MICHAELA NOVOTNÁ, Ph.D. candidate[1]
E-mail: michaela.novotna7@student.upce.cz
(Corresponding author)
DALIBOR GOTTWALD, Ph.D.[1]
E-mail: dalibor.gottwald@upce.cz
[1] Faculty of Transport Engineering,
University of Pardubice
Studentská 95, 532 10, Pardubice 2, Czech Republic

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CURRENT CHALLENGES FOR THE POSTAL SERVICES SECTOR IN THE CONTEXT OF E-COMMERCE – PREDICTIVE ANALYSIS OF V4 STATES

ABSTRACT

The article's focus is on the postal services sector. The sector plays an important role in a process of delivering packages to the customers. Over the last few years, there has been a significant growth in volume of shipments transported. The aim of the article is to demonstrate the current development and subsequent prediction of two selected indicators that play an important role in the context of e-commerce development in the V4 states. One of the indicators is the number of shipments; the other is the indicator of CO_2 emissions. While the values of the CO_2 emission in the predictive analysis in comparison with the growing e-commerce turnover indicator stagnate, the number of shipments is growing alongside the e-commerce turnover values. In the light of these findings, it is clear that the growing number of shipments will result in the need to change the approach to the organisation of the parcel delivery process, especially in big cities and agglomerations. It is also necessary to mention that organisational changes in the parcel delivery process in big cities and agglomerations must be carried out in an environmentally friendly way.

KEYWORDS

postal services; e-commerce; CO_2, city logistics.

1. INTRODUCTION

In the last few years, the issue of e-commerce has become increasingly important [1]. According to Eurostat, e-commerce can be defined as "purchases and sales made via websites or via automated data exchange but excluding normal email messages that are manually typed" [2]. Almost everything, from electronics, clothing or medicines to theatre tickets and other services can be currently purchased through e-commerce [3]. Several business models can be identified within the e-commerce marketplace. The models are distinguished from each other based on parties that carry out commercial transactions with each other [4]. The business model that generates the highest turnover is the B2B – Business-to-Business model. The model with the second largest turnover is the B2C – Business-to-Customer. This business model is more extensive in terms of number of customers who carry out business transactions with each other than the B2B model. Thus, a characteristic feature of this business model (B2C) is the execution of a larger number of business transactions than in the B2B model, but to a lesser financial extent of each individual transaction compared to the B2B model [2].

The quality of customer service within the e-commerce is determined by factors that are directly connected to the quality of logistics services, such as availability of desired products, delivery options, precision, accuracy of orders, or absence of damaged goods [5]. The possibility of delivery, precision, and absence of damaged goods are inherently linked to the organisation and quality of postal services or services involved in ensuring package deliveries [6]. As a result of development of e-commerce as a new form of business transaction execution, greater emphasis is placed on quality of logistics services [7]. Some authors even say that the e-commerce growth stimulates development of the entire logistics industry [8]. Already in 2012, the European Commission pointed out the increasing volume of goods that need to be transported from the sellers to the buyers [9]. Important challenges for postal service providers in connection with development of e-commerce include on-time

delivery, logistics costs reduction, "last mile delivery" changes and reaction to these changes, minimisation of return shipments, etc. [10, 11]. The growing importance of these challenges is also confirmed in another document in which it is mentioned that the importance of transportation has increased exponentially. Transportation became a necessity without which the development of an open market would not be possible. This is mainly because a large part of the shipments is transported around the world. For most of these shipments, the destination of delivery is the area of the big city or its conurbation [12]. Therefore, the issue of ensuring the delivery of shipments to major cities and agglomerations will consequently become increasingly important – around 66% of the world's population is projected to live in cities by the end of 2050 [13]. The increase in externalities cost is associated with the increase in population needs. A term externality is used for costs/benefits caused by companies or individuals to the third parties not involved directly in given trades (or production of goods) [14]. Transportation is described by many experts as an industry generating a wide range of activities that meet the definition of negative externality, such as air pollution, noise pollution, traffic congestion, accidents, and wear and tear of transport infrastructure, etc. [15]. In particular, the air pollution issue is considered to be one of the most serious negative externalities in the field of transportation. According to the epidemiologists, solid particles, such as nitrogen oxides, carbon monoxide (CO_2), aliphatic and aromatic hydrocarbons, sulphur dioxide, and heavy metals are classified among the most important air pollutants [16, 17].

In the scientific literature the issue of air pollution in the context of the development of e-commerce can be found many times over. For example, the intensity of the carbon footprint is examined in the context of increasing volume of shipments (such as personal purchases) within the e-commerce segment [18]. Other authors are engaged in modelling the growth of e-commerce causing increasing emissions due to the increase in transportation – specifically analysing the CO_2 indicator [19].

The main objective of the article is to demonstrate the current development and subsequent prediction of two selected indicators that play an important role in the context of e-commerce development in the V4 states.

To achieve the goal stated in the article, it is necessary to take the following steps. First of all, it is necessary to demonstrate that the growth of e-commerce is causing the increase in the number of shipments within the B2C business model in the V4 states. As a result of demonstrating this dependence, it will be possible to justify the need to pay attention to activities consisting in optimising the delivery process to large cities and agglomerations where most of the world's population resides. Furthermore, it will also be necessary to verify whether the growth of e-commerce causes an increase in the CO_2 emissions.

Secondly, it is necessary to predict the future number of shipments and future turnover of e-commerce within the B2C business model for the V4 states. At the same time, CO_2 emissions will also have to be predicted. Predictions of all three indicators will be carried out using the triple exponential smoothing method.

Thirdly, the predicted trend of e-commerce within the B2C business model for V4 states will be compared with the predicted development of CO_2 emissions, as well as with the number of shipments. Based on this comparison, it will be possible to offer recommendations for bodies engaged in the organisation of the delivery process in large cities and agglomerations, especially with respect to the current social phenomenon, such as the protection of the environment of the population in large cities.

The contribution of the article from the point of view of the scientific public can be seen especially by using the modern triple exponential smoothing method to predict the future volume of e-commerce, the future number of shipments, and future production of CO_2 emissions. Another benefit can be seen from the point of view of the complexity of the procedure to achieve the goal of the article. The authors first verify the topicality of the given issue based on the results of the correlation analysis, and only then submit the selected indicators to prediction. Last but not least, it is also necessary to mention the contribution to the professional public, in particular to the entities responsible for designing and implementing projects relating to the reorganisation of the delivery process in large cities and agglomerations.

2. DESCRIPTION OF METHODS AND DATA DESCRIPTION

This part of the article is primarily focused on justification of the choice of methods used, followed by a detailed description of the methods:

- Kolmogorov-Smirnov test – mathematical statistical method for determining the distribution of probability
- Pearson correlation coefficient – correlation analysis
- Triple exponential smoothing method.

This section is then concluded by detailed description of data files which will be processed by the methods noted above.

Cities form the basic structure of the settlement of the landscape, and at the same time cities can also be viewed as separate living organisms. Many interconnected processes are generated in these so-called organisms. Each of these processes needs and uses a certain infrastructure. The basic source supplying energy to the individual processes are the residents, the businesses, and other entities that are part of the city. The fundamental goal of the residents, the businesses, and all other entities in the urban area is to ensure its compactness. Secondly, there is an effort to ensure healthy growth and functionality of the process. Unfortunately, externalities are also generated resulting from the implementation of these processes through which compactness, healthy growth, and functionality of the urban whole are ensured. These externalities are most likely to be associated with the use of infrastructure [20].

A wide range of information will be provided during the implementation of the processes. These data are collected and can be subsequently used, for example, in order to assess the impact of certain measures on the certain area of the urban unit.

In order to evaluate these impacts (to determine the strength of their influence), it is firstly necessary to determine whether there is a dependence among certain information that are most often presented as indicators. It is possible to determine the dependence of indicators using correlation analysis. The analysis requires a normality test.

One of the tests to verify the normality of the data is the Kolmogorov-Smirnov test (K-S test):

$$D_n = \sup \left| F_n(x) - F(x) \right| \quad [1]$$

where:

F_n – empirical distribution function for n independent and identically distributed ordered observations X_i

$\sup_x$ – supremum of the set of distance

The zero hypothesis assumes that the tested data series correspond to the selected theoretical distribution, i.e., the normal distribution. A zero hypothesis is rejected if the critical boundary (D_{max}) of criterion D_n is exceeded. As a rule, zero hypothesis is rejected if P-value <0.05. Therefore, if P-value <0.05, it is unlikely that the data series follows the normal distribution.

After verifying the normality of the tested data and after the acceptance of the zero hypothesis using the Kolmogorov-Smirnov test, the strength of the correlation of the monitored variable using the Pearson correlation coefficient will be examined:

$$r = \frac{\sum (X - \overline{X})(Y - \overline{Y})}{\sqrt{\sum (X - \overline{X})^2 \sum (Y - \overline{Y})^2}} \quad [2]$$

where:

$\overline{X}$ – mean of X variable

$\overline{Y}$ – mean of Y variable

The final determination of significance of correlation was established on the basis of calculation of P-value with significance level at 5%.

Measures accepted and implemented to ensure compactness, healthy growth, and functionality of large cities and agglomerations are not one-time measures. In most cases, it is a set of measures that is prepared within the framework of a larger strategic plan, which often takes several years to implement, so it is advisable to have an idea of the future development of indicators through which it is possible to evaluate compactness, healthy growth, and functionality of large cities and agglomerations. Triple exponential smoothing method is a method by which it is possible to predict their future development based on the existing values of selected indicators.

The triple exponential smoothing is the most advanced variant of exponential smoothing and allows you to develop models of double and simple exponential smoothing. The exponential smoothing technique (EC) predicts values for the next period using the weighted average of all previous values, whereby weights fall exponentially from the newest to the oldest historical value. When applying the EC, it is essentially assumed that the recent values of the time series are much more important for calculation than older values. Triple smoothing, or Holt-Winters exponential smoothing, adjusts the ES technique so that it can be used even if a certain trend is detected in the data series, as well as the seasonality discrepancies.

The use of a triple application is considered a rule of thumb technique, rather than one based on theoretical foundations and has often been overemphasised by practitioners. Suppose we have a sequence of observations *xt*, beginning at time *t*=0

with a cycle of seasonal change of length L. The method calculates a trend line for the data as well as seasonal indices that weight the values in the trend line based on where that time point falls in the cycle of length L. Let s_t represent the smoothed value of the constant part for time t, bt is the sequence of best estimates of the linear trend that are superimposed on the seasonal changes, and ct the sequence of seasonal correction factors. We wish to estimate ct at every t time L in the cycle that the observations take on. As a rule of thumb, a minimum of two full seasons $2L$ periods of historical data is needed to initialise a set of seasonal factors. The output of the algorithm is again written as $Ft+m$, an estimate of the value of $xt+m$ at time $t+m>0$ based on the raw data up to time t. Triple exponential smoothing with multiplicative seasonality is given as follows:

$$\begin{aligned} s_0 &= x_0 \\ s_t &= \alpha \frac{x_t}{c_t - L} + (1 - \alpha)(s_{t-1} + b_{t-1}) \\ b_t &= \beta(s_t - s_{t-1}) + (1 - \beta) b_{t-1} \\ c_t &= \gamma \frac{x_t}{s_t} + (1 - \gamma) c_{t-L} \\ F_{t+m} &= (s_t + m b_t) c_{t-L+1+(m-1) \bmod L} \end{aligned} \quad [3]$$

where α ($0 \leq \alpha \leq$) is the data smoothing factor, β ($0 \leq \beta \leq 1$) is the trend smoothing factor, and γ ($0 \leq \gamma \leq 1$) is the seasonal change smoothing factor.

The general formula for the initial trend estimate b is:

$$b_0 = \frac{1}{L}\left(\frac{x_{L+1} - x_1}{L} + \frac{x_{L+2} - x_2}{L} + \ldots + \frac{x_{L+L} - x_L}{L} \right) \quad [4]$$

Setting the initial estimates for the seasonal indices c_t for $i=1,2,\ldots,L$ is a bit more involved. If N is the number of complete cycles present in your data, then:

$$\begin{aligned} & c_i = \frac{1}{N} \sum_{j=1}^{N} \frac{x_{L(j-1)+i}}{A_j} \quad \text{for} \quad i = 1, 2, \ldots, L \\ & \text{where} \\ & A_j = \frac{\sum_{i=1}^{L} x_{L(j-1)+i}}{L} \quad \text{for} \quad i = 1, 2, \ldots, L \end{aligned} \quad [5]$$

Triple exponential smoothing with additive seasonality is given as follows:

$$\begin{aligned} s_0 &= x_0 \\ s_t &= \alpha(x_t - c_{t-L}) + (1 - \alpha)(s_{t-1} + b_{t-1}) \\ b_t &= \beta(s_t - s_{t-1}) + (1 - \beta) b_{t-1} \\ c_t &= \gamma(s_t - s_{t-1} - b_{t-1}) + (1 - \gamma) c_{t-L} \\ F_{t+m} &= s_t + m b_t + c_{t-L+1+(m-1) \bmod L} \end{aligned} \quad [6]$$

Following the earlier mentioned objective of this article, data series of the Visegrad Group, which is an alliance of central European states – the Czech Republic, Hungary, the Republic of Poland, and the Slovak Republic, will be monitored. The V4 alliance has formed its roots already in 1335, when the kings of the time agreed to cooperate closely on political and trade issues. The modern alliance was then established in 1991, and since 2004, after the states' admission to the European Union, cooperation has deepened even further. The following datasets will be monitored for these states.

The dataset "Turnover within the B2C business model for the V4 states" was obtained from the Ecommerce Foundation, which cooperates with 19 national associations and more than 75,000 companies, including SAP, Asendia Management SAS, and MultiSafepay, as well as with national interest organisations in the e-commerce business, such as the Association for Electronic Commerce (APEK – Czech Republic), Ecommerce Hungary (Hungary), Chamber of Digital Economy (Poland). The E-Commerce Foundation analyses the B2C e-commerce market and focuses among other things also on negotiating better conditions for the development of e-commerce with the European Union legislators. At the same time, the data were obtained from the Slovak interest group Slovak Association for E-Commerce (SAEC). The values of the turnover for the B2C business have been obtained for the years 2015–2019. These numbers represent the total turnover of the B2C business model in the e-commerce framework [21, 22].

The dataset "Number of shipments carried by a group of V4 states" was obtained from the documents of the World Postal Union [23]. The World Postal Union brings together information from all national regulatory authorities of the Member Countries. These regulators provide the World Postal Union with data on the development of the postal services sectors on national level, for example, the number of employees, the number of mailboxes, the number of items (letter, parcel), the turnover of postal operators, etc. Parcel and express shipments transported within the area of each state were included in the dataset.

The dataset "CO_2 – total carbon dioxide emissions to air for a group of V4 states" was obtained from the documents of the European Statistical Office for the calendar years 2015 to 2019. These are the total emissions produced by industries [24].

First, all datasets will be tested for normality using the Kolmogorov-Smirnov method, and subsequently all data files will undergo correlation

analysis using the Pearson correlation coefficient. Consequently, the Triple exponential smoothing method will be used to predict future development of the datasets.

3. RESULTS

Based on the methodology described above, the content of this section of the article will be the presentation of the results of testing the validity of the established hypotheses. Subsequently, the correlation of the monitored variables will also be examined in more detail. In the end, predictions will be made for each data series.

Referring to the intended objective of the article, the following hypotheses were established:

H01: The development of the e-commerce B2C turnover indicator in a given state does not have a significant impact on the development of the number of shipments transported in that state.

HA1: The development of the e-commerce B2C turnover indicator in a given state has a significant impact on the development of the number of shipments transported in a given state.

H02: The development of the national turnover indicator B2C e-commerce does not have a significant impact on the development of the CO_2 emissions in that state.

HA2: The development of the national turnover indicator B2C e-commerce has a significant impact on the development of the CO_2 emissions in that state.

The validity of the hypotheses set will be verified for the V4 states – the Czech Republic, Hungary, Poland, and the Slovak Republic.

3.1 Czech Republic

The Kolmogorov-Smirnov test was used to assess whether the monitored data series from *Table 1* have a normal distribution. The test results for the data series of the Czech Republic are shown in *Table 2*.

Testing shows that all data series have a normal distribution. Based on confirmation of normal data distribution, it is possible to perform correlation analysis using Pearson correlation coefficient. *Table 3* shows the results of the Pearson correlation coefficient, resulting in a strong dependence between e-commerce and B2C turnover and the number of shipments, but the dependence between e-commerce and B2C turnover and CO_2 – total carbon dioxide emissions – is refuted.

3.2 Hungary

The Kolmogorov-Smirnov test was used to assess whether the monitored data series from *Table 4* have a normal distribution. The test results for the Hungarian data series are shown in *Table 5*.

Table 1– The Czech Republic data series

Year	2015	2016	2017	2018	2019
E-commerce B2C turnover (EUR bn)	3.15	3.8	4.47	5.25	6.09
Number of shipments	4 983 100	5 319 910	12 948 747	13 227 434	18 770 400
CO_2 emissions (tons)	84 065 230	86 435 296	84 686 901	86 395 475	87 855 955

Source: [21, 23, 24]

Table 2 – Czech Republic - Kolmogorov-Smirnov test for data

Data series	D_n	P-value	D_{max}	Test result
E-commerce B2C turnover (EUR bn)	0.305	0.2545	0. 565	H0 accepted
Number of shipments	0.263	0.80339	0. 565	H0 accepted
CO_2 emissions (tons)	0.246	0.85694	0. 565	H0 accepted

Table 3 – Czech Republic - Pearson correlation coefficient

Data series	Pearson's r	P-value	95% interval	Test result
E-commerce B2C turnover and number of shipments	0.9566	0.0108	0.4767 to 0.9972	HA_1 accepted
E-commerce B2C turnover and CO_2 emissions	0.7987	0.105	-0.2829 to 0.9861	$H0_2$ accepted

Table 4 – The Hungary data series

Year	2015	2016	2017	2018	2019
E-commerce B2C turnover (EUR bn)	0.825	0.99	1.174	1.33	1.55
Number of shipments	11 680 185	16 936 000	20 460 000	21 051 000	22 476 000
CO_2 emissions (tons)	36 418 072	35 921 581	37 384 246	37 410 515	37 058 145

Source: [21, 23, 24]

Table 5 – Hungary - Kolmogorov-Smirnov test for data

Data series	D_n	P-value	D_{max}	Test result
E-commerce B2C turnover (EUR bn)	0.333	0.173	0. 565	H0 accepted
Number of shipments	0.292	0.6969	0. 565	H0 accepted
CO_2 emissions (tons)	0.247	0.85325	0. 565	H0 accepted

Table 6 – Hungary - Pearson correlation coefficient

Data series	Pearson's r	P-value	95% interval	Test result
E-commerce B2C turnover and number shipments	0.9283	0.0228	0.2543 to 0.9954	HA_1 accepted
E-commerce B2C turnover and CO_2 emissions	0.661	0.2245	-0.5308 to 0.9748	$H0_2$ accepted

Testing shows that all data series have a normal distribution. Based on the confirmation of normal data distribution, it is possible to perform correlation analysis using Pearson correlation coefficient. *Table 6* shows the results of the Pearson correlation coefficient, resulting in a strong dependence between e-commerce B2C turnover and the number of shipments, but the dependence between e-commerce B2C turnover and CO_2 – total carbon dioxide emissions – is refuted.

3.3 Poland

The Kolmogorov-Smirnov test was used to assess whether the monitored data series from *Table 7* have a normal distribution. The test results for the data series of the Poland are shown in *Table 8*.

Testing shows that all data series have a normal distribution. Based on the confirmation of normal data distribution, it is possible to perform correlation analysis using Pearson correlation coefficient. *Table 9* shows the results of the Pearson correlation

Table 7 – The Poland Data Series

Year	2015	2016	2017	2018	2019
E-commerce B2C turnover (EUR bn)	4.96	6.28	8.38	9.3	11.6
Number of shipments	229 240 000	282 497 787	325 552 363	391 700 000	456 172 527
CO_2 emissions (tons)	278 084 062	288 554 898	292 059 103	295 208 244	277 046 203

Source: [21, 23, 24]

Table 8 – Poland - Kolmogorov-Smirnov test for data

Data series	D_n	P-value	D_{max}	Test result
E-commerce B2C turnover (EUR bn)	0.342	0.152	0. 565	H0 accepted
Number of shipments	0.263	0.80339	0. 565	H0 accepted
CO_2 emissions (tons)	0.265	0.7963	0. 565	H0 accepted

Table 9 – Poland - Pearson correlation coefficient

Data series	Pearson's r	P-value	95% interval	Test result
E-commerce B2C turnover and number of shipments	0.9892	0.0014	0.8397 to 0.9993	HA_1 accepted
E-commerce B2C turnover and CO_2 emissions	0.1886	0.976	-0.8780 to 0.8864	$H0_2$ accepted

coefficient, resulting in a strong dependence between e-commerce B2C turnover and the number of shipments, but the dependence between e-commerce B2C turnover and CO_2 – total carbon dioxide emissions – is refuted.

3.4 Slovak Republic

The Kolmogorov-Smirnov test was used to assess whether the monitored data series from *Table 10* have a normal distribution. The test results for the data series of the Slovak Republic are shown in *Table 11*.

Testing shows that all data series have a normal distribution. Based on the confirmation of normal data distribution, it is possible to perform correlation analysis using Pearson correlation coefficient. *Table 12* shows the results of the Pearson correlation coefficient, resulting in a strong dependence between e-commerce, B2C turnover, and the number of shipments, but the dependence between e-commerce, B2C turnover and CO_2 – total carbon dioxide emissions – is refuted.

3.5 Prediction of data series

To achieve the objective of the article, individual data series will be predicted in the following section using the triple exponential smoothing method.

Figure 1 shows the forecasted e-commerce B2C turnover growth by 2023 based on data from the years 2015–2019. For the years 2020–2023, forecasted sales values of B2C e-commerce for individual states are always marked with darker colour. Lighter shades then correspond to the upper and lower limits of the reliability of forecasted data series. For better clarity, a secondary axis is used for data series of the Czech Republic and Poland. For all V4 states, as shown in *Figure 1*, it is possible to see a significant upward trend in turnover of B2C e-commerce.

Figure 2 shows the forecast of shipments until 2023 based on data from the years 2015–2019. For the years 2020–2023, the forecasted number of shipments for individual states is always marked with darker colour. Lighter shades then correspond to the upper and lower limits of the reliability of forecasted data series. For better clarity, the secondary axis is used for the data series for Poland. For all V4 states, as shown in *Figure 2*, it is possible to observe a significant upward trend in the number of shipments transported.

Figure 3 shows the forecast of CO_2 emissions – total carbon dioxide emissions until 2023, based on data from the years 2015–2019. For the years 2020–2023, the predicted CO_2 values – total carbon dioxide emissions for individual states – are always marked with darker colour. Lighter shades then correspond to the upper and lower limits of the reliability of data series. For better clarity, a secondary axis is used for the data series of Poland. For all V4

Table 10 – The Slovak Republic data series

Year	2015	2016	2017	2018	2019
E-commerce B2C turnover (EUR bn)	0.405	0.493	0.559	0.654	0.789
Number of shipments	6 076 254	7 025 068	7 785 799	9 333 213	10 892 152
CO_2 emissions (tons)	28 363 632	28 694 065	29 536 189	29 728 711	28 420 043

Source: [21, 23, 24]

Table 11 – Slovak Republic - Kolmogorov-Smirnov test for data

Data series	D_n	P-value	D_{max}	Test result
E-commerce B2C turnover (EUR bn)	0.329	0.182	0. 565	H0 accepted
Number of shipments	0.201	0.96023	0. 565	H0 accepted
CO_2 emissions (tons)	0.272	0.77207	0. 565	H0 accepted

Table 12 – Slovak - Pearson correlation coefficient

Data series	Pearson's r	P-value	95% interval	Test result
E-commerce B2C turnover and number of shipments	0.9976	0.0001	0.9620 to 0.9998	HA_1 accepted
E-commerce B2C turnover and CO_2 emissions	0.1566	0.8014	-0.8420 to 0.9128	$H0_2$ accepted

states, as shown in *Figure 3*, it is possible to follow the trend of CO_2 stagnation – total emissions of carbon dioxide.

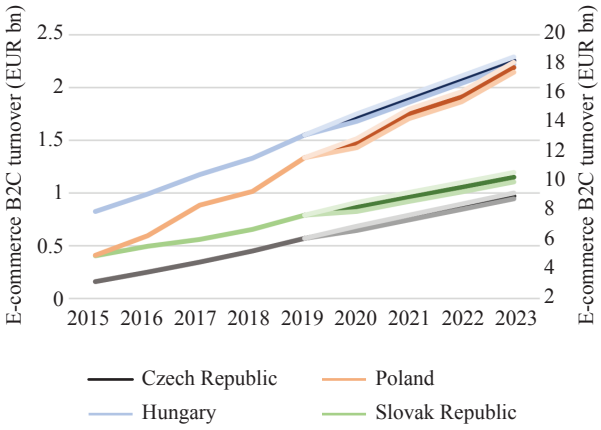

Figure 1 – Turnover for B2C e-commerce [21, 22]

4. DISCUSSION AND CONCLUSION

The topic of the growing importance of e-commerce has been brought up numerous times in professional circles [24, 25]. Since a significant part of the e-commerce production process is related to the postal services (delivery of consignments), the focus of the article is on the postal sector in the context of the development of e-commerce. The e-commerce segment is described by many authors as a segment that has directly influenced the development of one of the sub-disciplines of logistics in the last few years, the city logistics.

One of the main objectives of the city logistics is, among other things, to ensure smooth movement of goods in cities and urban agglomerations, as logistical operations in cities face complex traffic conditions, cramped space while trying to protect the already burdened environment [26–28].

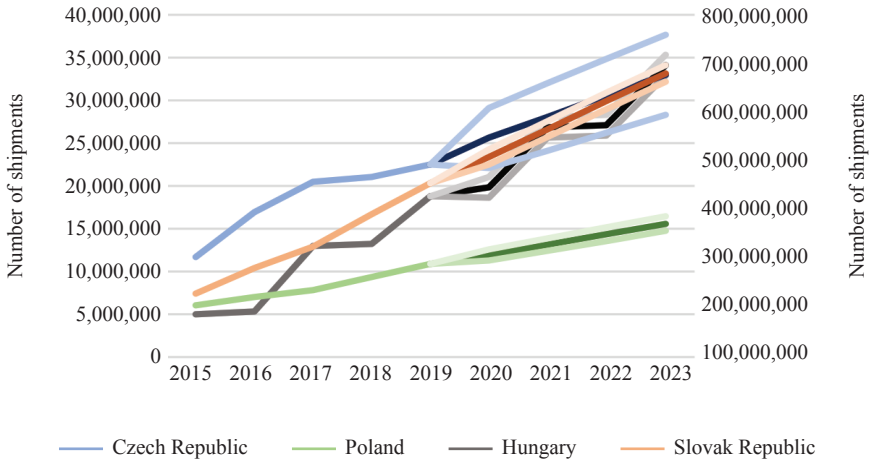

Figure 2 – Shipments transported [23]

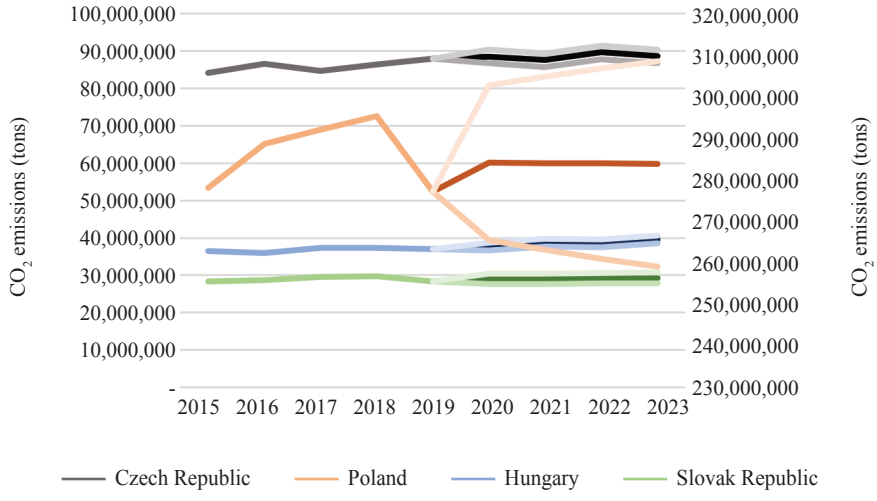

Figure 3 – Total carbon dioxide emissions [23]

The aforementioned facts lead us to the objective of the article which is to describe current development and subsequently to model future trend of the two selected indicators that play an important role in the context of e-commerce development in the V4 states. In order to meet the objective of the article, it was necessary to specify indicators that will later undergo analysis. Based on the literary research, two main indicators were selected, which were further analysed precisely in the context of the development of e-commerce. Firstly, it was the indicator of the number of executed shipments, and secondly, the indicator of CO_2 emissions. Before the correlation and predictive analysis were performed, it was necessary to verify that the dataset has a normal distribution; the Kolmogorov-Smirnov test was used. All data files have been shown to have normal data distribution. Based on this result the correlation analysis was carried out using the Pearson correlation coefficient.

Based on the presented results of the correlation analysis, it can be unequivocally confirmed that the growth of e-commerce within the B2C business model also triggers increase in the number of packages transported in all four monitored states. Following the proven correlation between the growth of e-commerce and the number of shipments, it is therefore possible to expect more pressure on postal service providers that ensure the delivery of shipments to final customers. The pressure to ensure trouble-free delivery of shipments will be gradually increasing because the percentage of population that lives in cities will reach around 66% by the end of 2050 [13]. Subsequently, a correlation analysis was carried out between the growth of the e-commerce and CO_2 emissions. Based on the results of the correlation analysis, it was not possible to confirm the dependence between the two variables in any of the V4 states.

The last part of the analysis of the selected indicators was the implementation of predictive analysis (using the triple exponential smoothing method). Predictive analysis was processed until 2023.

The results of the predictive analysis confirmed an increasing trend in subsequent years (until 2023) for the e-commerce B2C turnover indicator, as well as for the number of shipments indicator. The CO_2 emissions indicators in subsequent years (until 2023) confirmed a trend of stagnation.

Based on the results of correlation and of predictive analysis, it is possible to conclude and discuss these findings. The forecast of the movement of the indicator "Number of shipments carried by a group of V4 states" until 2023, which at the same time confirmed the dependence on the indicator "Turnover within the B2C business model for the V4 states", shows that there will be an increasing volume of shipments in the upcoming years. Over the last few years, major cities especially have faced a vast problem in ensuring their transport services, therefore significant attention must be paid to this issue.

In the context of this fact, the focus should be mainly on eliminating congestion in large cities, thereby increasing their attractiveness. Increasing the attractiveness of the big cities is also one of the main objectives of city logistics [28]. There are currently projects dealing with this issue (Granada, Spain) Accessibility and Mobility Plan, New York City Off-Hour Delivery Project, Ecologistics Parma (Emilia-Romagna Region). However, these projects are primarily implemented in Western Europe or in the United States of America. [28, 29]

The unconfirmed dependence of the indicator "CO_2 — total carbon dioxide emissions for a group of V4 states" on the indicator "Turnover within the B2C business model for the V4 states" is due to the fact that the indicator "CO_2 — total carbon dioxide emissions for a group of V4 states" shows a stagnant trend based on the data in *Tables 1, 4, 7, and 10*. The stagnation trend is also confirmed in the predictive analysis (forecast until 2023), the outputs of which are demonstrated in *Figure 3*, while the indicator "Turnover within the B2C business model for the V4 states" shows an upward trend. The stagnation of the CO_2 emission indicator can be explained by the fact that in the last few years, it has been possible to observe a wide range of activities by the world's leading organisations such as the United Nations Environment Programme (UNEP) or the OECD programme, which is aimed at reducing environmental impacts. The issue of reducing emissions in the context of urban transport has also received a great deal of attention in the last few years in the context of scientific public science [30, 31].

On the basis of the carried out analysis, it can then be concluded that more efficient transport services must be ensured in agglomerations and in big

cities. However, these new solutions must also be environmentally friendly, taking into account the long-term trend of stagnation of the CO_2 indicator.

However, in order to maximise the objectivity of the results presented in the article, it is also necessary to mention certain limits. In particular, the main concern is that all analyses have been limited to a narrow group of states. Provided that more states which differ significantly from each other e.g. in economic development or in political regime, were included, the results, in particular in the field of predictive analysis of the CO_2 emission indicator, would not necessarily be so uniform. A larger number of states were not included mainly because of data limitation. The authors of the article did not have data representing individual indicators from the same source at the time of the analyses.

At the same time, the topic for further research should be mentioned, specifically in relation to the impact of COVID-19. This pandemic is having a major impact on almost all sectors of the national economies worldwide. As part of further research, it would be interesting to analyse in more detail the change in development of the above-mentioned indicators. Namely, the e-commerce turnover indicator within the B2C business model and the number of shipments transported should show a much larger increase than indicated in the prediction of the authors, who were using the pre-pandemic data series. In extremely short time, people worldwide started to rely predominantly on e-commerce business which affected to even bigger extend the indicators (B2C e-commerce turnover and number of shipments) that had been used throughout this article. It is possible to already find work within the circles of the scientific public about the impact of COVID-19 on e-commerce [32]. In one study, the spread of the coronavirus on global e-commerce companies was investigated. The prevalence of coronavirus was measured with cumulative cases, new cases, cumulative deaths, and new deaths [33]. In the second study carried out in Slovakia, the authors point to a significant increase in e-commerce during the COVID-19 pandemic. The authors of the study emphasise the impact of the COVID-19 pandemic, which does not only cause negative effects and losses, but there are positive sides as well, such as future opportunities and challenges that can be turned into new innovations in the era of the industrial revolution 4.0 [34]. It follows that the impact of the COVID-19 pandemic on the e-commerce market will be a significant topic under review.

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Ing. **MICHAELA NOVOTNÁ**, Ph.D. candidate[1]
E-mail: michaela.novotna7@student.upce.cz
Ing. **DALIBOR GOTTWALD**, Ph.D.[1]
E-mail: dalibor.gottwald@upce.cz
[1] Dopravní fakulta Jana Pernera, Univerzita Pardubice
Studentská 95, 532 10, Pardubice 2, Česká republika

SOUČASNÉ VÝZVY PRO SEKTOR POŠTOVNÍCH SLUŽEB V KONTEXTU E-COMMERCE: PREDIKATIVNÍ ANALÝZA STÁTŮ V4

ABSTRAKT

Tento článek se zaměřuje na sektor poštovních služeb. Tento sektor hraje důležitou roli v procesu doručování balíkových zásilek zákazníkům. Za posledních několik let došlo k výraznému nárůstu objemu přepravovaných zásilek. Cílem článku je demonstrovat aktuální vývoj a následnou predikci dvou vybraných ukazatelů, které hrají důležitou roli v kontextu vývoje e-commerce ve státech V4. Jedním z ukazatelů je počet zásilek; druhým je indikátor emisí CO_2. Zatímco hodnoty emisí CO_2 v prediktivní analýze ve srovnání s rostoucím ukazatelem obratu e-commerce stagnují, s hodnotami obratu e-commerce roste i počet zásilek. Z těchto zjištění je zřejmé, že rostoucí počet zásilek bude mít za následek potřebu změnit přístup k organizaci procesu doručování balíkových zásilek zejména ve velkých městech a aglomeracích. Je také nutné zmínit, že organizační změny v procesu doručování balíků ve velkých městech a aglomeracích musí být prováděny způsobem šetrným k životnímu prostředí.

KLÍČOVÁ SLOVA

poštovní služby; e-commerce; CO_2, city logistika.

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