMEs green and digital transformation/investments.

10.2. CONCLUSION

The Regional Mapping Analysis Report demonstrates the important role of small and medium-sized enterprises (SMEs) in the changing landscape of green and digital manufacturing. The insights from this study highlight the need for a comprehensive approach to support these businesses in their journey towards sustainability and technological advancement.

The key recommendations from the report emphasize the importance of integrating sustainability into all levels of management. This means not only setting strategic goals but also putting them into action through dedicated roles like Sustainability Heads and fostering circular economy principles through partnerships with other industries.

There is a significant focus on developing digital and green skills within the SME workforce. This can be achieved through tailored training and mentoring programs that use virtual platforms to reach a wider audience. These programs should be practical and adaptable to the rapidly evolving technology landscape.

Promoting green and digital solutions through real-life examples and incentives like innovation vouchers and green financial mechanisms is crucial. These initiatives not only encourage SMEs to adopt sustainable practices but also make them more financially feasible.

Leadership plays a vital role, and appointing Chief Sustainability Officers and Green Technology Officers within SMEs can drive strategic commitment and operational execution of sustainability and technology initiatives. This leadership is essential in guiding SMEs towards a more sustainable future.

Collaboration with research institutions and sharing knowledge across regions are powerful tools in bridging the gap between current capabilities and future needs. These partnerships can facilitate applied research, joint development, and the transfer of knowledge, speeding up the adoption of innovative practices.

Finally, access to finance and capacity building are fundamental elements that support the transition to green and digital manufacturing. Innovative financing models and comprehensive capacity-building programs can empower SMEs to navigate the challenges of this transition effectively.

The proposed action plan, based on these recommendations, aims to create an environment where SMEs are not only encouraged but also equipped to embrace green and digital transformations. By addressing the barriers of finance, knowledge, and policy, and fostering a culture of collaboration and innovation, SMEs can make significant contributions to a more sustainable, efficient, and technologically advanced manufacturing sector. This transformation benefits not only the businesses themselves but also the wider economy and the environment, marking a positive step towards a sustainable future.

University of Ljubljana
Faculty of Social Sciences
Centre for Social Informatics

Interreg CENTRAL EUROPE
Co-funded by the European Union

GREENE 4.0

GREENE 4.0 – Acceptance factors and barriers of SMEs in adopting environmentally friendly and sustainable practices

Version:

June, 2023

INSTRUCTIONS:

Thank you for deciding to complete the questionnaire! Let us remind you that there are no standard answers to this questionnaire, and there are no "right", "wrong", "good" or "bad" answers. So you do not need to think long about each question, just read each question carefully and give your answer according to your perception.

Please express your views; you do not need to discuss with other employees or management before you answer. We want to hear your opinion!

The data provided through this survey will be anonymized and will not be used publicly. Part of the data requested will be used also for reporting purposes to Interreg CENTRAL Europe Joint Secretariat.

Part A: Company information

A1 Company details

Company name:

The target group of this questionnaire and GREENE 4.0 project are mainly small and medium enterprises. Is it accurate that your company:

Employs fewer than 250 persons (YES / NO)

Has an annual turnover not exceeding 50 million EUR (YES / NO)

Has an annual balance sheet not exceeding 40 million EUR (YES / NO)

Country:

Industry / sector:

☐ 1 Agriculture, forestry and fishing

☐ 2 Mining and quarrying

☐ 3 Manufacturing

☐ 4 Electricity, gas, steam and air conditioning supply

☐ 5 Water supply; sewerage; waste management and remediation activities

☐ 6 Construction

☐ 7 Wholesale and retail trade; repair of motor vehicles and motorcycles

☐ 8 Transportation and storage

☐ 9 Accommodation and food production/service activities

☐10 Information and communication

☐11 Real estate activities

☐12Professional, scientific and technical activities – Technical and technological design, research, development for industry/manufacturing/energy/waste/circular economy

☐13 Human health and social work activities (manufacturing of products for health and social services delivery)

☐14 Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use

☐15 Activities of extraterritorial organisations and bodies

☐16 Other industry (please, specify category):_____

What is your company's primary business model?

☐1 B2C (Business to Consumer) - Our company primarily sells products or services directly to individual consumers.

☐2 B2B (Business to Business) - Our company primarily sells products or services to other businesses.

☐3 Both B2C and B2B - Our company sells products or services to both individual consumers and other businesses.

☐4 Other - Please specify: _____

Year of company's establishment:

Number of employees:

☐1 Less than 10 employees

☐2 10 – 49 employees

☐3 50 – 99 employees

☐4 100 – 250 employees

☐5 More than 250 employees

Geographic markets?

☐1 Local

☐2 Regional

☐3 National

☐4 International

☐5 Cross-border

☐6 Other, please specify:

A2 Company size and financials

On a scale of 1 (not at all) to 5 (a lot), how much do you rely on the following sources for financing your operations?

	Not at all	Little	Somewhat	Quite a bit	To a large extent
Cash-flow from sales	☐1	☐2	☐3	☐4	☐5
Bank loans or lines of credit	☐1	☐2	☐3	☐4	☐5
Credit from suppliers	☐1	☐2	☐3	☐4	☐5
External investment (e.g., venture capital, private equity)	☐1	☐2	☐3	☐4	☐5
External funding (grants, subsidies, etc.)	☐1	☐2	☐3	☐4	☐5
Investments from shareholders or partners	☐1	☐2	☐3	☐4	☐5
Self-financing from business profits	☐1	☐2	☐3	☐4	☐5
Other (please specify):	☐1	☐2	☐3	☐4	☐5

What is your maximum production capacity per month? Please select an appropriate number of units:

In the context of manufacturing, a "unit" is the final product that the company creates and sells. It is a complete, individual item that is ready for use or sale. What qualifies as a "unit" can vary based on the type of product a company makes.

For example:

- In the automotive industry, a "unit" could be one complete car.
- In the furniture industry, a "unit" could be one table or chair.
- In the textile industry, a "unit" could be one piece of clothing, like a shirt or a pair of jeans.
- In a food processing industry, a "unit" might be a package or box of the finished food product.

By "unit", we mean/understand the complete, final product that the company produces, as per their product range.

☐1 Less than 1000 units

☐2 1000 - 5000 units

☐3 5000 - 10,000 units

☐4 10,000 - 50,000 units

☐5 50,000 - 100,000 units

☐6 More than 100,000 units

☐7 Does not apply. Please comment/describe_____

What measures are you taking to improve production efficiency and narrow the gap between actual and potential output?

☐1 Investing in new equipment

☐ 2 Hiring additional staff

☐ 3 Streamlining production processes

☐ 4 Exploring new supply chain partnerships

☐ 5 Invest in circular technologies and processes

☐ 6 Green innovation and green technology purchase

☐ 7 Other (please specify)

How often do you experience delays in receiving raw materials?

☐ 1 Rarely or never

☐ 2 Sometimes (about 25% of the time)

☐ 3 Often (about 50% of the time)

☐ 4 Very often (more than 50 % of the time)

A3 Technology and innovation

Please mention which of the following technologies are currently in use in your company?

☐ 1 Cloud Computing

☐ 2 CRM (Customer Resource Management)

☐ 3 ERP (Enterprise Resource Planning)

☐ 4 Intelligent Document Processing applications

☐ 5 Internet of Things (IoT) – IoT platform for management, monitoring and improvement of production flows, include remote management and adjustments

☐ 6 Artificial Intelligence (AI) applications/systems or platform for smart manufacturing management, including automation

☐ 7 Augmented Reality / Virtual Reality for managing manufacturing process, for planning production flows, for simulating different business models, production models or processes

☐ 8 Other (please specify)

☐ 9 None of the above

☐ 10 Not applicable

If you are not currently using any form of the above mentioned digital technologies, what are the main barriers?

☐ 1 Lack of knowledge / skills

☐ 2 High costs

☐ 3 Unclear benefits

☐ 4 Lack of time

☐ 5 Not relevant to our operations

☐ 6 Other (please specify):

A4 Green manufacturing practices

Which of the following green manufacturing technologies does your company use?

☐ 1 Energy-efficient machinery and equipment

☐ 2 Renewable energy sources (solar, wind, biomass)

☐ 3 Advanced process control systems

☐ 4 Waste recycling systems

☐ 5 Environmentally friendly materials in production

☐ 6 Lean manufacturing practices

☐ 7 Waste reduction strategies (e.g. composting, recycling)

☐ 8 Water-efficient systems (e.g. rainwater harvesting)

☐ 9 Sustainable packaging materials

☐ 7 Low VOC (Volatile Organic Compounds) finishes and glues

☐ 8 Use of recycled or sustainable materials in vehicles

☐ 9 None of the above

☐ 10 Do not know

Does your company hold any of the following green manufacturing certifications or labels?

☐ 1 ISO 14001

☐ 2 EMAS (EU Eco-Management and Audit Scheme)

☐ 3 LEED (Leadership in Energy and Environmental Design)

☐ 4 Green Seal Certified

☐ 5 Carbon Trust Standard

☐ 6 Energy Star Certified

☐ 7 None of the above

☐ 8 Other (please, specify):

A5 Supply chain and partnerships

Where are your key suppliers based?

☐ 1 Most of our key suppliers are based within the EU

☐ 2 Most of our key suppliers are based outside of the EU

☐ 3 We have a mix of key suppliers both within and outside of the EU

Does your company have partnerships with suppliers (including startups) for testing, customizing, and buying innovative/green technologies?

☐ 1 Yes

☐ 2 No

☐ 3 I do not know

You mentioned you have partnerships with suppliers (including startups) for testing, customizing, and buying innovative/green technologies. Could you please provide more information on the nature of these partnerships?

☐ 1 Joint R&D projects with suppliers

☐ 2 Purchase of new technology solutions from suppliers

☐ 3 Customization of existing technologies with suppliers

☐ 4 Testing of suppliers' technologies in our operations

☐ 5 Other, please specify:

PART B: Usage behaviour

B1 **On a scale of 1 (not at all) to 7 (to an extremely large extent), how much would you estimate your company uses green manufacturing practices?**

- ☐ 1 Not at all
- ☐ 2 To a very small extent
- ☐ 3 To a small extent
- ☐ 4 To a moderate extent
- ☐ 5 To a large extent
- ☐ 6 To a very large extent
- ☐ 7 To an extremely large extent

PART C: Perceived usefulness

C1 **On a scale of 1 (strongly disagree) to 7 (strongly agree) please indicate to what extent do you agree or disagree with the following statements:**

Sustainability is about making sure that the things we do today don't negatively impact the ability of future generations to do the same things. It's a way of acting and living that keeps the health of our planet and our communities in mind. Sustainability often comes up in three main areas: environmental, social, and economic, often referred to as the "three pillars of sustainability." These are manufacturing or production processes designed with an emphasis on minimizing negative environmental impacts, conserving energy and natural resources, being safe for employees, communities, and consumers, and being economically efficient.

	Strongly disagree	Disagree	Somewhat disagree	Neither disagree nor agree	Somewhat agree	Agree	Strongly agree
Using green manufacturing (e.g - recycled materials) in production would, in my opinion, improve the efficiency of our company.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
The introduction of digital technologies (e.g. AI, IoT, automated systems, etc.) would, in my opinion, increase the sustainability of our company	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
By adopting green manufacturing practices, I believe our company would improve the quality of its products.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
I think the introduction of energy-efficient machines/production lines	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

would reduce our production costs.

C2 **On a scale of 1 (strongly disagree) to 7 (strongly agree) please indicate to what extent do you agree or disagree with the following statements:**

	Strongly disagree	Disagree	Somewhat disagree	Neither disagree nor agree	Somewhat agree	Agree	Strongly agree
Digitizing our company's production processes would green our manufacturing flows (e.g reduce waste)	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Implementing digital systems would improve our company capacity for greening the supply chain.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Digitizing our company's production processes would make our products greener and sustainable	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Green manufacturing investments will reduce our company risk exposure towards traditional raw materials, their price volatility, and supply chain fragmentations.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART D: Effort expectancy

D1 **On a scale of 1 (strongly disagree) to 7 (strongly agree) please indicate to what extent do you agree or disagree with the following statements:**

	Strongly disagree	Disagree	Somewhat disagree	Neither disagree nor agree	Somewhat agree	Agree	Strongly agree
The introduction of digital technologies (e. g. AI, IoT, automated systems, etc.) would be too complicated for many employees to use.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The effort required to transform our business to be more environmentally friendly and sustainable would be too great.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

D1 **On a scale of 1 (strongly disagree) to 7 (strongly agree) please indicate to what extent do you agree or disagree with the following statements:**

	Strongly disagree	Disagree	Somewhat disagree	Neither disagree nor agree	Somewhat agree	Agree	Strongly agree
The costs of transitioning our company to a greener and more sustainable business is too high for our current market position and capabilities.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART E: Facilitating conditions

E1 **On a scale of 1 (strongly disagree) to 7 (strongly agree) please indicate to what extent do you disagree or agree with the following statements:**

	Strongly disagree	Disa-gree	Some-what disa-gree	Neither disa-gree nor agree	Some-what agree	Agree	Strongly agree
The required knowledge and technical resources for the green manufacturing transition are available in our organization.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The company has all the necessary technical infrastructure for digitization.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
More green manufacturing practices cannot be implemented because of the regulatory obstacles.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
There are enough regulatory pressures pushing our company to adopt green manufacturing practices.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The regulatory system contains sufficient incentives to encourage the green transition.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The government doesn't provide enough information regarding sustainable production/green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
There is not enough external technical knowledge available to support adoption of green manufacturing practices.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

E2 **On a scale of 1 (strongly disagree) to 7 (strongly agree) please indicate to what extent do you agree or disagree with the following statements:**

	Strongly disagree	Disagree	Somewhat disagree	Neither disagree nor agree	Somewhat agree	Agree	Strongly agree
Our top management actively encourages the use of green manufacturing practices within the company.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Our employees have the necessary resources to make the shift towards green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Our company has a sufficient number of qualified employees to make the shift towards green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Our employees have received the necessary training to implement a transition to green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART F: Ease of use

F1 **On a scale of 1 (very difficult) to 7 (very easy), how easy or difficult do you think would be for your company right now…**

	Very difficult	Difficult	Somewhat difficult	Neither difficult nor easy	Somewhat easy	Easy	Very easy
... to increase the use of sustainable or recycled resources in manufacturing processes?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
... to introduce or increase the use of energy-efficient machinery in your company?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
... to implement waste reduction/reuse initiatives in your company?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
... to integrate new digital technologies, such as IoT, blockchain or	☐1	☐2	☐3	☐4	☐5	☐6	☐7

F1 **On a scale of 1 (very difficult) to 7 (very easy), how easy or difficult do you think would be for your company right now…**

	Very difficult	Difficult	Somewhat difficult	Neither difficult nor easy	Somewhat easy	Easy	Very easy
AI, into your company's existing processes?							
... for employees to operate the digital systems in general?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
... to train staff for digital operation and maintenance?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

Other difficulties related to green manufacturing practices, use of digital technologies which are not listed above? Please specify and explain/describe:

PART G: Influence

G1 **On a scale of 1 (not at all) to 7 (to an extremely large extent), please rate how much:**

	Not at all	To a very small extent	To a small extent	To a moderate extent	To a large extent	To a very large extent	To an extremely large extent
… consumer demand for environmentally friendly products affect your company's manufacturing processes?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
… consumer preference for digitized manufacturing influence your company's decisions?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

… market trends toward digital technologies influenced your company's manufacturing strategy to date?	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART H: Attitudes toward change

H1

On a scale of 1 (very unlikely) to 7 (very likely), how likely

	Very unlikely	Unlikely	Somewhat unlikely	Neither unlikely nor likely	Somewhat likely	Likely	Very likely	Already implemented
…is it that your company will integrate or increase green manufacturing processes into its production operations in the following 5 years?	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
… will you switch to energy-efficient machinery for your production in the following 5 years?	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8
… will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process in the following 5 years?	☐1	☐2	☐3	☐4	☐5	☐6	☐7	☐8

PART I: Enablers and barriers

I1 Please answer the following three questions in text form. Simple answers that state your main ideas in bullet point form are perfectly adequate:

What are the major drivers for your business to adopt or make investments in green manufacturing practices? Please consider the benefits to the environment, the economy, and the market, in addition to any additional benefits you anticipate.	

What do you think are the biggest obstacles or challenges to using green manufacturing techniques and technologies in your company? Please consider technical, financial, regulatory barriers, market challenges and any additional barriers you anticipate.	

What kind of support, resources or infrastructure do you think your organization would need to successfully adopt green manufacturing practices? Please provide details about training, technology, finance, or other types of support.	

PART J: Details of the respondent

I1 Please, in the end provide some of the information about yourself.

Position in the company:

☐ 1 CEO (Director)

☐ 2 CTO (Chief Technical Officer)

☐ 3 CPO (Chief Production Officer)

☐ 4 Production responsible

☐ 5 Quality manager

☐ 6 Other, please specify:

Nationality:

E-mail (to be used for further communication about project results and possible cooperation)

Year of birth:

Gender:

☐ 1 Male

☐ 2 Female

☐ 3 Other

Please indicate the number of years you have been working for the company:

☐ 1 Less than 1 year

☐ 2 1-3 years

☐ 3 More than 3 years and up to 5 years

☐ 4 More than 5 years and up to 10 years

☐ 5 More than 10 years

Thank you for completing the questionnaire!

Interreg CENTRAL EUROPE

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GREENE 4.0

Annex 1

to D.1.1 - Regional Mapping Analysis

Contents

A. Co-working seminars for drafting the survey

CO-WORKING SEMINAR FOR DRAFTING THE SURVEY #1

Event report

WP1 - Design, test and deploy user acceptance model

A1.1 - REGIONAL MAPPING AND ANALYSIS REGARDING PERCEPTIONS, ATTITUDES, BARRIERS AND ACCEPTANCE

7.6.2023

Partner:	All partners under coordination of PP4 - UL
Contact Person:	Lea Lebar

Title of Event:	Co-working seminar for drafting the survey #1
Date:	6.6.2023
Venue:	Online (Zoom)
Language:	English
Type of Event:	Internal partner event
No. of Attendees	18

Location in Google Drive:	https://drive.google.com/drive/folders/1lxKbuh5HbDQrRrsCYxXFpoCtsNZlhIlz?usp=drive_link

Summary of the event (max 500 characters)

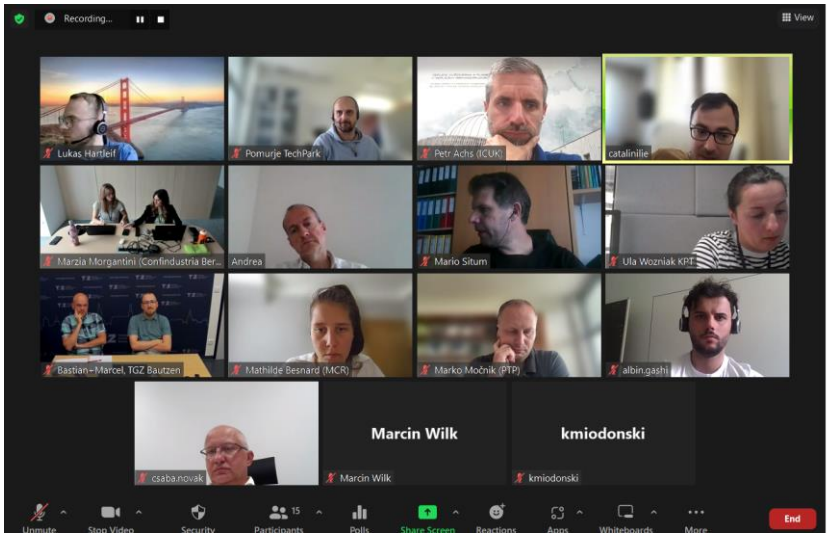
Internal project meeting minutes:

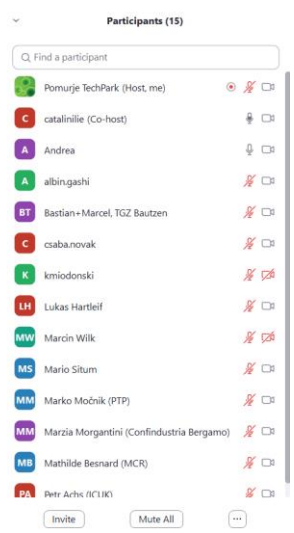
- Lukas introduces Albin Gashi
- 2nd stage – check the draft and achieve common agree on form and contents /by context of each region and target group – how to address and to apply easily and how to get common nominative for the document.
- Upon data collected Pilots will be tested for user acceptance model –
- 1st scope - attitude, knowledge, and actions towards adopting & investing in green technologies.
- 2nd scope – to change behaviour of SME towards green manufacturing.
- Soon Eu will have obligatory legislation on green manufacturing, to later by 2030, will be measured and upon taxes will be paid, also access to finances will be affected by been green.
- Catalin will upload corrected version in 2nd round fine tuning – glossary will be needed; terms of focus must be explained in glossary.
- Glossary with short information exists; few things to be added; purpose: use at interviews with companies to explain them relevance and value added of their input – concept with more text…with specifics for several sectors…digitalization is horizontal component – measuring or to ensure sustainability.
- Glossary for person who will do the interview from PP in case to be ready for SME interviewed person.
- Mathilde (glossary is meant for person conducting interview from PP, but not necessary that all will be used) & Andrea -go through questions first and then return to glossary.
- Mathilde: what would be success rate – 450 (aka approx. 60/PP)!
- To all questions are necessary therefore we need to filter: Mathilde…where all these data and how it will be used? Purpose of data? Catalin: Data will be used in various areas – awareness next level is change behaviour towards green, sustainable business models (now optional, later obligatory, therefore changing behaviour means being ready for change, smoother transition…can be regionally differently for whom and when it will be mandatory; next, who will decide in SMEs to change, based on 7 key factors they will be able to understand value added if they start transition
- Marko: delete name & surname, keep nationality, position in company needs to be first to define (drop-down menu)
- Andrea – profile of interviewee – we have a specific wish? Do more profiles from same company have to be interviewed – Catalin: yes at least 2 persons shall give picture on same topic from different aspects, since it makes it more relevant to get broader picture.
- Keep in gender to see difference on preferences.
- PPs provide inputs for education – it makes sense to see if education/gender affect user acceptance.
- Marcia- reg. names used, do not share data on open document (GDPR)
- Csaba – what we characterize – companies or people (not to characterize who runs SMEs, what do they represent); which companies we bring in? Those we know, trust, first, the rest will be harder; Part A to be kept short and be sure what this data will be used!

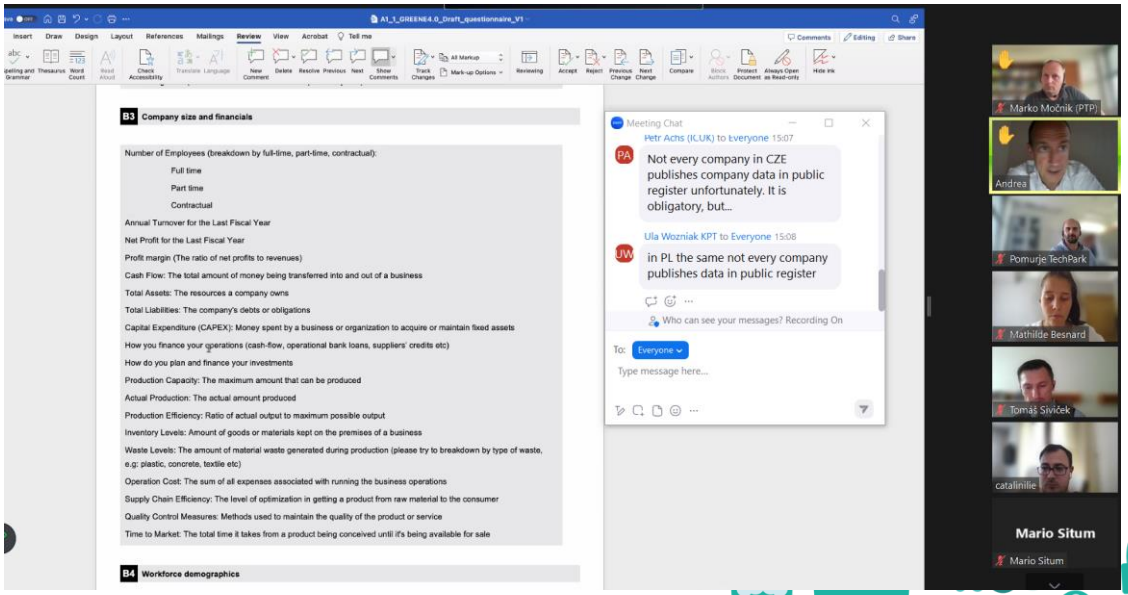
Final Agenda (English Version)
Not applicable!

Social Media / Webpage Links
Not applicable!

Photos / Screenshots







Signature List / Online attendance sheet

Name (Original Name)	User Email	Join Time	Leave Time	Duration (Minutes)	Guest	Recording Consent	In Waiting Room
Pomurje TechPark	info@p-tech.si	6.06.2023 13:56	6.06.2023 16:30	155	No		No
Lukas Hartleif		6.06.2023 13:57	6.06.2023 16:30	153	Yes	Yes	No
Marko Močnik (PTP)		6.06.2023 13:58	6.06.2023 16:30	153	Yes	Yes	No
kmiodonski		6.06.2023 13:59	6.06.2023 16:15	137	Yes	Yes	No
Marcin Wilk		6.06.2023 13:59	6.06.2023 15:44	105	Yes	Yes	No
Mario Situm		6.06.2023 13:59	6.06.2023 16:30	151	Yes	Yes	No
Petr Achs (ICUK)		6.06.2023 14:00	6.06.2023 16:30	151	Yes	Yes	No
catalinilie		6.06.2023 14:00	6.06.2023 16:30	151	Yes	Yes	No
Marzia Morgantini (Confindustria Bergamo)		6.06.2023 14:00	6.06.2023 16:30	151	Yes	Yes	No
Andrea		6.06.2023 14:00	6.06.2023 16:30	151	Yes	Yes	No
Bastian+Marcel# TGZ Bautzen		6.06.2023 14:00	6.06.2023 16:03	123	Yes	Yes	No
Ula Wozniak KPT		6.06.2023 14:00	6.06.2023 16:03	123	Yes	Yes	No
Mathilde Besnard (Mathilde Besnard (MCR))		6.06.2023 14:00	6.06.2023 16:30	150	Yes	Yes	No
Albin Gashi (albin.gashi)		6.06.2023 14:01	6.06.2023 16:30	150	Yes	Yes	No
csaba.novak		6.06.2023 14:01	6.06.2023 16:04	123	Yes	Yes	No
karin.steiner		6.06.2023 14:05	6.06.2023 16:30	145	Yes	Yes	No
Tomáš Siviček		6.06.2023 14:10	6.06.2023 16:30	141	Yes	Yes	No
Alice Reissová		6.06.2023 14:42	6.06.2023 16:30	109	Yes	Yes	No

Target Groups	
Category	**Number**
SME	N/A
Start-up	N/A
Public Administration	N/A
ICT Provider	N/A
Business Support Organization	N/A
EDIH	N/A
DIHs	N/A
General Public	N/A
Total Number of Attendees:	N/A

CO-WORKING SEMINAR FOR DRAFTING THE SURVEY #2

Event report

WP1 - Design, test and deploy user acceptance model

A1.1 - REGIONAL MAPPING AND ANALYSIS REGARDING PERCEPTIONS, ATTITUDES, BARRIERS AND ACCEPTANCE

14.6.2023

Partner:	All partners under coordination of PP4 - UL
Contact Person:	Lea Lebar

Title of Event:	Co-working seminar for drafting the survey #2
Date:	13.6.2023
Venue:	Online (Zoom)
Language:	English
Type of Event:	Internal partner event
No. of Attendees	19

Location in Google Drive:	https://drive.google.com/drive/folders/1qnoRz2Xgt95Hp5PVodzJYfhVKNjjIyFf?usp=drive_link

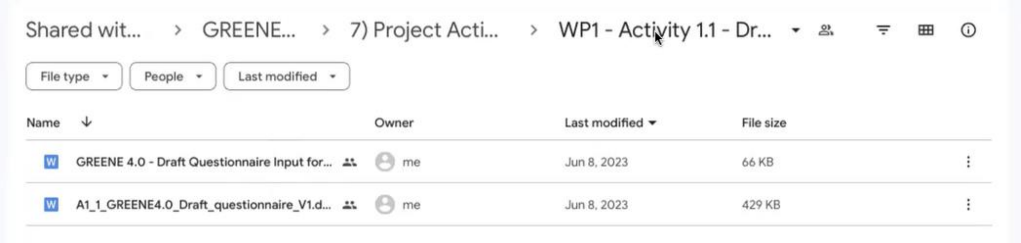
Summary of the event (max 500 characters)

Internal project meeting minutes:

1. Presentation of document location in Google drive

Catalin has presented/pointed out where files can be found for further manipulation:

https://drive.google.com/drive/u/2/folders/1-izbAP8iW28K7zcVzLIGxsCZK4wYZ42J



2. Presentation of contents in Questionnaire and subsequently debate

Intro section

Glossary – Catalin presented it … use of terms for common understanding in questionnaire during interviews. PPs' are invited to contribute terms (by stating their PP acronym and what the Input/wording would be (naturally always related to in column "Observations & recommendation" aka tips & tricks to what to pay attention while doing interview).

Next, short description was presented where few glossary terms have already been listed (Green manufacturing for example) and Mathilde challenged the positioning of this glossary (whether to have at the beginning of questionnaire or at the end). Accepted was methodology where each question will be shortly explained what the question is after (which information) and items of glossary to be in annex, not to make questionnaire substantial for use.

Debate on methodology was about conducting interview online filling and "in person" (hard copy/printed slight difference in time of conducting interview. We are flexible on collection whether it is performed in person or online (and online the interviewee can always "jump" always to glossary section, while PP+s person doing interview can skip that section unless interviewee will have an issue of understanding…but also available to person doing interview

Language used (not a problem for general questions – but collecting data in open box question/sections will need to be later translated (to English) by PPs from country from which interviewee will be.

Number of interviews performed/collected 450 in AF; preferred are interviews shall be in person, in "emergency situation", we shall foster online filling. If low number collected, we could prolong the date (deadline set). We should avoid biases by person that performs interview-they should talk. Andrea said that time difference is not that different, yet in person it may take longer…more aside information collected.

Catalin mentioned not only SMEs involvement to this survey only, but also later in piloting…so long-term relations to be established.

One pager is essential as intro to interview!

PART A – respondent details on respondent's name, education, email address
Related to "not qualitative" data to be processed, so it can be at the end (Csaba, Mathilde – no to split and gender is not relevant; slight difference if in person or online – we can leave out gender/we see them; email is not secret). Anonymity guarantee of respondent is assured by aggregated / cumulative answers while data on person responding is not part of report and it will be only used for those 450 respondents.

PART B – company's details – to be shortened (Kacper), as it takes more than 20 minutes and problem of disclosure of financial data (only B2 should stay). Tomaš similar hesitations on feedback from companies in B3 session…we agreed on reduction of details to be collected (but we should help companies to fill in the questionnaire with predefined answers instead of open box questions and thus answers). Innovation, digital technologies (processes) and green tech questions shall stay in that section! B6 supply chain section – suppliers to be defined by origin!

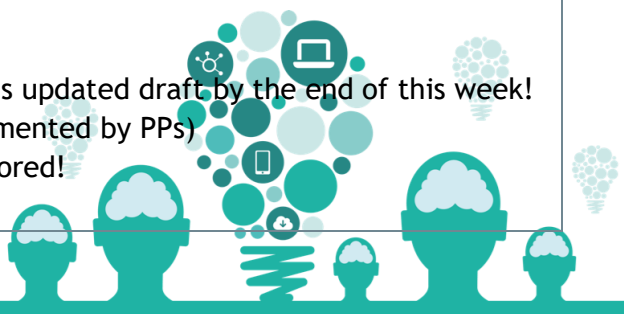
PART C – user behaviour
Multiple answers from predefined list are possible.
…
PART F – Influence
Scale issue /in descriptive naming, especially in case of national translations (PP's will have to handle these so that no meaning is lost in translation).

PART I – Open box answers (Enablers & Barriers)
Answering in bulletins is welcome (more EB's are collected this way collected); important last question: their needs identified will help us a lot (Catalin: what type they need – case of "Green village incentives" in USA). Andrea – these 3 questions provide (if done in person) deeper knowledge on SMEs' needs, while online might be "poor" as being at the end, people could be less interested…tired.
Eliška and Mathilde on 450 SME and regions to be covered…whether only NUTS3 or you can do it NUTS2 or even NUTS1. In case of AT PP, they go cross border to DE (it is OK). Czech PP are 2 so they can go NUTS1 in order not to compete among…all in all to reach 57/PP in average, which would be difficult for them to reach in one region only. Issue will be not only reaching enough companies in one NUTS2 region but getting their cooperation, so we should focus on getting average 57 SMEs even if they come from other NUTS2 as PP.

3.To Do's

Partners are asked to provide:
A) comments on questionnaire and
B) adding terms for glossary

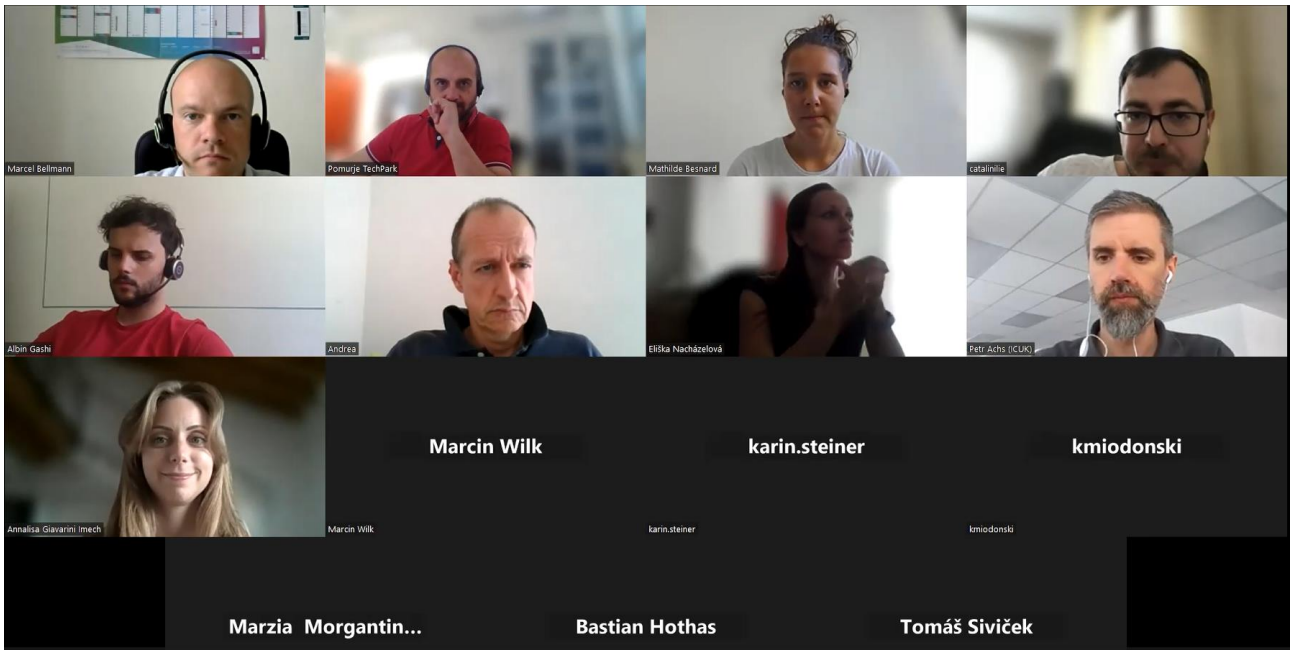
DL for both is 22.6.2023, while Catalin will provide this updated draft by the end of this week!
One-pager will be ready by 20.6.2023 (also to be commented by PPs)
Partners will get link to drive where documents are stored!



Final Agenda (English Version)

Activity
Presentation of document location in Google drive
Presentation of contents in Questionnaire
To Do's

Photos / Screenshots



Social Media / Webpage Links

Not applicable!

Signature List / Online attendance sheet

Name (Original Name)	User Email	Join Time	Leave Time	Duration (Minutes)	Guest	Recording Consent	In Waiting Room
Borut Zrim (PTP) (Pomurje TechPark)	info@p-tech.si	13.06.2023 11:58	13.06.2023 13:32	95	No		No
Eliška Nacházelová		13.06.2023 11:58	13.06.2023 13:32	94	Yes	Yes	No
Albin Gashi		13.06.2023 11:59	13.06.2023 13:32	94	Yes	Yes	No
Marcel Bellmann		13.06.2023 11:59	13.06.2023 13:32	94	Yes	Yes	No
kmiodonski		13.06.2023 11:59	13.06.2023 13:32	94	Yes	Yes	No
Marzia Morgantini (Confindustria Bergamo)		13.06.2023 11:59	13.06.2023 13:32	94	Yes	Yes	No
Annalisa Giavarini Imech		13.06.2023 11:59	13.06.2023 13:32	93	Yes	Yes	No
Petr Achs (ICUK)		13.06.2023 12:00	13.06.2023 13:32	93	Yes	Yes	No
Bastian Hothas		13.06.2023 12:00	13.06.2023 13:32	93	Yes	Yes	No
karin.steiner		13.06.2023 12:01	13.06.2023 13:32	92	Yes	Yes	No
Marcin Wilk		13.06.2023 12:04	13.06.2023 13:32	89	Yes	Yes	No
Tomáš Siviček		13.06.2023 12:05	13.06.2023 12:59	54	Yes	Yes	No
Mathilde Besnard		13.06.2023 12:07	13.06.2023 13:32	86	Yes	Yes	No
catalinilie		13.06.2023 12:08	13.06.2023 13:32	85	Yes	Yes	No
Andrea		13.06.2023 12:09	13.06.2023 13:32	84	Yes	Yes	No
Albert Kondricz - IFKA		13.06.2023 12:25	13.06.2023 13:32	68	Yes	Yes	No
Mario Situm		13.06.2023 12:33	13.06.2023 13:32	60	Yes	Yes	No
Lukas Hartleif		13.06.2023 12:40	13.06.2023 13:15	35	Yes	Yes	No
Tomáš Siviček		13.06.2023 12:59	13.06.2023 13:32	34	Yes	Yes	No

Target Groups	
Category	**Number**
SME	N/A
Start-up	N/A
Public Administration	N/A
ICT Provider	N/A
Business Support Organization	N/A
EDIH	N/A
DIHs	N/A
General Public	N/A
Total Number of Attendees:	N/A

B. Survey draft

Univerza v Ljubljani
Fakulteta za družbene vede

GREENE 4.0 – Acceptance factors and barriers of SMEs in adopting environmentally friendly and sustainable practices

Version:

V1

GLOSSARY

Short description:

Green manufacturing is all about making things in a way that's good for the environment. It means using methods that don't harm nature much, save energy, and limit waste. When we talk about digitalization in this context, we're talking about using digital technology like computers, software, and the internet to help make these good-for-environment practices even better. Here's how digital tools can help:

- Making Things More Efficient: Digital tools can help make everything run smoother and with less waste. Like using a smart thermostat at home, digital sensors can help machines run only when needed, saving energy.

- Keeping a Close Eye: With digital tech, we can watch production in real time. That means, if there's a problem, we can spot it quickly and fix it, which again, helps us avoid wasting resources.

- Predicting Problems: With special digital tools like data analytics, we can often see a problem coming before it happens, like if a machine is about to break down. Fixing issues before they happen means less downtime and again, less waste.

- Managing Resources Better: Digital tools can help us keep track of resources more effectively. For example, using digital simulations, we can try out different production processes virtually, without wasting actual physical materials.

- Supporting Reuse: Digital tools can help us keep track of where materials are in the product life cycle. This can make it easier to reuse and recycle materials, which cuts down on waste.

In simple terms, when we say green manufacturing with digitalization, we mean using digital tools to help make our good-for-environment manufacturing practices even better, saving more energy and creating less waste.

INSTRUCTIONS FOR COMPLETING THE QUESTIONNAIRE

Below are examples of questions to help you complete the questionnaire. Most questions can be answered by checking the appropriate answer. Please mark only one answer for each question.
There are no standard answers to this questionnaire, and there are no "right", "wrong", "good" or "bad" answers. So you do not need to think long about each question, just read each question carefully and give your answer according to your perception.
Please **express your views**; you do not need to discuss with other employees or management before you answer. We want to hear your opinion!

Example:

E1 **On a scale from 1 to 7 please indicate to what extent do you agree or disagree with the following statement:**

I think green behavior is very important to the whole society.

☐ 1 Strongly agree

☒ 2 Agree

☐ 3 Somewhat agree

☐ 4 Neither agree nor disagree

☐ 5 Somewhat disagree

☐ 6 Disagree

☐ 7 Strongly disagree

If there are multiple questions, please mark one answer for each of the statements.

Example:

E2 **On a scale from 1 to 7 please indicate to what extent do you agree or disagree with the following statement:**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
a) Our corporation is willing to increase investment in the green manufacturing innovative practices.	☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☐ 6	☐ 7
b) Our company is committed to improving green production to	☐ 1	☐ 2	☐ 3	☒ 4	☐ 5	☐ 6	☐ 7

	reduce pollution.						
c)	Our company uses raw materials that are green and environmentally friendly.	☐ 1	☒ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

Some questions can be answered by writing your answer in the box.

Example:

Please, explain:	Answer to the question

Details of the respondent

Name and surname:

Gender:

Position in the company:

Nationality:

Educational level

☐ 1 Primary education

☐ 2 Lower secondary education

☐ 3 Upper secondary education

☐ 4 Bachelor's degree

☐ 5 Master's degree

☐ 6 PhD

E-mail:

Phone:

PART B: Details of the company

B1 Company details

Company name:

Fiscal code:

Legal Form (e.g., Limited Liability Company, Joint-Stock Company, etc.)

Registered Office Address

Contact information (e-mail, phone):

Main city of operations:

Other locations where company operates:

Country:

Industry / sector

B2 Company profile

NACE code (The NACE codes are a standard classification system of similar European industries in function to Standard Industry Classification (SIC) – see https://ec.europa.eu/competition/mergers/cases/index/nace_all.html):

Description of Main Activities/Operations

Year of establishment:

Number of branches (if any):

Geographic markets (local, regional, national, international):

Market and market share:

Business growth (% increase in sales volume over past two years):

Company size and financials

Number of Employees (breakdown by full-time, part-time, contractual):

- Full time
- Part time
- Contractual

Annual Turnover for the Last Fiscal Year

Net Profit for the Last Fiscal Year

Profit margin (The ratio of net profits to revenues)

Cash Flow: The total amount of money being transferred into and out of a business

Total Assets: The resources a company owns

Total Liabilities: The company's debts or obligations

Capital Expenditure (CAPEX): Money spent by a business or organization to acquire or maintain fixed assets

How you finance your operations (cash-flow, operational bank loans, suppliers' credits etc)

How do you plan and finance your investments

Production Capacity: The maximum amount that can be produced

Actual Production: The actual amount produced

Production Efficiency: Ratio of actual output to maximum possible output

Inventory Levels: Amount of goods or materials kept on the premises of a business

Waste Levels: The amount of material waste generated during production (please try to breakdown by type of waste, e.g: plastic, concrete, textile etc)

Operation Cost: The sum of all expenses associated with running the business operations

Supply Chain Efficiency: The level of optimization in getting a product from raw material to the consumer

Quality Control Measures: Methods used to maintain the quality of the product or service

Time to Market: The total time it takes from a product being conceived until it's being available for sale

Workforce demographics

Average Age of Employees

Gender Distribution

Educational Background of Employees

- No education
- Middle education (college)
- Bachelor
- Master/Msc
- Phd

Job Role Distribution (management, skilled labor, unskilled labor, etc.)

Management

Production skilled labor

Production unskilled labor

Operations

Quality

Other

B5 Technology and innovation

Level of Automation in Production

Use of Digital Technologies (e.g., Cloud Computing, IoT, AI, Machine Learning)

Innovations Introduced in the Past 5 Years (products, services, process)

☐ **Green manufacturing practices**

Use of Green manufacturing Technologies (list to be specified based on industry)

Green manufacturing Certifications (e.g., ISO 14001, EMAS, sustainable production certification of sustainable products labels)

Energy Consumption and Energy Efficiency Measures

Waste Management Practices

Use of Renewable Energy

Circular practices or technologies for applying circularity

B7 **Supply chain and partnerships**

Number and Location of Suppliers

Participation in Industrial Clusters or Associations

Partnerships with Research Institutions or Universities

Partnership with suppliers (including startups) for testing, customizing and buying innovative technologies/green tech

PART C: Use behaviour

Digital technologies are key components for the transition process to green manufacturing. Industry 5.0 incorporates both technology and sustainability.

C1 **On a scale of 1 (to an extremely large extent) to 7 (not at all), how much would you estimate your company uses green manufacturing practices?**

☐ 1 To an extremely large extent

☐ 2 To a very large extent

☐ 3 To a large extent

☐ 4 To a moderate extent

☐ 5 To a small extent

☐ 6 To a very small extent

☐ 7 Not at all

C2 **How much, in your opinion, has your business embraced Industry 5.0 (green manufacturing) practices on a**

scale from 1 (to an extremely large extent) to 7 (not at all)?

☐ 1 To an extremely large extent

☐ 2 To a very large extent

☐ 3 To a large extent

☐ 4 To a moderate extent

☐ 5 To a small extent

☐ 6 To a very small extent

☐ 7 Not at all

PART D: Perceived usefulness

D1 **On a scale of 1 to 7 please indicate to what extent do you agree or disagree with the following statements (1 – strongly agree; 7 – strongly disagree)**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Using green manufacturing (e.g - recycled materials) in production would, in my opinion, improve the efficiency of our company.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
The introduction of Industry 5.0 technologies (e.g. AI, IoT, automated systems, etc.) would, in my opinion, Increase the sustainability of our company.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
By adopting green manufacturing practices, I believe our company would improve the quality of its products.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
I think the introduction of energy-efficient machines/production	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

lines would reduce our production costs.							
I think the introduction of more digital technologies (e.g. AI, IoT, automated systems, etc.) would increase the productivity of our company.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Green manufacturing practices such as reusing waste through circular economy, reducing waste, and using recycled raw materials would be beneficial to our company.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

D2 **On a scale of 1-7, how much do you believe that digital transformation and Industry 5.0 will positively impact your company's sustainability and competitiveness? (1 – to an extremely large extent; 7 – not at all)**

☐ 1 To an extremely large extent

☐ 2 To a very large extent

☐ 3 To a large extent

☐ 4 To a moderate extent

☐ 5 To a small extent

☐ 6 To a very small extent

☐ 7 Not at all

D3 **On a scale from 1 to 7 please indicate to what extent do you agree or disagree with the following statements (1 – strongly agree; 7 – strongly disagree)**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Digitizing our company's production processes would green our manufacturing flows (e.g reduce waste)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Implementing digital systems would improve our company greening the supply chain management.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

D3 **On a scale from 1 to 7 please indicate to what extent do you agree or disagree with the following statements (1 – strongly agree; 7 – strongly disagree)**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Digitizing our company's production processes would make our products greener and sustainable	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Green manufacturing investments will reduce our company risk exposure towards traditional raw materials, its price volatility and supply chains fragmentations.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

PART E: Effort expectancy

E1 **On a scale of 1 to 7 please indicate to what extent do you agree or disagree with the following statements (1 – strongly agree; 7 – strongly disagree)**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
The introduction of Industry 5.0 technologies (e. g. AI, IoT, automated systems, etc.) would be too costly.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
The introduction of Industry 5.0 technologies (e. g. AI, IoT, automated systems, etc.) would be too complicated for many employees to use.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Learning of Industry 5.0 technologies (e. g. AI, IoT, automated systems, etc.) would	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

take too much time away from our employees everyday tasks.							
The effort required to transform our business to be more environmentally friendly and sustainable would be too great.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The costs of transitioning our company to a greener and more sustainable business is too high for our current market position and capabilities.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The benefits of implementing Industry 5.0 technologies outweigh the costs.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The benefits of implementing green technologies outweigh the costs.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Green manufacturing investment incentives will contribute decisively on our decision to adopt and implement a green transformation process.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Dedicated green manufacturing financing instruments will provide crucial support to our company in making green investments and introducing new sustainable manufacturing models.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART F: Facilitating conditions

F1 **On a scale from 1 to 7 please indicate to what extent do you agree or disagree with the following statements (1 - strongly agree; 7 – strongly disagree)**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
All the resources required for the green manufacturing are available in our organization.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The company has all the necessary technical infrastructure for digitization.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Our company has a sufficient number of qualified employees to adopt Industry 5.0.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
More green manufacturing practices cannot be implemented because of the regulatory obstacles.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Too many regulations stand in the way of Industry 5.0 implementation.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
There are enough regulatory pressures pushing our company to adopt green manufacturing practices.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The legislative system contains sufficient incentives to encourage the transition to Industry 5.0.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The regulatory system has adequate incentives to encourage a transition to green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The government doesn't provide	☐1	☐2	☐3	☐4	☐5	☐6	☐7

enough information regarding sustainable production/green manufacturing.							
The implementation of green manufacturing practices cannot be supported by the availability of sufficient outside technical expertise.	☐1	☐2	☐**3**	☐4	☐5	☐6	☐7
There is not enough external technical knowledge available to support adoption of green manufacturing practices?	☐1	☐2	☐**3**	☐4	☐5	☐6	☐7

F2 **On a scale from 1 to 7 please indicate to what extent do you agree or disagree with the following statements (1 – strongly agree; 7 – strongly disagree)**

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
	☐1	☐2	☐3	☐4	☐5	☐6	☐7
Top management in our organisation is very proactive in promoting green manufacturing practices within the company.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The employees have resources necessary to implement a transition to green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The employees have sufficient information to implement a transition to green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7
The employees have received necessary training to implement a transition to green manufacturing.	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART G: Ease of use

On a scale of 1 to 7, how easy or difficult do you think would be for your company right now…

	Very easy	Easy	Somewhat easy	Neither easy nor difficult	Somewhat difficult	Difficult	Very difficult
... to increase the use of sustainable or recycled resources in manufacturing processes?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
... to introduce or increase the use of energy-efficient machinery in your company?	☐1	☐2	☐3	☐4	☐5	☐6	☐7

... to implement waste reduction/reuse initiatives in your company?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
... to integrate digital technologies, such as IoT, blockchain or AI, into your company's existing processes?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
... for employees to operate the digital systems in general?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
... to train staff for digital operation and maintenance?	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART G: Influence

G1 **On a scale from 1 (to an extremely large extent) to 7 (not at all), please rate how much:**

	To an extremely large extent	To a very large extent	To a large extent	To a moderate extent	To a small extent	To a very small extent	Not at all
… does consumer demand for environmentally friendly products affect your company's manufacturing processes?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
… does consumer preference for digitized manufacturing influence your company's decisions?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
… have market trends toward Industry 5.0 influenced your company's manufacturing strategy to date?	☐1	☐2	☐3	☐4	☐5	☐6	☐7
… does consumer preference for sustainable products/eco-friendly products influence your company's manufacturing processes or your business model?	☐1	☐2	☐3	☐4	☐5	☐6	☐7

PART H: Attitudes towards change

H1 **On a scale of 1 to 7, how likely is it that your company will integrate or increase green manufacturing processes into its production operations in the next few years?**

- ☐ 1 Very likely
- ☐ 2 Likely
- ☐ 3 Somewhat likely
- ☐ 4 Neither likely nor unlikely
- ☐ 5 Somewhat unlikely
- ☐ 6 Unlikely
- ☐ 7 Very unlikely

☐ **On a scale of 1 to 7, how likely will you switch to energy-efficient machinery for your production?**

- ☐ 1 Very likely
- ☐ 2 Likely
- ☐ 3 Somewhat likely
- ☐ 4 Neither likely nor unlikely
- ☐ 5 Somewhat unlikely
- ☐ 6 Unlikely
- ☐ 7 Very unlikely

H2 **On a scale of 1 to 7, how likely will you incorporate digital technologies like AI, blockchain and IoT devices into your manufacturing process?**

- ☐ 1 Very likely
- ☐ 2 Likely
- ☐ 3 Somewhat likely
- ☐ 4 Neither likely nor unlikely
- ☐ 5 Somewhat unlikely

☐ 6 Unlikely

☐ 7 Very unlikely

Enablers and barriers

What are the major drivers for your business to adopt or make investments in green manufacturing practices? Please consider the benefits to the environment, the economy, and the market, in addition to any additional benefits you anticipate.	
What do you think are the biggest obstacles or challenges to using green manufacturing techniques and technologies in your company? Please consider technical, financial, regulatory barriers, market challenges and any additional barriers you anticipate	
What kind of support, resources or infrastructure do you think your organization would need to successfully adopt green manufacturing practices? Please provide details about training, technology, finance, or other types of support.	

Thank you for filling out the questionnaire!

C. Technical seminars for elaborating sampling methodology

TECHNICAL SEMINARS FOR ELABORATING SAMPLING METHODOLOGY #1

Event report

WP1 - Design, test and deploy user acceptance model

A1.1 - REGIONAL MAPPING AND ANALYSIS REGARDING PERCEPTIONS, ATTITUDES, BARRIERS AND ACCEPTANCE

18.5.2023

Partner:	PP4 - UL
Contact Person:	Lea Lebar

Title of Event:	Technical seminars for elaborating sampling methodology *#1*
Date:	*17.5.2023*
Venue:	Online (Zoom)
Language:	*Slovene*
Type of Event:	Internal partner event
No. of Attendees	4

Location in Google Drive:	https://drive.google.com/drive/folders/1xL6T5-e3EmykxEtZs_JFCT-PbrbjfI9U?usp=drive_link

Summary of the event (max 500 characters)

Internal project meeting minutes:

Participants reviewed together the activities of the GREENE 4.0 project. To help with the first part of the project (preparation of a questionnaire on the attitudes, barriers and challenges faced by companies in their supply chains), Cataline Ilie was brought in as an external collaborator to potentially support the implementation of the project going forward.

At the technical seminar it was agreed that:

- The questionnaire will include the classic TAM/UTAUT scales that measure the acceptance factors of new technologies; with individual statements tailored to the adoption of green ICT technologies
- In addition to the classic TAM/UTAUT scales, we review measurement instruments and scientific papers dealing with key barriers to the adoption of green ICT technologies (e.g. Alayon et al, 2022 – this paper could be interesting to include in the questionnaire).
- It was agreed that the questionnaire will be uploaded to 1KA on completion, the questionnaire will be web-based and will include open-ended answers (Lea will be responsible for uploading the questionnaire with the help of Izidor if needed). 1KA also allows for easy translation for partners (into all languages), and Lea will prepare appropriate instructions for translation of the questionnaire for all partners and be available to support them if anything gets stuck.
- The first version of the questionnaires will be sent to the partners on 31 May 2023, together with an external collaborator. Before sending, it will be reviewed by all of us, updated and, if necessary, coordinated over the phone.
- Vesna pointed out that most of the instruments we normally work with will need to be adapted significantly (from health to green manufacturing) - in principle, the scales we use in health care are derived from the manufacturing.
- Potential instruments include the Technology Commitment Scale

	Sploh ne drži.	Malo drži.	Zmerno drži.	Precej drži.	Povsem drži.
Zelo me zanima tehnološki razvoj.	○	○	○	○	○
Ukvarjanje s tehničnimi novostmi mi običajno predstavlja velik izziv.	○	○	○	○	○
Vedno me zanima uporaba najnovejših tehnologij.	○	○	○	○	○
Pogosto se bojim neuspeha pri uporabi nove tehnologije.	○	○	○	○	○
Tehnične naprave bi si želel/-a uporabljati pogosteje, kot jih sedaj.	○	○	○	○	○
Bojim se, da bi nove tehnične naprave uničil/-a, namesto da bi jih pravilno uporabil/-a.	○	○	○	○	○
Hitro začnem uživati v novih tehničnih napravah.	○	○	○	○	○
Težko obvladujem nove tehnologije – večino časa tega nisem zmožen/na.					

- The date of the next technical seminar: 29. 5. 2023, 14:30

Final Agenda (English Version)
Not applicable!

Social Media / Webpage Links
Not applicable!

Photos / Screenshots
Not applicable!

Signature List / Online attendance sheet
Attended: prof. Vesna Dolničar, asist. Izidor Natek, asist. Lea Lebar, Catalin Ilie

Target Groups	
Category	**Number**
SME	N/A
Start-up	N/A
Public Administration	N/A
ICT Provider	N/A
Business Support Organization	N/A
EDIH	N/A
DIHs	N/A
General Public	N/A
Total Number of Attendees:	N/A

TECHNICAL SEMINARS FOR ELABORATING SAMPLING METHODOLOGY #2

Event report

WP1 - Design, test and deploy user acceptance model

A1.1 - REGIONAL MAPPING AND ANALYSIS REGARDING PERCEPTIONS, ATTITUDES, BARRIERS AND ACCEPTANCE

30.5.2023

Partner:	PP4 - UL
Contact Person:	Lea Lebar

Title of Event:	Technical seminars for elaborating sampling methodology *#2*
Date:	*29.5.2023*
Venue:	Online (Zoom)
Language:	*Slovene*
Type of Event:	Internal partner event
No. of Attendees	4

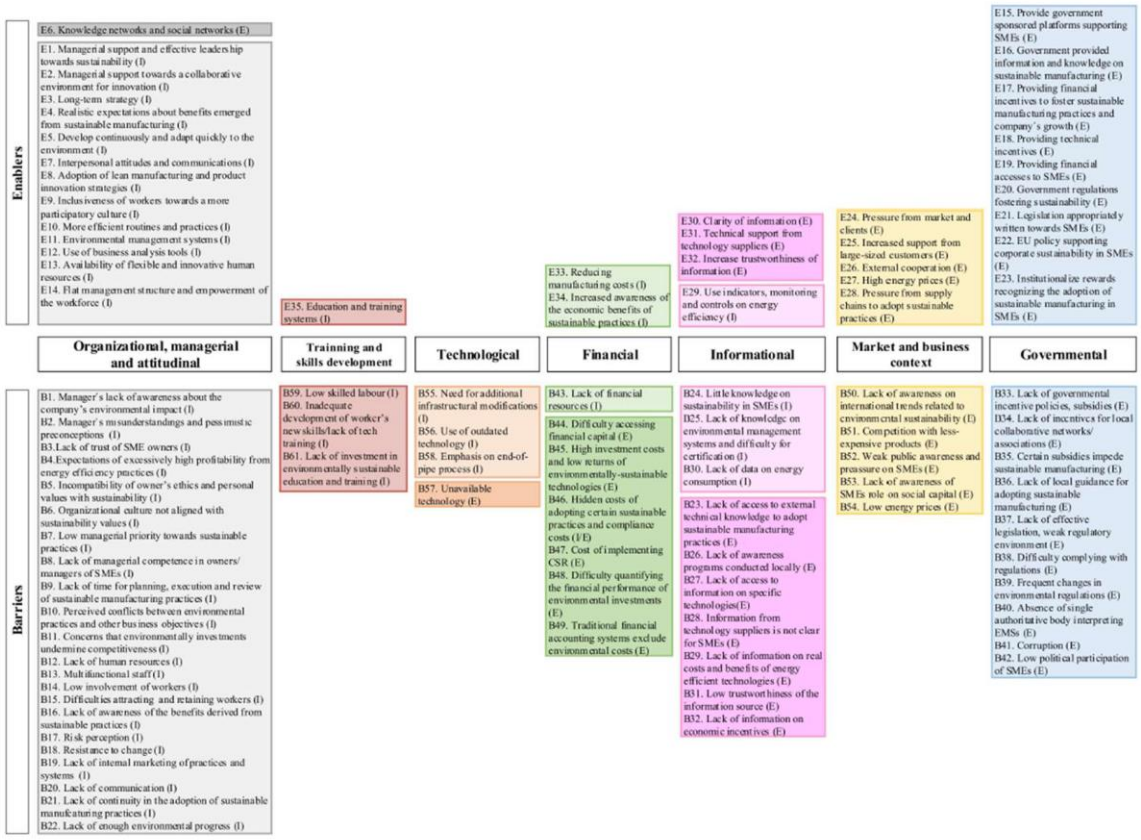
Location in Google Drive:	https://drive.google.com/drive/folders/1xL6T5-e3EmykxEtZs_JFCT-PbrbjfI9U?usp=drive_link

Summary of the event (max 500 characters)
Internal project meeting minutes: Questionnaire Review and Modifications: The initial questionnaire draft by Catalin Ilie, developed alongside Lea Lebar, was evaluated, here are results: • It should be shorter! • The introductory section should be concise. A broader question set at this stage will be refined later. • We need to group the statements according to domains like perceived benefit and social influence. The emphasis should be on staying close to the statements as they were written originally (as much as possible). While condensing the scales, we need to ensure that they remain analytically useful, maintaining at least 2-3 statements per domain. Convert extensive open-ended questions into two overarching statements (Lea). • Lea is tasked with streamlining the questionnaire's structure, using the conventional format used in our previous studies (an example will be forwarded by Vesna). • The introductory glossary should be shortened, i. e. " Below are examples of questions to help you complete the questionnaire. Most questions can be answered by checking the appropriate answer. Please mark only one answer for each question. There are no standard answers to this questionnaire, and there are no "right", "wrong", "good" or "bad" answers. • So you do not need to think long about each question, just read each question carefully and give your answer according to your perception. • Please express your views; you do not need to discuss with other employees or management before you answer. We want to hear your opinion!!" • Introduce an example to illustrate the questionnaire's completion at its outset. Partners can later decide whether to use it or not. • Format and Length: an overall length should not be exceeding 8 pages • Target Group and Data Collection: The survey focuses on SMEs, acknowledging that regional and country-specific definitions of SMEs exist. We need to make sure the relevance across all collaborative partners. Catalin will research current trends and seek craft a definition. • The engagement goal is set at 450 companies. Analysis will differentiate based on industry and geographical location. • The questionnaire will be initially in English and subsequently translated into other required languages. • Timeline and Methodology: The questionnaire is set to be finalized by 20 June. Although partners might deploy the survey during summer, logistical constraints might push the process into autumn. An interview-based survey is favoured for in-depth data acquisition, enhanced accuracy, and better response rates. However, a mixed-method approach could be adopted (needs to be discussed with LP). • Article Review: Lea assessed the Alayon article – it can be a good framework for presenting our survey results.

Final Agenda (English Version)
Not applicable!

Social Media / Webpage Links
Not applicable!

Photos / Screenshots

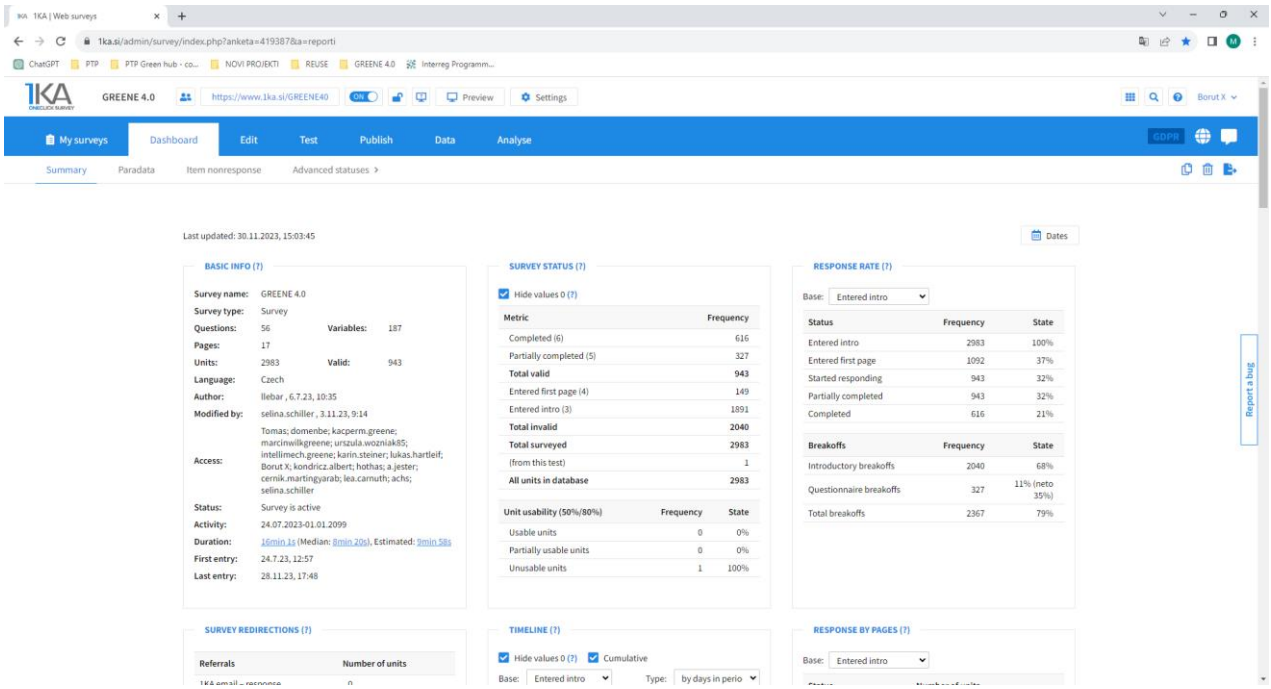


Signature List / Online attendance sheet
Attended: prof. Vesna Dolničar, asist. Izidor Natek, asist. Lea Lebar, Catalin Ilie

Target Groups	
Category	**Number**
SME	N/A
Start-up	N/A
Public Administration	N/A
ICT Provider	N/A
Business Support Organization	N/A
EDIH	N/A
DIHs	N/A
General Public	N/A
Total Number of Attendees:	N/A

D. Final digitalised survey

Digitalised survey available: https://www.1ka.si/admin/survey/index.php?anketa=419387&a=reporti



E. Companies interviewed