# “State support for the digitalization of SMEs in European countries”


| | |
|---|---|
| **AUTHORS** | Viktoriia Strilets<br>Serhiy Frolov<br>Viktoriia Datsenko<br>Oksana Tymoshenko<br>Maksym Yatsko |



| | |
|---|---|
| **ARTICLE INFO** | Viktoriia Strilets, Serhiy Frolov, Viktoriia Datsenko, Oksana Tymoshenko and Maksym Yatsko (2022). State support for the digitalization of SMEs in European countries. *Problems and Perspectives in Management*, *20*(4), 290-305. doi:10.21511/ppm.20(4).2022.22 |
| **DOI** | http://dx.doi.org/10.21511/ppm.20(4).2022.22 |
| **RELEASED ON** | Thursday, 01 December 2022 |
| **RECEIVED ON** | Monday, 22 August 2022 |
| **ACCEPTED ON** | Friday, 18 November 2022 |



| | |
|---|---|
| **LICENSE** | This work is licensed under a Creative Commons Attribution 4.0 International License |



| | |
|---|---|
| **JOURNAL** | "Problems and Perspectives in Management" |
| **ISSN PRINT** | 1727-7051 |
| **ISSN ONLINE** | 1810-5467 |
| **PUBLISHER** | LLC “Consulting Publishing Company “Business Perspectives” |
| **FOUNDER** | LLC “Consulting Publishing Company “Business Perspectives” |

| NUMBER OF REFERENCES | NUMBER OF FIGURES | NUMBER OF TABLES |
|---|---|---|
| 49 | 4 | 10 |



© The author(s) 2022. This publication is an open access article.

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

**Viktoriia Strilets** (Ukraine), **Serhiy Frolov** (Ukraine), **Viktoriia Datsenko** (Ukraine), **Oksana Tymoshenko** (Ukraine), **Maksym Yatsko** (Ukraine)

# STATE SUPPORT FOR THE DIGITALIZATION OF SMES IN EUROPEAN COUNTRIES

## Abstract

COVID-19 and Russia's war against Ukraine have created many challenges for the business models of SMEs, stimulating them to develop alternative forms of business. Among the key alternatives, one should single out digitization. However, imperfections of Ukraine's state support system for digital transformation necessitate adapting the positive practice of leading countries with excellent business digitalization. Therefore, this paper structures the practical experience of state support of European countries in the digitalization of SMEs. The study conducts a cluster analysis to identify countries whose experience in state support for business digitalization is the best for adoption. Clustering employed the criterion of using key digitization instruments: internet of things, integration of business processes into electronic processes, digital integration with customers/suppliers, cloud services, big data analysis, and artificial intelligence. Thus, 4 clusters were identified (the first cluster comprises 16 countries, the second – 2, the third – 5, and the fourth – 7). These findings contributed to the selection of some key measures. They included: expanding the financial capabilities of SMEs to adopt digital technologies in their processes; formation of digital hard skills among entrepreneurs and increasing the personnel potential of SME digitization; creation of a favorable business environment to stimulate the digital activity of SMEs; and popularization of business digitalization strategy as a component of digital transformation strategy in society.

**Keywords** digital transformation, state support, small and medium enterprises, artificial intelligence

**JEL Classification** M13, M15, O33

**Received on:** 22nd of August, 2022
**Accepted on:** 18th of November, 2022
**Published on:** 1st of December, 2022

© Viktoriia Strilets, Serhiy Frolov, Viktoriia Datsenko, Oksana Tymoshenko, Maksym Yatsko, 2022

Viktoriia Strilets, Doctor of Economics, Associate Professor, Department of International Economics and International Economic Relations, Poltava University of Economics and Trade, Ukraine.

Serhiy Frolov, Doctor of Economics, Professor, Department of Finance, Banking and Insurance, Sumy National Agrarian University, Ukraine. (Corresponding author)

Viktoriia Datsenko, Ph.D. in Economics, Associate Professor, Dean of the Faculty of Economics, Business and International Relations, University of Customs and Finance, Ukraine.

Oksana Tymoshenko, Ph.D. in Economics, Associate Professor, Department of Economics, Poltava University of Economics and Trade, Ukraine.

Maksym Yatsko, Ph.D. in Economics, Associate Professor, Department of Accounting and Auditing, State Higher Educational Institution "Uzhgorod National University", Ukraine.

This is an Open Access article, distributed under the terms of the Creative Commons Attribution 4.0 International license, which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.

**Conflict of interest statement:**
Author(s) reported no conflict of interest

## INTRODUCTION

SMEs are an essential element of countries' national economies in the world, contributing significantly to their development (49.7% – in the total number of employees, 60% – in the created added value, and 50% – in the volume of exports). However, the recent changes in the business environment (e.g., the transition to Industry 4.0, the economic downturn due to COVID-19, and the Russian war against Ukraine) caused many challenges for the business models of SMEs. Thus, since the beginning of the COVID-19 pandemic, every fourth SME entity in EU countries is on the verge of bankruptcy; 26% of young and 18% of experienced SMEs went bankrupt during the year. The situation is worsening due to the shock from inflation and rising energy prices caused by Russian aggression. The need to adapt to changing conditions and maintain competitiveness stimulates SMEs to develop alternative business forms and diversify their offers and markets.

Business digitalization is considered a key to achieving success in the long term. It involves implementing digital technologies that can improve the ability of SMEs to collect, combine, process, and use business data. The digitization of SME business processes can help retain and increase the number of consumers, increase competitiveness, and save on operating and transaction costs.



http://dx.doi.org/10.21511/ppm.20(4).2022.22

However, the existence of both internal problems in the development of digital processes of SMEs and those related to the imperfection of the system of state support for the digital transformation forces to adopt the best positive practice of EU countries. SMEs face significant digital innovation barriers because of their limited resources and opportunities compared to big enterprises. Working with digital technologies is significantly different from traditional ways of doing business. This requires modernization of the business model and additional state assistance. Teteriatnyk (2018), Strilets (2019), and Okoi et al. (2022) investigated the role of government in improving the productivity and growth of small businesses. Moreover, it was found that the government's involvement in supporting the digitalization of SMEs is necessary.

Therefore, the issue of structuring the practical experience of state support for business digitalization to identify those leading countries whose experience in forming a clear legal framework and adequate state support is possible for adopting in outsider countries is relevant and necessary.

## 1. LITERATURE REVIEW

Digitalization is fundamental for economic growth and job creation in modern conditions. Therefore, its development occupies a leading place in the Strategy "Europe 2021–2027". Furthermore, digitalization is a consistent unification of all sectors of the economy and adaptation of subjects to the new conditions of the digital economy (Parviainen et al., 2022).

Liu et al. (2011) described digitalization as integration of digital technologies and business processes into the digital economy. Bethlendi and Szőcs (2022) considered it a transformation of products, processes, and organizational aspects. Matt et al. (2015) concluded that it involves transformations in organizational methods, roles, and offers due to the implementation of digital technologies. Finally, Vial (2019) noted that it is improving processes by transforming its properties using information, computing, and communication technologies. As a result, digitalization increases countries' economic security and ensures financial systems' stability (Shkolnyk et al., 2022).

Business digitalization is a critical component of digitalization in society. Currently, digital technologies have penetrated almost all aspects of human life and opened new opportunities for businesses (Simatupang & Widjaja, 2012). Digitalization not only helps to overcome the information asymmetry between businesses and investors (Pedchenko et al., 2018) but also stimulates the development of SMEs in other business aspects. For example, the digitalization of banking services (Pham et al., 2022; Kuznyetsova et al., 2022), the insurance market (Polinkevych et al., 2021), and the chatbots (Jansom et al., 2022) became significantly more developed during the COVID-19 pandemic.

Generally, business digitalization describes how firms can improve their operations and generate value by transforming their business models (Samper et al., 2022). Parida et al. (2019) showed that digital technologies help innovate organizational models and offer opportunities for value creation in industrial ecosystems. Yu et al. (2022) noted that business digitalization models refer to continuous improvement. Here, information, computing, communication, and connection technologies are vital for an organization's restructuring.

Business digitalization is multifaceted, combining various tools with different goals and forcing the reconfiguration of strategic assets. Only some SMEs can adopt such transformations. The smaller the company is, the less likely it will adopt digital tools and the more likely it will limit the use of elementary services.

Business digitalization involves transformations of business models, services, goods, and structures (Hess et al., 2016; Heavin & Power, 2018). As a result, it accelerates the company's economic development, increases its productivity and performance, minimizes transaction costs, and opens ways to new markets (Williams, 2021). According to Natorina (2017), digital transformations are crucial to rational management decisions, including digitalizing operational processes, virtualiz-

ing employee effectiveness, and transactional productivity systems. As for the impact of digitalization of business on productivity, dynamic managers can harness the potential of new methods and encourage their adoption (Li et al., 2018).

Digitalization of business is also a driving force that contributes to its advancement. Its main advantages include saving time, increasing business productivity, automation of production and other internal company processes, and improving communications. Moreover, it offers cross-selling/upselling opportunities, reaching a new level of customer service and encouraging them to purchase more products, introducing competitive opportunities due to improved customer experience and overall optimization. Finally, it contributes to increasing GDP per capita and reducing CO2 emissions (Melnyk et al., 2021). According to Reim et al. (2022), SMEs may overcome obstacles and obtain various benefits (e.g., hiring highly-qualified staff) via digital technologies adoption.

Business digitalization across industries has enabled the internet of things (IoT), cloud computing, big data analytics, and artificial intelligence. By employing these tools, firms can enhance their performance (Lia et al., 2022; Polyakov et al., 2021). Thus, business digitalization involves cyber-physical systems, 3D printing, robotics, big data, and the internet of things. Moreover, to achieve success, mobile tools and applications, social media, analytical tools and applications, platforms for communication and data sharing, as well as collaboration applications, are necessary.

To digitize their offers, modern companies should adopt digital tools. Ting et al. (2020) noted that artificial intelligence (AI), 5G wireless networks, machine learning (ML), and deep learning (DL), as well as blockchain systems, contributed to a unique and beneficial environment in all sectors of the economy.

Almost a third of companies invest up to 50 million US dollars in the automation and digitization of business processes (Pereira et al., 2022). Thus, Maglakelidze and Erkomaishvili (2021) found that one of the alternative tools to overcome the challenges of the pandemic, which has given impetus to changes in business behavior, is to increase the volume of sales through digital channels. It is argued that business activities have become more favorable during the pandemic through digital channels. Therefore, governments should provide support programs (tax incentives and subsidies) for SMEs.

Sestino et al. (2020) explored big data and the internet of things as tools for business digitalization strategies. The study asserted that these technologies can increase the competitiveness of companies. Furthermore, IoT offers possibilities to analyze consumer attitudes, behavior, and intentions.

Lestari et al. (2021) highlighted the role of e-commerce for small businesses in improving their operations. The results showed that non-implementation of e-commerce resulted in lower revenues for small businesses than those that adopted e-commerce. They concluded that e-commerce could benefit both governments and small businesses in times of crisis, e.g., COVID-19.

Another essential tool of business digitalization – digital platforms – was thoroughly researched by Oro (2018), Li et al. (2021), and Akhter et al. (2022). They found that digital platforms positively impact SMEs' business innovations and reconfiguration capabilities. An intelligent digital platform that brings together innovative stakeholders (e.g., government, academia, companies, and community) enhances cooperation between various actors interested in sharing information and promoting and selling the results of SME activity (Maquera et al., 2022). According to Cenamor et al. (2019), a digital platform supports information sharing and enables companies to unify and update their data.

However, more than applying digital technologies is needed to stimulate business digitalization. The development of all business digitalization tools deserves the government's close attention and determines the need for financial, informational, advisory, and other types of support. Small and medium-sized businesses should possess the necessary digital strategies, capabilities, and culture and talent growth initiatives to achieve digital transformation successfully. Many studies are focused on the elements of a successful digital business strategy and the role of government support


http://dx.doi.org/10.21511/ppm.20(4).2022.22

(Matt et al., 2015; Fischer et al., 2020). SMEs need a stakeholder collaboration strategy to adopt and develop digitization practices (Nudurupati et al., 2022). Due to the significant investments needed, it could be challenging for SMEs to adopt digital technologies. Thus, governmental support is crucial here (Yuan et al., 2021).

Governments support SMEs in adopting various digital platforms. However, the spread of such platforms depends on the structural and political aspects of countries and regions. For example, OECD (2021a, 2021b), EC (2022), and GEM (2022) showed that the country's socio-economic and demographic features, population awareness of digital tools, concentration of platforms across sectors, and its structural aspects (freedom and the rule of law, product market regulation and digital services) affect the use of platforms in a country.

In response to COVID-19, countries introduced various initiatives to promote SMEs' digitization, including online platforms. However, no conceptual approach to studying state support for the digitalization of SMEs has been elaborated. In particular, there is a research gap in terms of the experience of using essential tools: online platforms, the internet of things, the integration of business processes into electronic processes; artificial intelligence; digital integration with customers/suppliers; 3D printing and robotics; big data analysis; cloud services, and others. In addition, there are scarce studies on how the improvement of sustainable competitiveness can describe the development of digitalization (Petkovski et al., 2022). Although the literature highlights numerous tools of digital innovations and their positive impact on the development of SMEs, the interdependence between the competencies of governments and digital innovations and the positive practices of using such dependence have been studied in a rather fragmentary manner.

The level of business digitization in countries is directly dependent on the favorable business environment created by the government for the digital transformation of society. Therefore, the purpose of this study is to structure the practical experience of state support in European countries in the field of digitalization of SMEs.

## 2. METHODOLOGY

The paper uses cluster analysis (for grouping countries into clusters according to the level of application of business digitization tools by SMEs). Clustering SMEs by the level of business digitalization is needed to identify countries with a favorable environment for the digital transformation of enterprises since these countries are characterized by adequate state support. The proposed sequence of cluster analysis involves the following stages:

- Stage 1: Analyzing analytical and statistical data and forming of a database for analysis;
- Stage 2: Forming a sample of the leading indicators for evaluating the digitization of SMEs;
- Stage 3: Studying modern trends of changes in the leading indicators (Appendix A);
- Stage 4: Selecting software for cluster analysis;
- Stage 5: Selecting cluster analysis criteria;
- Stage 6: Building a dendogram to form the number of clusters;
- Stage 7: Determining the fullness of clusters;
- Stage 8: Providing key characteristics of clusters;
- Stage 9: Generalizing conclusions.

Descriptive characteristics of cluster analysis are given in Appendix B.

## 3. RESULTS

Digitalization plays a significant role in increasing the sustainability of SMEs. It offers opportunities to restructure industries and enhance business competition. Companies adopt new business models and create value propositions via digital technologies. Therefore, SMEs enhance their performance, i.e., increase effectiveness and reduce operational costs, increase revenues, obtain more practical knowledge and innovations, and im-

Source: EC (2022), OECD (2021a), GEM (2022).

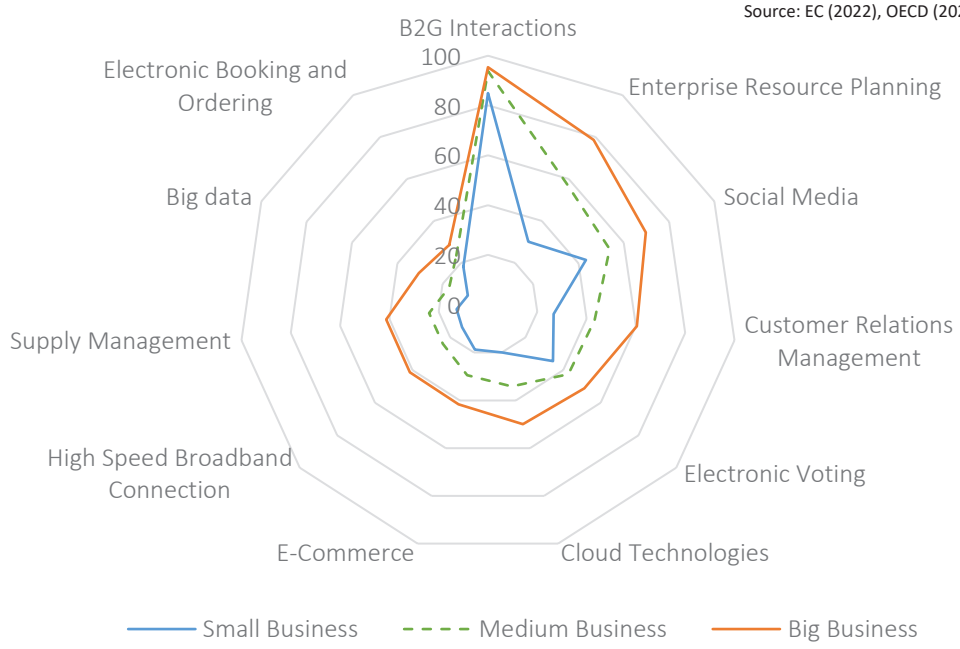



**Figure 1.** The use of digital technologies by business entities according to size in EU countries in 2020, %

prove customer engagement. Nevertheless, SMEs' digitization level is still deficient (Figure 1).

According to OECP calculations, other things being equal, the probability of closing an SME was approximately 10% higher than that of enterprises with a number of employees from 50 to 249. At the same time, SMEs in the field of wholesale and retail trade and hotel and catering establishments are particularly vulnerable to the consequences of the pandemic (OECD, 2021a). This evidence is consistent with the statement about the importance and necessity of government support for SMEs, especially regarding the digitization of their business processes. Therefore, the government should promote the competitiveness and productivity of SMEs, in particular, by encouraging the digitization of SME business processes.

In recent years, the digitalization of business has continued at a rapid pace. Across industries, business entities rapidly equip their employees with digital tools. However, smaller companies could be more successful in this sphere. There are also differences in implementing electronic business among countries (Figure 2).

Thus, studies on the integration of SMEs in digital technologies in foreign countries have shown that these processes take place most effectively in Finland, Denmark, and Belgium. In these countries, the level of integration of SMEs in electronic business is more than 45%. On the other hand, the level of integration in Latvia, Malta, Austria, Luxembourg, Lithuania, and France is somewhat lower but still relatively high.

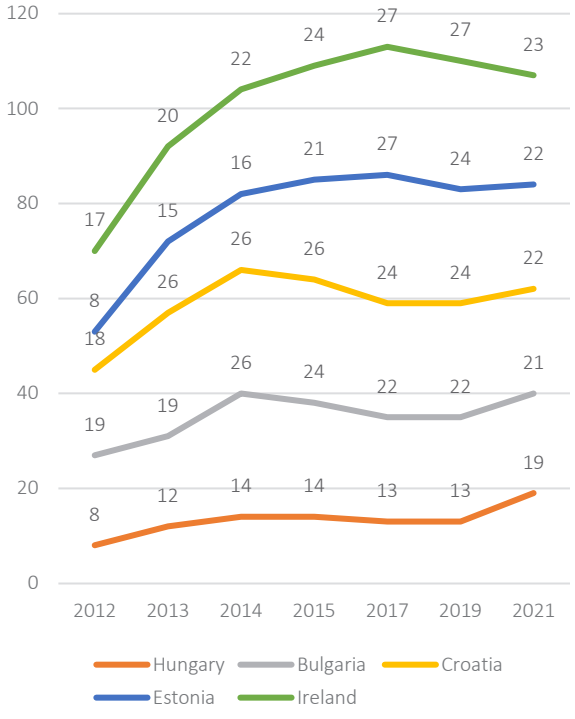
The European Union pays considerable attention to implementing digital technologies in business processes, defined primarily in the strategy "Europe 2021-2027". However, at the moment, the EU member states have an unequal use of digital tools. Therefore, in order to determine the most successful comprehensive approaches of the governments to stimulate business digitalization, it is proposed to cluster countries according to the level of implementation of all digitalization components. Moreover, it is vital to identify those "star countries" whose level of SME digitalization is the highest, and, therefore, their practices are the most successful (Table 1).

The descriptive characteristics of the cluster analysis (Appendix B) made it possible to determine a sufficient validity of clusters: there are 16 countries in cluster 1, 2 – in cluster 2, 5 – in cluster 3, and 7 – in cluster 4.

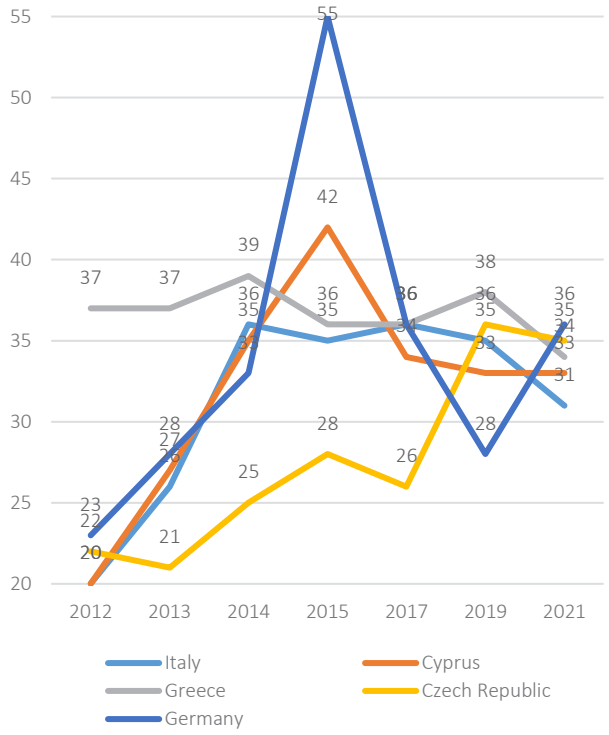
Therefore, the first cluster has relatively low (compared to other clusters) indicators of the use of


http://dx.doi.org/10.21511/ppm.20(4).2022.22

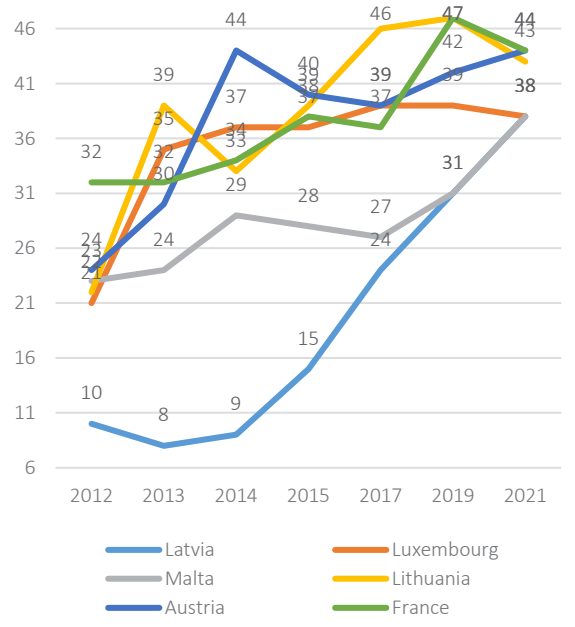
Source: EC (2022), OECD (2021a), GEM (2022).



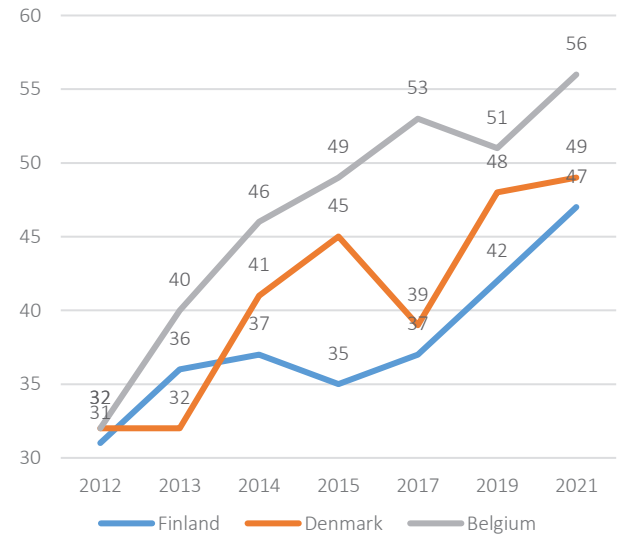

Group with a low level of integration in 2021 (18-23%)




Group with a sufficient level of integration in 2021 (31-36%)



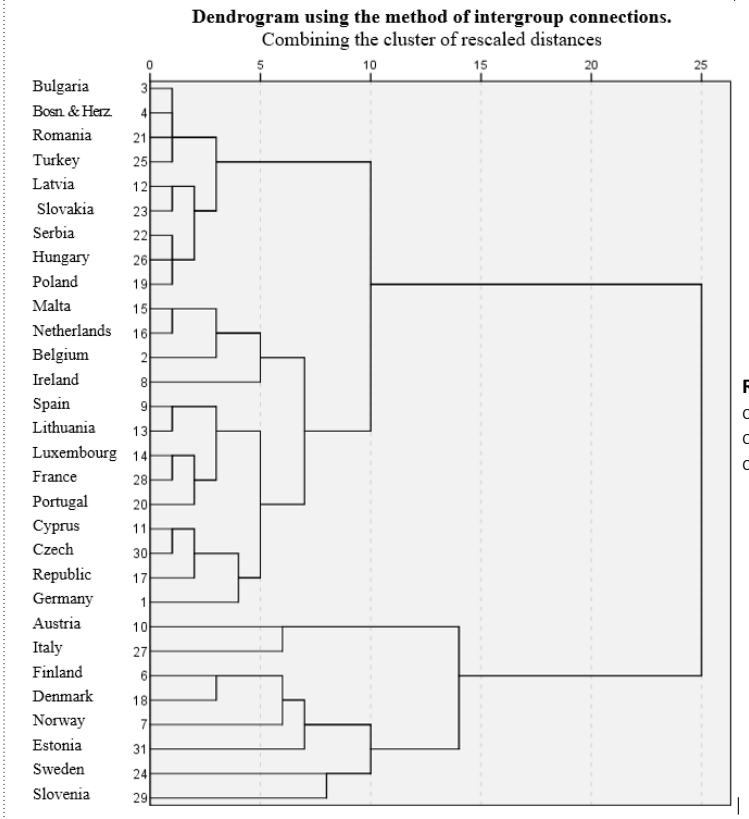

Group with an average level of integration in 2021 (38-44%)




Group with a high level of integration in 2021 (>45%)

**Figure 2.** Trends in the integration of SMEs into e-business in some countries in 2012-2021, % in the structure of SMEs

**Table 1.** Stages of cluster analysis

| | |
|---|---|
| **Stage 1: Analyzing analytical and statistical data and forming a database for analysis** | |
| Database of the European Commission; Organization for economic development and cooperation (reports on the activity of SMEs and digitalization of business; Global monitoring of entrepreneurship (GEM reports). | |
| **Stage 2: Forming a sample of the leading indicators for evaluating the digitization of SMEs** | |
| Statistical data on the use of digital technologies and opportunities (internet of things D1, integration of business processes into electronic processes D2; artificial intelligence D3; digital integration with customers/suppliers D4; 3D printing and robotics D5; big data analysis D6; cloud services D7). | |
| **Stage 3: Studying current trends in changes of the main indicators** | |
| Formation of a database by country. | |
| **Stage 4: Selecting software for cluster analysis** | |
| IPSS Statistics, Deductor Studio. | |
| **Stage 5: Selecting cluster analysis criteria** | |
| Number of observations 31, K-means analysis, intergroup connection method, Euclidean distance, error 0.05 | |
| **Stage 6: Building a dendogram to form the number of clusters** |  <br>Dendogram of countries' distribution according to the level of digitalization | **Result:** allocation of 4 clusters; cluster 1 – 16 countries; cluster 2 – 3; cluster 3 – 5; cluster 4 – 7 |
| **Stage 7: Determining the clusters** | |
| Cluster 1 | Austria, Belgium, Ireland, Spain, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Germany, Portugal, Slovakia, France, Croatia, Czech Republic |
| Cluster 2 | Greece, Italy, Finland |
| Cluster 3 | Denmark, Estonia, Norway, Slovenia, Sweden |
| Cluster 4 | Bulgaria, Bosnia and Herzegovina, Poland, Romania, Serbia, Turkey, Hungary |
| **Stage 8: Providing key characteristics of clusters** | |
| **Stage 9: Generalizing conclusions** | |

digital technologies, particularly in artificial intelligence, digital integration with customers and suppliers, and cloud services. However, it has an adequate level of big data analysis and the use of 3D printing and robotics. This cluster includes Austria, Belgium, Ireland, Spain, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Germany, Portugal, Slovakia, France, Croatia, and the Czech Republic.

The second cluster showed high use of internet of things and integration of business processes into electronic business; the highest level of digital integration with customers/suppliers; and the popu-


http://dx.doi.org/10.21511/ppm.20(4).2022.22

larization of cloud services. This cluster includes Greece, Italy, and Finland.

The third cluster is a leader in cloud services, big data analysis, and artificial intelligence. It sufficiently uses the internet of things and has an average level of digital integration with customers/suppliers. This cluster includes Denmark, Estonia, Norway, Slovenia, and Sweden.

The last (fourth) cluster is an outsider and has the lowest indicators for all the studied indicators, which indicates the lowest level of digitalization of SMEs in the countries of this group. This cluster includes Bulgaria, Bosnia and Herzegovina, Poland, Romania, Serbia, Turkey, and Hungary.

The results showed that the countries of the second and third clusters are examples to follow. In addition, it is appropriate to study the example of the first cluster regarding the use of big data analysis, 3D printing, and robotics. Thus, Table 2 summarizes the main measures implemented by the state bodies of the leading countries to stimulate the digitization of business.

Analysis of state support for digitization found that authorities have started to implement awareness-raising activities and policy actions regarding online platforms (Australia, Denmark, France, and the United Kingdom). In addition, various support initiatives stimulate SMEs to adopt online platforms, although the prevalence of online platforms differs due to structural and procedure causes (OECD, 2021a, 2019; EC, 2022). Among the latest trends, it is also worth highlighting financial support programs for the digitalization of SMEs (Norway, Switzerland, Greece, etc.) and advisory and informational support provided by the governments.

Table 2 shows that SMEs need appropriate policies and support programs from the government to successfully implement digital transformations. It is crucial to analyze the role of governmental support in increasing the harmonization of government policies and programs with SMEs' demands. Therefore, the development of a conceptual model of state support for the digitization of SMEs is necessary. This model should include main barriers and challenges of SMEs digitization, govern-

**Table 2.** State support measures for business digitalization

Source: OECD (2021a, 2019), EC (2022), GEM (2022).

| Country | State support measures for business digitalization |
|---|---|
| Estonia | Implementation of the "Digitalization Grant" program. Providing financial support for digital technologies and robots and automation in the manufacturing and mining industries. |
| France | A public online platform for the cooperation of SMEs wishing to digitize their business with public and private consultants throughout the country. The ability to implement functions: creating a digital strategy, increasing the presence on the Internet, developing the clientele, selling on the internet, etc. Consultants provide information on available financing options; information channels to offer data on support initiatives from the government and private sector actors; a daily radio show that discussed future digital trends. |
| Denmark | The government's program "SMEs: Digital" is part of the National Government's Strategy for Digital Growth; the initiative "SME: Digital Features the E-Commerce Centre" is designed to help small and medium-sized enterprises with online sales, includes grants for private consultations to clarify and develop the potential of the company in the field of e-commerce; E-Commerce Center workshops where online selling challenges are discussed with industry experts. |
| Sweden | The Digi-Lift initiative promoted digital transformations with an emphasis on the industrial sector. It is part of the smart industry strategy. |
| Italy | Due to the pandemic, Italian regions offer financial support to companies and self-employed workers to work from home. Funding is provided to cover the cost of training and purchasing digital tools/subscriptions to digital platforms for remote work. |
| Slovenia | "Digital vouchers" program support micro-SMEs with up to 10000 euros to improve digital competences, prepare a digital strategy, ensure cyber security, and implement digital marketing. |
| Ireland | Implementation of Digital Trading Online Voucher. Micro-enterprises can receive a voucher for 2500 euros to develop online sales and access to free online training. |
| Luxembourg | A digital technology fund with co-financing from public and private actors and focusing on venture investments in startups working in the field of ICT and related industries, including cyber security, big data, digital health, next-generation media and communication networks, digital training, satellite telecommunications, and services. |
| Portugal | Opendays i4.0 is an information campaign to popularize the need for digital transformation among SMEs. |
| Germany | Go-digital is a program to support SMEs (up to 100 employees and a total balance sheet of up to 20 million euros) in IT security, digitization of business processes, and digital market development, thanks to the expertise provided by consulting firms. |

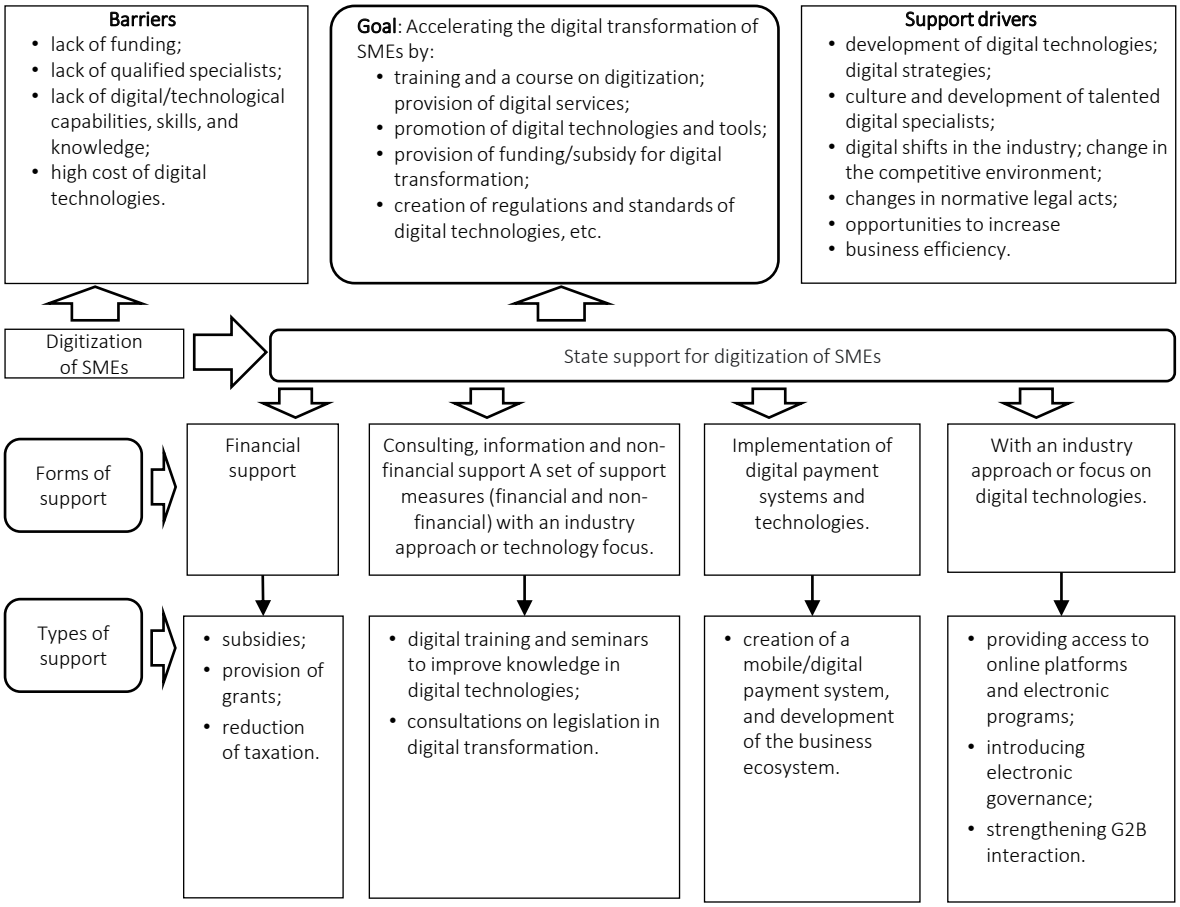



**Figure 3.** Conceptual model of state support for digitization of SMEs

mental functions in supporting the digitization of SMEs, drivers for stimulating the digitization of SMEs, and classification of existing types and forms of state support (Figure 3).

The heterogeneity of SME actions, the multiplicity of their business environments, and the urgent challenges facing them require a fundamental rethinking of state policy regarding SMEs and digitalization. A general government approach will be a key success factor, including effective multi-level governance mechanisms at the national and sub-national, regional, and urban levels, international learning, and enhanced monitoring and evaluation capacity.

The study of the positive practice of state support for the digitalization of SMEs in these countries contributed to the selection of a number of key forms of state support that will stimulate the digitalization of SMEs in the global economy (Figure 4). They are: financial support (financing programs for the digitalization of SMEs following the example of Estonia, Slovenia, or Luxembourg); advisory and informational support (information campaigns for the promotion of digital technologies; seminars and trainings on digital competencies similar to Portugal and Germany), state online platforms (as practiced in France), and ensuring the operation of digital payment systems and technologies, which is envisaged by the strategy of the national government of Denmark. Accordingly, crucial steps on the way to stimulating business digitalization are: expanding the financial capabilities of SMEs to adopt digital technologies in their processes; formation of digital hard skills among entrepreneurs and, on this basis, increasing the personnel potential of digitization of SMEs; creation of a favorable business environment to stimulate the digital activity of SMEs; popularization of the strategy of digitalization of business as a component of the strategy of digital transformation of society (Figure 4).


http://dx.doi.org/10.21511/ppm.20(4).2022.22

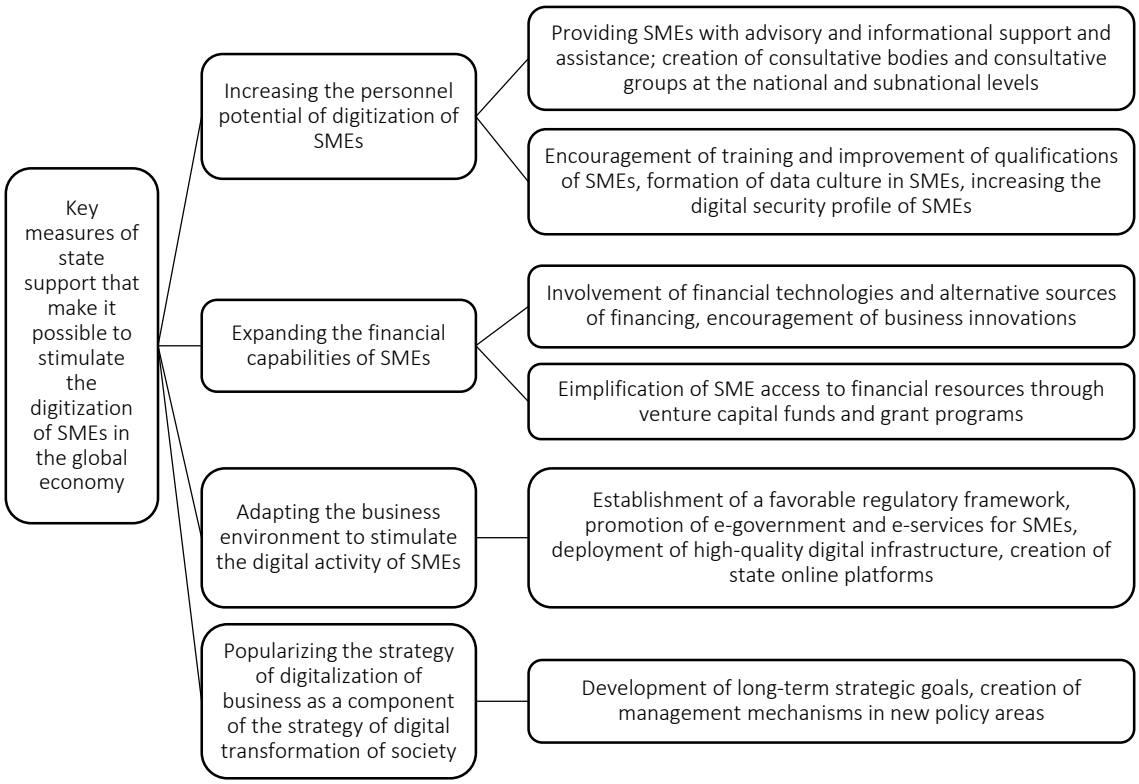



**Figure 4.** Key measures of state support to stimulate the digitalization of SMEs in the global economy

## 4. DISCUSSION

The previous literature noted the existing challenges of business digitalization (Lestari et al., 2021; Liu et al., 2011; Maglakelidze & Erkomaishvili, 2021), but the importance of government support for business digitalization, especially in countries with a low digital transformation rating, was not discussed in details. Scientists have identified business digitalization as a key tool for the development of SMEs in modern conditions (Cenamor et al., 2019; Guseva & Legominova, 2018; Li et al., 2018) and the importance of state support for business digitalization (Holotiuk & Beimborn, 2017; Hess et al., 2016; Lia et al., 2022). However, this was done at a very general level without specifying what the government support measures should be and how they can solve the existing digitization problems. There must be a variety of solutions for all countries as each country has a different level of digital transformation. However, SMEs face the same problems when changing their business model in favor of digitalization. Therefore, it is important to provide small and medium-sized enterprises with government support to adopt digital technologies with limited resources (informational, financial, or personnel). Supporting Fishchuk et al. (2018), the state should assume several roles simultaneously for digital modernization and transformation. They include: leader and experimenter (attraction of innovative SMEs and IT companies to carry out digital transformation of state bodies and enterprises; integration of services of private companies into their processes through online platforms, etc.); regulator and defender (normative and legal regulation (in particular, standardization), training and retraining of personnel, as well as ensuring access to capital, etc.); and popularizer (increasing competence in data science, artificial intelligence, and digital transformation).

## CONCLUSION

A study of the process of digital transformation in many countries showed that the pace of digitization of small and medium-sized businesses is lower than that of big ones. The literature review proved their

greatest vulnerability to the challenges of the pandemic, the Ukrainian-Russian war, and shocks from rising energy prices. The paper substantiates the necessity of using digital technologies as an alternative to business development in overcoming negative consequences. The results found that the level of digitization of business in countries is directly dependent on the favorable business environment created by the government for the digital transformation of society. In order to determine the countries whose experience in state support of business digitalization is the best for adoption, clustering was carried out according to the criterion of using crucial digitalization tools by SMEs in these countries.

The results made it possible to highlight a number of countries whose experience is sufficiently practical and, therefore, worthy of attention in terms of adoption in countries striving for digital development. The key positions of the state support strategies for SME digitalization in these countries became the basis for the formation of a conceptual model of state support for SME digitalization. It includes the following key components: the goal of SME digitalization; digitization drivers; barriers and challenges of digitization; types and forms of state support for digitization. In addition, the study of the experience of digitally active countries made it possible to outline the strategic prospects of digital business transformation for countries with a low level of digitization. They are: expanding the financial capabilities of SMEs to adopt digital technologies; formation of digital hard skills among entrepreneurs and, on this basis, increasing the personnel potential of digitization; creation of a favorable business environment to stimulate the digital activity of SMEs; and popularization of the strategy of business digitalization as a component of the digital transformation strategy of society.

## AUTHOR CONTRIBUTIONS

Conceptualization: Viktoriia Strilets, Serhiy Frolov, Oksana Tymoshenko.
Data curation: Viktoriia Datsenko, Maksym Yatsko.
Formal analysis: Maksym Yatsko, Oksana Tymoshenko.
Investigation: Serhiy Frolov, Viktoriia Datsenko, Oksana Tymoshenko.
Methodology: Viktoriia Strilets, Viktoriia Datsenko.
Software: Oksana Tymoshenko, Maksym Yatsko.
Validation: Serhiy Frolov, Viktoriia Datsenko.
Visualization: Viktoriia Strilets, Maksym Yatsko.
Writing – original draft: Viktoriia Strilets, Serhiy Frolov, Oksana Tymoshenko, Viktoriia Datsenko, Maksym Yatsko.
Writing – review & editing: Viktoriia Strilets, Serhiy Frolov.

## REFERENCES


1. Akhter A., Anwarul Islam K. M., Karim M., & Latif, W. B. (2022). Examining determinants of digital entrepreneurial intention: A case of graduate students. *Problems and Perspectives in Management, 20*(3), 153-163. http://dx.doi.org/10.21511/ppm.20(3).2022.13
2. Bethlendi, A., & Szőcs, Á. (2022). How the Fintech ecosystem changes with the entry of Big Tech companies. *Investment Management and Financial Innovations, 19*(3), 38-48. https://doi.org/10.21511/imfi.19(3).2022.04
3. Cenamor, J., Parida, V., & Wincent, J. (2019). How entrepreneurial SMEs compete through digital platforms: The roles of digital platform capability, network capability and ambidexterity. *Journal of Business Research, 100,* 196-206. https://doi.org/10.1016/j.jbusres.2019.03.035
4. EC. (2022). *Statistical information of the European Commission*. Retrieved from https://ec.europa.eu/eurostat/web/main/data/database
5. Fischer, M., Imgrund, F., Janiescha, C., & Winkelman, A. (2020). Strategy archetypes for digital transformation: Defining meta objectives using business process management. *Information & Management, 57*(5), 1-13. https://doi.org/10.1016/j.im.2019.103262
6. Fishchuk, V., Matyushko, V., Chernev, E., Yurchak, O., & Lavryk, Ya. (2018). *Ukraina 2030E – kraina z rozvynutoiu tsyfrovoiu ekonomikoiu [Ukraine 2030E – a country with a developed digital economy]*. Ukrainian Institute of the Future. (In Ukrainian). Retrieved from https://strategy.uifuture.org/kraina-z-rozvinutoyu-cifrovoyu-ekonomikoyu.html



http://dx.doi.org/10.21511/ppm.20(4).2022.22

7. Global Entrepreneurship Monitor (GEM). (2022). *Global Entrepreneurship Monitor 2021/2022 Global report: Opportunity Amid Disruption.* Retrieved from https://gemconsortium.org/report/gem-20212022-global-report-opportunity-amid-disruption

8. Guseva, O. Yu., & Legominova, S. V. (2018). Dydzhytalizatsiia – yak instrument udoskonalennia biznes-protsesiv, yikh optymizatsiia [Digitization as a tool for improving business processes, their optimization]. *Ekonomika. Menedzhment. Biznes – Economy. Management. Business, 1*(23), 33-39. (In Ukrainian). Retrieved from http://nbuv.gov.ua/UJRN/ecmebi_2018_1_7

9. Heavin, C., & Power, D. J. (2018). Challenges for digital transformation-towards a conceptual decision support guide for managers. *Journal of Decision Systems, 27*(sup1), 38-45. https://doi.org/10.1080/12460125.2018.1468697

10. Hess, T., Benlian, A., Matt, C., & Wiesböck, F. (2016). Options for formulating a digital transformation strategy. *MIS Quarterly Executive, 25*(2), 123-139. Retrieved from https://boris.unibe.ch/id/eprint/105447

11. Holotiuk, F., & Beimborn, D. (2017). Critical success factors of digital business strategy. *13th International Conference on Wirtschaftsinformatik* (pp. 991-1005). St. Gallen, Switzerland. Retrieved from https://wi2017.ch/images/wi2017-0244.pdf

12. Jansom, A., Srisangkhajorn, T., & Limarunothai, W. (2022). How chatbot e-services motivate communication credibility and lead to customer satisfaction: The perspective of Thai consumers in the apparel retailing context. *Innovative Marketing, 18*(3), 15-27. https://doi.org/10.21511/im.18(3).2022.02

13. Kuznyetsova, A., Boiarko, I., Khutorna, M., & Zhezherun, Y. (2022). Development of financial inclusion from the standpoint of ensuring financial stability. *Public and Municipal Finance, 11*(1), 20-36. https://doi.org/10.21511/pmf.11(1).2022.03

14. Lestari, D., Zainurossalamia, S., Siti, M., Wardhani, W., & Yudaruddin, R. (2021). The impact of COVID-19 pandemic on performance of small enterprises that are e-commerce adopters and non-adopters. *Problems and Perspectives in Management, 19*(3), 467-477. https://doi.org/10.21511/ppm.19(3).2021.38

15. Li, J. O., Liu, H., Ting, D. S. J., Jeon, S., Chan, R. V. P., Kim, J. E., Sim, D. A., Thomas, P. B. M., Lin, H., Chen, Y., Sakomoto, T., Loewenstein, A., Lam, D. S. C., Pasquale, L. R., Wong, T. Y., Lam, L. A., & Ting, D. S. W. (2021). Digital technology, tele-medicine and artificial intelligence in ophthalmology: A global perspective. *Progress in retinal and eye research, 82*, 100900. https://doi.org/10.1016/j.preteyeres.2020.100900

16. Li, L., Su, F., Zhang, W., & Mao, J. Y. (2018). Digital transformation by SME entrepreneurs: a capability perspective. *Information Systems Journal, 28*(6), 1129-1157. https://doi.org/10.1111/isj.12153

17. Lia, C., Khan, A., Ahmad, H., & Shahzad, M. (2022). Business analytics competencies in stabilizing firms' agility and digital innovation amid COVID-19. *Journal of Innovation & Knowledge, 7*(4), 100246. Retrieved from https://pesquisa.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/resource/pt/covid-who-2031460

18. Liu, D.-Y., Chen, S.-W., & Chou, T.-C. (2011). Resource fit in digital transformation: Lessons learned from the CBC Bank global e-banking project. *Management Decision, 49*(10), 1728-1742. https://doi.org/10.1108/00251741111183852

19. Maglakelidze, A., & Erkomaishvili, G. (2021). Challenges of small and medium enterprises during the COVID-19 pandemic: Case of Georgia. *Problems and Perspectives in Management, 19*(4), 20-28. http://dx.doi.org/10.21511/ppm.19(4).2021.02

20. Maquera, G., da Costa, B. F., Mendoza, Ó., Salinas, R. A., & Haddad, N. (2022). Intelligent Digital Platform for Community-Based Rural Tourism – A Novel Concept Development in Peru. *Sustainability, 14*(13), 7907. https://doi.org/10.3390/su14137907

21. Melnyk, L., Kubatko, O., Piven, V., Klymenko, K., & Rybina, L. (2021). Digital and economic transformations for sustainable development promotion: A case of OECD countries. *Environmental Economics, 12*(1), 140-148. https://doi.org/10.21511/ee.12(1).2021.12

22. Matt, G., Hess, T., & Benlian, A. (2015). Digital transformation strategies. Business & Information Systems Engineering, 57(5), 339-343. https://doi.org/10.1007/s12599-015-0401-5

23. Natorina, A. O. (2017). Didzhytal-transformatsiia diialnosti pidpryiemstv [Digital-transformation of enterprises activities]. *Ekonomika ta derzhava – Economy and the State, 4*, 90-93. (In Ukrainian).

24. Nudurupati, S. S., Budhwar, P., Pappu, R. P., Chowdhury, S., Kondala, M., Chakraborty, A., & Ghosh, S. K. (2022). Transforming sustainability of Indian small and medium-sized enterprises through circular economy adoption. *Journal of Business Research, 149*, 250-269. https://doi.org/10.1016/j.jbusres.2022.05.036

25. OECD. (2019). *Financing SMEs and Entrepreneurs 2019: An OECD Scoreboard.* Paris: OECD Publishing. Retrieved from https://www.oecd.org/cfe/smes/Policy-Highlights-Scoreboard2019-Final-opt.pdf

26. OECD. (2021a). *The Digital Transformation of SMEs.* Paris: OECD Publishing. https://doi.org/10.1787/bdb9256a-en

27. OECD. (2021b). *SME and Entrepreneurship Outlook 2021.* Paris: OECD Publishing. https://doi.org/10.1787/97a5bbfe-en

28. Okoi, I., Ubi, I., Iheanacho, M., Emori, E., & Sunday, E. (2022). Strategic entrepreneurship practices and performance of small and medium-sized enterprises in Nigeria. *Problems and Perspectives in Management, 20*(1), 108-116. http://dx.doi.org/10.21511/ppm.20(1).2022.10

29. Oro, D. (2018, November 13). *Gartner Identifies Top 10 Strategic IoT Technologies and Trends from 2018–2023.* IoT Central. Retrieved from https://www.iotcentral.io/blog/gartner-identifies-top-10-strategic-iot-technologies-and-trends-f

30. Parida, V., Sjodin, D., & Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. *Sustainability, 11*(2), 391. https://doi.org/10.3390/su11020391

31. Parviainen, P., Tihinen, M., Kaariainen, J., & Teppola, S. (2022). Tackling the digitalization challenge: How to benefit from digitalization in practice. *International Journal of Information Systems and Project Management, 5*(1), 63-77. https://doi.org/10.12821/ijispm050104

32. Pedchenko, N., Strilec, V., & Rudenko, N. (2018). Method of Delpni as an innovative tool for managing asymmetric information in financial relationships of potential investors and small business entities. *Marketing and Management of Innovations, 3,* 68-80. https://doi.org/10.21272/mmi.2018.3-06

33. Pereira, C. S., Veloso, B., Durão, N., & Moreira, F. (2022). The influence of technological innovations on international business strategy before and during COVID-19 pandemic. *Procedia Computer Science, 196,* 44-51. https://doi.org/10.1016/j.procs.2021.11.071

34. Petkovski, I., Fedajev, A., & Bazen, J. (2022). Modelling Complex Relationships Between Sustainable Competitiveness and Digitalization. *Journal of Competitiveness, 14*(2), 79-96. http://dx.doi.org/10.7441/joc.2022.02.05

35. Pham, T. T., Hoang, H. T. T., & Do, H. T. T. (2022). What is the future of the bank branch in the midst of the 4.0 industrial revolution? Answers from Vietnam. *Banks and Bank Systems, 17*(2), 199-208. https://doi.org/10.21511/bbs.17(2).2022.17

36. Polinkevych, O., Glonti, V., Baranova, V., Levchenko, V., & Yermoshenko, A. (2021). Change of business models of Ukrainian insurance companies in the conditions of COVID-19. *Insurance Markets and Companies, 12*(1), 83-98. https://doi.org/10.21511/ins.12(1).2021.08

37. Polyakov, M., Khanin, I., Shevchenko, G., & Bilozubenko, V. (2021). Data mining as a cognitive tool: Capabilities and limits. *Knowledge and Performance Management, 5*(1), 1-13. https://doi.org/10.21511/kpm.05(1).2021.01

38. Reim, W., Yli-Viitala, P., & Arrasvuori, J. (2022). Tackling business model challenges in SME internationalization through digitalization. *Journal of Innovation & Knowledge, 7*(3), 100199. https://doi.org/10.1016/j.jik.2022.100199

39. Samper, M. G., Sukier, H. B., Palencia, D. B., Molina, R. I. R., Alfaro, K. B., Sánchez, Y. S., & Sarmiento, A. C. F. (2022). Digital transformation of business models: influence of operation and trade variables. *Procedia Computer Science, 203,* 565-569. https://doi.org/10.1016/j.procs.2022.07.125

40. Sestino, A., Prete, M., Piper, L., & Guido, G. (2020). Internet of Things and Big Data as enablers for business digitalization strategies. *Technovation, 98,* 102173. https://doi.org/10.1016/j.technovation.2020.102173

41. Shkolnyk, I., Frolov, S., Orlov, V., Datsenko, V., & Kozmenko, Y. (2022). The impact of financial digitalization on ensuring the economic security of a country at war: New measurement vectors. *Investment Management and Financial Innovations*, *19*(3), 119-138. http://dx.doi.org/10.21511/imfi.19(3).2022.11

42. Simatupang, T. M., & Widjaja, F. B. (2012). Benchmarking of Innovation Capability in the Digital Industry. *Procedia – Social and Behavioral Sciences, 65,* 948-954. http://dx.doi.org/10.1016/j.sbspro.2012.11.225

43. Strilets, V. Yu. (2019). *Zabezpechennia rozvytku maloho pidpryiemnytstva: teoriia, metodolohiia, praktyka [Ensuring the development of small enterprises: theory, methodology, practice]* (457 p.). Poltava: PUET. (In Ukrainian). Retrieved from http://dspace.puet.edu.ua/bitstream/123456789/8544/1/Strilec%20Zabezpechennia%20rozvytku%20malyh%20pidpryemstv.pdf

44. Teteriatnyk, B. S. (2018). Didzhytyzatsiia ta didzhytalizatsiia v konteksti virtualizatsii hospodarskoi diialnosti [Digitization and digitalization in the context of virtual economic activity. *Vseukrainska naukovo-praktychna konferentsiia "Innovatsiina systema ta informatsiini tekhnolohii v suchasnii nautsi" – All-Ukrainian scientific and practical conference "Innovative system and information technologies in modern science".* Kharkiv, Ukraine. (In Ukrainian). Retrieved from https://ndipzir.org.ua/14-06-2017

45. Ting, D. S. W., Carin, L., Dzau, V., & Wong, T. Y. (2020). Digital technology and COVID-19. *Nature Medicine, 26*(4), 459-461. https://doi.org/10.1038/s41591-020-0824-5

46. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems, 28*(2), 118-144. https://doi.org/10.1016/j.jsis.2019.01.003

47. Williams, L. (2021). Concepts of Digital Economy and Industry 4.0 in Intelligent and information systems. *International Journal of Intelligent Networks, 2,* 122-129. https://doi.org/10.1016/j.ijin.2021.09.002

48. Yuan, S., Musibau, H. O., Genç, S. Y., Shaheen, R., Ameen, A., & Tan, Z. (2021). Digitalization of economy is the key factor behind fourth industrial revolution: How G7 countries are overcoming with the financing issues? *Technological Forecasting and Social Change, 165.* https://doi.org/10.1016/j.techfore.2020.120533

49. Yu, H., Fletcher, M., & Buck, T. (2022). Managing digital transformation during re-internationalization: Trajectories and implications for performance. *Journal of International Management, 28*(4), 100947. https://doi.org/10.1016/j.intman.2022.100947




http://dx.doi.org/10.21511/ppm.20(4).2022.22

# APPENDIX A

**Table A1.** Initial data for the cluster analysis of countries by the level of SME digitization

Source: Authors' elaboration.

| Country | Internet of things | Integration of business processes into electronic processes | Artificial intelligence | Digital integration with customers/ suppliers, supply chain management | 3D printers and robotics | Big data analysis | Cloud services |
|---|---|---|---|---|---|---|---|
| Austria | 48 | 44 | 7 | 19 | 3 | 5 | 37 |
| Belgium | 25 | 56 | 8 | 21 | 5 | 19 | 49 |
| Bulgaria | 14 | 21 | 3 | 9 | 1 | 5 | 10 |
| Bosnia and Herzegovina | 13 | 25 | 2 | 11 | 3 | 3 | 6 |
| Greece | 21 | 34 | 4 | 8 | 2 | | 20 |
| Denmark | 17 | 49 | 20 | 55 | 8 | 21 | 62 |
| Estonia | 16 | 22 | 2 | 61 | 2 | 7 | 55 |
| Ireland | 31 | 23 | 6 | 16 | 2 | 20 | 56 |
| Spain | 26 | 48 | 6 | 32 | 5 | 5 | 27 |
| Italy | 31 | 31 | 5 | 95 | 4 | 6 | 59 |
| Cyprus | 32 | 33 | 2 | 12 | 5 | 2 | 48 |
| Latvia | 25 | 38 | 5 | 12 | 2 | 5 | 25 |
| Lithuania | 24 | 43 | 3 | 25 | 3 | 8 | 29 |
| Luxembourg | 20 | 38 | 12 | 12 | 3 | 15 | 29 |
| Malta | 24 | 38 | 8 | 21 | 8 | 25 | 53 |
| Netherlands | 18 | 41 | 10 | 22 | 5 | 23 | 62 |
| Germany | 34 | 36 | 9 | 15 | 6 | 15 | 38 |
| Norway | 22 | 38 | 9 | 63 | 3 | 16 | 61 |
| Poland | 15 | 30 | 2 | 11 | 2 | 6 | 24 |
| Portugal | 20 | 51 | 16 | 16 | 4 | 9 | 31 |
| Romania | 9 | 16 | 1 | 15 | 1 | 4 | 13 |
| Serbia | 15 | 21 | 0 | 19 | 1 | 1 | 25 |
| Slovakia | 24 | 30 | 4 | 14 | 3 | 4 | 33 |
| Slovenia | 46 | 34 | 9 | 57 | 3 | 4 | 39 |
| Turkey | 20 | 27 | 2 | 19 | 3 | 5 | 8 |
| Hungary | 20 | 19 | 3 | 12 | 3 | 5 | 23 |
| Finland | 39 | 47 | 12 | 81 | 6 | 17 | 71 |
| France | 20 | 44 | 5 | 21 | 3 | 18 | 26 |
| Croatia | 21 | 22 | 8 | 39 | 3 | 11 | 36 |
| Czech Republic | 28 | 35 | 3 | 9 | 4 | 7 | 42 |
| Sweden | 38 | 33 | 8 | 43 | 5 | 11 | 73 |

# APPENDIX B

**Table B1.** Initial centers of clusters

| Indicators | Cluster | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| D1 | 48 | 31 | 17 | 9 |
| D2 | 44 | 31 | 49 | 16 |
| D3 | 7 | 5 | 20 | 1 |
| D4 | 19 | 95 | 55 | 15 |
| D5 | 3 | 4 | 8 | 1 |
| D6 | 5 | 6 | 21 | 4 |
| D7 | 37 | 59 | 62 | 13 |

*Note:* Created in IBM SPSS Statistics.

**Table B2.** Chronology of iterations

| Iteration | Change of cluster centers | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | 22.134 | 9.626 | 19.202 | 8.431 |
| 2 | 1.302 | 3.209 | 3.200 | 1.054 |
| 3 | .077 | 1.070 | .533 | .132 |
| 4 | .005 | .357 | .089 | .016 |
| 5 | .000 | .119 | .015 | .002 |
| 6 | 1.559E-5 | .040 | .002 | .000 |
| 7 | 9.170E-7 | .013 | .000 | 3.216E-5 |
| 8 | 5.394E-8 | .004 | 6.859E-5 | 4.020E-6 |
| 9 | 3.173E-9 | .001 | 1.143E-5 | 5.025E-7 |
| 10 | 1.866E-10 | .000 | 1.905E-6 | 6.281E-8 |

*Note:* Created in IBM SPSS Statistics. a: Iterations are terminated because the maximum number of iterations has been completed. Iterations did not lead to convergence. The maximum change of the absolute coordinate for any center: 000. The current iteration is 10. The minimum distance between the initial centers: 50.941.

**Table B3.** Belonging of countries to clusters

| Observation number | Country | Cluster | Distance |
|---|---|---|---|
| 1 | Austria | 1 | 23,517 |
| 2 | Belgium | 1 | 21,408 |
| 3 | Bulgaria | 4 | 7,781 |
| 4 | Bosnia and Herzegovina | 4 | 10,541 |
| 5 | Greece | 2 | 15,85 |
| 6 | Denmark | 3 | 23,043 |
| 7 | Estonia | 3 | 20,860 |
| 8 | Ireland | 1 | 25,413 |
| 9 | Spain | 1 | 21,001 |
| 10 | Italy | 2 | 14,439 |
| 11 | Cyprus | 1 | 18,057 |
| 12 | Latvia | 1 | 17,315 |
| 13 | Lithuania | 1 | 13,654 |
| 14 | Luxembourg | 1 | 14,901 |
| 15 | Malta | 1 | 19,951 |
| 16 | Netherlands | 1 | 27,412 |
| 17 | Germany | 1 | 10,133 |
| 18 | Norway | 3 | 11,034 |
| 19 | Poland | 4 | 11,618 |
| 20 | Portugal | 1 | 18,696 |
| 21 | Romania | 4 | 9,635 |
| 22 | Serbia | 4 | 11,581 |
| 23 | Slovakia | 1 | 14,652 |
| 24 | Slovenia | 3 | 27,527 |
| 25 | Turkey | 4 | 11,357 |
| 26 | Hungary | 4 | 9,927 |
| 27 | Finland | 2 | 14,440 |
| 28 | France | 1 | 16,615 |
| 29 | Croatia | 1 | 26,719 |
| 30 | Czech Republic | 1 | 13,045 |
| 31 | Sweden | 3 | 22,396 |

*Note:* Created in IBM SPSS Statistics.


http://dx.doi.org/10.21511/ppm.20(4).2022.22

**Table B4.** End centers of clusters

| Factor | Cluster | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| D1 Internet of things | 26 | 35 | 28 | 15 |
| D2 Integration of business processes into electronic processes | 39 | 39 | 35 | 23 |
| D3 Artificial intelligence | 7 | 9 | 10 | 2 |
| D4 Digital integration with customers/suppliers | 19 | 88 | 56 | 14 |
| D5 3D printing and robotics | 4 | 5 | 4 | 2 |
| D6 Big data analysis | 12 | 12 | 12 | 4 |
| D7 Cloud services | 39 | 65 | 58 | 16 |

*Note:* Created in IBM SPSS Statistics.

**Table B5.** Distance between the end centers of clusters

| Clusters | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | | 74,227 | 41,654 | 32,267 |
| 2 | 74,227 | | 33,971 | 93,426 |
| 3 | 41,654 | 33,971 | | 63,332 |
| 4 | 32,267 | 93,426 | 63,332 | |

*Note:* Created in IBM SPSS Statistics.

**Table B6.** Number of observations in each cluster

| | | |
|---|---|---|
| Cluster | 1 | 16,000 |
| | 2 | 2,000 |
| | 3 | 5,000 |
| | 4 | 7,000 |
| Valid | | 30,000 |
| Missed | | 1,000 |

*Note:* Created in IBM SPSS Statistics.

**Table B7.** Distance of ANOVA clusters

| Indicators | Cluster | | error | | F | Significance |
|---|---|---|---|---|---|---|
| | Average square | Degrees of freedom | Average square | Degrees of freedom | | |
| D1 | 312.281 | 3 | 64.256 | 26 | 4.860 | .008 |
| D2 | 434.713 | 3 | 73.893 | 26 | 5.883 | .003 |
| D3 | 70.037 | 3 | 15.329 | 26 | 4.569 | .011 |
| D4 | 4581.129 | 3 | 52.768 | 26 | 86.816 | .000 |
| D5 | 8.722 | 3 | 2.646 | 26 | 3.296 | .036 |
| D6 | 106.924 | 3 | 41.657 | 26 | 2.567 | .076 |
| D7 | 2328.838 | 3 | 120.006 | 26 | 19.406 | .000 |

*Note:* Created in IBM SPSS Statistics. F-criterion should be used only for description purposes, since the clusters are selected so that the difference between observations in different clusters is maximal. The observed significance levels are not adjusted for this and, therefore, cannot be used to test the hypothesis of equality of cluster means.