

# Hungary's digital economy and society maturity in the light of DESI 2022

**Andrea Tick**

Óbuda University, Keleti Károly Faculty of Business and Management,  
[tick.andrea@kgk.uni-obuda.hu](mailto:tick.andrea@kgk.uni-obuda.hu)

*Abstract: Numerous digital services are available in our current economy and society, such as public and business services, which enhance efficiency and convenience for citizens. There has been notable advancement in digitalizing education, social media, and entertainment. However, individuals require digital competencies to utilize these services effectively, making digital competency a critical prerequisite for optimal use. The ongoing development of digital services and digital competencies among society members is crucial for the competitiveness of the economy and society. This paper highlights areas where development is suitable and where improvement is necessary, considering factors such as time, society, countries, and regions. The paper focuses on Hungary and evaluates its maturity applying the Digital Economy and Society Index. It recognizes the significance of education and awareness in strategic areas that will shape our future.*

*Keywords: DESI, DII, Network Readiness Index, Hungary, Digital intelligence, Digital competences, Digital Readiness, Digital Maturity, SME*

## 1 Introduction

In 2023, Hungary's digital economy and society have made significant strides, positioning the country as a notable player in the digital landscape. With a focus on fostering innovation, technological advancement, and digital inclusion, Hungary has achieved remarkable maturity in its digital economy and society, however, there is always some space to develop and improve. The nation has witnessed a rapid expansion of its digital infrastructure, including robust broadband networks and advanced mobile connectivity, enabling seamless digital communication and access to information for its citizens. Furthermore, Hungary has invested heavily in cultivating a thriving startup ecosystem, nurturing entrepreneurial talent, and promoting digital entrepreneurship. This has contributed to the emergence of innovative digital solutions and a vibrant tech industry. Moreover, Hungary has prioritized digital literacy and skills development, ensuring that its population is equipped with the knowledge and capabilities needed to thrive in the digital era, despite the fact that it is not reflected in the (self-)assessment of the people. As a result, Hungary's digital economy and society have flourished, driving economic

growth, improving public services, and enhancing the overall quality of life for its citizens.

## **1.1 Situation in Hungary today**

Hungary's digitalization efforts have resulted in an increasingly digital economy and society, which brings forth a wide array of services. These services not only enhance the efficiency and productivity of the economy but also provide convenience to citizens while expanding opportunities. In the public sector, services such as eEsz, eRecipe, eHungary, and NAV have been introduced, streamlining administrative processes and facilitating interactions between the government and its citizens. Additionally, the business sector has embraced digitalization, offering a plethora of services like e-tickets for transportation (MÁV, BKV, theaters, cinemas), SmartBank for online banking, and online shopping platforms.

Furthermore, digitalization has revolutionized communication in Hungary, enabling people to connect effortlessly. Popular messaging applications such as Skype, WhatsApp, Telegram, and Messenger have become integral parts of daily interactions, allowing individuals to stay connected with friends, family, and colleagues across distances. Education has also experienced a significant shift towards digital platforms. Due to the emergency remote teaching during the COVID-19 pandemic platforms like Teams, Zoom, GoogleMeet and Webex have become an integral part of teaching practices. These digital tools have provided new opportunities for learning and collaboration, making education more accessible and flexible [1].

Moreover, digitalization has profoundly impacted the realm of entertainment and leisure. Social Media like Facebook, Twitter, streaming platforms like Netflix, HBOGo, Spotify, and Pandora have gained immense popularity, offering a wide range of content and experiences to entertain and engage individuals. Additionally, the concept of remote work has been widely embraced, with home offices becoming a new way of working. This transition has been facilitated by digital technologies, enabling professionals to work efficiently from the comfort of their homes, fostering flexibility and work-life balance [2], [3].

This paper presents three indicators – the Digital Economy and Society Index (DESI), the Network Readiness Index (NRI), the Digital Intelligence Index (DII) – and evaluates Hungary's situation in light of these index numbers. Furthermore, it evaluates the Digital Readiness Level, presents a Digital Maturity Model and assesses SMEs' position in relation to these models. Finally, it links the findings to the digital maturity of the population in order to understand why education and training is a key component in achieving a higher digitalization status and growth rate.

## 2 Digital Economy and Society level in Hungary

### 2.1 The Digital Economy and Society Index

The Digital Economy and Society Index (DESI) has been a vital tool for the European Commission to monitor the digital progress of Member States since 2014 [4]. The DESI reports provide a comprehensive analysis of Europe's digital performance by utilizing a composite index, which incorporates various indicators that are relevant to the digital landscape, offering a summary of each country's digital development [5].

The primary purpose of the DESI is to track the evolution of EU Member States across four main dimensions of digitalization, namely (1) digital public services, (2) digital skills of the human capital, (3) integration of digital technologies and (4) connectivity (Figure 1). By assessing these key aspects, the DESI reports enable policymakers and stakeholders to gain insights into the overall digital performance of each country. This monitoring mechanism plays a crucial role in identifying areas of strength and areas that require improvement, facilitating evidence-based policy-making and promoting the development of a digitally inclusive and competitive European Union.

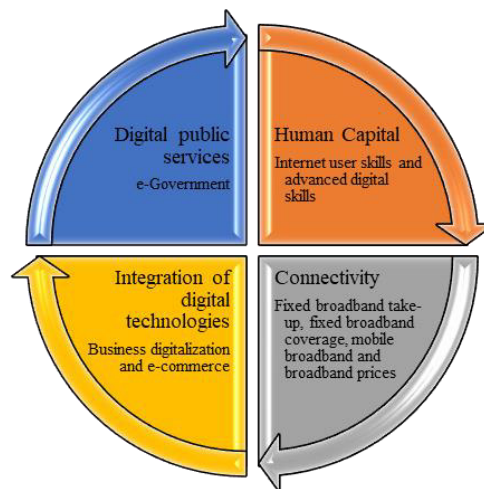


Figure 1.

Structure of DESI 2021 (Source: Developed by author)

The EU member states have achieved a different state of digital economy and society. Northern EU states like Finland, Denmark, the Netherlands and Sweden lead the group gaining a high level of digitalization in each aspect of the Index. On the other hand, Hungary is lagging behind the EU average (52.3) and takes the 22<sup>nd</sup> place with its combined 43.8 score (Figure 2) [6].

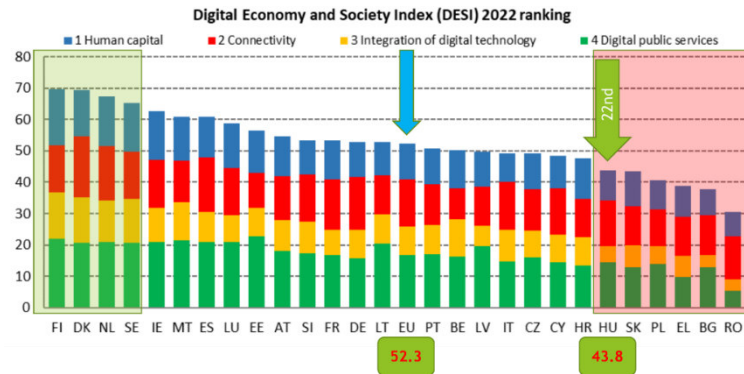


Figure 2.

Digital Economy and Society Index, 2021 [4]

Analyzing member states Figure 3 shows the average yearly growth in scores and in percentage in relation to the countries' 2017 DESI score. In the case of Hungary in the period between 2017 and 2022 the state of digital economy and society is at a lower level compared to the most developed countries, its relative growth rate is higher than those of the flagship countries. However, as the average yearly growth rate for Hungary is under the convergence curve, the country slightly underperforms while the countries over the curve perform better than what convergence curve shows.

In relation to the absolute growth the countries with higher digital economy and society index develop more than the countries in the bottom end, despite their growth rate being lower.

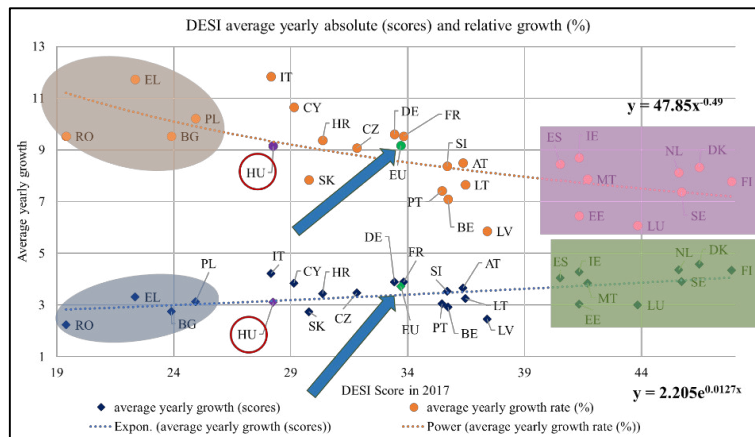


Figure 3.

DESI – Member States' progress, 2017-2021 (source: developed by author based on [4])

Compared to the EU average Hungary followed the EU growth trend between 2017 and 2022 and managed to gain 1.5 times higher DESI score by 2022 (Figure 5).

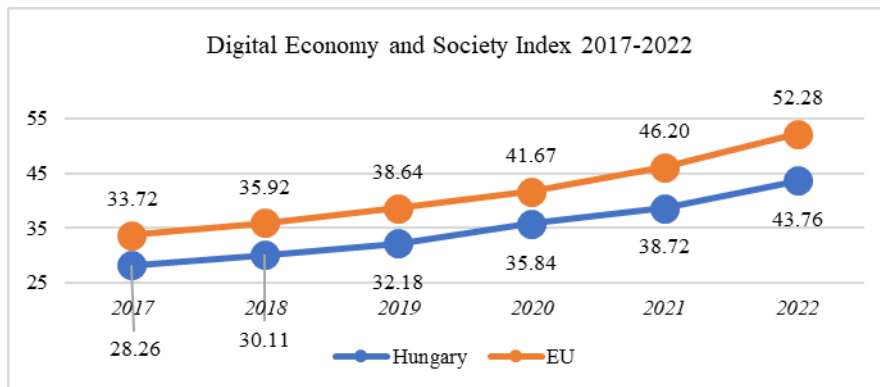


Figure 4.

Hungary's DESI index (scores) compared to the EU 2017-2022 (Source: developed by the author based on [4])

However, in detail Hungary outperforms in the field of Connectivity and Digital Public Services while there is serious lack in digital skills (Human Capital) and in the field of Integration of digital technologies (Figure 6).

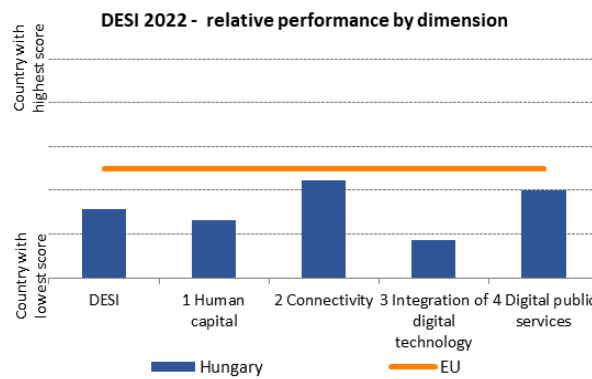


Figure 5.

DESI 2022 –relative performance by dimension [5]

The Connectivity indicator performed the best, putting the country to the 13<sup>th</sup> place in the EU (scores 57.6). Each sub indicator continuously improves, as for example there is a 97% fast broadband coverage, 84% mobile broadband take-up among individuals and 83% overall fixed broadband take-up. There is still room in the 5G coverage to develop (18% of populated area).

Regarding digital public services Hungary is the 21<sup>st</sup> with a score of 57.4. The sub indicators are slowly improving, 81% of the internet users are also e-Government

users, and as part of the digital government, there is a 64% rate of digital public services to citizens and 74% rate of digital public services to businesses.

The Human Capital indicator scored 38.4 (23<sup>rd</sup> among the EU countries), which level is even worse compared to the 2021 level. 49% of the population had at least basic digital skills, while only 22% of the population had digital skills above the basics [6]. Out of the active population (aged 15-74) a mere 3.9% are ICT specialists and an even lower rate of graduates got degree in ICT field (3.1%).

The Integration of digital technology shows the least positive picture; Hungary is the 25<sup>th</sup> among the EU countries scoring 21.6. The numbers show a positive trend with time, however, the rate of integration of digital technologies in industry, trade and services by SMEs and enterprises is still extremely low. In the case of enterprises, 21% of them share information electronically, 13% of them use social media, 7% of them take advantage of Big data possibilities, 21% of them use cloud services, 3% of them deploy Artificial Intelligence and 13% issue e-Invoices. In the case of SMEs, 34% of them operate with at least a basic level of digital intensity, 18% of them sell online out of which 7% sell online cross-border.

In summary, Hungary has good connectivity and a relatively wide scale of digital public services, however, both the human and the business sectors (enterprises and SMEs as well) need serious improvement to catch up with the digitally more developed countries.

## **2.2 Network Readiness in Hungary**

The Network Readiness Index (NRI) is a comprehensive assessment of a country's ability to leverage information and communication technologies (ICTs) for social and economic development [7]. It provides an overall measure of a nation's preparedness to participate in the digital economy and harness the benefits of the digital revolution. The NRI takes into account various factors such as ICT infrastructure, affordability, skills and education, regulatory environment, and the social and economic impact of ICTs. By analyzing these indicators, the NRI offers valuable insights into a country's strengths and weaknesses in terms of its digital readiness and highlights areas that require attention and improvement. Governments, policymakers, and businesses can utilize the NRI to identify areas for investment and policy reforms to enhance their digital ecosystems and foster inclusive growth. It serves as a benchmarking tool that enables countries to assess their progress and compare themselves with their peers on a global scale. Ultimately, NRI plays a crucial role in guiding nations towards building resilient and thriving digital economies in an increasingly interconnected world.

The network Readiness of Hungary shows similar results as for DESI. As seen in Figure 7, Hungary needs to improve on Skills and education (People) and Technology, the points for these aspects lowered from 2021 to 2022, while the

points for the regulatory environment and the economic and social impact of ICTs increased.

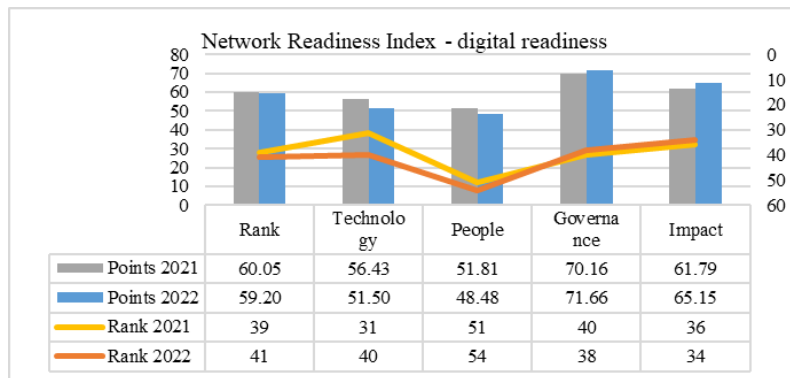


Figure 6.

Network readiness index (Source: developed by authors based on [7])

### 2.3 Digital Intelligence in Hungary

The Digital Evolution is a comprehensive tracking system that assesses the state and momentum of the global economy's digitalization process [8]. Covering 95% of the world's population over a twelve-year period from 2008 to 2019, this measurement, known as the Digital Intelligence Index (DII), offers valuable insights and guidance for both businesses and policymakers in their pursuit of digital growth. The DII is determined by two primary factors: the current state of digitization and the pace of digitization over time. It segments countries into four distinct categories based on their digital development (Figure 8).

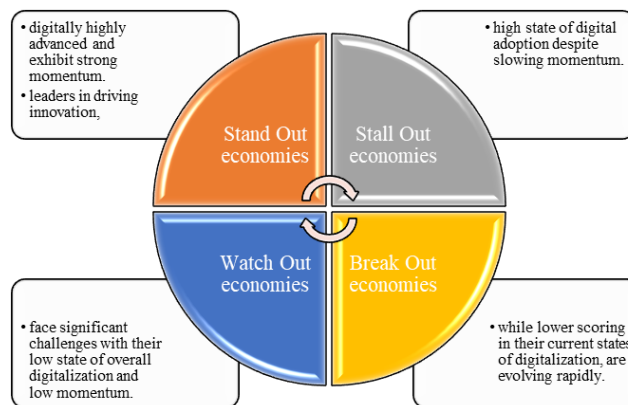


Figure 7.

Digital Intelligence Index segmentation

The *Stand Out* economies are highly advanced digitally and demonstrate strong momentum, positioning themselves as leaders in driving innovation. *Stall Out* economies, on the other hand, have achieved a high level of digital adoption but experience a slowdown in momentum [9]. *Break Out* economies may have lower scores in their current state of digitalization, but they are evolving rapidly and show great potential for future growth. Finally, the *Watch Out* economies face significant challenges with their overall low level of digitalization and lack of momentum. By categorizing nations in this way, the DII enables stakeholders to identify areas of strength and weakness, providing valuable insights for strategic decision-making and targeted interventions to foster digital transformation.

Considering Hungary's position, it needs to be highlighted that despite the initiatives and the Digital Success Program [10], Hungary still needs to make serious effort to catch up even with the neighboring and further Eastern-Central European countries. The countries that used to belong to the socialist block are either at a better Digital Evolution Momentum (Figure 10), as for instance Kazakhstan, Russia and the Eastern Central European countries like Croatia, Slovakia, Slovenia, or Czechia or are developing faster as the V4 countries, Slovenia and Slovakia, etc. As classical economic theory would presume, Hungary which is at a lower digital evolution momentum, should develop at a faster rate.

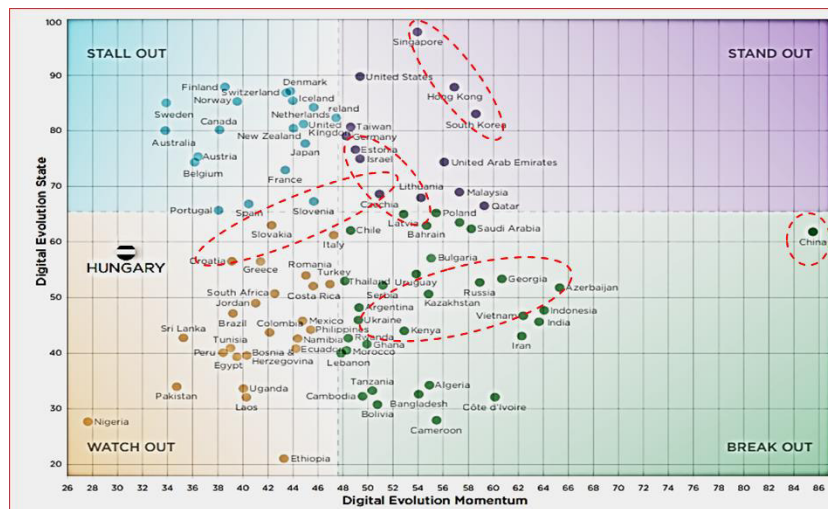


Figure 8.  
Countries on the Digital Planet Map [8]

## 2.4 Digital Readiness Level

Several research compiled digital maturity models [11]–[16], some defining a three pillar model while others define four [17], [18] or five pillars for digital maturity [19], [20]. Each digital maturity framework aims at measuring and enhancing digital



maturity, and emphasizes that pillars must be in balance, otherwise an enterprise cannot step forward in the path of digital transformation. The three-pillar framework focuses on three key pillars and ten distinct features. The first pillar is *leadership*, encompassing overall vision and fostering a culture of innovation within an organization. The second pillar is *technology*, which involves evaluating the effectiveness of technology infrastructure, processes, and systems, as well as creating external networks. The third pillar is *value*, which includes assessing skills, workforce performance, optimized operations, and the optimization of external networks. By utilizing this comprehensive framework, organizations can gain insights into their digital maturity and identify areas for improvement, ultimately driving their digital transformation initiatives forward.

Deloitte's Digital Maturity Model [20] is an industry-standard assessment tool that plays a crucial role in evaluating an organization's digital capability. By examining five well-defined business dimensions, which encompass 28 subdimensions, this model offers a comprehensive view of an organization's digital maturity across its various functions. The assessment provides valuable insights that enable benchmarking against industry standards, allowing organizations to gauge their digital performance relative to their peers. Moreover, the model assists in identifying gaps in digital capabilities, enabling organizations to establish key areas to prioritize and determine where to begin their digital transformation journey.

The first dimension of the Digital Maturity Model is the *customer*. This dimension emphasizes the importance of providing customers with a seamless digital experience, where they perceive the organization as their digital partner. By leveraging their preferred channels of interaction, organizations can empower customers to take control of their connected future both online and offline. The *strategy* dimension focuses on how businesses transform and operate to gain a competitive edge through digital initiatives. It emphasizes the integration of digital strategies within the overall business strategy. The *technology* dimension underpins the success of digital strategy by enabling the creation, processing, storage, security, and exchange of data, all of which are essential for meeting customer needs at low costs and minimal overheads. The *operations* dimension highlights the execution and evolution of processes and tasks through the utilization of digital technologies, driving strategic management and enhancing overall business efficiency and effectiveness. Lastly, the *organizations and culture* dimension stresses the significance of defining and developing an organizational culture with appropriate governance and talent processes to support progress along the digital maturity curve. This flexibility allows organizations to achieve their growth and innovation objectives in the digital era.

## **2.5 Journey to digital maturity**

Embarking on the journey towards digital maturity involves several key steps. The first step is for organizations to assess their current position in their transformation

journey. This involves evaluating their digital capabilities, strengths, and weaknesses to establish a baseline. Once this assessment is complete, organizations can then create goals and develop plans for their digital transformation. These goals should encompass both short-term and long-term objectives, outlining the desired outcomes and milestones to be achieved along the way. As part of this journey, organizations must also make strategic investments in impactful transformation projects. These projects can vary depending on the organization's current digital maturity level, which can range from being a digital outsider to a digital expert or champion. By investing in the right initiatives and leveraging digital technologies effectively, organizations can progress along the maturity spectrum, ultimately becoming digital leaders in their industry.

The journey to digital maturity encompasses several stages, starting from being a Digital Outsider and progressing towards becoming a Digital Champion [21], [22]. In the initial stage, the *Digital Outsider*, organizations have limited or no digital presence, lacking the necessary infrastructure and awareness of digital technologies (Figure 9).

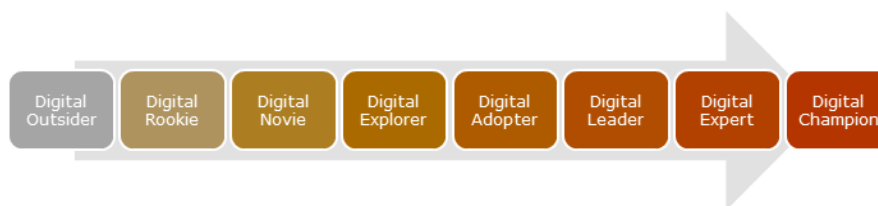


Figure 9.

Digital Readiness Level - From Outsider to Champion [22]

As they begin their digital transformation, they transition to the *Digital Rookie* stage, where they start experimenting with digital tools and strategies, albeit with limited understanding and implementation. The next stage, the *Digital Novice*, indicates a deeper engagement with digital technologies, accompanied by a growing understanding of their potential. As organizations continue to invest in digital capabilities and broaden their knowledge, they become *Digital Explorers*, actively seeking innovative solutions and experimenting with emerging technologies. The subsequent stage, the *Digital Adopter*, signifies a significant integration of digital practices and technologies into various aspects of the organization, resulting in increased efficiency and effectiveness. As the journey progresses, organizations strive to become *Digital Leaders*, excelling in digital innovation, customer experience, and business transformation. The next stage, the *Digital Expert*, represents organizations that possess advanced digital capabilities, leveraging cutting-edge technologies and data-driven insights to drive continuous improvement and gain a competitive edge. Finally, the pinnacle of the journey is reached when an organization becomes a *Digital Champion*, recognized as a leader in their industry, consistently pushing the boundaries of digital innovation and setting the standard for others to follow. Each stage in this journey represents a

significant step forward in digital maturity, and organizations must navigate through these stages to remain competitive and relevant in the rapidly evolving digital landscape.

### **3 Potentials of digitalization for SMEs**

The digital transformation journey of small and medium-sized enterprises (SMEs) is driven by two key factors: firmographics and behavioral characteristics. Firmographics, encompassing the size, sector, age of business, staff profile, and product/service type, play a crucial role in shaping an organization's digital strategy. Understanding these factors helps SMEs tailor their digital initiatives to suit their unique context and requirements. Additionally, behavioral characteristics, such as digital readiness, tech adoption profile, and attitude towards growth and business risk, greatly influence the pace and extent of digital transformation. Digital readiness, in particular, has become increasingly important as SMEs strive to adapt to the "new normal" and navigate the digital landscape effectively. The concept of the digital divide highlights the gap in skills, readiness, financing, and attitudes towards growth and the use of digital technology. SMEs that successfully cross this divide are able to enhance their digital capabilities and embrace new ways of working. By embracing digital tools, technologies, and strategies, SMEs can improve their operational efficiency, expand their market reach, and foster innovation. It is essential for SMEs to recognize the significance of these factors and proactively address them to unlock the full potential of their digital transformation efforts.

#### **3.1 Categories of SME digital readiness to respond to COVID-19**

The COVID-19 pandemic had a significant impact on small and medium-sized enterprises (SMEs), with their response varying based on their digital readiness. The crisis highlighted the importance of digital capabilities in ensuring business continuity and resilience. As we transition to the post-COVID business environment, SMEs need to adapt in two key dimensions: their level of digital readiness and their ability to adjust to the new normal [23] (Figure 10).

Some SMEs may fall into the category of "Fadeaways," struggling to survive as they lacked sufficient digital readiness and failed to adapt effectively. On the other hand, the "Reinventors" seized the opportunity to transform their business models, leveraging digital technologies to meet evolving customer needs and capture new market opportunities (traditional retail shops, hospitality, events). The "Adaptors" demonstrated flexibility by quickly adjusting their operations and adopting digital

tools to remain competitive (construction, manufacturing and traditional professional services).

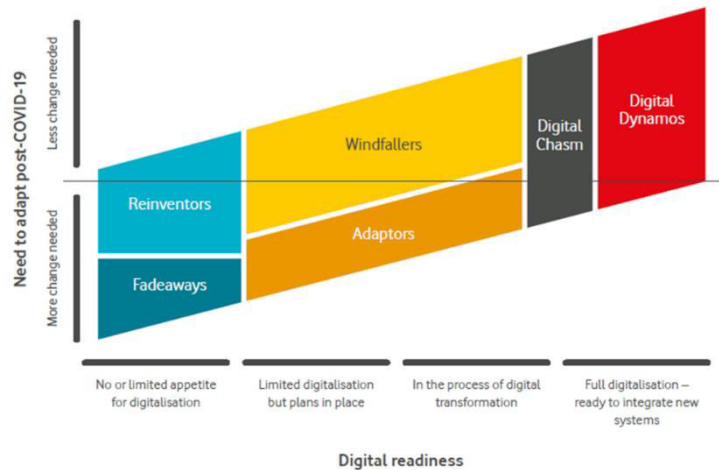


Figure 10.

Digital maturity of SMEs - From Fadeaways to Digital Dynamos [23, p. 13]

The "Windfallers" experienced unexpected success during the pandemic due to their existing digital readiness, enabling them to capitalize on emerging trends (legal services, insurance, logistics, healthcare). However, the crisis also exposed the "Digital Chasm," or "Digital Divide" the gap between digitally advanced and digitally lagging SMEs. Bridging this gap requires concerted efforts to provide support, resources, and training to enhance digital readiness among SMEs. Lastly, the "Digital Dynamos" were already digitally mature and continued to thrive in the post-COVID environment, leveraging their advanced digital capabilities to maintain their competitive edge (software, online retailers and banking and financial services). Overall, adapting to the post-COVID business environment entails a focus on digital readiness and the ability to embrace digital transformation as a strategic imperative for long-term success. The most digitalized SMEs have identified new business opportunities during COVID-19 at more than double the rate of the least digitalized.

### 3.2 Supporting SMEs to cross the digital divide

According to the Vodafone Policy Paper [23] government can help and support SMEs to be able to step forward in the long path from Fadeaways to Digital Dynamos by providing a flexible and guided digital investment scheme, providing training programs, access to high-speed connectivity, thus closing the connectivity gap. These governmental programs should be provided to the SME that have not crossed the Digital Chasm or Digital Divide.



Figure 11.  
Governmental support options for SMEs [23, p. 23]

#### 4 Are we digitally mature?

A survey in 2019 by [24] served to explore the digital maturity of the population in Hungary. According to the results (Figure 12) 61% of the population aged between 15 and 75 still considers themselves digitally immature and 20% of the population believe that they are digitally mature. The rest of the population is digitally open, which shows a positive attitude.

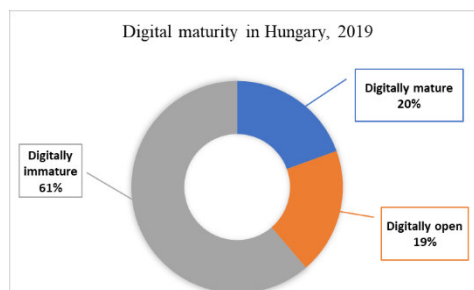


Figure 12.  
Distribution of population aged 15-75 by digital maturity (source: developed by author based on [24])

The low level of digital maturity needs to be developed in the near future. The Digital Divide in the population is also due to the different level of “digitalization” of the groups in the Digital Society. The digital landscape can be divided into several groups based on individuals' engagement with technology [25]. *Digital hermits* are those who rarely use technology, either due to economic constraints or a deliberate choice to avoid overwhelming stimuli or trust issues. However, with workplaces increasingly demanding computer proficiency, this state cannot be sustained for long. *Explorers* have taken initial steps into the digital world, but their engagement feels more compelled than voluntary. *Nomads*, while still uncertain and insecure, use the web primarily as an additional source of information, relying more on traditional mediums like books. *Wanderers* show greater involvement than nomads but lack at least one of the eight essential qualities of settlers. *Settlers*, on the other hand, are considered ideal citizens of the information society. They possess qualities such as multitasking ability, online administration skills, adaptability to new websites, extensive digital communication, and a strong presence on social media. They heavily rely on web-based information sources and enthusiastically embrace multimedia devices. Finally, *conquerors* represent the most digitally advanced group, fully immersed and proficient in the digital realm. As for SMEs the Digital Divide split the citizens into one who crossed the Digital Divide line and the ones who have not (hermits, Explorers, Nomads and Wanderes).

Thirdly, the challenges stands at the Z and  $\alpha$  generations, since despite of their digital exposure to t digital technology and the digital society, they are still not digitally mature (Figure 13).

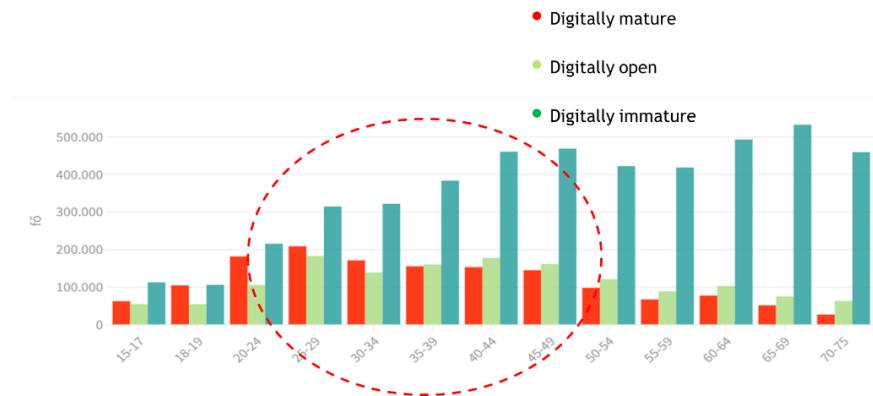


Figure 13. Age group distribution by digital maturity in Hungary 2019 [24]

The percentage distribution of age groups by digital maturity clearly shows that in the active population the proportion of population with digital maturity is low compared to digital immaturity and digital openness. The situation in Hungary calls for further digitally intensive trainings and trainings to improve digital skills and

competences. Citizens, similarly to SMEs, need to be supported to reach the skills and competence level of Digital Conquerors, since SMEs that are getting more and more digitalized will need labor force with high digital skills and competences and members of the Z and  $\alpha$  generations entering the labor market without digital maturity will not be able to fulfill the market and industry requirements and demand.

The Digital Competence Wheel is a possible tool to assess an individual's digital skills and competences [26]. Its purpose is to provide an overview of digital competences, and offer concrete and specific tools to how these competences can be elevated and improved. It serves as a valuable resource for individuals and organizations seeking to assess and develop their digital skills in an ever-evolving digital landscape.

## Conclusions

The various indicators and index numbers show some contradictions but converge in the case of Hungary. In Hungary as could be seen from the DESI, DII and NRI, the digitalization should speed up to reach the average yearly growth rate of the countries standing at the same digitalization level. A speeding up digitalization could move the Hungarian economy from the 'Watch out' to the 'Stall out' economy, reaching a double effect and achieving a higher digitalization momentum and digital evolution state. Since the country has a backlog in the Human Capital and the Integration of digital technologies, further training programs are required in the everyday operation of not only the SMEs, but already in schools and higher education to improve the digital skills and competences of people [27]–[29]. Further incentives are required to help SMEs to apply more and more digital tools and possibilities and transform their operational, manufacturing and administrative processes digital.

The Digital Chasm and Digital Divide could be narrowed with direct investments into SMEs being in the groups of Fadeaways, Reinventors and Adaptors. SMEs in the Adaptors category, which need more change and have limited digitalization but plans to digitalize are the easiest to support since these SMEs have the will to digitalize [30], [31]. These SMEs are also Digital Explorers, Adopters who could easily become Digital leaders in their economic sector.

The present research compared three index numbers and explored how Hungary perform according to these indicators. The situation of Hungarian SMEs in terms of digitalization and the digital maturity of SMEs and the population have also been discussed. The paper summarized what incentives can be provided and how education and training could boost digitalization and improve the country's performance.

## References

- [1] D. J. Cranfield, A. Tick, I. M. Venter, R. J. Blignaut, and K. Renaud, "Higher Education Students' Perceptions of Online Learning during COVID-19—A Comparative Study," *Education Sciences*, 11(8), pp. 403, Aug. 2021, doi: 10.3390/educsci11080403.
- [2] A. Tick, G. Szabó, and R. Zs. Reicher, "Contribution of a CRM System to the Creation of a Family-Friendly Working Environment," *ACTA POLYTECH HUNG*, 18(11), pp. 75–96, 2021, doi: 10.12700/APH.18.11.2021.11.5.
- [3] D. Cranfield, I. Venter, A. Tick, R. Blignaut, and K. Renaud, "THE E-LEARNING QUAGMIRE OF COVID-19: AN ACADEMIC PERSPECTIVE," in *INTED2023 Proceedings of 17th International Technology, Education and Development Conference*, Valencia, Spain, 2023, pp. 4716–4725. Accessed: Apr. 16, 2023. [Online]. Available: <https://library.iated.org/view/CRANFIELD2023ELE>
- [4] European Commission, "The Digital Economy and Society Index (DESI) | Shaping Europe's digital future." European Commission, 2022. Accessed: May 29, 2023. [Online]. Available: <https://digital-strategy.ec.europa.eu/en/policies/desi>
- [5] European Commission, "Digital Economy and Society Index (DESI) 2022 - thematic chapters," 2023. Accessed: Jun. 10, 2022. [Online]. Available: <https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2021>
- [6] European Commission, "Digital Economy and Society Index (DESI) 2022 - Hungary," 2023.
- [7] The Portulans Institute, "Network Readiness Index – Benchmarking the Future of the Network Economy," <https://networkreadinessindex.org/>, 2022. <https://networkreadinessindex.org/> (accessed Mar. 16, 2023).
- [8] The Fletcher School, "Digital Intelligence Index," *Digital Planet*, Dec. 01, 2020. <https://sites.tufts.edu/digitalplanet/digitalintelligence/> (accessed Jul. 15, 2023).
- [9] B. Chakravorti, R. S. Chaturvedi, C. Filipovic, and G. Brewer, "DIGITAL IN THE TIME OF COVID." The Fletcher School at Tufts University, 2020. Accessed: May 19, 2022. [Online]. Available: <https://sites.tufts.edu/digitalplanet/files/2021/03/digital-intelligence-index.pdf>
- [10] KFÜ, "Digital Success Programme," *About Digital Success Programme*, 2023. <http://digitalisjoletprogram.hu/en> (accessed Mar. 10, 2023).



- [11] A. Aras and G. Büyüközkan, “Digital Transformation Journey Guidance: A Holistic Digital Maturity Model Based on a Systematic Literature Review,” *Systems*, vol. 11, no. 4, p. 213, 2023, doi: 10.3390/systems11040213.
- [12] Á. Gubán and Á. Sándor, “A KKV-k digitálisérettség-mérésének lehetőségei,” *Vezetud*, 52(3), pp. 13–28, Mar. 2021, doi: 10.14267/VEZTUD.2021.03.02.
- [13] T. Haryanti, N. A. Rakhmawati, and A. P. Subriadi, “The Extended Digital Maturity Model,” *BDCC*, 7(1), pp. 17, Jan. 2023, doi: 10.3390/bdcc7010017.
- [14] R.-L. Ochoa-Urrego and J.-I. Peña-Reyes, “Digital Maturity Models: A Systematic Literature Review,” in *Digitalization*, D. R. A. Schallmo and J. Tidd, Eds., in *Management for Professionals*. Cham: Springer International Publishing, 2021, pp. 71–85. doi: 10.1007/978-3-030-69380-0\_5.
- [15] T. Thordsen, M. Murawski, and M. Bick, “How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models,” in *Responsible Design, Implementation and Use of Information and Communication Technology*, M. Hattingh, M. Mathee, H. Smuts, I. Pappas, Y. K. Dwivedi, and M. Mäntymäki, Eds., in *Lecture Notes in Computer Science*, 12066. Cham: Springer International Publishing, 2020, pp. 358–369. doi: 10.1007/978-3-030-44999-5\_30.
- [16] C. Williams, D. Schallmo, K. Lang, and L. Boardman, “Digital Maturity Models for Small and Medium-sized Enterprises: A Systematic Literature Review,” in *Proceedings of the XXX ISPIM Innovation Conference: Celebrating Innovation: 500 Years Since Da Vinci*, I. Bitran, S. Conn, C. Gernreich, M. Heber, E. Huizingh, O. Kokshagina, M. Torkkeli, and M. Tynhammar, Eds., Florence: ISPIM, 2019, pp. 1–15.
- [17] M. Gill and S. VanBoskirk, “The Digital Maturity Model 4.0,” p. 17, 2016.
- [18] S. VanBoskirk, M. Gill, D. Gree, A. Berman, J. Swire, and R. Birrell, “The Digital Maturity Model 5.0,” pp. 18, 2017.
- [19] I. V. Aslanova and A. I. Kulichkina, “Digital Maturity: Definition and Model,” in *Proceedings of the 2nd International Scientific and Practical Conference “Modern Management Trends and the Digital Economy: from Regional Development to Global Economic Growth” (MTDE 2020)*, Yekaterinburg, Russia: Atlantis Press, 2020. doi: 10.2991/aebmr.k.200502.073.
- [20] Deloitte, “Digital Maturity Model, Achieving digital maturity to drive growth.” Deloitte, 2018. Accessed: Feb. 28, 2023. [Online]. Available: <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/deloitte-digital-maturity-model.pdf>

- [21] DRL, “Digital Readiness Level,” <https://drl-tool.org/about>, 2017. <https://drl-tool.org/about> (accessed Mar. 10, 2021).
- [22] The Manufacturer, “Free Digital Readiness Level Tool shows the way to industrial digitalisation,” The Manufacturer, 2018. <https://www.themanufacturer.com/articles/free-digital-readiness-level-tool-shows-the-way-to-industrial-digitalisation/> (accessed Mar. 20, 2023).
- [23] Deloitte, “SME Digitalisation - charting a course towards resilience and recovery,” Vodafone, 2020. Accessed: Dec. 10, 2022. [Online]. Available: <https://www.vodafone.com/sites/default/files/2020-10/sme-digitalisation.pdf>
- [24] I. Tatár, “Digitális érettség Magyarországon,” PanMedia.hu, Mar. 30, 2020. <https://panmedia.hu/digitalis-erettseg/> (accessed Feb. 16, 2023).
- [25] A. Buda, “Generációk, társadalmi csoportok a 21. században,” Ma.Tud., 180(1), pp. 120–129, Jan. 2019, doi: 10.1556/2065.180.2019.1.12.
- [26] A. Skov, “The Digital Competence Wheel,” <https://digital-competence.eu/>, 2015. <https://digital-competence.eu/> (accessed Jul. 17, 2022).
- [27] R. Saáry, J. Kárpáti-Daróczi, and A. Tick, “Profit or less waste?: Digitainability in SMEs: A comparison of Hungarian and Slovakian SMEs,” *Serb J Management*, 17(1), pp. 33–49, 2022, doi: 10.5937/sjm17-36437.
- [28] Z. R. Szabó and L. Hortoványi, “Digitális transzformáció és ipar 4.0: magyar, szerb, szlovák és román tapasztalatok,” *Külgazdaság*, vol. 65(5-6), pp. 56–76, 2021, doi: 10.47630/KULG.2021.65.5-6.56.
- [29] A. Tick, J. Kárpáti-Daróczi, and R. Saáry, “‘To familiarize or not to familiarize’ - Industry 4.0 implementation in SMEs in Hungary,” in *Possibilities and barriers for Industry 4.0 implementation in SMEs in V4 countries and Serbia*, T. Milan, Ed., Bor: University of Belgrade, Technical Faculty in Bor, Engineering Management Department (EMD), 2022, pp. 35–61. [Online]. Available: [https://media.sjm06.com/2022/04/MONOGRAPHY\\_I4.0\\_2022.pdf](https://media.sjm06.com/2022/04/MONOGRAPHY_I4.0_2022.pdf)
- [30] A. Tick, “Industry 4.0 Narratives through the Eyes of SMEs in V4 Countries, Serbia and Bulgaria,” *ACTA POLYTECH HUNG*, 20(2), pp. 83–104, 2023, doi: 10.12700/APH.20.2.2023.2.5.
- [31] A. Tick, R. Saáry, and J. Kárpáti-Daróczi, “Conscious or Indifferent: Concerns on digitalisation and sustainability among smes in Industry 4.0,” *Serb J Management*, 17(1), pp. 145–160, 2022, doi: 10.5937/sjm17-36412.