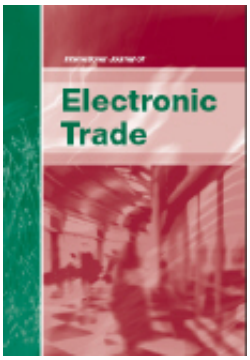

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The efficiency of e-commerce in the EU logistics sector

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Abstract: Advanced technologies help optimise product movement through supply chains, where electronic administration of logistics commerce is available. It represents an essential player in the development of logistics and distribution networks. Based on the average added value in the logistics sector in EU countries in 2021, the efficiency of e-commerce in the logistics sector by using a data envelopment analysis (DEA) can be calculated. The DEA calculation is based on the available statistical IT-oriented variables for each country as the input to the calculation and the logistics sector turnover in total enterprise turnover as the output. To better understand how countries are efficient, cluster analysis was used to classify the countries into three clusters according to the added value in the logistics sector in the year 2021. The results show more significant variation in the efficiency of e-commerce in the logistics sector between countries, despite similar IT input indicators between them.

Keywords: e-commerce sales; information technology; IT indicators; logistics; supply chain; logistics sector turnover; ERP software; digital subscriber line; DSL; DEA; cluster analysis.

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1 Introduction

The accelerated explosion of information technology (hereinafter: IT) usage represents an indispensable part of everyday life and the basis for the unwavering operation of electronic commerce (hereinafter: e-commerce). Younger generations have grown up with technology, which is also one of the factors in the rise in the use of e-commerce. Of course, other factors also contribute to this, such as increased access to internet services, easier price comparison between providers, easy online shopping via websites, platforms and applications, and lower costs (Mubarak, 2021) of transactions and deliveries – which can be done from the comfort of our homes. Thus, consumers have freedom when and where they do their shopping. Consequently, companies are dependable on modern IT systems that provide 24/7 support for the management and performance of e-commerce business operations since 'any other business model is inadequate' (Dragomirov, 2020).

E-commerce differs among countries and in the proportions of companies performing e-sales. In 2020, 22% of European companies had e-commerce sales, and 19% reported that online sales reached a minimum of 1% of their total turnover (Eurostat, 2021). Among these, 16% conducted e-sales only through websites or applications, 3% used only electronic data interchange (EDI) sales, and the others used 3% of both (Eurostat, 2022a). In 2021, 74% of internet users in the European Union shopped online, among which 42% made purchases for amounts between €100 and €500 (Eurostat, 2022b). As seen, the process of digital market transactions cannot be implemented without suitable and adequate e-commerce platforms that are responsible for purchase-related automation through logistics activities (Dragomirov, 2020). The most significant limitations can be providing the necessary protection and security (Andrushchak, 2022) for consumers and their own company regarding confidential information and transactions, adamant knowledge of e-commerce and logistics, and adequate, up-to-date information circulation, amongst others.

To enable smooth operations of e-commerce, bottlenecks must be eliminated in international logistics, which can be accomplished by researching synergy issues between global supply chains, logistics, e-commerce ecosystem (Xie et al., 2022) and IT indicators. Due to the significance of e-commerce and logistics activities, this paper presents the efficiency of e-commerce in the logistics sector by using a data envelopment analysis (DEA) of EU countries based on five input IT indicators considering the part of logistics sector turnover in total enterprises turnover.

2 Literature review

2.1 E-commerce and information technology

Information and communication technologies (hereinafter: ICTs) have reshaped traditional business forms by eliminating temporal and geographic barriers and forming new virtual communities of consumers and providers. All aspects of traditional business performance can now be carried out via online networks, where e-commerce comes into play – "the act of conducting business through the internet" (Ahmed and Kumari, 2022).

E-commerce can be defined as buying and selling small or large physical or non-physical products and services online (Moghaddasi et al., 2022). E-commerce comprises communication systems, data management systems and security, which with the help of mutual correlation, exchange commercial information about products and services (Nanehkaran, 2013). It also refers to a wide range of online economic activities linked with either online buying, selling or "any transactions incorporating the transfer of ownership or privileges towards using" physical products and/or services across computer networks (Rahman et al., 2022). A complete definition would be: "e-commerce is the use of electronic communications and digital information processing technology in business transactions to create, transform, and redefine relationships for value creation between or among organisations, and between organisations and individuals" (Mubarak, 2021).

The telegraph was the first so-called representative of e-commerce in the early 20th century. Telegraphic payments were replaced in the 1930's by payments made through the improved Telex telegraph machine. In the mid-1980's, commercial services sold products via dialogue and credit cards. Because of e-commerce, consumers can now purchase products of the broadest range and in the shortest possible time, from anywhere, at reasonable and comparable prices (Kim, 2022). E-commerce and newly emerging digital technologies are tools for developing and improving livelihood by connecting countries and remote regions through various scientists, development professionals, managers, and people in general (Ahmed and Kumari, 2022). E-commerce is the industrial form of sustainable business execution (Nanehkaran, 2013) of this century, presenting an alternative to traditional trading processes (Dragomirov, 2020). It represents one of the crucial phenomena based on ICT (Moghaddasi et al., 2022) while being only a small part of the e-business world (Ahmed and Kumari, 2022).

E-commerce expedites the electronification and informatisation process of traditional commerce because the engagement of the internet has changed the mode of information exchange between transaction subjects from different countries (Xie et al., 2022). Thus, e-commerce, as a fundamental dynamic of the economy, allows companies to extend to a broad consumer range, which has contributed to its growth and significance, and its practicality has led it to become the fastest-growing retail market (Taher Al-Lami, 2021).

2.2 Four models and platforms of e-commerce

E-commerce can provide a platform for connecting companies, consumers, buyers, and sellers through four main models described below.

The first model is named business to business (hereinafter: B2B), which describes a company's performance, providing another company with products or services (Taher Al-Lami, 2021). This model encompasses electronic transactions for ordering,

purchasing, and other administrative tasks between companies, where the latter can be physical or virtual (Mubarak, 2021). B2B model accounts for almost 80% of all e-commerce (Gupta, 2014) and is expected to increase into the industry's largest value sector (Kandhro et al., 2022). The main advantages of this model are efficient maintenance of the supply chain movement, procuring and manufacturing processes. It enables the automation of company processes to deliver the right products, at the right time with cost efficiency (Mubarak, 2021).

Business to customers (hereinafter: B2C) model involves transactions between a company providing products or services and its consumers over the internet (Mubarak, 2021). Consumers can browse the online pages of various companies (Taher Al-Lami, 2021), where product information is available in a database (Mubarak, 2021). This model is more vulnerable and prone to security threats because of credit card and personal information acquired on the site (Kandhro et al., 2022). Therefore, companies must provide security mechanisms to guarantee secure e-business processes (Mubarak, 2021).

The customer to customer (hereinafter: C2C) model involves transactions between two or more consumers, where a consumer sells products or services directly to another consumer (Taher Al-Lami, 2021). This can be done via online auction pages, where both seller and buyer must be registered so the goods can be advertised and sold (Mubarak, 2021) without any intermediaries (Moghaddasi et al., 2022). C2C is the most rapidly expanding of all four models (Rahman et al., 2022).

The last, customer to business (hereinafter: C2B) model, involves a transaction between a consumer and a company. It is the opposite of the B2C model – here, the consumer is the seller, and the company is the buyer (Mubarak, 2021).

E-commerce platforms are mainly considered as specialised software solutions that present products or services in the digital space. They play a significant role in the organisation of marketing, financial and other logistics and supply chain processes (Dragomirov, 2020). It is estimated that by 2040, 95% of all purchases will be done online, and all online sales will be made through mobile devices. Online purchasing is an integral part of the global economy, increasingly becoming global in nature, thus already quite challenging to regulate (Kim, 2022). The latter can be optimised with logistics management through several indicators related to the integration of supply chains (Dragomirov, 2020).

2.3 E-commerce, logistics sector and IT indicators

The current e-commerce supply chain is shorter than the traditional one because of e-commerce platforms; it greatly reduces costs, making transactions global, transparent, and timely with the help of the internet (Xie et al., 2022). Factors, affecting cross-border e-commerce supply chain performance have seven characteristics (Lopatin, 2020): informatisation level, crisis response ability, logistics ability, innovation ability, customer satisfaction, sustainable development ability, sales and profits. The expeditious development of international e-commerce is supported by cross-border merchant logistics and various characteristics that differ from traditional cross-border logistics (Xie et al., 2022). The efficiency of global e-commerce logistics is closely correlated to the impact of several factors, such as cross-border logistics: information-sharing level, resource allocation, functional services and optimisation capability, the openness of the environment, and lastly, the ability to distribute logistics resources optimally (Xie et al., 2022).

As seen, e-commerce logistics is of great significance, as it manages the physical flow of goods (Xiao et al., 2012), informational flow and flow of knowledge, which makes it "the 'backbone' of e-commerce operations" (Delfmann et al., 2002). Thus, getting logistics right is significant in e-commerce (Risberg, 2022), which is almost impossible without adequate IT. Kain and Verma (2018) state that logistics, business flow, and information flow represent the three pillars of the modern economy. Global IT, the combination of economic globalisation and information processing technology, are becoming considerably advanced in the development process, where IT can remarkably improve the ability of information collecting, processing and analysing (Shang, 2022). If a company wants to stay competitive in a highly informational society, it has to follow the development of IT, its trends and indicators, while taking advantage of their advancements (Saeidi et al., 2019).

Chong (2006) presents five different indicators that impact the e-commerce sector: organisational indicators, industry indicators, national and local indicators, innovation indicators, and communication indicators. The last two indicators can be closely correlated to IT since technology is an innovation based on the means to enable optimised information sharing. Another paper presents indicators based on which emerging technologies are identified through (Xu et al., 2021): growth, novelty and influence they have. In another, development indicators are divided into four groups (Kulmamat and Nizomov, 2022): cost, time, update and content indicators. The third group, update indicators, consists of two IT-related sub-indicators (out of a total of four), which are

1 the number of new products developed in technological innovations and their implementation

2 acquired (given freely) new technological advances (Kulmamat and Nizomov, 2022).

Some authors even emphasise the importance of quality indicators, closely related to IT and information resource management systems, when designing an integrated information security system (Khoroshko et al., 2022). On the other hand, many studies on digitalisation indicators research the digitalisation process effectiveness, without process implementation or performance and efficiency (Merzlikina and Mogharbel, 2022; Pile, 2020; Remane et al., 2017; Starykh et al., 2020). While logistics efficiency describes the overall construction of the logistics system, from a management perspective, efficiency represents the ratio of all inputs and outputs of a company in a specified time interval (Yao, 2022).

Urban e-commerce logistics can benefit from five types of data (Buldeo Rai and Dablanc, 2022):

1 general city indicators

2 logistics infrastructure indicators (number of collection points and location of distribution centres)

3 consumer indicators

4 delivery volume (delivery density)

5 delivery trip indicators (roundtrip distance, parcels per roundtrip and vehicle type).

When selecting any indicators, the differences between them should be considered and as well as the difficulty of obtaining them (Li and Wei, 2022).

3 Methodology

The efficiency of e-commerce in the logistics sector (NACE code: 'transportation and storage') by using a DEA was analysed. DEA is a linear mathematical programming approach that evaluates the efficiency of homogeneous decision-making units (DMUs). Efficiency is the ratio between the outputs produced and the number of inputs used. DEA optimises the performance measure of each DMU (Charnes et al., 1994). The DMUs that are not on the efficiency frontier are inefficient. An inefficient unit must reach the efficiency frontier in order to become efficient.

In the first phase of the research, we used cluster analysis (ward's method) to classify the countries into three groups or clusters, according to the added value in the logistics sector in the year 2021. In the second phase, we defined the input and output variables of the DEA model considering all three defined clusters. Also, a 'special' cluster was defined, consisting of all countries. Thus, DEA analyse was made for four clusters. In doing so, we considered all EU countries for which data on IT indicators could be obtained from the EU Statistics Portal. This means that we have taken into account 25 EU countries.

For input IT oriented variables, we selected the percentage of enterprises with the following characteristics:

- enterprises with e-commerce sales (X_1)
- enterprises which have an ERP software package to share information between different functional areas (X_2)
- enterprises with a website (X_3)
- enterprises which use any social media (X_4)
- enterprises which use DSL or other brand connection (X_5).

For output we used the part (represents by percentage) of logistics sector turnover in total enterprises turnover (Y).

We performed an efficiency analysis (DEA) for each cluster separately and for all countries together. Based on characteristics of the DMUs and relevant research (Wen et al., 2003), the efficiency of e-commerce in logistics sector is calculated based on a Charnes, Cooper and Rhodes (CCR) input-oriented model with constant return to scale. The mathematical programming problem for the CCR input-oriented model is (Charnes et al., 1994):

$$\max \frac{\sum_r u_r y_{ro}}{\sum_i v_i x_{io}} \tag{1}$$

$$\frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1 \text{ for } j = 0, 1, \ldots, n \tag{2}$$

$$\frac{u_r}{\sum_i v_i x_{io}} \leq \varepsilon, \text{ for } r = 1, 2, \ldots, s \tag{3}$$

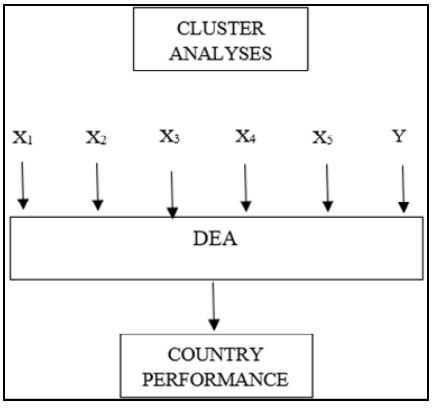
$$\frac{v_i}{\sum_i v_i x_{io}} \leq \varepsilon, \text{ for } i = 1, \ldots, m \tag{4}$$

where

- x and y are the input and output vectors
- v and u are the input and output weights.

Figure 1 presents the research model, where we obtained the data from Eurostat (n.d.). In the research, we included countries where data for 2021 was available. Data was analysed by using the SPSS (cluster analyse) and open-source DEA software (DEA for all three clusters and separately all countries together).

Figure 1 Research model



4 Results

The average added value in the logistics sector in EU in 2021 was 24,841 (in million EUR). Germany, France, and Italy created the highest added value among the analysed countries, while Malta, Cyprus and Estonia created the lowest.

Table 1 shows the list of all countries from EU, that were encompassed in this research, and their data on individual indicators value for the year 2021. The indicators are represented by numbers, where:

1 indicator represents enterprises total turnover from e-commerce (percentage of turnover)

2 indicator represents enterprises with e-commerce sales (percentage of enterprises

3 indicator represents enterprises which have ERP software package (percentage of enterprises)

4 indicator represents enterprises with a website (percentage of enterprises)

5 indicator represent enterprises which use any social media (percentage of enterprises)

6 indicator represents enterprises which use DSL or other brand connection (percentage of enterprises).

Among all 27 countries, data for only two of them is not complete: Finland lack data on the first indicator 'enterprises total turnover from e-commerce', and Portugal lack data on fourth indicator 'enterprises with a website' and fifth indicator 'enterprises which use any social media'. Thus, these two countries were latter on excluded from further analysis.

Table 1 List of researched countries from EU and data on indicators value for the year 2021

Country	*1 – indicator*	*2 – indicator*	*3 – indicator*	*4 – indicator*	*5 – indicator*	*6 – indicator*
Austria	18	31	31	77	53	82
Belgium	28	25	50	74	50	100
Bulgaria	7	5	16	41	32	83
Croatia	14	44	21	65	51	95
Cyprus	3	7	37	79	65	99
Czechia	29	14	22	67	41	87
Denmark	33	36	35	77	54	100
Estonia	14	15	15	70	33	92
Finland	/	19	29	87	63	87
France	27	11	42	55	44	90
Germany	14	11	23	73	39	93
Greece	7	12	54	61	38	95
Hungary	30	19	14	49	41	76
Ireland	54	34	17	77	52	85
Italy	8	10	20	62	37	97
Latvia	10	6	40	49	36	85
Lithuania	20	44	44	65	46	98
Luxembourg	14	16	33	65	55	97
Malta	18	37	42	90	82	96
Netherlands	26	26	33	87	66	97
Poland	14	9	24	56	34	79
Portugal	20	18	37	/	/	100
Romania	7	8	12	42	25	86
Slovakia	10	9	23	67	43	83
Slovenia	13	51	22	68	43	91
Spain	17	23	48	65	53	93
Sweden	38	29	22	74	52	87

In the first indicator, the highest percentage of total turnover from e-commerce has Ireland (54%), and the lowest has Cyprus (3%). For the second indicator, with the highest percentage of enterprises, which conduct business with e-commerce sales, is Slovenia

(51%), and with the lowest percentage is Bulgaria (5%). In third indicator, Greece has the highest percentage of enterprises, which have ERP software packages to share information between different functional areas (54%), and Romania has the lowest percentage (12%). The highest percentage of enterprises, which have a website, is in Malta (90%), and the lowest percentage is in Bulgaria (41%) for the fifth indicator. The last indicator encompasses enterprises, which use DSL or other brand connection, where Belgium, Denmark and Portugal have the highest percentage (100%), and Hungary has the lowest percentage (76%).

Based on the cluster analysis, ten countries were placed in the first cluster with the added value in the logistics sector ranging from about 11.200 EUR to about 43.100 EUR; 12 in the second cluster ranging from less than 600 EUR to about 6.700 EUR; and three countries in the third cluster in the range from about 81.200 EUR to 146.600 EUR (Table 2).

Table 2 Results of cluster analysis

1 – cluster	*2 – cluster*	*3 – cluster*
Austria	Bulgaria	France
Belgium	Croatia	Germany
Czechia	Cyprus	Italy
Denmark	Estonia	
Greece	Hungary	
Netherlands	Ireland	
Poland	Latvia	
Romania	Lithuania	
Spain	Luxembourg	
Sweden	Malta	
	Slovakia	
	Slovenia	

Table 3 Results of CCR input-oriented model solution

DMUs	*Value*	*Efficient*
Austria	0.503	
Belgium	0.773	
Czechia	1	Yes
Denmark	0.836	
Greece	0.282	
Netherlands	0.674	
Poland	0.751	
Romania	0.437	
Spain	0.527	
Sweden	1	Yes

In the first cluster (Table 3), according to the selected input and output variables, Czechia and Sweden are efficient. Compared to the other countries in the group, Sweden and Czechia achieve a large share of turnover from e-commerce according to the other input variables. The lowest efficiency is achieved by Greece. In Greece, companies in the logistics sector generate only 7% of total turnover from e-commerce, which is the cause of low efficiency within the cluster.

Table 4 Results of CCR input-oriented model solution

DMUs	*Value*	*Efficient*
Bulgaria	0.863	
Croatia	0.307	
Cyprus	0.260	
Estonia	0.585	
Hungary	0.992	
Ireland	1	Yes
Latvia	1	Yes
Lithuania	0.439	
Luxembourg	0.544	
Malta	0.306	
Slovakia	0.688	
Slovenia	0.291	

In the second cluster (Table 4), Ireland and Latvia are efficient. Among all analysed countries, Ireland has the largest share of total turnover from e-commerce (54%). Although Latvia has a low share of total turnover from e-commerce, it also has lower values of input variables compared to other countries. The lowest efficiency is achieved by Cyprus. Cyprus has the lowest share of total turnover from e-commerce among all countries (3%), which affects the lowest efficiency score.

Table 5 Results of CCR input-oriented model solution

DMUs	*Value*	*Efficient*
France	1	Yes
Germany	0.947	
Italy	0.622	

In the third cluster (Table 5), only France is efficient, but Germany also achieves high efficiency score (0.947). Italia achieves the lowest efficiency with 0.622. Italia achieves the lowest percentage of total turnover from e-commerce in third cluster (8%).

When we combine the analysed countries into one group (Table 6), the average efficiency is 0.556. The most effective countries are Czechia, France, and Ireland. The lowest efficiency score has Cyprus. Greece and Slovenia achieve a bottom-line efficiency, which is much lower than the average.

Table 6 Results of CCR input-oriented model solution

DMUs	*Value*	*Efficient*	*DMUs*	*Value*	*Efficient*
Austria	0.361		Italy	0.373	
Belgium	0.639		Latvia	0.679	
Bulgaria	0.596		Lithuania	0.439	
Croatia	0.307		Luxembourg	0.425	
Cyprus	0.175		Malta	0.304	
Czechia	1	Yes	Netherlands	0.563	
Denmark	0.611		Poland	0.689	
Estonia	0.515		Romania	0.429	
France	1	Yes	Slovakia	0.496	
Germany	0.589		Slovenia	0.291	
Greece	0.270		Spain	0.419	
Hungary	0.948		Sweden	0.788	
Ireland	1	Yes			

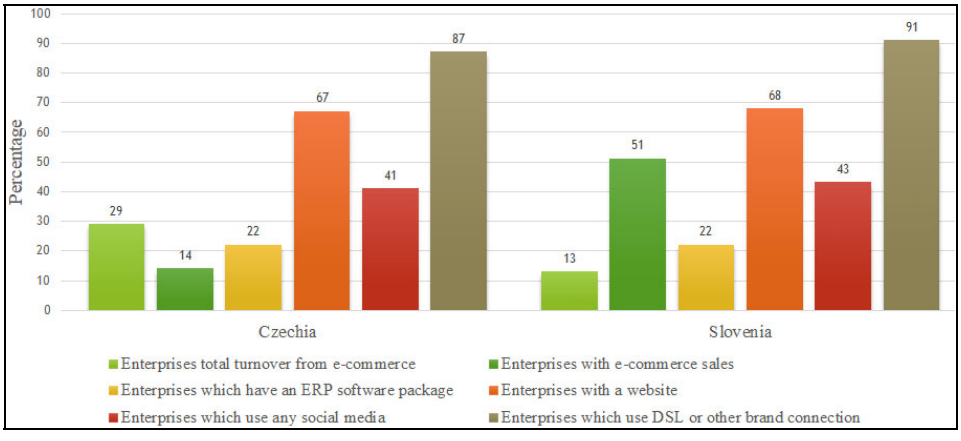
5 Analysis and discussion

Let us look at the case of Czech and Slovenia. Both come from similar backgrounds, and both have a similar historical background and development. They also have similar GDP per capita (Czech 22.270 EUR and Slovenia 24.777 EUR/capita). The last four of five input variables are also similar (Figure 2). They differ only markedly for the first input indicator 'enterprise with e-commerce sales' and for the output indicator 'logistics sector turnover in total enterprises turnover'. For the first input indicator, Slovenia has 51%sales in e-commerce, where Czechia has 14%. For the output indicator, Slovenia has 13% in logistics sector turnover in total enterprises turnover, and Czechia has 29%. Yet it turns out that the Czech Republic is one of the most efficient countries and Slovenia one of the least efficient (third from the bottom). In terms of the level of IT development, Slovenia is the most developed among all the countries we compared (51% enterprises), according to the IT indicator 'enterprise with e-commerce sales', where Czechia's indicator in significantly lower (14%). On the second IT indicator, "enterprise which have an ERP software package to share information between different functional areas", Slovenia is in the top third of the countries we compared (22% enterprises), and Czechia has the same value. The third IT development indicator, 'enterprise with a website', ranks Slovenia around the middle of the list (68% of enterprises), and Czechia is almost the same (67%). The indicator 'enterprise which uses any social media' ranks just below the list's average (with 43% of enterprises), and Czechia has two percent less (41%). Even for the last IT indicator, 'enterprise which use DSL or other brand connection', which we have taken into account in the DAE analysis, Slovenia falls just below the median level of development (91% enterprise), and Czechia has four percent less (87%) in the list of observed countries.

In conclusion, Slovenia is considered to have a lot of room for development and improvement in e-commerce in the case of companies in the 'transportation and storage' sector, as the IT infrastructure is relatively well developed. To put it another way,

Slovenia has a rather average IT performance, yet it is underdeveloped and inefficient in the area under observation.

Figure 2 Comparison of indicators for Slovenia and Czechia (see online version for colours)



6 Conclusions

Cai and Lo (2020) claim that the main path of e-commerce logistics is complex, which may be the reason for the scattered literature on this topic.

Within industries, still more used to physical shopping, such as fast-moving consumer products and pharmaceuticals, there is now a massive opportunity for companies to setup platforms that can cumulate comprehensive use. Nonetheless, there is always capacity to improve the digital experience across all fields of businesses (Ahmed and Kumari, 2022). Knowing that the importance of e-commerce will continue to strengthen, innovative companies will focus their efforts on providing the best online products and services.

The e-commerce sector has a vital role in the development and emergence of countries (Mubarak, 2021), the advancement of IT (Taher Al-Lami, 2021), significant impact on regional and global economies (Ahmed and Kumari, 2022; Belkhamza and Wafa, 2014), and company's overall sales and production (Rahman et al., 2022). E-commerce influence will continue to enhance economic efficiency, the competitiveness of companies, profitability and further accelerate the growth of the information society (Ahmed and Kumari, 2022). On the other hand, the growth and development of e-commerce are dependent on people's ability to use the services of ICT (Rahman et al., 2022).

In our study, we used DEA analysis to compare the performance of e-commerce across EU countries in the year of 2021. In doing so, we have shown, based on the statistics obtained, that some countries are surprisingly relatively inefficient in implementing e-commerce, despite being relatively high in terms of their IT development indicators. To achieve better efficiency in the logistics sector, Slovenia, for example, should increase the share of total turnover from e-commerce, which will consequently affect greater competitiveness and higher added value of Slovenia's logistics sector.

References

Ahmed, N. and Kumari, A. (2022) 'Implication of e-commerce emerging markets in post-COVID era', *International Entrepreneurship and Management Journal*, Vol. 1, No. 1, pp.21–31.

Andrushchak, I. (2022) 'Security features of innovative electronic commerce on the internet network', Presented at the *Proceedings of the XXIV International Scientific and Practical Conference 'Multidisciplinary Academic Notes Science Research and Practice'*, International Science Group, Madrid, Spain, pp.518–522.

Belkhamza, Z. and Wafa, S. (2014) 'The role of uncertainty avoidance on e-commerce acceptance across cultures', *International Business Research*, Vol. 7, No. 5, pp.166–173.

Buldeo Rai, H. and Dablanc, L. (2022) 'Hunting for treasure: a systematic literature review on urban logistics and e-commerce data', *Transport Reviews*, Vol. 43, No. 2, pp.204–233, doi: 10.1080/01441647.2022.2082580.

Cai, Y-J. and Lo, C.K.Y. (2020) 'Omni-channel management in the new retailing era: a systematic review and future research agenda', *International Journal of Production Economics*, Vol. 229, p.107729.

Charnes, A., Cooper, W.W., Lewin, A.Y. and Seiford, L.M. (1994) *Data Envelopment Analysis: Theory, Methodology, and Applications*, Springer Science, New York [online] https://link.springer.com/book/10.1007/978-94-011-0637-5 (accessed 3 December 2022).

Chong, S. (2006) 'An empirical study of factors that influence the extent of deployment of electronic commerce for small- and medium-sized enterprises in Australia', *Journal of Theoretical and Applied Electronic Commerce Research*, Vol. 1, No. 2, pp.45–57, doi: 10.3390/jtaer1020012.

Delfmann, W., Albers, S. and Gehring, M. (2002) 'The impact of electronic commerce on logistics service providers', *International Journal of Physical Distribution & Logistics Management*, Vol. 32, No. 3, pp.203–222, MCB UP Ltd.

Dragomirov, N. (2020) 'E-commerce platforms and supply chain management – functionalities study', *Economic Alternatives*, Vol. 2, pp.250–261.

Eurostat (2021) *Online Sales Continue to Grow among EU Enterprises*, 28 December [online] https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20211228-1 (accessed 24 November 2022).

Eurostat (2022a) *E-Commerce Statistics*, February [online] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=E-commerce_statistics (accessed 24 November 2022).

Eurostat (2022b) *E-Commerce Statistics for Individuals*, January [online] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=E-commerce_statistics_for_individuals (accessed 24 November 2022).

Eurostat (n.d.) [online] https://ec.europa.eu/eurostat (accessed 25 November 2022).

Gupta, A. (2014) 'E-commerce: role of e-commerce in today's business', *International Journal of Computing and Corporate Research*, Vol. 4, No. 1, p.8.

Kain, R. and Verma, A. (2018) 'Logistics management in supply chain – an overview', *Materials Today: Proceedings*, Vol. 5, No. 2, Part 1, pp.3811–3816, doi: 10.1016/j.matpr.2017.11.634.

Kandhro, I.A., Ali, M., Tariq, R., Wagan, A.A., Chhajro, M.A., Uddin, M. and Shorfuzzaman, M. (2022) 'Electronic commerce: online platform for managing structures and issues', *Open Science Framework* [online] https://doi.org/10.17605/OSF.IO/WUEDV.

Khoroshko, V., Kudinov, V., Kapustian, M., Хорошко, В., Кудінов, В. and Капустян, М. (2022) 'Evaluation of quality indicators of functioning cyber protection management systems of information systems', *International Scientific Journal, Оцінка Показників Якості Функціунування Систем Управління Кіберзахистом Інформаційних Систем*, Vol. 2, pp.47–56.

Kim, O.E. (2022) 'E-commerce as a development factor in international trade', *The EUrASEANs: Journal on Global Socio-Economic Dynamics*, Vol. 1, Nos. 1/32, pp.20–28.

Kulmamat, M. and Nizomov, M.K. (2022) 'Priority directions and indicators of the development of innovative technologies in Uzbekistan', *International Journal of Trends in Business Administration*, Vol. 12, No. 1, pp.162–169.

Li, Y. and Wei, Z. (2022) 'Regional logistics demand prediction: a long short-term memory network method', *Sustainability, Multidisciplinary Digital Publishing Institute*, Vol. 14, No. 20, p.13478.

Lopatin, A. (2020) 'Use of rough set theory and neural networks methods in supply chain management', *Modern Economics*, Vol. 22, No. 1, pp.44–49.

Merzlikina, G. and Mogharbel, N. (2022) 'Digital capital as an indicator of the effectiveness of the use of digital technologies in the management of socio-economic systems', in Nazarov, D. and Juraeva, A. (Eds.): *SHS Web of Conferences*, Vol. 141, p.8.

Moghaddasi, A., Bizel, G., Kurnaz, H.E., Katenova, M., Zeitouny, M., Uslu, M.A., Srinivasan, S. et al. (2022) 'Chapter 2: electronic commerce; concepts, models and frameworks', in Acar, S. (Ed.): *Business World Studies in the Scope of Management, Trade and Marketing*, pp.17–34, IKSAD Publishing House, Ankara, Turkey.

Mubarak, D.M. (2021) 'Business organization and e-commerce', *Journal of Advance Research in Science and Social Science*, Vol. 4, No. 1, p.11.

Nanehkaran, Y.A. (2013) 'An introduction to electronic commerce', *International Journal of Scientific & Technology Research*, Vol. 2, No. 4, pp.190–193.

Pile, Y.E. (2020) 'Resource-based approach to digitalization measurement', *Economics, Entrepreneurship and Law*, Vol. 10, No. 2, pp.253–268.

Rahman, M.A., Khan, M.A. and Islam, M.R. (2022) 'Design and implementation of a web-based electronic-commerce system', *European Journal of Engineering and Technology Research*, Vol. 7, No. 2, pp.124–127.

Remane, G., Hanelt, A., Wiesböck, F. and Kolbe, L. (2017) 'Digital maturity in traditional industries – an exploratory analysis', *25th European Conference on Information Systems (ECIS)*, p.16.

Risberg, A. (2022) 'A systematic literature review on e-commerce logistics: towards an e-commerce and omni-channel decision framework', *The International Review of Retail, Distribution and Consumer Research*, Vol. 33, No. 6, pp.1–25, doi: 10.1080/09593969.2022.2089903.

Saeidi, P., Saeidi, S.P., Sofian, S., Saeidi, S.P., Nilashi, M. and Mardani, A. (2019) 'The impact of enterprise risk management on competitive advantage by moderating role of information technology', *Computer Standards & Interfaces*, Vol. 63, pp.67–82.

Shang, Y. (2022) 'Design of an integrated approach to industrial logistics information based on supply chain management', Li, Q. (Ed.): *Advances in Multimedia*, Vol. 2022, No. 8, pp.1–8, doi: 10.1155/2022/5294669.

Starykh, S.A., Solovyov, S.V. and Baroyan, A.A. (2020) 'Qualitative assessment of the level of digitalization of the economy in the Russian Federation', *Region: Systems, Economics, Management*, Vol. 2, No. 49, p.13.

Taher Al-Lami, G. (2021) 'E-commerce: advantages and limitations', *International Journal of Academic Research in Accounting Finance and Management Sciences*, Vol. 10, No. 4, pp.153–165.

Wen, H.J., Lim, B.B.L. and Huang, H.L. (2003) 'Measuring e-commerce efficiency: a data envelopment analysis (DEA) approach', *Industrial Management and Data Systems*, Vol. 103, Nos. 8–9, pp.703–710.

Xiao, X., Liu, Y. and Zhang, Z. (2012) 'The analysis of the logistics mode decision to e-commerce', *Journal of Electronic Commerce in Organizations (JECO)*, Vol. 10 No. 4, pp.57–70, IGI Global.

Xie, C., Wang, H. and Jiao, J. (2022) 'Cross-border e-commerce logistics collaboration model based on supply chain theory', *Security and Communication Networks*, Vol. 2022, p.e1498765, Hindawi.

Xu, S., Hao, L., Yang, G., Lu, K. and An, X. (2021) 'A topic models based framework for detecting and forecasting emerging technologies', *Technological Forecasting and Social Change*, Vol. 162, p.120366.

Yao, C. (2022) 'Cross-border e-commerce logistics efficiency improvement system based on multi-network and multi-node data perception', Presented at the *2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS)*, pp.1117–1120.