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Comprehensive Assessment of Enterprise Digital Competitiveness

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Abstract

There are studies investigating a country's digital competitiveness; however, there is a lack of research examining digital competitiveness at the enterprise level. Hence, the current study aims at composing an enterprise digital competitiveness index (EDCI), which provides a possibility to assess the level of enterprise digital competitiveness and could be used by policymakers in the development of a strategy for transitioning to the digital economy. The CRITIC and COPRAS approaches are employed for the index construction. The criteria and subcriteria provided by Eurostat (2022) are used as antecedents of the EDCI. The results indicate that Nordic countries have reached the highest level of enterprise digital competitiveness. The mentioned countries' GDP per capita is in the top 5 among the EU countries, while the countries with the lowest GDP per capita show the lowest EDCI.

Keywords: competitiveness, digital competitiveness, enterprise competitiveness, digital economy

JEL Codes: F43, O47

1. Introduction

Competitiveness is a well-discussed topic in different research fields, starting with technological sciences and ending with humanities. Social sciences are not an exception and especially the field of economics. Researchers have investigated competitiveness from a wide range of perspectives, including higher education competitiveness (Parasii-Verhunenko et al., 2020), sustainable competitiveness (Nadalipour et al., 2019), European competitiveness (Ketels and Porter, 2021), tourism competitiveness (Cibinskiene and Snieskiene, 2015; Tleuberdinova et al., 2022), regional competitiveness (Bahrami et al., 2022), and others.

Scientists operating in the field of economics assert that competitiveness is one of the substantial elements influencing the level of a country's economic development (Bruneckienė et al., 2021; Muradov et al., 2019; Mynkin, 2017). Moreover, competitiveness diminishes the size of the shadow economy (Poufinas et al., 2021), which, in turn, could influence overall economic growth. Some view competitiveness at a narrow perspective and investigate it at the enterprise level (Guo and Lu, 2022; Peruchi et al., 2022) and most of the studies cover overall enterprise competitiveness (Pankratov and Trifonov, 2021; Zaernyuk et al., 2020).

However, there is a lack of studies investigating the level of digital competitiveness of enterprises, which is a relatively new concept that experienced a boom during the COVID-19 pandemic, when a large number of organisations switched to remote work. In fact, not all of them are going to get back to their previous working routine and will perform, at least partially, online; hence, digital competitiveness concepts become more and more important. Still, there are only few studies investigating this phenomenon. For instance, Stankovic et al. (2021) investigated the digital competitiveness of the European Union countries by using three criteria, such as CT usage in households and by individuals, ICT usage in enterprises and digital skills. Kő et al. (2023) analysed the relationship between digital agility, digital competitiveness and innovative performance in the context of SMEs. Martincevic (2022) researched the relationship between digital technology and digital competitiveness and distinguished the factors that create digital competitiveness. Although there are several studies on digital competitiveness, there is a lack of articles exploring digital competitiveness of enterprises.

Hence, the present study aims at examining the level of digital competitiveness of enterprises at a country level (the EU countries are included in the research) and developing an enterprise digital competitiveness index devoted to measuring the digital competitive ability of business organisations. The index will enable organisations to align their digital strategies with industry benchmarks and emerging trends, which will lead to improved strategic planning, ensuring that digital initiatives are focused on areas that enhance competitiveness. Moreover, it will help provide a baseline for ongoing assessment and measurement of digital performance, which will encourage a culture of continuous improvement by identifying and addressing areas for enhancement.

The methodology that could be used for obtaining the enterprise digital competitiveness index is proposed based on the multi-criteria decision-making (MCDM) approach and consists of two stages. The first is devoted to assignment of weights to selected indicators measuring the level of enterprise digital competitiveness using the CRITIC method (criteria importance through intercriteria correlation). During the second stage, the index is calculated using

the COPRAS method (complex proportional assessment). The results of the present study contribute to the existing knowledge on competitiveness and, moreover, complement research into enterprise performance by proposing an index of enterprise digital competitiveness.

The paper has the following structure: Section 2 discusses the concept of enterprise digital competitiveness and highlights the role of the digital economy. Section 3 reports on the data and describes the research methodology. Section 4 provides the empirical findings representing the calculated index for the EU countries and offers a scientific discussion. The concluding section points out the scientific contribution of the results and further research directions.

2. Theoretical Background

Business competitiveness has remained one of the most discussed topics among scholars. Authors claim that business competitiveness could help sustain future growth opportunities (Keung and Shen, 2017), which, in turn, brings stability to the market. Moreover, there are authors claiming that improvement in business competitiveness could cause improvement in a firm's innovative ability and profit growth (Xu, 2007). Business competitiveness is sometimes treated as an antecedent of economic progress (Carrasco Vega et al., 2021; Porter, 2004). Thus, it could be stated that business competitiveness is essential for every sphere of a country's economy. However, studies on competitiveness usually do not consider digital competitiveness, which has significantly risen during the last decade and especially during the pandemic. Hence, nowadays, in order to compete on the global market, it is essential to be digitally competitive.

Despite the fact that there are few articles dealing with digital competitiveness, all of the existing ones could be divided into two central areas: country digital competitiveness and enterprise digital competitiveness studies. Based on the information provided by Web of Science, there are only 45 articles investigating countries' digital competitiveness in the database (e.g., Cahyadi and Magda, 2021; Jurčević et al., 2020), much less examining digital competitiveness at the company level even though these are closely related topics.

It should be mentioned that there are very few articles analysing e-business competitiveness; to be more precise, there are only twelve papers with the phrase "e-business competitiveness" or "e-commerce competitiveness". However, it should be noted from the very beginning that e-business competitiveness and enterprise digital competitiveness are different concepts.

Hence, due to a low number of articles dealing with the analysed topic, it is crucial to define digital competitiveness.

Kő et al. (2023) defined digital competitiveness as a component of digital innovation capability and digital transformation maturity, where digital innovation capability includes

expertise, capabilities, employee training programmes and networks to develop new digital solutions. According to them, digital transformation maturity reflects a company's digital transformation status relative to its competitors. In other words, "digital competitiveness is a component of digital innovation capability and digital transformation maturity". Based on the definition presented by Martincevic (2022), digital competitiveness could be understood as the ability of an enterprise to adopt and explore digital technologies that lead to changes in industrial production and business models.

Enterprise digital competitiveness could be reached with the help of ICT usage for different purposes of the company (not only for buying or selling goods as it is done in e-business/e-commerce).

ICT has been examined by many scholars from different perspectives, one of which is competitiveness. There are authors stating that ICT promotes business competitiveness (Phuthong, 2022), which, in this article, is suggested to be called the digital competitiveness of the enterprise. It is worth mentioning that only new, updated technologies contribute to the competitiveness of enterprises. Thus, it is obvious that ICT could be treated as an aid to enterprise digital competitiveness. Stankovic et al. (2021) assessed the digital competitiveness of European countries using 13 indicators grouped into three categories. The second one covers ICT usage in enterprises and includes the following indicators: websites and use of social media; e-business; e-commerce (enterprises with e-commerce sales); connection to the internet (enterprises with internet access); ICT security (security measure used). Moreover, measuring the countries' digital competitiveness, they found that ICT usage in enterprises has the highest relative importance compared to ICT usage in households and by individuals with digital skills. Still, it should be asserted that both e-business and e-commerce could serve as one of the criteria influencing the overall enterprise's digital competitiveness.

While analysing digital competitiveness, it became obvious that it is primarily related to e-business and e-commerce. There are authors claiming that e-business has become a new growth point of economic development (Xu et al., 2012). In fact, e-commerce is a prerequisite for promoting enterprise competitiveness (Li, 2015). In other words, e-commerce could significantly increase companies' competitiveness and strengthen their position in a global market (Jaganjac et al., 2020).

Remeikiene et al. (2019) asserted that e-business has an impact on the country's competitiveness. A country's competitiveness is closely related to the enterprises' competitiveness; hence, e-business and e-commerce could be treated as antecedents of the digital competitiveness of enterprises.

Companies provide customers with information via their websites or social media in the digital economy (Amin et al., 2021; Ghazali et al., 2018). The benefits provided by social media as a marketing tool enhance enterprises' competitiveness (Chen et al., 2021). Social media advertising might be used as a tool to increase SMEs' competitiveness (Konstantopoulou et al., 2019). Moreover, social media improve companies' performance (Dirgiatmo, 2019). Websites are crucial for enterprises' competitiveness as well. For example, Lányi et al. (2021) claimed that websites have a positive influence on companies' competitiveness. Suryani et al. (2022) stated that managers should improve their websites while ameliorating their competitiveness in the digital business era. Consequently, websites and use of social media are among the factors influencing enterprise digital competitiveness.

Moreover, without a connection to the internet, it is impossible to provide any online services. In fact, internet technologies provide new opportunities for enterprises to be competitive on the global market and play a significant role in the world's economy (Čiarnienė and Stankevičiūtė, 2015). Because of that, connection to the internet is counted as one of the criteria of enterprise digital competitiveness.

To ensure stability and trust of digital services, ICT security is vital. Candra et al. (2020) stated that customers are more likely to enter individual data if they trust the security system offered by an online platform. The use of personal data, in turn, is necessary to proceed with purchasing online goods or services. It is obvious that security is essential in electronic commerce (Trabelsi-Zoghlami et al., 2020). Hence, ICT security is treated as one of the factors of enterprise digital competitiveness.

The enterprise's level of digital competitiveness is closely related to the digital economy's competitiveness. For instance, Domazet et al. (2018) asserted that only development of ICT (which could be a measure of digital competitiveness) promotes creation of a strong economy. There are scientists claiming that ICT is the driver of a competitive digital economy (Azman et al., 2015; Domazet et al., 2018). In turn, digitally competitive business is a background for a competitive digital economy. In other words, it is essential to examine the level of digital competitiveness of enterprises in order to ensure a competitive digital economy, which is an essential part of the country's whole economy.

3. Methodology

The present study's objective is to evaluate the level of enterprise digital competitiveness in the EU member states by constructing an index of digital competitiveness. The steps of constructing the composite index are based on the methodology proposed by the OECD (OECD, 2008), where development of a theoretical framework and selection of variables play a vital role. According to the OECD (2008), the theoretical framework includes concept definition, determination of sub-groups and identification and selection of criteria. These steps were covered and presented in the theoretical background.

The concept of the enterprise digital competitiveness index (EDCI) is based on five categories, which are offered by Eurostat (2022), i.e., e-business, e-commerce, connection to the internet, websites and usage of social media, and ICT security. All these categories were analysed in the theoretical background section of the present paper. All these categories are treated as criteria by which the EDCI is created. The EDCI itself helps measure the enterprises' digital competitiveness at the country level. The index ranges from 0 to 100, where 0 means the lowest level and 100 means the highest level of enterprise digital competitiveness. All the categories (criteria) are related to each other as proposed by the OECD (2008). The indicators (subcriteria) were selected based on the dataset provided by Eurostat (2022). All the subcriteria reflect the category (criterion) in which they are included and fully describe the phenomenon being measured, i.e., the enterprise digital competitiveness index.

Moreover, based on the OECD (2008), the quality of available criteria and subcriteria should be checked. The Eurostat (2022) data are used in the present paper, which are a priori trusted to be of high quality.

In order to construct the index, a two-stage approach is employed. In the first stage, the procedure of weighting is completed using the CRITIC method. In the second stage, the EU countries are ranked in terms of enterprise digital competitiveness indicators and the enterprise digital competitiveness index is proposed based on the COPRAS method.

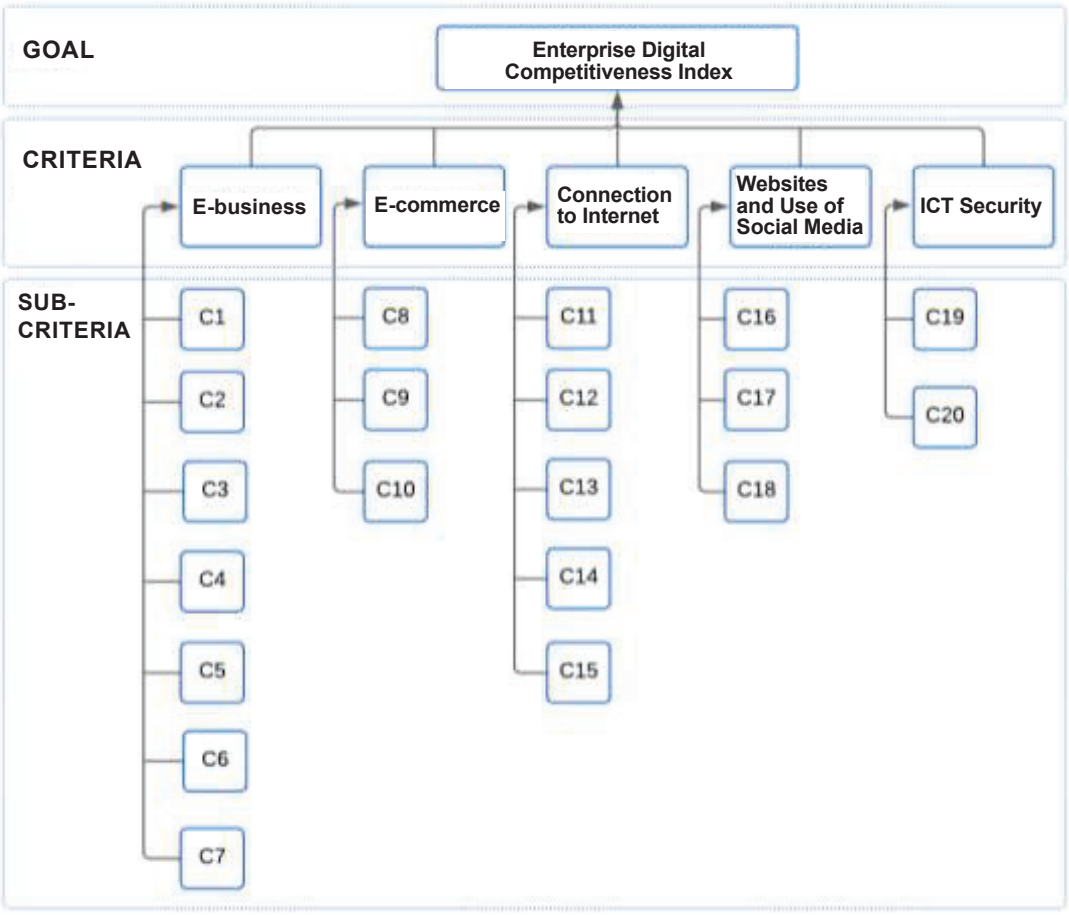
3.1 Data and model development

In order to create the enterprise digital competitiveness index, statistical data were collected from the Eurostat database. The criteria were selected based on the factors provided in the theoretical background. In order to make the data more complete, the subcriteria presented in the Eurostat database were included in the research as well. The data were collected in 2022 (the last available data). All the EU countries were included in the research. In other words, the following criteria and subcriteria were used as antecedents of the digital competitiveness of enterprises (Eurostat, 2022):

- E-business:
  - Integration of internal processes (C1)
  - Integration with customers/suppliers, supply chain management (C2)
  - Cloud computing services (C3)
  - Big data analysis (C4)
  - 3D printing and robotics (C5)
  - Internet of things (C6)
  - Artificial intelligence (C7)
- E-commerce:
  - E-commerce sales (C8)
  - Value of e-commerce sales (C9)
  - Obstacles to web sales (C10)
- Connection to the internet:
  - Internet access (C11)
  - Use of computers and the internet by employees (C12)
  - Type of connections to the internet (C13)
  - Use of mobile connections to the internet (C14)
  - Use of mobile connections to the internet by employees (C15)
- Websites and use of social media:
  - Websites and functionalities (C16)
  - Social media use by type, internet advertising (C17)
  - Social media use by purpose (C18)
- ICT security:
  - Security policy: measures, risks and staff awareness (C19)
  - Security incidents and consequences (C20)

Based on the selected criteria and subcriteria, the research model was developed (see Figure 1).

Figure 1: Research model



Source: authors based on Eurostat (2022)

The selected criteria represent the digital competitiveness of enterprises, which could be treated as the backbone of the overall performance of the digital economy.

When assessing the economic reality, it is necessary to consider the impact of digital competitiveness on factors such as GDP growth, job creation, industry competitiveness and overall economic resilience. The developed index has an exact numerical expression, as do its components; hence, the calculation of the impact becomes possible. In other words, creating an index involves quantifying the factors and developing a scoring system. Organisations, research institutions or government bodies might use the calculated scores in order to acquire a comprehensive view of the digital competitiveness of enterprises within a region or industry. However, it is important to note that the landscape of digital competitiveness is dynamic and the index needs to be regularly updated to reflect the changing nature of technology and its impact on the economy.

CRITIC approach

Assigning weights to criteria is considered to be an essential part of executing the COPRAS method. In order to get reliable results, the weights should be calculated as accurately as possible. Hence, the widely used AHP method, which is based on an expert evaluation procedure, is not the most appropriate one, as the judges could be affected by their knowledge and biases. Hence, it is necessary to employ an alternative technique that could overcome the mentioned issues. Therefore, the CRITIC method was selected as it is considered to be an objective technique (Diakoulaki et al., 1995; Lu et al., 2021; Tuş and Aytaç Adalı, 2019). One of the significant advantages of the CRITIC method is that it is considered an effective method for determining the weights of criteria (Nasawat et al., 2021). Moreover, the CRITIC approach recognises that criteria in decision-making processes are often not independent and may have varying degrees of correlation. This is very important for the present study, as the selected subcriteria are related to each other. What is more, considering intercriteria correlations can make the decision model more robust to uncertainties and dynamic relationships among criteria.

The CRITIC method approach is described in the following steps (Krishnan et al., 2021; Paradowski et al., 2021; Wichapa et al., 2021).

Step 1: Construction of the decision matrix X, showing the performance of different alternatives with respect to selected subcriteria:

$$X = \left[x_{ij}\right]_{m\times n} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \quad i \in \{1,\ 2,\ \dots,\ m\},\ j \in \{1,\ 2,\ \dots,\ n\} \tag{1}$$

Step 2: Normalisation of the decision matrix:

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \quad i \in \{1,\ 2,\ \dots,\ m\},\ j \in \{1,\ 2,\ \dots,\ n\} \tag{2}$$

where m represents the number of alternatives, n is the number of criteria, $x_j^{max} = \max\left(x_{ij},\ j = 1,\ 2,\ 3,\ \dots,\ n\right)$ and $x_j^{min} = \min\left(x_{ij},\ j = 1,\ 2,\ 3,\ \dots,\ n\right)$

Step 3: Calculation of the standard deviation σ_j of each criterion r_j .

Step 4: Calculation of the correlation of every pair of normalised criteria and construction of the symmetric matrix with elements R_{ij} .

Step 5: Determination of the conflict measure between criteria:

$$\sum_{j=1}^{n}\left(1-R_{ij}\right) \tag{3}$$

Step 6: Determination of the information amount C_j released by the j-th criterion:

$$C_j = \sigma_j \sum_{j=1}^{n}\left(1-R_{ij}\right) \tag{4}$$

Step 7: Determination of the weights of criteria:

$$w_j = \frac{C_j}{\sum_{j=1}^{n} C_j} \tag{5}$$

It is worth mentioning that in the CRITIC method it is not necessary to select minimising and maximising criteria, as this is done in the next stage – during application of the COPRAS method.

COPRAS approach

After the weights are assigned, the COPRAS method is used for the development of the prioritisation line. The COPRAS method was initially proposed by Zavadskas et al. (1994).

The steps are as follows (Popović et al., 2012; Schitea et al., 2019; Stankevičienė and Kraujalienė, 2017):

Step 1: Construction of the decision matrix:

$$D = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix}\begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \tag{6}$$

where D is the decision matrix, A_i is the selected European country, x_{ij} are the data obtained from Eurostat for every country, m is the number of alternatives, and n is the number of subcriteria.

Step 2: Normalisation of the decision matrix:

$$\overline{x}_{ij} = x_{ij} \Big/ \sum_{i=1}^{m} x_{ij} \tag{7}$$

Step 3: Construction of the weighted decision matrix:

$$\tilde{x}_{ij} = \overline{x}_{ij} \cdot w_j \tag{8}$$

Step 4: Calculation of the maximising and minimising index for each alternative:

$$S_{+i} = \sum_{j=1}^{n} \tilde{x}_{+ij} \tag{9}$$

$$S_{-i} = \sum_{j=1}^{n} \tilde{x}_{-ij} \tag{10}$$

where: $\tilde{x}_{+ij}$ is the weight-normalised values of maximising criteria, and $\tilde{x}_{-ij}$ weight-normalised values of minimising criteria.

Step 5: Calculation of the relative weight of each alternative:

$$Q_i = S_{+i} + \frac{S_{-\min} \sum_{i=1}^{m} S_{-i}}{S_{-i} \cdot \sum_{i=1}^{m} \frac{S_{-\min}}{S_i}} \tag{11}$$

where: S_{-i} is the sum of minimising criteria for each alternative, and $S_{-\min}$ is the minimum value of S_{-i}.

Step 6: Computation of the enterprise digital competitiveness index (EDCI) for all the alternatives (countries):

$$EDCI_i = \frac{Q_i}{Q_{max}} \cdot 100\% \tag{12}$$

4. Results and Discussion

The first step of the research included calculating the weights of the selected criteria measuring the digital competitiveness of the EU countries at the enterprise level. The results are presented in the Table 1 below.

Table 1: Obtained weights

Criteria	Subcriteria	Weights of subcriteria	Weights of criteria
E-business	Integration of internal processes	0.047679	0.356930
	Integration with customers/suppliers, supply chain management	0.035903	
	Cloud computing services	0.069457	
	Big data analysis	0.057527	
	3D printing and robotics	0.061008	
	Internet of things	0.037195	
	Artificial intelligence	0.048162	
E-commerce	E-commerce sales	0.059015	0.145444
	Value of e-commerce sales	0.041295	
	Obstacles to web sales	0.045134	
Connection to internet	Internet access	0.045699	0.250094
	Use of computers and the internet by employees	0.063821	
	Type of connections to the internet	0.043387	
	Use of mobile connections to the internet	0.043709	
	Use of mobile connections to the internet by employees	0.053478	
Websites and use of social media	Websites and functionalities	0.071982	0.183092
	Social media use by type, internet advertising	0.047237	
	Social media use by purpose	0.063873	
ICT security	Security policy: measures, risks and staff awareness	0.039474	0.064439
	Security incidents and consequences	0.024965	

Source: authors' calculations

Based on the results obtained, it could be stated that the e-business criterion has the most significant position in evaluating the level of enterprise digital competitiveness at the level of EU countries. Actually, it is quite a logical result as the mentioned criterion consists of the largest number of indicators, the so-called subcriteria. Moreover, e-business is the essential criterion of the digital competitiveness of enterprises as it helps enhance the efficiency of the companies, especially in the COVID-19 era, when a significant number of services moved online. Moreover, e-business is critical for encouraging companies to be part of the online competition (Huo et al., 2019), i.e., to be involved in digital competitiveness. Gómez et al. (2022) claimed that e-business technologies have a positive impact on a firm's productivity. High productivity, in turn, positively influences a firms' competitiveness. Knapčíková et al. (2021) argued that e-business, represented by using different

internet tools, leads to a higher level of enterprise competitiveness. Connection to the internet also has a high weight. Actually, this criterion is connected to the e-business and e-commerce criteria. Without any doubt, this criterion is vital for the digital competitiveness of enterprises, as, without a smooth connection, e-activities would not be available. Lányi et al. (2021) stated that the existence and quality of websites have a positive influence on SME competitiveness. Actually, this statement could be used for all organisations, not only SMEs, as high-quality connection makes it easier for all firms to provide services to customers. Apart from that, ICT contributes to the enterprise competitiveness level as well. For instance, Ollo-López and Aramendía-Muneta (2012) claimed that ICT has a great degree of influence on competitiveness. Soylu et al. (2023) and Milićević et al. (2020) have found that ICT boosts the competitiveness of countries. As enterprises are part of countries' economic systems, it could be stated that in line with countries' competitiveness, ICT promotes the level of companies' competitiveness as well. However, all the authors speak about ICT, but not ICT security. This article analyses ICT security precisely for this reason. It was found that ICT security could be treated as a part of enterprise competitiveness, although it has the lowest value among the criteria. This is quite a new result, because, as was mentioned, the scholars have analysed ICT, but not ICT security.

Table 2: Enterprise digital competitiveness index and country ranking.

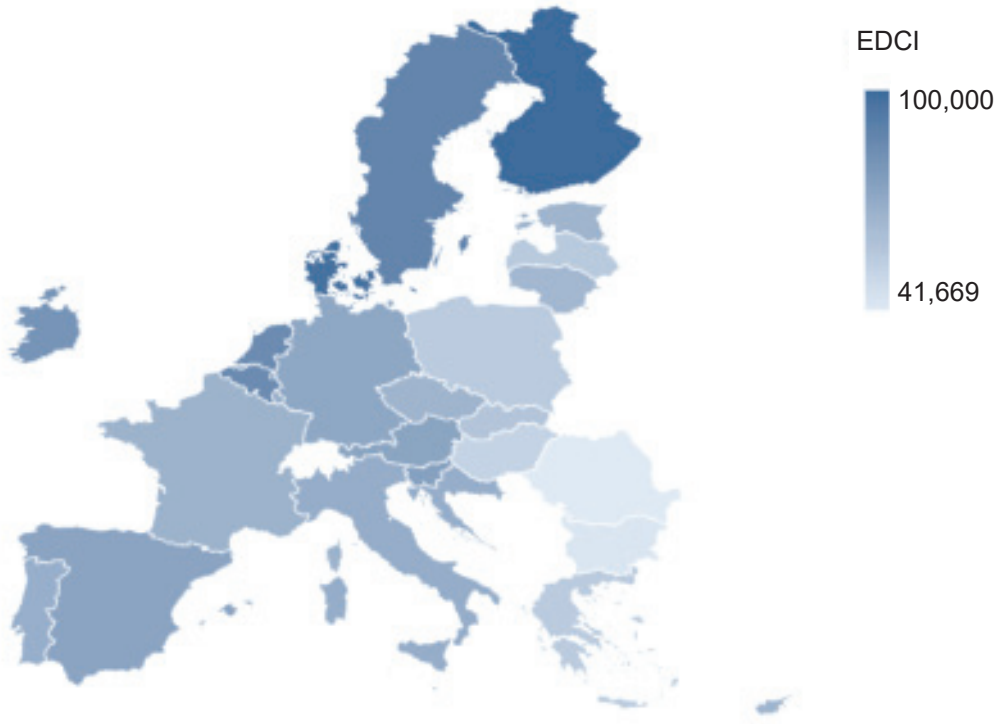
Country	Enterprise digital competitiveness index (EDCI)	Rank	Country	Enterprise digital competitiveness index (EDCI)	Rank
Finland	100	1	**Portugal**	68.454	15
Denmark	97.088	2	**France**	67.012	16
Sweden	87.693	3	**Czech Republic**	66.543	17
Belgium	84.894	4	**Cyprus**	66.507	18
Netherlands	84.850	5	**Estonia**	66.429	19
Malta	83.178	6	**Lithuania**	64.589	20
Ireland	81.071	7	**Slovakia**	58.217	21
Slovenia	74.830	8	**Latvia**	56.043	22
Spain	73.302	9	**Poland**	55.565	23
Austria	73.076	10	**Greece**	55.455	24
Germany	72.130	11	**Hungary**	51.847	25
Italy	69.608	12	**Bulgaria**	43.327	26
Croatia	69.135	13	**Romania**	41.669	27
Luxembourg	68.920	14			

Source: authors' calculations

As for subcriteria, the most significant ones are website and functionalities, cloud computing services, social media use by purpose, use of computers and the internet by employees, and 3D printing and robotics. All these indicators belong to different categories, which means that despite the variety of weights, all the categories are extremely important for enterprises to be competitive in the digital era.

In the next step of the study, the COPRAS method was used in order to assess and develop a priority line of the EU countries based on enterprises operating in these countries' digital competitiveness. The results are provided in the Table 2.In order to fully understand the results, a visualisation is provided below (see Figure 2).

Figure 2: Enterprise digital competitiveness index by country



Source: authors

The results provided in the Table 2 and Figure 2 show that the highest level of enterprise digital competitiveness is in the Nordic countries – Finland, Denmark, and Sweden. Finland received 100 points, which means that Finland is the starting point (base) for other countries' index computation. In fact, the Finnish government pays significant attention to the issue of digital competitiveness as, for instance, the Finnish Ministry for Foreign Affairs launched

an intersectoral Virtual Finland project to boost Finland's digital competitiveness (Finnish Government, 2022). Under this initiative, the Finnish government seeks to develop a digital service infrastructure for all the participants of the economy, including enterprises.

The study results show that enterprise digital competitiveness is dynamic and involves various interactions and interdependencies. For instance, e-business and e-commerce involve the use of digital technologies to conduct business processes, including online transactions, customer services and supply chain management. ICT infrastructure provides the backbone for e-business and e-commerce operations. Robust and scalable ICT infrastructure is necessary for seamless connectivity, data storage and communication channels, enabling organisations to effectively execute their e-business and e-commerce strategies. The use of websites and social media should be secure as security is one of the competitive aspects. To sum up, enterprise digital competitiveness includes several criteria and could be defined as the ability of an organisation to effectively exploit digital technologies, strategies, and resources to gain a competitive advantage on the market.

The results of our EDCI have an impact on economic growth and social welfare. A higher digital competitiveness index indicates that enterprises are utilizing digital technologies efficiently. This increased efficiency leads to higher productivity levels across industries, contributing to overall economic growth. Moreover, enterprises with high digital competitiveness are better positioned to compete on a global scale, which enhances a country's overall economic competitiveness and could lead to increased exports, foreign investment, and economic expansion. Additionally, the pursuit of higher digital competitiveness requires investments in digital infrastructure, which could have multiplier effects, stimulating economic activity and promoting infrastructure development. Apart from that, it should be mentioned that digital competitiveness often results in the digitisation of services, making them more accessible to a broader population, which include healthcare, education, finance and government services, improving overall social welfare. In summary, a high level of enterprise digital competitiveness contributes to both economic growth and social welfare by driving innovation, increasing productivity, creating jobs, improving access to services, and fostering inclusive and sustainable development.

It is worth mentioning that the enterprise's digital competitiveness could be one of the factors influencing the country's overall digital competitiveness, which could be seen from the comparison of the results with the World Digital Competitiveness Ranking (WDCR) provided by IMD World Competitiveness Centre (2021). The ranking demonstrates that the countries listed in the first three positions are in the top 5 European countries ranked as the most digitally competitive ones, which means that investment into enterprise digitisation makes sense. Another

index connected to digital competitiveness is the Digital Economic and Society Index (DESI), proposed by the European Commission (2021). Actually, the DESI was created in 2014 and modified in 2021. According to the DESI, the first three places are Denmark, Finland, and Sweden. Thus, we see that there is a rotation between those countries within the three first positions, but they do not receive lower positions than the third when considering the EU countries. Another index that is related to digital competitiveness is the Digital Readiness Index (DRI), which was created to measure the capacity to use ICT to increase well-being and competitiveness at a country level (Bharatula and Murthy, 2020). According to that index, the first three positions in terms of the EU go to Denmark, the Netherlands and Sweden; Finland is ranked in the fifth position. A very similar index is the Network Readiness Index (NRI), according to which the most developed countries (top 5) are the Netherlands, Sweden, Denmark, Finland and Germany. It means that the top three countries within the index developed in the present study are linked to the top countries of the NRI. Hence, the linkage between different indices related to the digital economy and digitisation with the index provided in this paper is evident. Consequently, it could be stated that our enterprise digital competitiveness index is reliable as all the connections are logical. It is necessary to mention that our index differs from all the mentioned ones as it measures exactly the enterprises' digital competitiveness. At the same time, the others are not directly related to that phenomenon. The other indices are linked to countries' performance and do not analyse the enterprise level. Hence, our EDCI enhances organisations' global competitiveness by aligning with digital best practices on a global scale and encourages data-driven decision-making by providing metrics and analytics related to digital performance.

In order to check the connections between the analysed indices statistically, the correlation coefficients between the developed index and the others were calculated[1]. The results are presented in Table 3.

1 Malta was excluded from the calculations due to missing data.

Table 3: Correlation analysis

		EDCI	DESI	WDCR	NRI	DRI
EDCI	Pearson correlation	1	.897**	.842**	.840**	.675**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000
	Sum of squares and cross-products	5218.519	3216.174	4214.508	2481.441	805.165
	Covariance	208.741	128.647	168.580	99.258	32.207
	N	26	26	26	26	26
DESI	Pearson correlation	0.897**	1	0.931**	0.909**	0.699**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000
	Sum of squares and cross-products	3216.174	2464.234	3203.633	1844.680	572.799
	Covariance	128.647	98.569	128.145	73.787	22.912
	N	26	26	26	26	26
WDCR	Pearson correlation	0.842**	0.931**	1	0.964**	0.697**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000
	Sum of squares and cross-products	4214.508	3203.633	4801.777	2730.127	797.054
	Covariance	168.580	128.145	192.071	109.205	31.882
	N	26	26	26	26	26
NRI	Pearson correlation	0.840**	0.909**	0.964**	1	0.724**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000
	Sum of squares and cross-products	2481.441	1844.680	2730.127	1670.360	488.060
	Covariance	99.258	73.787	109.205	66.814	19.522
	N	26	26	26	26	26
DRI	Pearson correlation	0.675**	0.699**	0.697**	0.724**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	Sum of squares and cross-products	805.165	572.799	797.054	488.060	272.298
	Covariance	32.207	22.912	31.882	19.522	10.892
	N	26	26	26	26	26

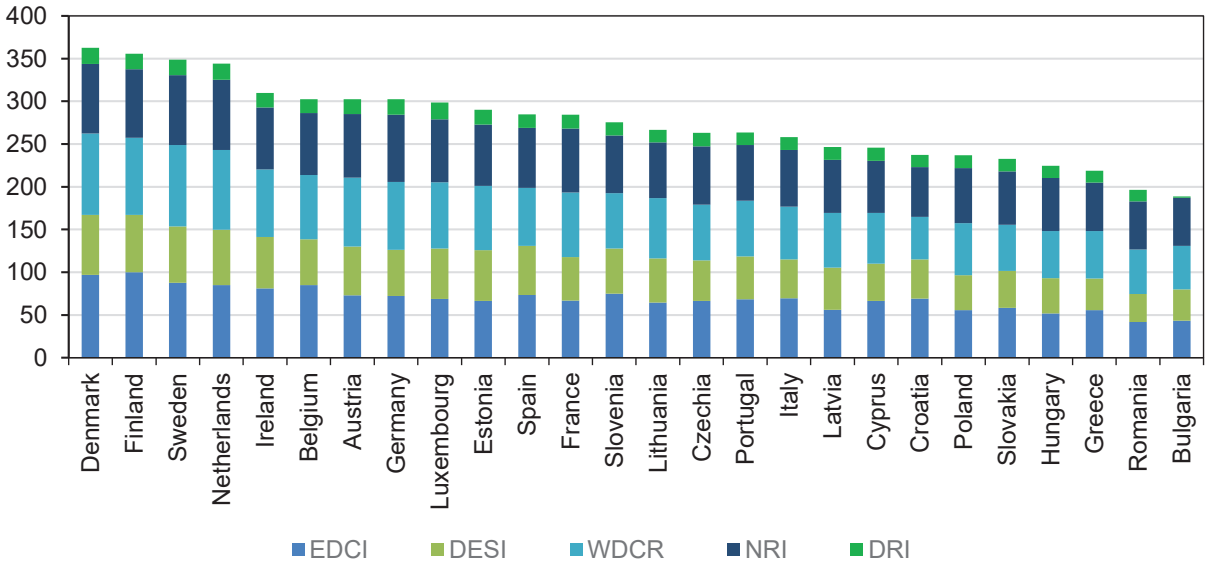
Notes: **. Correlation is significant at the 0.01 level (2-tailed)

Source: authors' calculations

As can be seen from Table 3, all the correlations between the different indices, including the proposed EDCI, are significant at the 0.01 level. Moreover, all the coefficients are very high and indicate a strong positive relationship between the variables (indices). It means that the index proposed in the present study is in line with other indices devoted to the digital economy, which, as was mentioned above, shows its reliability.

In order to see the full picture, all the analysed indices are combined and shown in Figure 3.

Figure 3: Stacked column chart of analyses indices



Source: authors

The representation of all the analysed indices shows that Finland, Denmark and Sweden scored the highest. In principle, the results repeat all the previous outcomes. The lowest scores are in Hungary, Greece, Romania, and Bulgaria – the countries that were rated the lowest in terms of the EDCI. It could be summed up that a higher level of enterprise digital competitiveness could be related to a country's higher economic performance.

5. Conclusions

Enterprise competitiveness is a widely analysed topic among scientists from different fields. It could help run a business successfully by attracting new customers, which in turn helps get more funding for developing new products. However, the common concept of competitiveness has undergone a change and transformed into digital competitiveness. This could be explained by the fact that the world faces digitisation in almost all spheres of life, including economic

performance. Hence, in order to make the economy efficient and competitive, the presence of ICT is a must. Because of that, digital competitiveness is a topic that should be addressed in the scientific literature as it becomes the primary manifestation of competitiveness. However, there is still a lack of scientific literature examining this phenomenon, especially at the enterprise level. Consequently, the objective of the present study was to propose an enterprise digital competitiveness index in order to analyse its level in the EU.

The obtained results contribute to the scientific literature on competitiveness and its measurement. In the present research, a methodology for the calculation of the enterprise digital competitiveness index was proposed by using MCDM methods (CRITIC for objective weighting and COPRAS for index computation). The study outcomes could be valuable for the EU countries' policymakers in the development of a strategy for transitioning to the digital economy. Based on the study, the policymakers will know where their country is and have a benchmark that should be treated as the country's vision.

According to the calculated EDCI, the countries with high economic performance are in higher positions. The Nordic countries – Finland, Denmark, and Sweden – are in the first three positions and Finland is treated as a starting point (base) of the proposed index. It should be noted that the mentioned countries are in the top 5 among the EU member states according to GDP per capita. This supports the conclusion that the most developed countries are paying more attention to ICT development and digital competitiveness promotion, which, in turn, affects the country's economic growth. In other words, it is like a virtuous circle: enterprise digital competitiveness influences economic development and vice versa. This is to say that the countries with the lowest GDP per capita, such as Romania, Bulgaria, and Hungary, have the lowest EDCI. However, it should be noted that Croatia is in the bottom 5 countries regarding GDP per capita; nonetheless, it is in the middle regarding the EDCI. This could be explained by the fact that Croatia has announced its National Development Strategy 2030, which covers an action plan for the period 2018–2030 and aims at supporting digital transition (Misheva, 2021).

However, the present study has limitations. Due to the unavailability of data for Malta, the country was excluded from the correlation analysis. Moreover, some indices, such as the DESI, are available only for EU countries, so a comparison of the EDCI with the DESI will not be possible outside the EU.

As digitisation and competitiveness are highly discussed topics, future research directions will include, but will not be limited to, investigation into digital competitiveness at a country level. There are a lot of studies investigating countries' competitiveness, but not digital competitiveness. Hence, the research into digital competitiveness will contribute to the knowledge of competitiveness and bring new insights into countries' development strategies.

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