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Leveraging Digital Transformation for Enhanced ESG Performance

Digital transformation plays an important role in achieving ESG (environmental, social and governance) goals, as modern technologies support sustainability efforts. Digital tools such as cloud computing, smart robotics and IoT enable companies to manage their resources more efficiently, reduce their environmental footprint and operate more transparently. The aim of this study is to explore how digitalisation contributes to the success of ESG strategies, in particular environmental sustainability, and how it helps companies to achieve their sustainability goals, focusing especially on Hungarian companies.
Keywords: digital transformation, information and communication technologies (ICT), ESG, environmental sustainability
JEL code: M14, Q56

https://doi.org/10.32976/stratfuz.2024.46

1. Introduction

At the UN summit in September 2015, the world's 193 member states pledged to end poverty, fight injustice and tackle climate change. The 2030 Agenda (United Nations, 2015) was adopted, setting out sustainability goals in 17 areas to guide countries, regions, organisations and companies on how to protect the planet and achieve social and economic prosperity.
The European Union will set further targets for its Member States under the Green Deal and provide solutions and tools to achieve them. The European Green Deal aims to "transform the EU economy into a modern, resource-efficient and competitive economy" (European Commission, 2019). In their study, Papp et al. (2022) point out that the state and central institutions must also play an active role in the green economic transition. This requires a financial system that integrates sustainability aspects into capital allocation decisions and provides financial resources to support industries using environmentally friendly technologies.
Some studies (Raihan and Tuspekova, 2022) and (Lopolito et al., 2022) see the realisation of sustainability through technology. Hódiné (2023) identifies technology as a key element of an integrated model of sustainability. It expands the traditional dimensions of sustainability - environmental, social and economic - with additional aspects such as human, corporate, political/governance, cultural and technological (*Figure 1*). And "*technology permeates and supports the whole sustainability framework, as it is the basis and also one of the tools for achieving sustainability*" (Hódiné, 2023). While (Kocziszky & Szendi, 2023) emphasizes the importance of conducting both ex-ante and ex-post sustainability assessments to ensure that development projects are sustainable and effective in the long term.

The importance of technological innovation, including digitalisation, is also highlighted by the EU in its "European Digital Decade" (European Parliament and Council, 2022) and "Digital Agenda 2030: A European way to achieve the Digital Decade" (European Commission, 2021a). As it writes: "*Digital technologies such as artificial intelligence, 5G, cloud computing, edge networking and the Internet of Things can accelerate and maximise the impact of climate and environmental policies. Digitalisation also offers new opportunities for remote monitoring of air and water pollution, and for monitoring and optimising the use of energy and natural resources*". In these Communications, the European Commission also stresses the need for Europe to take advantage of the opportunities offered by the digital switchover, which is also essential to

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achieving sustainability objectives. Recognising that sustainability and digitalisation are not only two priority areas for the EU economy and competitiveness, but also mutually supportive and interlinked issues, the EU published in 2022 its strategic report "Aligning the green and digital transition in the new geopolitical environment" (European Commission, 2022), which identifies areas where digitalisation can support sustainability and the achievement of sustainability goals by helping to achieve climate neutrality, reduce pollution, restore biodiversity, greener transport, green buildings, smart agriculture and green energy.

Figure 1: Eight dimensions of sustainability
Source: Hódiné, 2023

IT and digitalisation therefore contribute significantly to the achievement of sustainability goals by improving resource efficiency, helping to protect the environment and reducing environmental impacts in different sectors of the economy. The link between digitalisation and sustainability has been explored in several studies, such as (Brenner & Hartl, 2021), (Del Río Castro et al., 2021) and (Irajifar et al., 2023).

2. Literature review

Businesses have a key role to play in achieving the goals set in today's rapidly changing world of sustainability and digitalisation. Sustainability and digital transformation are becoming increasingly important for businesses as well, as they have a significant impact on the long-term success and growth of organisations. Several studies have addressed the relationship between sustainability and digitalisation in the corporate context, for example (Cai et al., 2023), (Dabbous et al., 2023), (Broccardo et al., 2023) and (Lipták, 2024).
ESG is a company-level approach to sustainability (BÉT, 2021), which includes factors that assess the non-financial performance of companies, that is Environmental, Social and Governance. In the long term, companies that integrate ESG aspects into their corporate strategy will remain competitive. However, new tools and methods are needed to achieve the new objectives. In this process, digitalisation and the exploitation of the opportunities offered by digital transformation can be an effective way to achieve ESG goals, especially as the use of technology is key to the long-term sustainable operation of companies, as these two major challenges of our time are increasingly interlinked. Information and Communication Technologies (ICT) and digitalisation play a significant role in achieving sustainability goals, taking into account social, environmental and economic aspects, although primarily supporting environmental goals (Vacchi et al., 2021), (Charfeddine & Umlai, 2022), (Horváth et. al. 2023) and (Qayyum, et al., 2024).

For companies, environmental sustainability, or the "E" leg of ESG, means that they need to consider and mitigate not only direct but also indirect environmental impacts. In other words, it is not enough for a company's operations to be environmentally sustainable, the products produced, and services provided must also be sustainable (Hódiné, 2022). Digitalisation enables companies to operate more efficiently and sustainably, minimising environmental pressures and reducing social and environmental risks, while contributing to environmental measures and sustainability goals.
The WEF (2021) has published a guide entitled "Bridging Digital and Environmental Goals" to help business leaders align their digital and environmental goals to achieve results that serve both sustainability and business interests. The recommendations are built around seven digital transformation dimensions (*Table 1*).

Table 1: The seven business dimensions of digital transformation in achieving ESG goals

Business dimension	From…	To…
New value	A linear value chain, shareholder value	A dynamic value map, stakeholder value
Business models	Digital channels for products	Data-led services or outcomes, digital ecosystems
Operating models	Hierarchical, isolated, on-premise	Agile, AI-enhanced, platform-based
Supply chain	Globalized, low-cost, just in time	Localized, resilient, efficient, ethical
Decision-making	Manual, based on historical data	Predictive, real-time, intelligent, at the edge
Finance/investments	New tech capabilities and growth objectives	De-risking cost/revenue, finding new revenue, hitting ESG targets
Talent	Closing known skill gaps	An elastic, rapidly upskilled digital workforce, talent-on-demand models

Source: WEF, 2020, p.8

According to a survey of Bain & Company and the World Economic Forum (Anderson & Caimi, 2022), the main areas where digitalisation will help companies to achieve their sustainability goals are:

- strengthen data privacy and security;
- optimize resources;
- enhance employee work and safety;
- enable data gathering and storage;
- increase energy, water, or fuel efficiency;
- upgrade product safety;
- facilitate new hybrid working models;
- optimize processes;
- reduce carbon emissions;
- make supply chains traceable and transparent.

3. Material and methods

In 2021, the European Commission carried out a survey under the "Business survey on the use of digital technologies" programme, which focused on the use of information and communication technologies (ICT) by firms and their environmental actions. This is the first EU-wide study to explore how digital technologies support the environmental sustainability of businesses in the EU and how this could be further strengthened in the future.

The study covered the use and impact of the following digital technologies:

- The Internet of Things (IoT)
- Management Information System
- Transaction platforms
- Collaboration platforms
- Intelligent robotics
- Audiovisual technologies
- Artificial intelligence
- Cloud computing or cloud storage

The survey was carried out between 25 January 2021 and 29 March 2021, covering 29 countries in Europe, the EU 27 plus Iceland and Norway, and involving nearly 10,000 businesses (European Commission, 2021b).In this study, we used this EU survey database to find out what digital technologies are used by Hungarian businesses, what they do with them and how they use them to protect the environment. By analysing the data, we can gain valuable insights into the relationship between the use of digital technologies and sustainability. Our research analysed the main reasons for the adoption of digital technologies by European companies, especially in Hungary, and their impact on environmental sustainability. For data analysis and visualisation, we used several different digital tools. For data preparation, initial processing and some visualisations we used Microsoft Excel, while for other visualisation charts we used the RStudio and Microsoft Power BI environment, which allowed for easy-to-understand, interactive visualisation.

4. Results

Based on the topic of our research, we investigated the following areas: the main reasons for the use of digital technologies by European companies, with a focus on Hungary, and the impact of digital technologies used by companies on the environment and environmental sustainability.

4.1. Main reasons for using digital technology in European companies

First, we look at the reasons why companies use digital technologies and the areas where digitalisation is taking place in their operations. This is shown in *Table 2*, broken down by company size. Based on the survey, the following reasons were identified by companies, ranked in order of importance. The results of the research show that, overall, large companies have a higher-than-average identification with the motivations examined in the study. When analysing the specific data, the development of products and services emerged as the top priority for all business categories, with 76% of large enterprises and 66% of micro enterprises, particularly in supporting digitalisation. In addition, sustainability considerations, such as “ecological” motivations for the use of ICT technologies, were also more frequent among large enterprises. The results clearly show that both the adoption of digitalisation and its economic role increase with the size of the company.

Table 2: Main reasons for digital technology use by company size (% of companies)

Description	Micro	Small	Medium-sized	Large enterprise
Improve products or services	66	71	72	76
Reduce operating costs	67	69	73	76
Opportunities to grow the business	63	67	70	70
Capture information or metrics	64	68	67	68
Improve customer experience	58	61	62	65

Description	Micro	Small	Medium-sized	Large enterprise
Decrease environmental footprint	57	58	60	62
Increase sales	53	57	53	54
Virtualise products/services	45	45	46	54
Reduce the use of raw materials or other inputs	40	42	44	47
Reorganise value chain	37	40	45	46

Source: edited by the authors based on European Comission, 2021b, N=3404

Overall, large enterprises are integrating digital technologies more intensively and more widely into their business processes, thus exploiting the opportunities offered by digitalisation to a greater extent than smaller enterprises. The study by (Csiszár, 2023) also emphases that the uptake of digital technologies by businesses remains uneven, varies depending on the technology concerned and varies significantly between Member States and economic sectors.

4.2. Main reasons for using digital technology in Hungarian companies

We examined the main reasons for digital technology use in domestic firms relative to the 27 EU Member States (*Figure 2*). The results illustrate the percentage of firms that identified the following factors as reasons for technology use. When comparing the data, we see that while EU companies use digital technologies primarily to improve products or services, reduce their operating costs (70-70%) and grow their business, in contrast to the EU average, domestic companies use digital technologies mainly to capture information and metrics and decrease their ecological footprint (59%). The least important aspect for companies in both the EU and Hungary is the reorganisation of the value chain. The biggest difference in the reasons given by EU and domestic companies is also found in this area and in the improvement of products or services.
It may be interesting to note that while in the EU27, product/service development is the main reason, it is not present at all in Hungary's top three. Likewise, reducing the ecological footprint is a top priority for Hungary, but does not feature in the EU27 top3.

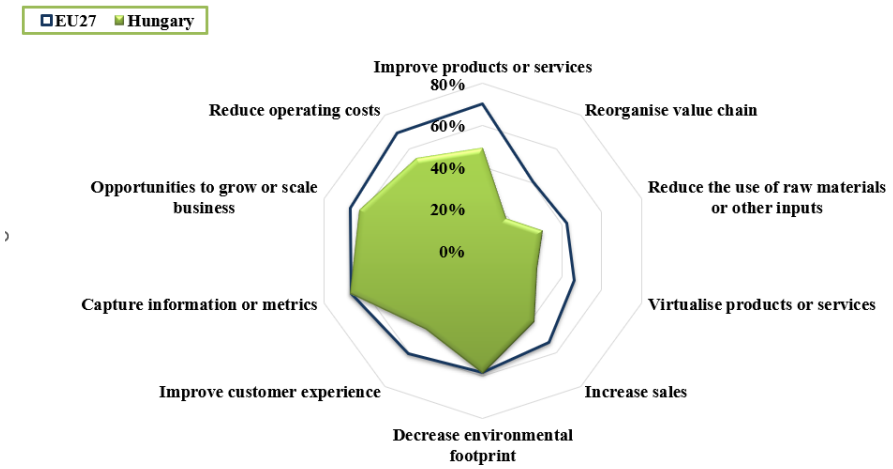

Figure 2: ***Main reasons for using digital technology***
Source: edited by the authors based on European Commission, 2021b N=604 (HU); N=3404 (EU27)

4.3. The impact of digital technologies on your company's environmental footprint

The authors examined how companies perceive the impact—whether positive or negative—of the digital technologies they employ on their environmental footprint, underscoring that these perceptions may not necessarily reflect the actual environmental consequences. The figures below (*Figures 3 and 4*) show the results for each technology, according to whether businesses judged it to have a positive impact, a negative impact, neutral (that is no impact) or could not know it. In the figures, each technology is ranked in descending order of high positivity value, illustrating which technologies are perceived to have a greater impact on the environmental footprint of the business. The findings indicate that collaborative platforms hold a prominent position among ICT tools utilized by businesses, specifically as digital technologies with the most substantial positive influence on reducing environmental footprints. Seventy-eight percent of EU enterprises evaluated the environmental impact of collaborative platforms as either very positive or highly significant. Subsequently, cloud computing and smart robotics exhibited significant beneficial effects. In contrast, the adverse environmental effects linked to these technologies were negligible.

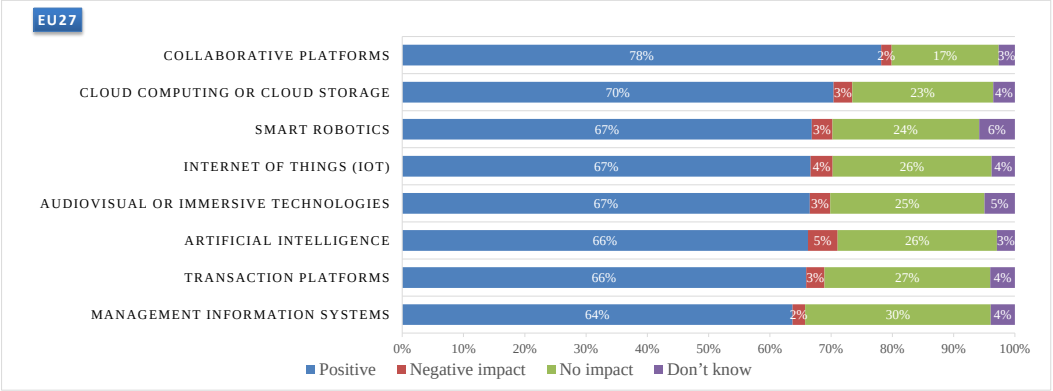

Figure 3: The impact of applied digital technologies on the environmental footprint, EU27

Source: edited by the authors based on European Commission, 2021b, N=3404

However, 5% of businesses using artificial intelligence and 4% of those using the Internet of Things reported that the use of these technologies had a negative impact on the environmental footprint of their business. However, collaboration platforms (2%) and management information systems (2%) have the least negative impact on the environmental performance of companies. The research did not provide a detailed explanation of the precise nature of the negative impacts and although only a small percentage of businesses report that these technologies have a negative effect, the actual environmental costs could be significant. For instance, artificial intelligence relies heavily on data centers, which consume vast amounts of electricity and require significant cooling, leading to substantial carbon dioxide emissions. Similarly, IoT devices often lead to increased electronic waste and their production involves the extraction of rare minerals, which has considerable environmental impacts.

Comparison of EU results with domestic outcomes reveals the following trends. In general, Hungarian companies rated the use of the above-mentioned digital technologies as having a lower impact on their environmental performance than the EU average. The largest difference is in the case of artificial intelligence, as Hungarian companies overall perceive artificial intelligence as having the least positive impact on reducing their environmental footprint of all digital technologies, with many even rating it as having a negative impact, but with the highest proportion of companies unable to assess the impact of the technology. There is also a mixed picture of which

types of ICT are most positively assessed in each country as having an impact on business performance. When looking at the top 3 areas in the EU27 and Hungary, collaboration platform leads, followed by cloud computing, management information systems in Hungary comes third and smart robotics in the EU. In Hungary, the most divisive area is in the assessment of the potential of artificial intelligence, with the highest perception of negative impact and the highest uncertainty in this category, with a quarter of businesses unable to assess whether ICT has any impact on their environmental performance.

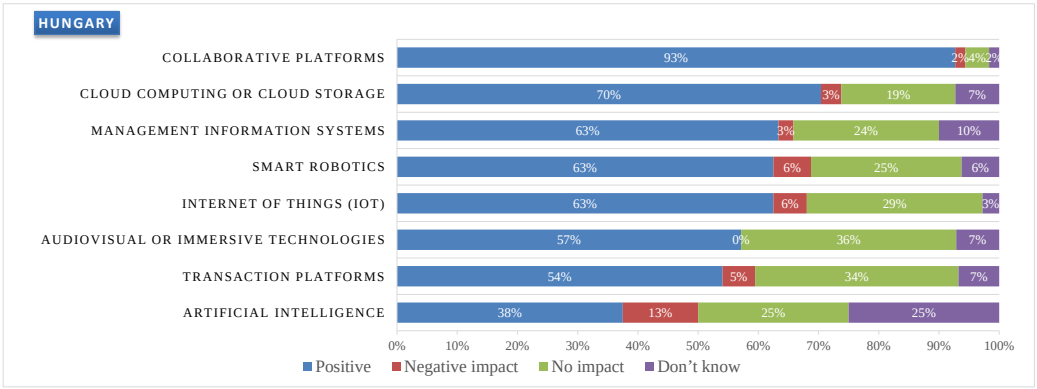

Figure 4: Impact of applied digital technologies on the environmental footprint in Hungary

Source: edited by the authors based on European Commission, 2021b, N=604

Figure 5 below shows companies' views on the extent to which they agree that the digital technologies used by their company can have an impact on different environmental dimensions. The figure shows the percentage of respondents who fully or partially agree with the statement. Pollution prevention, greenhouse gas reduction and climate change management show the highest percentages. EU27 companies tend to show higher levels of agreement than Hungarian companies on all environmental dimensions, which may indicate either a higher level of digital inclusion or greater confidence in the environmental benefits of digital technologies. The biggest differences are observed in the protection of biodiversity and the sustainable use of water resources, which can probably be explained by territorial characteristics.

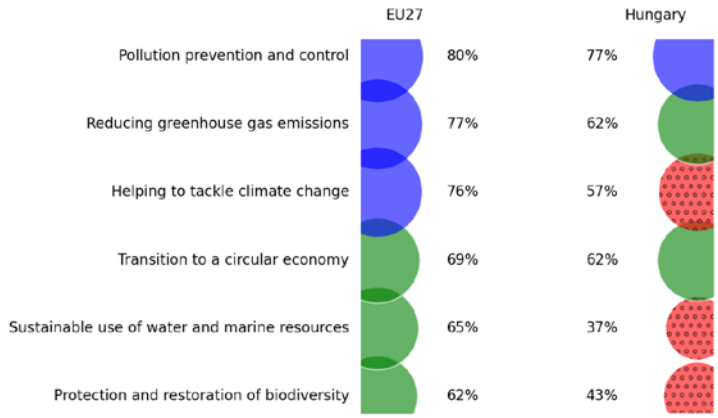

Figure 5: Assessing the environmental impact of digital technologies

Source: edited by the authors based on European Commission, 2021b, N=604 (HU); N=3404 (EU27)

Overall, the data reflect a strong link in the potential of digital technologies to address environmental challenges. Differences between Hungary and the EU in general may reflect differences in technology adoption, sectoral composition or environmental policy focus. Further studies may be useful to better understand and address these factors. The survey also looked at the areas where digital technologies used by companies have helped them.

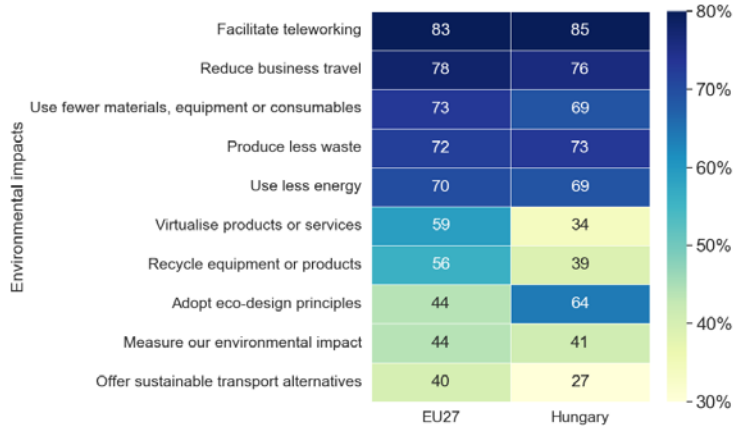

Figure 6: Impact of digital technologies on environmental sustainability, EU27-Hungary

Source: edited by the authors based on European Commission, 2021b, N=604 (HU); N=3404 (EU27)

Figure 6 shows the proportions of businesses that answered yes to the question that digital technology had helped them in this area. Of these areas, EU businesses reported that digital technologies helped them most in facilitating teleworking (83%) and reducing business travel. In addition, the areas of using less materials, less waste or using less energy were also mentioned relatively often by businesses. According to EU companies, ICTs contributed least to sustainable transport alternatives (40%), adopting green design principles and measuring environmental impact. Hungarian companies are around the EU average in terms of the areas where digital technologies help them, with only a few areas that differ, one positive and three negative. Hungarian companies are well above the European average in adopting eco-design principles, while they are well below the European average in virtualisation of products or services, recycling of equipment or products and sustainable transport alternatives.

The authors analyzed the relationship between digital technologies and environmental measures (*Figure 7*) by assessing levels of agreement with specific statements. *Figure 7* illustrates the proportion of responses indicating either a strong or moderate level of agreement, highlighting the perceived alignment between digital technology adoption and positive environmental outcomes.It appears that businesses have different views on the link between digital technologies and sustainability. The analysis reveals that over half of Hungarian businesses recognize digital technologies as accelerators of environmental initiatives. Examining the frequency of environmental actions among businesses, findings indicate that highly proactive companies in environmental matters are more likely than average to support both positive views on digital technology's role. The study also explores how EU businesses utilize ICT to advance environmental sustainability. In Hungary, businesses report a lower perception of digital technologies' impact on their environmental footprint (73%) compared to the EU27 average (81%).

Additionally, the influence of environmental objectives on technology choices appears consistent across both groups, suggesting a comparable integration of sustainability factors in technology-related decisions. However, technology acceleration driven by environmental measures is notably

lower in Hungary (46%) than the EU27 average (60%), possibly reflecting a slower pace of green innovation adoption.

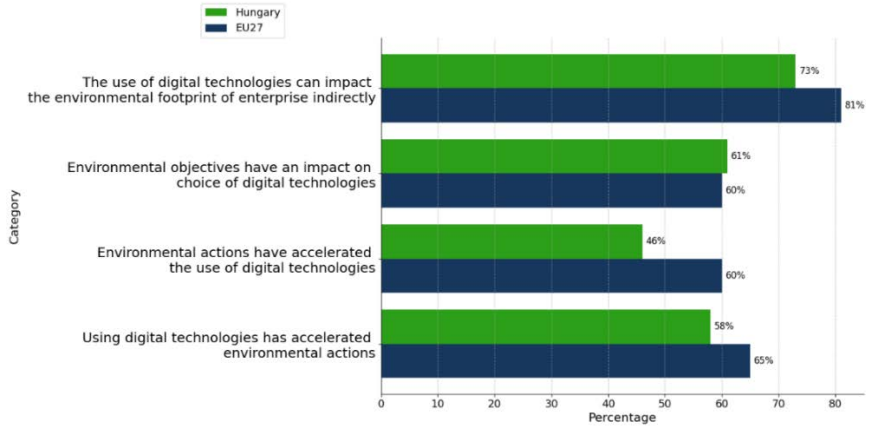

Figure 7: The link between digital technologies and environmental measures
Source: edited by the authors based on European Commission, 2021b, N=604 (HU); N=3404 (EU27)

The impact of digital technologies on environmental protection measures is also lower in Hungary compared to the EU27, which may indicate that the introduction of digital tools has not triggered as much environmental improvement in Hungary as the EU average. Overall, these results suggest that more attention needs to be paid to the integration of digital technologies and environmental protection in Hungary to ensure that innovations contribute more effectively to achieving sustainability goals. This issue was also examined in terms of how the degree of digitalisation influences the results obtained. The results show that, in line with the EU average, both less digitised and highly digitised companies are slightly more likely to say that the use of ICT has accelerated their environmental activities, rather than that environmental measures have accelerated the use of ICT. The level of agreement for each statement varies depending on the digital intensity of the business. Highly digital businesses are more likely to acknowledge the link between digital technologies and sustainability. This comparative analysis shows that the link between digital technologies and sustainability may vary across countries and that the level of agreement may partly depend on the digital sophistication and environmental sensitivity of businesses.

5. Conclusions

The study supports the claim that the use of ICT plays a significant role in the environmental sustainability actions of EU enterprises. The research has shown that while ICT can significantly enhance environmental performance by optimizing resources and reducing carbon footprints, the actual utilization and effects of such technologies can be inconsistent across different enterprises sizes and sectors. Larger enterprises are more likely to integrate digital technologies extensively into their operations, realizing greater benefits from digitalization compared to smaller companies. Digital technologies effective adoption and the realization of potential benefits depend greatly on company size and the capacity to implement such technologies. Enterprises, especially in Hungary, should invest in thorough impact assessments of their technology use to ensure that the environmental benefits are maximized and the adverse effects are minimized. Furthermore, the comparison between EU and Hungarian companies reveals that Hungarian firms are somewhat behind in acknowledging the environmental benefits of digital technologies, particularly in areas like artificial intelligence where there is a significant perception of negative impact. This indicates a need for Hungarian companies to enhance their understanding and management of digital tools

to better align with environmental sustainability practices observed in other EU countries. This analysis also points to a broader implication for policy-makers and business leaders: to foster an environment where digital technologies are not only adopted but are also effectively utilized to advance sustainability objectives. Encouraging the adoption of green ICT practices, supporting smaller enterprises in their digital transformation, and promoting rigorous impact assessments could bridge the existing gap between perceived and actual impacts of digital technologies. The results will allow companies to further develop their use of digital technologies for sustainability, which could contribute to improving the environmental performance of the whole region.

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