EKONOMIA i ŚRODOWISKO

Ekonomia i Środowisko

contents

THEORETICAL AND METHODOLOGICAL PROBLEMS

ENVIRONMENTAL POLICY AND MANAGEMENT

STUDIES AND MATERIALS

GENERAL ENVIRONMENTAL AND SOCIAL PROBLEMS

DISCUSSION AND REVIEWS

THEORETICAL AND METHODOLOGICAL PROBLEMS

PROBLEMY TEORETYCZNE I METODYCZNE

Izabela **DZIADUCH**

THE DEGREE OF SUSTAINABLE DEVELOPMENT PRINCIPLES IMPLEMENTATION IN TRANSPORTATION BASED ON AN ECONOMIC ANALYSIS OF RAIL BUSES' LIFE CYCLE

Izabela **Dziaduch,** BEng (ORCID: 0000-0001-8067-4707) – *Wroclaw University of Economics and Business, Department of Logistics*

Correspondence address:
Komandorska Street 118/120, 53-345, Wrocław, Poland
e-mail: izabela.dziaduch@ue.wroc.pl

ABSTRACT: The article presents an economic analysis of the life cycle of rail buses. As this analysis part, the costs incurred by the user in the exploitation phase of a rail bus were assessed. The cost estimate was based on the author's own method of forecasting the exploitation costs of a technical object (e.g. means of transport, equipment, machinery), which takes into account the variability of the costs incurred over time. The article also provides the implementation of the aforementioned method, verifying its practical application when estimating the exploitation costs of technical objects. Experimental verification aimed at assessing the usability of the cost forecasting method is the purpose of this article.

The verification was carried out for eight single mode X type rail buses produced by the same manufacturer. The experimental verification of the method used to estimate exploitation costs in the life cycle of objects consisted in: 1. Conducting reliability analysis of the exploitation objects in order to obtain data of technical and economic nature; 2. Entering data into the method and calculating cost forecasts; 3. Assessing correctness of the results.

The degree of accuracy of the exploitation cost forecast was measured using ex post relative forecast error. The compatibility analysis of the forecast cost values with the actual ones showed their high compatibility, as evidenced by the level of the estimated relative errors (the average error was 4.9%). Therefore, it can be concluded that the prognostic value of the method is relatively high.

KEYWORDS: Life Cycle Cost Analysis (LCCA), exploitation cost, rail buses, sustainable transport

Introduction

Rail buses are diesel-powered vehicles used to handle traffic on non-electrified lines and those with smaller passenger flows. These vehicles represent the means of transport characterised by high ecological values, which result, i.a. from their high transport capacity, punctuality of transport (due to the absence of traffic congestion) as well as the limited impact on environmental pollution. Therefore, a rail bus is a means of transport that implements, to a very significant extent, the assumptions of sustainable transport, i.e. the one which considers not only the economic aspect but also some environmental and social factors (Dzwonkowska, 2013).

To assess the degree of implementation of sustainable transport principles, an integrated analysis of the life cycle of a technical object (in this case, a means of transport) can be used. In each of the object life cycle phases (figure 1), separate activities are carried out, generating costs and remaining the source of various types of emissions. Each type of emission has a different, specific impact on the environment.

In the engineering design phase, both the raw materials and components to be used in the production of an object, as well as the technological process are selected. In the next phase of the life cycle, raw materials are obtained (extraction and processing), and the construction of a technical object in
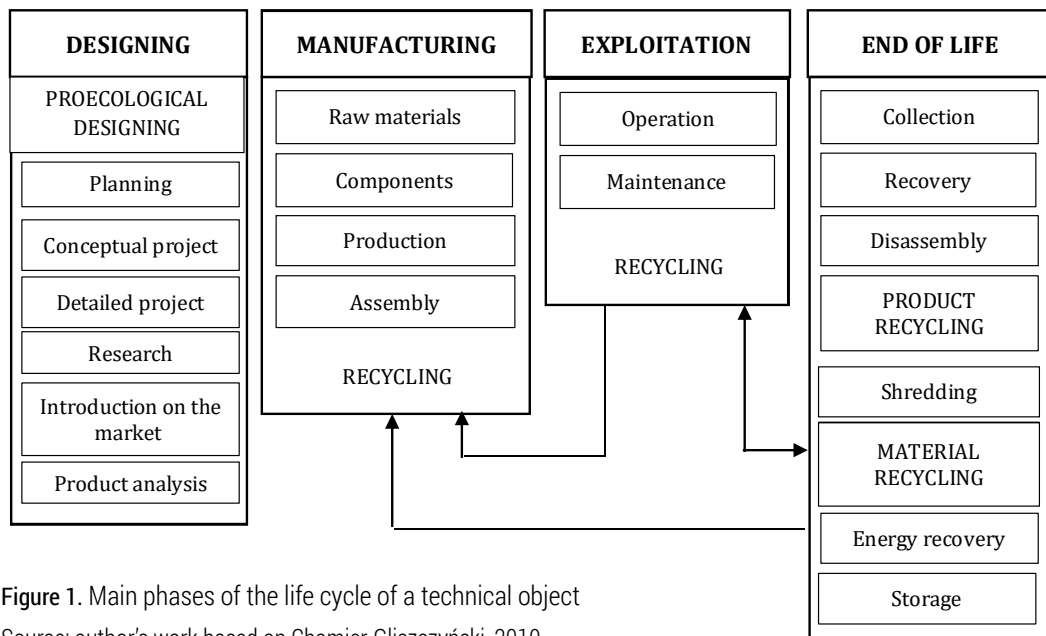

Figure 1. Main phases of the life cycle of a technical object

Source: author's work based on Chamier-Gliszczyński, 2010.

accordance with the prepared design takes place. The exploitation phase is the subsequent stage of a technical object life cycle, in the course of which an object performs these tasks for which it was designed and manufactured (Woropay, 1996). Finally, the life cycle finishes with the end of life phase, during which the activities related to the end of life of a technical object are performed. As shown in figure 1, in all phases of the product life cycle (design, production, operation and end of life), there are opportunities for their pro-ecological rationalisation.

The integrated life cycle analysis, which includes Life Cycle Cost Analysis (LCCA), Environmental Life Cycle Assessment (LCA) and Social Life Cycle Assessment (S-LCA), is one of the basic methods to support making investment decisions. This analysis helps to choose the means of transport which is the most economically efficient and the least harmful to the environment and society. It takes into account all costs and burdens incurred in the life cycle of each of the assessed purchasing alternatives and not just the direct costs of the purchase. Therefore, the integrated life cycle analysis covers both producer and user costs as well as social and environmental costs and burdens.

Because the social and environmental analysis of the life cycle of rail buses is currently in its preliminary research phase, this article presents an economic analysis of the life cycle of the above-mentioned technical objects. Within the framework of this analysis, the costs incurred by the user in the exploitation phase of a rail bus were assessed. To estimate the costs, the author's own method of forecasting the exploitation costs of a technical object was used, which allows conducting a comparative analysis of the alternative purchasing options. The article also provides the implementation of the aforementioned method verifying the possibility of its practical application when estimating the exploitation costs of technical objects. The verification was carried out for single-mode X type rail buses produced by the same manufacturer.

Exploitation costs of technical objects in LCCA – theoretical issues

From a customer's perspective purchasing a new technical object, the exploitation costs account for a significant part of its life cycle costs. It results from the fact that the exploitation covers approximately 90% of an object's entire life cycle duration (Młyńczak, 2012). Therefore, it is primarily the exploitation costs that should be analysed when assessing the effectiveness of alternative investments (pursuing the same goal). The assessment of exploitation costs allows eliminating the acquisition of cheap technical

objects regarding their purchase costs; however, expensive in their exploitation.

As opposed to purchase costs, exploitation costs are recurring and spread over time, hence difficult to estimate. However, estimating exploitation costs, based on the results obtained from the previously conducted exploitation analyses of technical objects, unquestionably increases the accuracy of their level measurement (Dziaduch, 2011a).

The source literature studies of the area under analysis confirm that one of the most important tasks in LCC modelling is to determine the cost breakdown structure (Cieślak, 2008; PN-EN 60300-3-3, 2001; Sarama, Adeli, 202; Świderski, 2003). It consists of breaking down the cost categories into lower-division levels (the so-called components of a given cost category) until the lowest level is achieved, the so-called cost parameter. A cost parameter is a value that cannot be determined by the sum of other costs. It is defined using mathematical formulas containing functions and constant values, e.g., the person-hour cost of maintenance personnel, the labour intensity of maintenance, etc. (Szkoda, 2007). An example of the breakdown structure of a technical object exploitation cost is presented in figure 2.

The estimation of cost components and parameters is based on analytical expressions defined or selected from the source literature by the researcher. The estimation methods of both the cost components and parameters of object exploitation are presented, e.g., in the study (Dziaduch, 2020b), whereas the methods for calculating the preventive maintenance cost components and parameters are addressed, i.a. in (Dhillon, 2007; Jong-Woon, Jong-Duk, Seok-Yun, 2009; Kumar, Chattopadhyay, Pannu, 2004; Norsok Standard: O-CR-001, 1996; PN-EN 60300-3-3, 2001; SINTEF Report, 1998). In the same studies and, e.g., (Jun, Kim, 1994; Kumar, Gardoni, Sanchez-Silva, 2009; Monteith, 1984; Val, Stewart, 2003; Val, Stewart, 2005), the methods for calculating parameters of corrective maintenance costs are discussed. The calculation methods for calculating the logistic support costs of the corrective maintenance were presented, i.a. in (PN-EN 60300-3-3, 2001) and (Kumar, Chattopadhyay, Pannu, 2004), while the method for estimating the logistic support costs of preventive maintenance are covered, e.g., in (Ntuen, 1985). The studies (Hinow, Waldron, Muller, 2008; Norsok Standard: O-CR-001, 1996; Norsok Standard: O-CR-002, 1996; Parra, Moreu, Gomez, Gonzalez, 2009; PN-EN 60300-3-3, 2001) present methods for calculating the cost components and parameters of the production loss caused by object damage.

It is worth emphasising the existing gap in scientific studies, apart from few exceptions, addressing LCC estimation that would comprehensively analyse the problem of exploitation costs calculation for each technical object from the position of its purchaser.
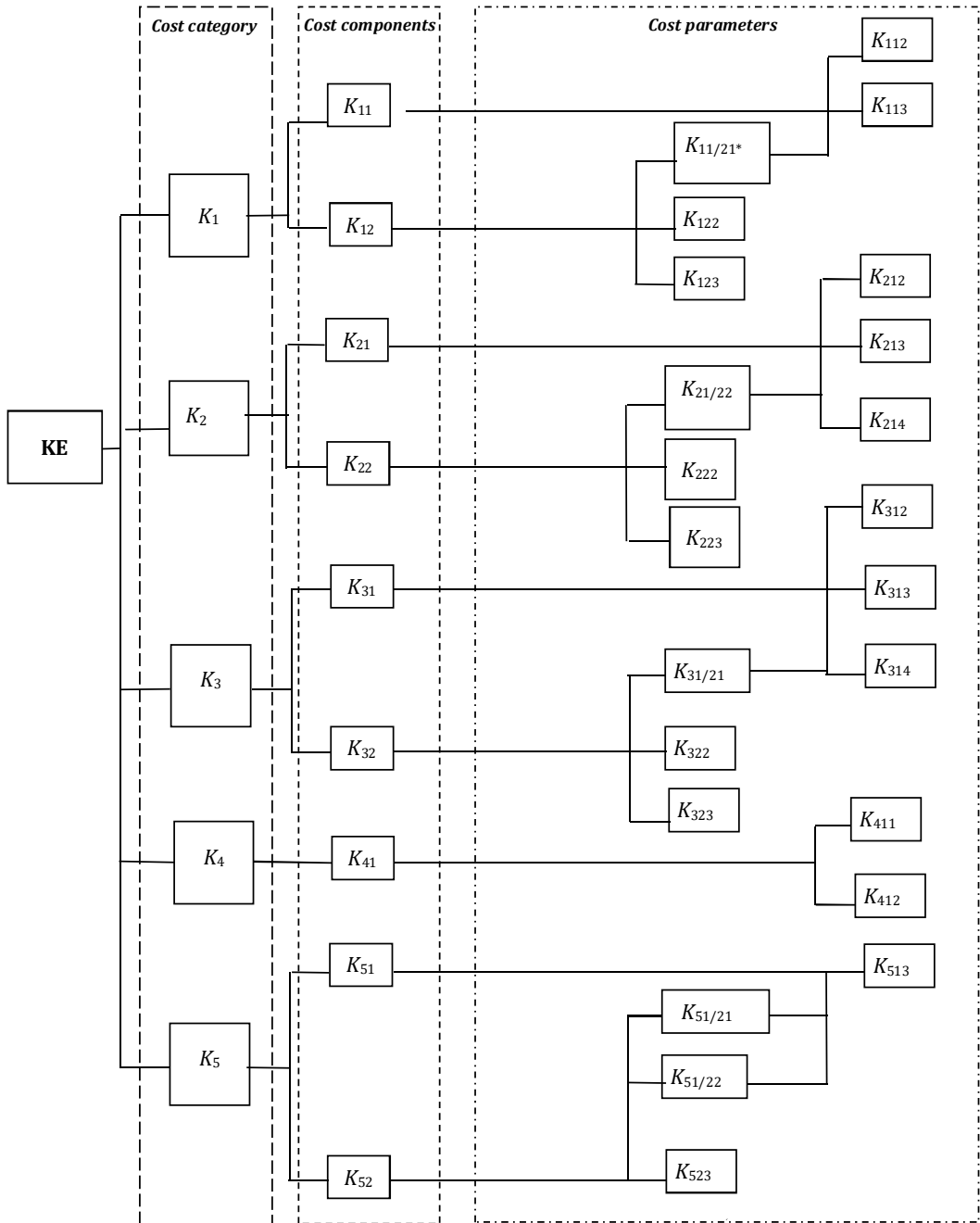
Description of the figure:

$K_{11/21*}$ –   the first parameter of both the first and the second cost component assigned to the first exploitation cost category (in this case, it is the time of the vehicles' operation, necessary to determine the salaries of employees operating the technical object and the cost of diesel consumption

KE –   exploitation costs covered during the full life cycle of a technical object

K_1 –   operation costs covered during the full life cycle of a technical object

K_{11} –   costs of salaries (labour) of the personnel using the technical object

$K_{11/21}$ –   work or exploitation time per unit of time, e.g., mileage per unit of time

K_{112} –   cost of human labour per unit of time

K_{113} –   number of people using an object

K_{12} –   energy consumption costs

K_{122} –   purchase price of an energy unit

K_{123} –   energy consumption per unit of time

K_2 –   costs of performing preventive maintenance

K_{21} –   costs of service personnel remuneration

$K_{21/21}$ –   number of preventive maintenance

K_{212} –   number of people performing preventive maintenance

K_{213} –   unit duration of preventive maintenance

K_{214} –   labour cost of service personnel per unit of time

K_{22} –   costs of consumables and spare parts used in the implementation of preventive maintenance

K_{222} –   price of the r-th spare part or a consumable material used in preventive maintenance

K_{223} –   number of the r-th spare part or a consumable material used in preventive maintenance

K_3 –   costs of performing corrective maintenance

K_{31} –   costs of service personnel remuneration

$K_{31/21}$ –   number of performed corrective maintenance (damage)

K_{312} –   number of people performing corrective maintenance

K_{313} –   unit duration of corrective maintenance

K_{314} –   labour cost of service personnel per unit of time

K_{32} –   costs of consumables and spare parts used in the implementation of corrective maintenance

K_{322} –   price of the r-th spare part or a consumable material used in corrective maintenance

K_{323} –   number of the r-th spare part or a consumable material used in corrective maintenance

K_4 –   costs of logistic support for corrective maintenance

K_{41} –   costs of maintaining the r-th part in stock in a warehouse per unit of time

K_{411} –   unit cost of maintaining the r-th part in a warehouse

K_{412} –   number of spare parts to be kept in stock in case of damage

K_5 –   other costs related to the damageability of a technical object than the costs of corrective maintenance

K_{51} –   costs of production loss caused by an object damage

$K_{51/21}$ –   object downtime due to damage per unit of time

$K_{51/22}$ –   number of performed corrective maintenance (damage)

K_{513} –   size of the production lost as a result of damage

K_{52} –   penalty costs resulting from unplanned downtime

K_{523} –   unit penalty costs related to the non-performance of tasks

Figure 2. The example of the exploitation costs structure of a technical object from the user's perspective

Source: author's work.

In the existing procedures, the measurement of costs is usually performed based on average parameter values/sizes resulting from the analysis of the previous years. On their basis, the annual cost component is calculated. The cost component value is constant (the same for the first and the final year of the object's exploitation). However, these costs are not a determined value but a random variable. For this reason, it is necessary to use these methods that allow estimating exploitation costs to take into account their variability over time resulting from gradual changes in the object's parameters caused by the processes of technical wear.

Research methods

Method for forecasting the exploitation costs of a technical object taking into account the variability of costs overtime consists of 10 stages (figure 3). In the method, while estimating cost parameters, the central tendency values and lower and upper quantiles are used, which allows estimating costs in three variants: the expected variant (e.g. modal), the optimistic variant and the pessimistic one.

The starting point is defining the exploitation cost breakdown structure and collecting the essential data to estimate the exploitation cost parameters. These data should be obtained from the enterprises exploiting technical objects of a given (the same) class or technically similar to the object intended to be purchased by a decision-maker. Next, the equal length (span) of time periods should be determined. The unit of timescale can take the form of, e.g., a calendar month, a mileage (e.g. every 10,000 km), etc. The longer the analysis period of the objects, the larger the number of time intervals (the longer the time series). Estimating the parameter mean value for the time interval remains the next step of the method, followed by verifying whether the parameter mean value depends on time. Suppose a given cost parameter does not depend on time. In that case, the probability distribution should be determined for the mean parameter values, and the central tendency values should be calculated along with the upper and lower quantiles. Otherwise, i.e. if a given cost parameter is time-dependent, the trend line should be fitted to the parameter mean values specified for the defined time intervals and the trend line equation should be determined as well as the upper and lower quantile of the parameter should be estimated for each time interval. The subsequent step is focused on verifying whether the upper and lower quantile of the parameter is time-dependent. Suppose the values of upper and lower quantiles of the parameter are not time dependent. In that case, the probability distribution for these parameter values should be determined,
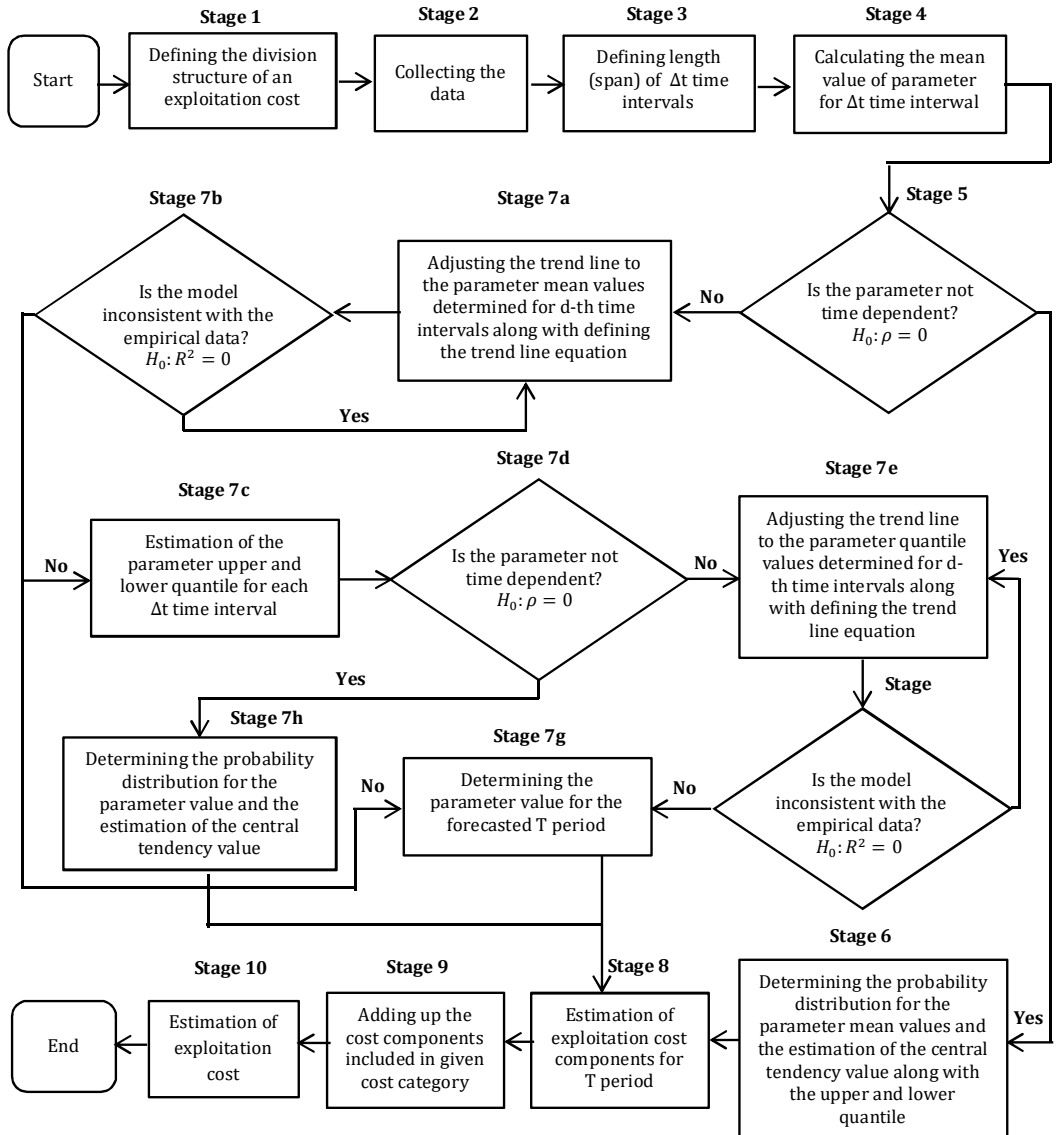
Figure 3. An algorithm followed in the method for forecasting the exploitation costs of a technical object

Source: author's work based on Dziaduch, 2020a.

and the central tendency values should be calculated. Otherwise, i.e. if the values of upper and lower quantiles of the parameter remain time-dependent, the trend line should be fitted to the value of parameter quantiles identified for the defined time intervals, and its equation should be determined.

For the parameter mean values and/or for the values of lower and upper quantiles to which the trend line was fitted, the parameter values should be determined for the expected period of the object life cycle. The parameter values estimated in this way should be used in estimating cost components based on analytical expressions defined in the literature or developed by the researcher.

The particular stages of the method are described in detail in (Dziaduch, 2020a).

It is worth indicating that the exploitation costs are incurred at various time intervals. During this time, the value of money changes (from the present perspective, this value declines along with time). This is caused, firstly, by inflation, i.e. the annual increase in the prices of goods and services in the economy, and secondly, it is always an alternative investment to deposit money in the bank at a certain interest. Therefore, in order to maintain the cost value comparability overtime throughout the entire life cycle of a technical object, a discount calculation can be used based on which the value of money is made real regardless of when it is spent. In such a case, it could be the last step in the cost forecasting method presented above. The methods of calculating future costs for a given moment, i.e. at the time of conducting the analysis, are presented, i.a. in the studies (Alaska Department of Education and Early Development, 1999; Anders, Endrenyi, 2005; Fuller, Petersen, 1996; Goedeckeb, Therdthianwong, Gheewa, 2007; Hennecke, 1999; Parra, Crespo, Cortes, Fyoueroa, 2006; Parra, Moreu, Gomez, Gonzalez, 2009).

Application of the method for forecasting the exploitation costs of technical objects

Object and research period

The study covered eight single-mode X series rail buses produced by the same manufacturer. Three vehicles were purchased directly from the manufacturer, whereas the remaining five were from the manufacturer's agent, which significantly impacted the costs incurred (there are differences, e.g., in purchase costs or maintenance costs). These vehicles are used by the carrier, alternately on the same routes, in similar exploitation conditions.

The analysis period covered 1,295 calendar days, from December 14, 2013, until June 30, 2017 (figure 4). During this period, it was possible to determine the technical and economic parameters from the 1st to the 50th month of the rail buses exploitation.

The objects covered by the research included both new rail buses and also the ones previously exploited by another railway carrier. The hand-

ing-over of rail buses to the analysed enterprise took place at various times; hence the exploitation time covered by the study is not the same for all the analysed rail buses (Figure 4). For buses 1, 2 and 3, determining the cost parameters was possible from the 9th till the 50th month of exploitation. However, for the buses No. 4 and 5, it was possible from the 1st till the 19th month of exploitation, whereas for other objects from the 1st till the 16th, 13th and 12th month, i.e., for buses 6, 7 and 8, respectively.
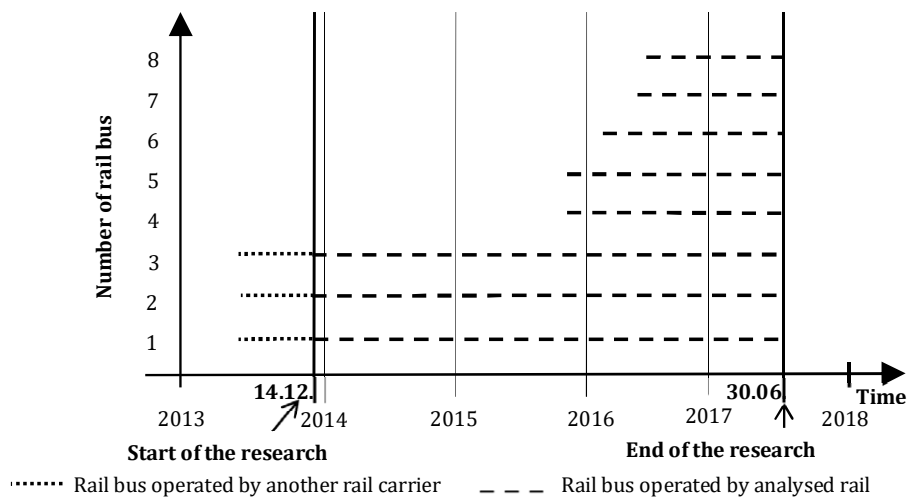
Figure 4. Time schedule of performed research analysis
Source: author's work.

Assumptions

The exploitation cost structure is described by the following correlation:

$$KE = KU + \sum_{i=1}^{I} KOP_i + KOK , \qquad (1)$$

where:
KE – exploitation costs covered during the full life cycle of a rail bus,
KU – operation costs covered during the full life cycle of a rail bus,
KOP_i – costs of performing the i-th kind of preventive maintenance in the life cycle of a rail bus,
KOK – corrective maintenance costs incurred throughout the life cycle of a rail bus.

The presented article does not describe the time and cost parameters necessary for the operation cost analysis, as they have been analysed in detail and estimated in the study (Dziaduch, 2020b). However, these parameters

were taken into account when estimating the exploitation cost of rail buses (formula 1).

The costs incurred while performing preventive maintenance inspections of rail buses are the sum of the costs incurred performing 8 types of inspections, i.e. PU1, PU2-1, PU2-2, PU2-3, PU3-1, PU3-2, PU4 and PU5 (Dziaduch, I., 2011b). All vehicle inspections are repeated in a cyclical manner. They are performed after completing a determined number of units of a vehicle working time, expressed in kilometres covered by the vehicle, its hours of operation or after a given calendar operation time (days, months, years), whichever comes first. The collected data allowed a detailed analysis of PU1, PU2-1, PU2-2 and PU2-3 level inspections as well as a general analysis of PU3 rail bus preventive maintenance inspections. Due to a short operation time, the PU4 and PU5 vehicle levels were not inspected as yet. PU1 and PU2 time-cost parameters were estimated based on the collected data, while the information on PU3, PU4 and PU5 time-cost parameters was collected in the course of interviews with the enterprise employees.

The analysis and assessment of the corrective maintenance process was possible to a limited extent, e.g., due to the lack of information on the duration of corrective maintenance and the number of people performing it. This mainly resulted from the fact that the majority of corrective maintenance was carried out during the preventive maintenance. Based on the available information, only the unit costs of removing the recorded damage and the duration of corrective maintenance were determined.

The maintenance cost was estimated adopting the following assumptions:

1. The preventive maintenance of PU1 is performed by 2 in-house service employees, both during and after the 3-year vehicle warranty period;
2. Preventive maintenance of PU2 during the vehicle warranty period is performed for a fee by the vehicle manufacturer's service. The cost of this inspection for 1-3 vehicles amounts approximately to PLN 15,000, and for 4-8 vehicles – PLN 33,000. After the warranty period expires, the preventive maintenance of PU2 is performed by 2 in-house service employees. Due to the fact that after the warranty period expiry, the parameters for PU2-1, PU2-2 and PU2-3 are almost identical, they were not determined separately for each type of PU2 preventive maintenance.
3. Preventive maintenance of PU3 is performed for a fee by the vehicle manufacturer's service, both during and after the warranty period. The parameters referring to these types of preventive maintenance are as follows:
   – The maintenance time is 15 and 35 working days for PU3-1 and PU3-2, respectively;

- The unit cost of PU3-1 and PU3-2 maintenance is approximately PLN 57,000 and PLN 340,000, respectively;
- PU3-1 maintenance is performed, on average, after every 19 months of exploitation, while PU3-2 service is performed, on average, after every 36 months of the vehicle exploitation.

4. Preventive maintenance of PU4 and PU5 is performed for a fee by the vehicle manufacturer's service, both during and after the warranty period. The parameters referring to these types of preventive maintenance are as follows:
   - PU4 duration is 45 working days, and PU5 – 60 working days;
   - The unit cost of PU4 maintenance is PLN 800,000, while PU5 – PLN 2,500,000;
   - The moments of performing PU3 maintenance were considered the basis for determining the moment of carrying out PU4 and PU5 maintenance.
5. The central tendency measure is the expected value of E(x) parameters;
6. The adopted horizon of cost forecasting is 50 months;
7. The exploitation month is not the same as the calendar month;
8. When calculating the number of days in the month of exploitation, it was adopted that the calendar year has 365 days;
9. Costs are not discounted;
10. The structure of operating costs consists of seven components and nineteen cost parameters included in them (figure 5).

Cost components were defined based on the following formulas:

$$K_{21} = K_{21/21} \cdot K_{212} \cdot K_{213} \cdot K_{214}, \tag{2}$$

$$K_{22} = K_{21/21} \cdot K_{222}, \tag{3}$$

$$K_{31} = K_{31/21} \cdot K_{312} \cdot K_{313} \cdot K_{314}, \tag{4}$$

$$K_{32} = K_{31/21} \cdot K_{322}, \tag{5}$$

$$K_{41} = K_{411} \cdot K_{412}, \tag{6}$$

At the significance level of α=0.1, the statistical significance of the trend model was verified.

At the significance level of α=0.05, the hypothesis about the absence of correlation between the cost parameter and the exploitation time was verified.
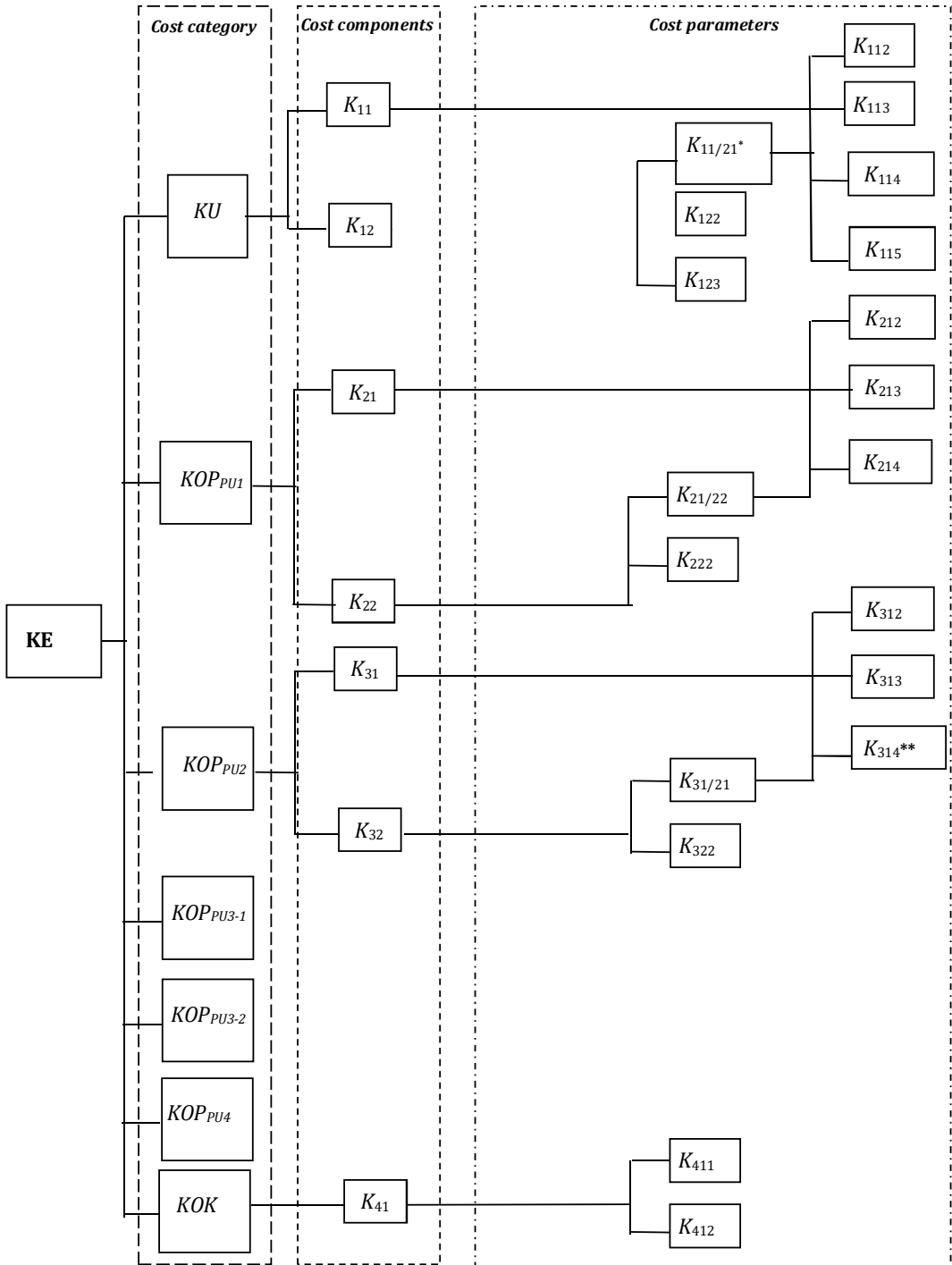
Description of the figure:

$K_{11/21*}$ – the first parameter of both the first and the second cost component assigned to the first exploitation cost category (in this case, it is the time of the vehicles' operation, necessary to determine the salaries of employees operating the technical object and the cost of diesel consumption)

$K_{314**} = K_{214}$

K_{11} –   costs of salaries (labour) of the personnel using the technical object

$K_{11/21}$ – exploitation time, e.g., mileage per unit of time

K_{112} –   cost of conductors' work per unit of time

K_{113} –   number of conductors in a vehicle

K_{114} –   cost of train drivers' work per unit of time

K_{115} –   number of train drivers in a vehicle

K_{12} –   cost of diesel fuel consumption

K_{122} –   purchase price of a litre of diesel

K_{123} –   diesel fuel consumption per unit of time

K_{21} –   costs of service personnel remuneration for performing PU1 maintenance

$K_{21/21}$ – number of PU1 preventive maintenance

K_{212} –   number of people performing PU1 preventive maintenance

K_{213} –   unit duration of PU1 preventive maintenance

K_{214} –   labour cost of service personnel per unit of time

K_{22} –   costs of consumables and spare parts used in the implementation of PU1 preventive maintenance

K_{222} –   unit cost of consumables and spare parts used in the implementation of PU1 preventive maintenance

K_{31} –   costs of service personnel remuneration for performing PU2 maintenance

$K_{31/21}$ – number of PU2 preventive maintenance

K_{312} –   number of people performing PU2 preventive maintenance

K_{313} –   unit duration of PU2 preventive maintenance

K_{314} –   labour cost of service personnel per unit of time

K_{32} –   costs of consumables and spare parts used in the implementation of PU2 preventive maintenance

K_{322} –   unit cost of consumables and spare parts used in the implementation of PU2 preventive maintenance

K_{41} –   costs of performing corrective maintenance

K_{411} –   number of performed corrective maintenance (damage)

Figure 5. The structure of costs distribution of a rail bus exploitation adopted for calculations

Source: author's work.
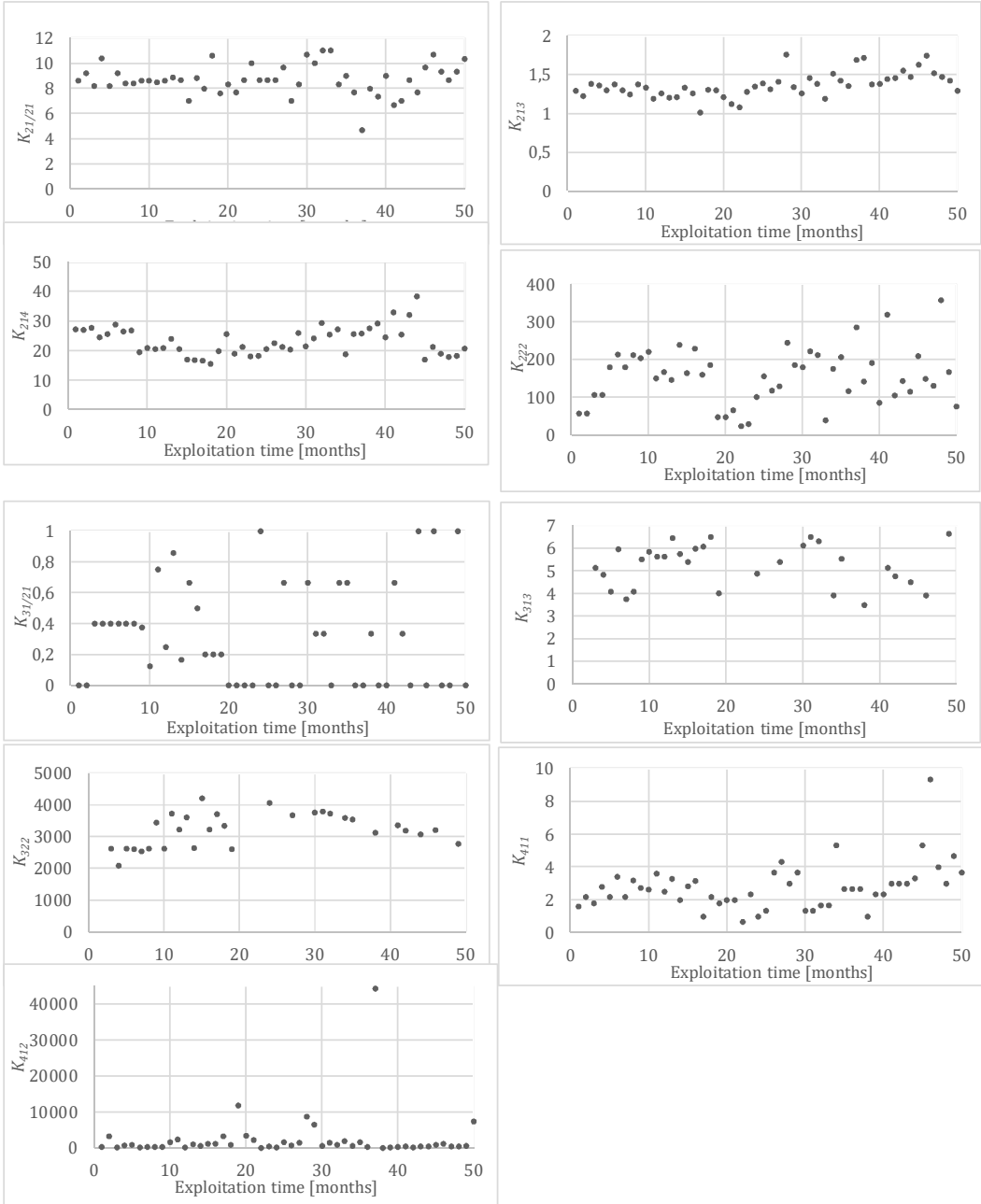
Figure 6. Data for the time series analysis covering a given maintenance cost parameter of rail buses

Source: author's work.

The accuracy degree of the exploitation cost forecast was measured using the ex-post relative forecast error from the formula (Cieślak, 2005):

$$\gamma_t = \frac{KE_t - KE_t^{rz}}{KE_t} \bullet 100 \,, \tag{7}$$

where:
γ_t –   ex-post relative forecast error at the end of Δt time interval,
KE_t –   forecasted operation cost value at the end of Δt time interval,
KE_t^{rz} –   actual value of the vehicle exploitation costs in Δt time interval.

The statistical data analysis was performed using the functions and commands available in Microsoft Excel. Weibull++ application was also used, which allowed, e.g., as follows:
• developing histograms and cumulative distribution functions for random variables,
• verification of hypotheses (carried out using Spearman's rho ρ correlation coefficient) in the form of distributions of the analysed random variables,
• estimation of the unknown distribution characteristics.

Results of the research

For the purpose of exploitation cost calculation, time series for cost parameters were developed. These series were constructed by averaging the cost parameters per month of rail bus exploitation. Figure 6 presents the data necessary to analyse the time series of the maintenance cost parameters.

The list of parameters necessary to estimate the cost components described by formulas (2-6) is presented in table 1.

The collected material analysis shows that most exploitation cost parameters do not depend on time. These parameters can be modelled using normal and log-normal distribution – high values of the Spearman's rank correlation coefficient (ρ) were obtained, ranging from 0.88 to 0.99. For the probability distribution fitting of the parameters, the expected value $E(x)$ and the lower and upper quantiles for q=0.05, Since the PU2 maintenance does not take place in every time interval (they are performed cyclically), it was adopted that $K_{31/21}$ parameter is described with the normal distribution. Having adopted this assumption, the average number of PU2 maintenance services is 0.307, with a standard deviation of 0.328. For the above-mentioned reason, it is not justified to estimate the values of both lower and upper quan-

Table 1. Parameters of the maintenance cost components for time intervals presented as the months of vehicle exploitation

		$K_{21/21}$	K_{213}	K_{214}	K_{222}	$K_{31/21}$	K_{313}	K_{322}	K_{411}	K_{412}
Correlation coefficient (r)	Mean values (x)	0,01	0,54	0,06	0,15	0,007	-0,06	0,23	0,36	0,11
	$F(x_{0,95})$		0,30						0,07	
	$F(x_{0,05})$		0,55						0,54	
H0 : ρ=0 dla α=0,05	Mean values (x)	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes
	$F(x_{0,95})$		No						Yes	
	$F(x_{0,05})$		No						No	
Type of probability distribution	Mean values (x)	Normal		Log-normal	Normal		Normal	Normal		Log-normal
	$F(x_{0,95})$								Normal	
	$F(x_{0,05})$									
Distribution matching (ρ)	Mean values (x)	0,97		0,99	0,99		0,98	0,98		0,99
	$F(x_{0,95})$								0,95	
	$F(x_{0,05})$									
Central tendency values	E(X)	8,70		23,24	155	0,307	5,3	3219	4,48	2348
	$M_O(X)$	8,70		21,88	155		5,3	3219		59
	$M_e(X)$	8,70		22,76	155		5,3	3219		686
Upper and lower quantile	$F(x_{0,95})$	10,68		31,87	278	0,383	6,8	4115		9054
	$F(x_{0,05})$	6,71		16,25	33	0,231	3,7	2323		52
Trend line equation	Mean values (x)		$x_t=1,1536+0,0719\ln(t)$						$x_t=1,5022+0,4271\ln(t)$	
	$F(x_{0,95})$		$x_{0,95t}=1,4381+0,0043t$							
	$F(x_{0,05})$		$x_{0,05t}=0,9119+0,0977\ln(t)$						$x_{0,05t}=-0,8125+0,7114\ln(t)$	
$H_0 : R^2 = 0$ dla α = 0,1	Mean values (x)		No						No	
	$F(x_{0,95})$		No							
	$F(x_{0,05})$		No						No	

Source: author's work.

tiles. The value of the lower quantile would amount to 0, meaning that PU2 maintenance service is not present during the vehicle exploitation period. Instead of the values of lower and upper quantiles, the 90% confidence interval was estimated for the average number of PU2 maintenance services.

The data analysis also indicates that the average values of two exploitation cost parameters, i.e. K_{213} – unit of time of PU1 preventive maintenance and K_{214} – the number of corrective maintenance (damage), depend on the rail buses exploitation time and the parameters of the logarithmic trend lines adjusted to them are statistically significant. The values of both lower and upper quantiles of the unit of time of PU1 maintenance service also depend on the vehicle exploitation time. The analysis of K_{213} lower quantile values indicates a logarithmic trend, whereas the analysis of upper quantile values of this cost parameter presents a linear trend. In both cases, the parameters of fitted models are statistically significant. In addition, the data show that the values of lower quantiles of the number of damages also depend on the vehicle exploitation time and the parameters of the logarithmic trend model adjusted to them are statistically significant. However, there is no statistically significant correlation between the values of upper quantiles of the number of damages and the vehicle exploitation time. The analysis shows that a normal distribution can describe this variable – a high value of the Spearman's rank correlation coefficient ρ was obtained, amounting to 0.95.

Figure 7 shows the forecast values of exploitation costs against the background of real costs in the period covered by the study. Due to the significant difference in the amount of costs incurred for PU2 maintenance, the exploitation cost estimation was performed separately for vehicles 1-3 and 4-8.

The relative errors made when measuring operation costs at the end of time interval, i.e. the last period in which the actual costs were recorded, are summarised in table 2. The analysis shows that the forecast error for the majority of the studied cases is lower than 10%. The average error in the exploitation cost forecast was approx. 4.9%.

Conclusions

The exploitation costs for the single-mode X series rail buses were calculated in the article. The cost calculation was performed based on technical and economic data collected from December 14, 2013, till June 30, 2017. These data allowed analysing rail buses' operation and maintenance process and determining the cost parameters necessary to calculate the exploitation costs. The cost forecast was prepared in accordance with 10 stages of the method for forecasting the exploitation costs of a technical object, taking into

Table 2. Relative errors in measuring exploitation costs of rail buses

Rail bus number	Last month of the rail bus exploitation T	KE_t^{rz}	KE_t	γ_t
1	50	4 474 901,00	4 387 329,00	-0,02
2	50	4 118 997,00	4 389 392,00	0,06
3	50	4 302 119,00	4 389 392,00	0,02
4	19	1 502 556,00	1 811 856,00	0,17
5	19	1 697 219,00	1 811 856,00	0,06
6	16	1 360 361,00	1 363 534,00	0,00
7	13	1 070 808,00	1 105 428,00	0,03
8	12	1 041 423,00	1 019 539,00	-0,02

Source: author's work.
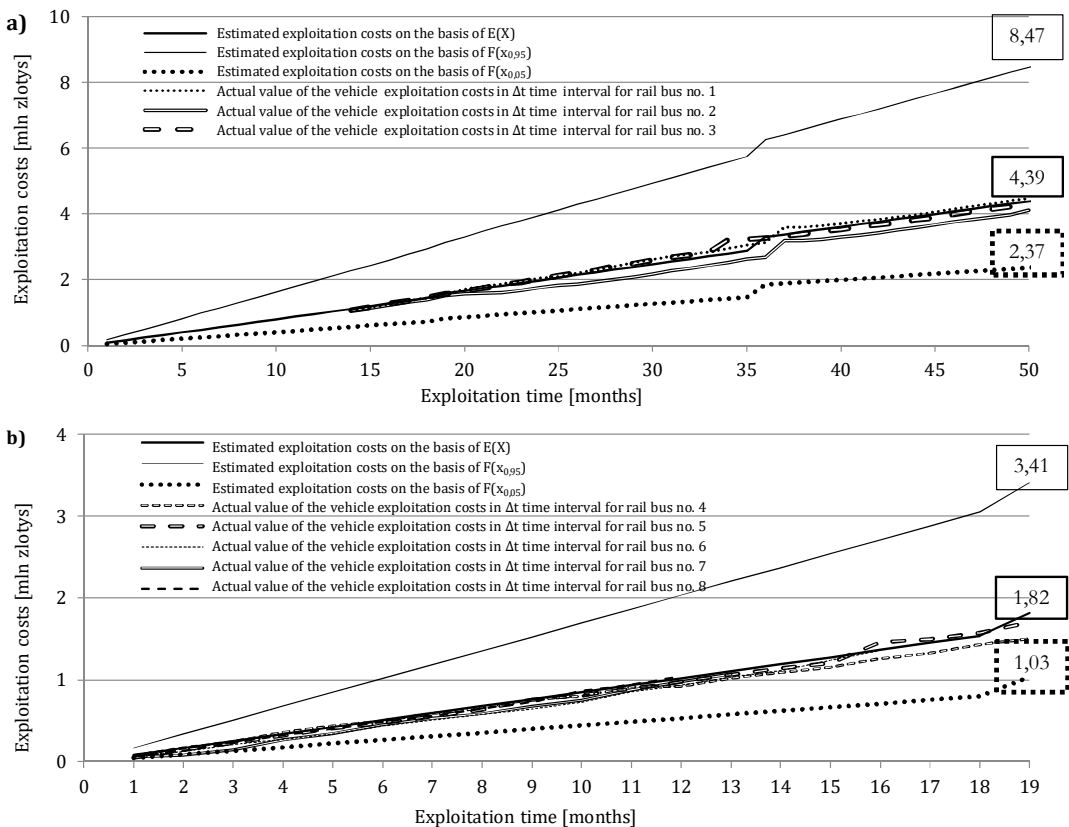
Figure 7. Cumulative exploitation costs of rail buses in the analysed period presented as the months of exploitation for vehicles: a) 1-3, b) 4-8

Source: author's work.

account their variability over time. The verification conducted regarding the correctness of the findings was performed for the exploitation costs estimated based on the expected value of $E(x)$ cost parameters. The obtained cost forecast results were compared with the real costs incurred by the carrier during the last analysed month of the vehicle exploitation. The degree of accuracy of the exploitation cost forecast was measured using ex-post relative forecast error. The average error was 4.9%. This means that the real cost values do not differ much from the forecasted values. Therefore, it can be concluded that the prognostic value of the method is relatively high.

A great advantage of the discussed method is the possibility of determining costs in the adopted exploitation period, not only in the most probable variant (based on $E(x)$), but also in the optimistic and pessimistic ones. The optimistic variant of the forecast means the minimum exploitation cost to be incurred by the object user, while the pessimistic variant of the forecast determines the maximum value of costs to be covered by the user in the course of the object exploitation. The costs in the optimistic variant are determined based on the values of lower quantiles of cost parameters; in turn, following the pessimistic variant of the forecast, the values of upper quantiles of cost parameters are taken into account.

The method of the exploitation cost forecasting of a technical object, taking into account cost variability over time, can represent the tool supporting investment decisions related to purchasing a new technical object. From the perspective of a technical object potential user, the estimated exploitation costs of such an object, along with the costs of its acquisition, make up the life cycle cost. This method eliminates the acquisition of technical objects that are cheap in terms of purchase costs, however, expensive in exploitation.

The economic life cycle analysis of technical objects presented in the article represents one of the tools used in assessing the degree of implementation of sustainable development principles in transport. However, the assessment of applying the philosophy of sustainable development in practice is based not only on the knowledge provided by the economic life cycle analysis but also on the knowledge of environmental and social assessment of object life cycle. Therefore, the analysis of the life cycle of rail buses taking into account environmental and social aspects is the next stage of the research work conducted by the author of this article.

Acknowledgements

References

Alaska Department of Education and Early Development, 1999. Life Cycle Cost Analysis Handbook Alaska Department of Education and Early Development, Juneau.

Anders, G.J., Endrenyi, J., 2005. A probabilistic Approach to Life Cycle Management. PowerTech, IEE Russia, 27-30 June 2005, 1-6, https://doi.org/10.1109/PTC.2005.4524593.

Chamier-Gliszczyński, N., 2010. Analiza cyklu życia obiektów technicznych w transporcie. Autobusy: technika, eksploatacja, systemy transportowe, 6, 1-8.

Cieślak, M., 2005. Prognozowanie gospodarcze. Metody i zastosowania, Wydawnictwo Naukowe PWN, Warszawa.

Cieślak, M., 2008. Life cycle costs of pumping stations. World Pumps, 505, 30-33.

Dhillon, B.S., 2007. Applied Reliability and Quality. Fundamentals, Methods and Procedures. Springer. London, https://doi.org/10.1007/978-1-84628-498-4.

Dziaduch, I., 2011a. Analiza kosztów okresu istnienia (LCC) obiektu technicznego w aspekcie jego niezawodności. Logistyka, 2, 139-150.

Dziaduch, I., 2011b. Analiza kosztów obsług profilaktycznych autobusów szynowych w pełnym cyklu ich obsługi. Logistyka, 6, 865-876.

Dziaduch, I., 2020a. The Concept of the Method for Forecasting the Life Cycle Costs of Technical Objects Supporting the Process of Making Purchasing Decisions. In: Sustainable Economic Development and Advancing Education Excellence in the era of Global Pandemic. Proceedings of the 36th International Business Information Management Association Conference (IBIMA) / Soliman Khalid S. (red.), 2020, International Business Information Management Association (IBIMA), 475-484, ISBN 9780999855157.

Dziaduch, I., 2020b. Forecasting operational costs of technical objects based on the example of railbuses. Engineering Management in Production and Services, 12(4), 52-63, https://doi.org/10.2478/emj-2020-0027.

Dzwonkowska, D., 2013. Zrównoważony Transport. Innowacja i rozwój, A, 4-8, ISBN 978-83-938154-0-1.

Fuller, S.K., Petersen, S.R., 1996.:Life-Cycle Costing Manual for the Federal Energy Management Program. US Government Printing Office, Washington.

Goedeckeb, M., Therdthianwong, S., Gheewa, S.H., 2007. Life cycle cost analysis of alternative vehicles and fuels In Thailand. Energy Policy, 35 (6), 3236-3246.

Hennecke, F.W., 1999. Life cycle cost of pumps in chemical industry. Chemical Engineering and Processing 38, 511-516.

Hinow, M., Waldron, M., Muller, L, 2008. Substation life cycle cost management supported by stochastic optimisation algorithm. Cigré Session 42, Paris, France, 24-29 August 2008.

Jong-Woon, K., Jong-Duk, Ch., Seok-Yun, H, 2009. Life cycle cost model for evaluating RAMS requirements for rolling stocks. Computers & Industrial Engineering. CIE 2009, International Conference on, 1189-1191.

Jun, H.K., Kim, J.H., 2007. Life Cycle Cost Modeling for Railway Vehicle. Proceeding of International Conference on Electrical Machines and Systems, Seoul, Korea, October 8-11 2007, 1989-1994.

Kumar, D., Chattopadhyay, G., Pannu, H.S., 2004. Total Cost of Ownership for Railway Assets: A Case Study on Boxn Wagons of Indian Railways. In Proceedings of the

Fifth Asia-Pacific Industrial Engineering and Management Systems Conference 2004, 12-15 December 2004, Gold Coast, Australia.

Kumar, R., Gardoni, P., Sanchez-Silva, M, 2009. Effect of cumulative seismic damage and corrosion on the life-cycle cost of reinforced concrete bridges. Earthquake Engineering and Structural Dynamics, Vol 38, Issue7, 887-905.

Młyńczak, M., 2012. Metodyka badań eksploatacyjnych obiektów mechanicznych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław.

Monteith, D.O., 1984. Reliability considerations for power system design. Telecommunications Energy Conference, INTELEC '84 International, 1984, 491-494.

Ntuen, C. A., 1985. Availability-based life cycle cost model: a simulation approach. Microelectronics Reliability, 25, 331-342.

Norsok Standard: O-CR-001, 1996. Life cycle cost for systems and equipment. Rev. 1.

Norsok standard: O-CR-002, 1996. Life cycle cost for production facility. Rev. 1.

Parra, C., Crespo, A., Cortes, P., Fyqueroa, S., 2006. On the consideration of reliability in the Life Cycle Cost Analysis (LCCA). A review of basic models. Safety and Reliability for Managing Risk. Guedes Soares & Zio (Eds.), Taylor & Francis Group, London, 2203-2214.

Parra, C., Moreu, P., Gómez, J., González Díaz, V, 2009. Non-homogeneous Poisson Process (NHPP), stochastic model applied to evaluate the economic impact of the failure in the Life Cycle Cost Analysis (LCCA). Taylor & Francis Group, London, 929-939.

PN-EN 60300-3-3, 2001. Zarządzanie niezawodnością. Przewodnik zastosowań. Szacowanie kosztu cyklu życia.

Sarama, K.C., Adeli, H., 2002. Life-cycle cost optimisation of steel structures. International Journal for Numerical Methods in Engineering, 55(12), 1451-1462.

SINTEF Report, 1998. Life Cycle Cost Analysis in Railway Systems. SINTEF Industrial Management, 8-24.

Szkoda, M., 2007. Koszt cyklu trwałości jako kryterium efektywności modernizacji lokomotyw spalinowych. Problemy eksploatacji, 2, 159-169.

Świderski, M., 2003. Analiza LCC (Life Cycle Cost Analysis) narzędziem wspomagającym ocenę projektów inwestycyjnych związanych z techniką pompową. IX Forum Użytkowników Pomp, Szczyrk.

Val, D.V., Stewart, M.G., 2003. Life-cycle cost analysis of reinforced concrete structures in marine environments. Structural Safety, 25, 343-362.

Val, D.V., Stewart, M.G., 2005. Decision analysis for deteriorating structures. Reliability Engineering & System Safety, 87, 337-385.

Woropay, M., 1996. Podstawy racjonalnej eksploatacji maszyn. Wydawnictwo Instytutu Technologii Eksploatacji, Bydgoszcz – Radom.

ENVIRONMENTAL POLICY AND MANAGEMENT

POLITYKA EKOLOGICZNA I ZARZĄDZANIE ŚRODOWISKIEM

Małgorzata BURCHARD-DZIUBIŃSKA

THE ROLE OF URBAN GARDENING IN BUILDING CITY RESILIENCE TO CLIMATE CHANGE

Małgorzata **Burchard-Dziubińska,** Associate Prof., PhD, DSc (ORCID: 0000-0001-5546-2032)
– *University of Lodz*

Correspondence address:
Rewolucji 1905 r. Street 41, 90-214 Łódź, Poland

ABSTRACT: This article has two purposes. The first is to illustrate the role that urban gardening can play in building city resilience to various negative impacts caused by changes in the economic and social spheres, as well as their connection to global warming. The second goal is to investigate whether Polish cities use urban gardening to strengthen the resilience of socio-economic systems to climate change. Based on literature studies, experiences and contemporary trends in urban gardening in different countries were presented as a key factor for improving the resilience of cities. Some initiatives and projects were described based on dedicated websites. To formulate recommendations for Polish cities, the results of the "Let's Feel the Climate" project, under which 44 urban adaptation plans were developed, were subjected to critical analysis. Worldwide, the usage of urban gardening to strengthen cities' resilience to climate change is becoming more and more common. Polish cities have yet to join this positive trend.

KEYWORDS: urban gardening, climate change, urban resilience, adaptation to climate change

Introduction

Since there is no universal definition of an urbanised area, estimates of the size of the urban population vary depending on the source. However, all researchers agree that the percentage of the urban population in the total population is constantly growing. According to UN data in 1960, there were twice as many people living in rural settings (2 billion) than in urban areas (1 billion). The latest published estimations show therefore, that 55% of people in the world lived in urban areas in 2018 (World Urbanization Prospects). According to the Statista (https://www.statista.com/statistics/270860/urbanization-by-continent/), in 2020, North America was the most urbanised continent worldwide, with 82 percent of the population living in cities followed by Latin America and the Caribbean, and Europe with 79 and 75 percent of the urban population, respectively. It is projected that the global share of people living in urban areas will increase to 70 percent in 2050, compared to 56 percent in 2020. Urbanisation is a global issue that concerns several scientific and political interest fields – society, economy, innovation, infrastructure, services, environment and resources, governance, and diplomacy. Today it is commonly agreed that cities, despite their attractiveness due to easy access to services and labour market, are places where the cumulation of various social and economic problems is very high (Bauman, 2001, Therborn, 2013).

Global warming is an additional threat that affects the urban population differently, particularly through extreme weather phenomena (Robin, 2007, Dell et al., 2014, Graczyk et al., 2019). Climate warming in urban areas means an increase in heat stress for residents, especially during more frequent and long-lasting heat waves, increased risk of flash floods due to rains falling on a hardened and impermeable surface, flooding because of significant loads on the sewage network with rainwater during storms and torrential rains (Della-Marta, 2007). In turn, periods of drought result in deterioration of the microclimate and the condition of vegetation, as well as a reduction in air quality (Gomez-Baggethun, Barton, 2013; Wang et al., 2014, Kabisch et al., 2015). Urban heat islands, limited access to green spaces and fresh, locally produced food, high level of social isolation undermine the vitality of expanding metropolises. Increasing the resilience of local socio-economic and natural systems to various types of stress became a challenge for city authorities.

This article has two purposes. The first is to show the role that urban gardening can play in building city resilience to various negative impacts resulting from changes in the economic and social spheres and connection with global warming. The second goal is to investigate whether Polish cities use urban gardening to strengthen the resilience of socio-economic systems

to climate change. Resilience is understood as the capacity of a city to respond to a perturbation or disturbance by resisting damage and recovering quickly. It concerns both social and technical infrastructure, including blue and green infrastructure.

Research methods

Various methods were used to collect data for the research. Based on literature studies, experiences and contemporary trends in urban gardening in different countries were presented as a key factor for improving the resilience of cities. Some initiatives and projects were described based on dedicated websites. To formulate recommendations for Polish cities, the results of the "Let's Feel the Climate" project, under which 44 urban adaptation plans were developed, were subjected to critical analysis. The project was implemented under the auspices of the Ministry of Environment (http://44mpa.pl/miejskie-plany-adaptacji/). In the study, data from Statistics Poland were also used.

A new approach to an urban horticulture

Urban gardening is as old as cities. The ancient Romans used the term *rus in urbe* to describe the presence of fields and gardens in cities, providing food, shade, and relaxation. The concept of *rus in urbe*, which means 'a country within a city', has penetrated the development of cities until today (Melvin, 2018). The potential of urban horticulture was demonstrated both during the industrial revolution, when it was a remedy for the disastrous living and working conditions of millions of factory workers, and during both world wars in the twentieth century, when produce was grown in private gardens and public parks in Victory Gardens (e.g., in the United Kingdom, the United States, Canada, Australia, and Germany) to supplement food rations during the rationing period and to increase the morale of societies. Although Victory Gardens were portrayed as a patriotic duty, 54% of Americans polled said they gardened for economic reasons, while only 20% mentioned patriotism (Bentley, 1998).

Today, urban gardening is experiencing a genuine revival. It is evident in the number of people involved in this type of activity and the innovative approach to the very organisation of work, location, and technology used (Guitart et al., 2012). Urban food gardens can be divided into individual and collective gardens. The former include family gardens and allotment gardens,

community gardens, educational and school gardens, and therapeutic gardens. Squatter gardens are a special category and can fall into both groups. Gardens' sizes vary from crops in balcony pots, through small plots of land squeezed between houses, to large gardens set up on former wastelands and the roofs of parking lots and other buildings. Food production in the city can be a kind of hobby, a way to save on purchases, but it can also fulfil other significant social, economic, and ecological functions, also connected with the transition to a low-carbon future (Walker, Salt, 2006; Aiken, 2012, Goldstein, 2016). The research has shown a positive impact on food production (both for self-consumption and sale) in neglected residential districts characterised by high unemployment and crime rates. In addition, collective gardening in specially designated public places turned out to be a factor facilitating establishing contacts, strengthening social ties, improving the safety of residents, and gaining new knowledge and skills. Such effects have been reported in a long-term project in Philadelphia (Branas et al., 2018).

In turn, the *Unit* of *Community Action* (*Unités d'Action Communautaire*) in Geneva initiated a garden plots project within the public sphere for the use of local residents. The area occupied, initially 310 m^2, was enlarged in 2010 to 4,290 m^2. The Beaulieu collective, a group formed by the neighbours' association and the ecology foundation, manages the garden. The collective reclaimed the abandoned greenhouses and the flower beds of the city's green space management service. Community activities related to food production and ecology education have increased each year, including seed conservation, beekeeping, and organic agriculture promotion. The greenhouse produces ancient horticulture species and provides them to a conservation group, distributing rare seedlings to other community gardens and organic shops. The project is located within a public park helping to gain new followers and to promote the project. The findings provided by Food Urbanism Initiative (supported by the Swiss National Science Foundation under the National Research Programme NRP 65 "New Urban Quality") puts forth urban strategies that summarise the lessons learned through the project's research. The developed recommendations create social opportunities, guarantee ecological benefits, extend urban economies, and make the city fertile (https://www.foodurbanism.org/urban-strategies/).

Singapore, a sovereign island city-state is another good example of the drive for large-scale green and climate-friendly solutions. Green buildings play a key role in climate change mitigation strategy. They are energy-saving, water-saving, and pretty to visually appealing. Since the launch of the BCA Green Mark scheme in 2005, the number of green buildings in Singapore has increased from 17 in 2005 to over 3,000 by 2021. The task is to green 80% of all buildings in Singapore by 2030. Food production is also increasing in

accordance with undertaken by the Singapore Food Agency (SFA) action to achieve the '30 to 30' goal to meet 30% of food needs locally by 2030. The SFA launched the tender for sites on the rooftops of Housing & Development Board (HDB) multi-story car parks for urban farming. The sites will be used to farm vegetables and other food crops, as well as for other related purposes, such as the packing/storage of produce. It is a part of a broader concept known as HDB's Green Towns Programme dedicated to intensifying greening in HDB estates. It is also important to encourage Singaporeans to grow their own edibles and experience the benefits of health and well-being that come from gardening. This idea is realised by NParks launching such an initiative as 'Gardening with Edibles' (https://www.nparks.gov.sg/gardening/gardening-with-edibles). To support the interest in edible gardening, by 2030, NParks aims to increase the number of community gardens islandwide to 3,000 and the number of allotment plots in parks to 3,000 under its flagship gardening program, Community in Bloom (CIB). The program was launched in May 2005 and was first carried out at Mayfair Park Estate. The CIB nationwide gardening movement aims to foster a community spirit and bring together all residents to make Singapore the City in Nature. Today, the CIB has over 1,600 community gardens across Singapore that have engaged more than 40,000 gardening enthusiasts (https://www.nparks.gov.sg/gardening/community-in-bloom-initiative). Allotment gardens situated in public parks and gardens are another initiative. They are not fenced to allow the public to visit and appreciate them. Each allotment garden plot consists of a raised planter bed (2.5m x 1m) and comes equipped with soil in the planter box and a mini-storage area for tools. The lease period for these plots will be typically up to 3 years at a charge of 57 Singapore dollars per year (excluding tax) but may vary depending on the location (https://www.nparks.gov.sg/gardening/allotment-gardens).

Public gardens are also meeting places for people. It is especially important for seniors, the number of which is growing rapidly, particularly in highly developed countries. During heat waves, weakened and sick, they often die alone in their apartments, and this fact is sometimes discovered after many weeks or months. In Japan, known as a country with a huge population of people 85+ living in one-person households, the number of unaccompanied and undetected deaths has risen significantly. In Japanese, there is even a special word to name lonely death (*kodokushi*). It is 'bad death' that affects the apartment in which it took place. They are called *jiko bukken* – 'black property', or the 'psychologically harmful property', and are much cheaper than others. This *signum temporis* results from broader societal challenges such as social isolation, poverty, or social exclusion. Nowadays *kodokushi* is at the centre of public attention. It became a stimulus to develop efficient local

welfare networks. To reduce the number of lonely deaths and develop more resilient social structures special initiatives are undertaken. They include raising the residents' awareness of the issue and re-activating neighbourhood life in green areas and community gardens (https://savvytokyo.com/heres-how-to-join-a-community-garden-in-tokyo/; https://www.dezeen.com/2013/09/12/pasona-urban-farm-by-kono-designs/).

The growing awareness of the dependence of the quality and safety of life of city dwellers on the condition of the natural and man-made ecosystems is visible in a dynamic development of interest in blue and green infrastructure (Wagner et al., 2013) and in ecosystem services provided by city greenery, lakes, rivers. Ecosystem services are defined as benefits that humans obtain from ecosystem functions (de Groot et al., 2002; Millennium Ecosystem Assessment, 2003) or as direct and indirect contributions from ecosystems to human well-being (TEEB, 2010, 2011). Thus, building the resilience of cities to the effects of climate change has become a particular challenge.

Table 1. Benefits of urban gardening

Area of recognised benefits	Kind of benefit
Economic	Access to fresh, inexpensive food Shortening the path "from field to plate" Lowering the cost of living of households Increasing household savings Business development opportunities Generating income Employment and qualification opportunities Increasing the value of the real estate Reducing city's maintenance costs
Social	Community meeting place Building social capital Revealing social activism Improving food security and variety in the diet Strengthening food justice Expression of cultural heritage (access to food of cultural importance) Outdoor physical and mental recreation Education in horticulture / agriculture and a healthy diet
Ecological	Increasing urban green spaces Mitigation of urban heat islands Improving air quality Increasing biodiversity Increasing the capture and infiltration of rainwater Protection against floods Reducing food waste through composting Reintegrating city dwellers into the natural environment Reducing the carbon footprint of cities

Source: author's work.

Gardens and parks in cities mitigate urban heat islands, improve air quality, increase biodiversity, increase the capture and infiltration of rainwater, protect against flash floods, and reduce the carbon footprint of cities (Robine et al., 2007, Dymitryszyn, Urban, 2015, Graczyk et al., 2019). Reduction of the carbon footprint of cities can be achieved in cooperation with residents, using their willingness to be active in gardening. This can be done by increasing food production in cities and shortening the way from 'field to plate' and thus reducing the number of 'foodmiles'. In addition, cultivation sites provide physical activity, stimulate social interaction, encourage healthy nutrition, and reinforce dwellers' connection to the earth. In turn, using the retention capacity of gardens acts as a buffer in case of flash floods and flooding. This avoids many losses in the property of various entities and lowers the city's maintenance costs. Results of literature studies are summarised in table 1.

The project "Let's Feel the Climate" and urban gardening – the case study of Poland

A project "Let's Feel the Climate" ("Wczujmy się w klimat") involving the development of adaptation plans to climate change in cities with more than 100,000 inhabitants covered 44 of the largest Polish cities. It was initiated by the Ministry of the Environment and implemented from January 12, 2017, to January 12, 2019, by the consortium in cooperation with city authorities, residents and experts. The scale of the project was significant because, together with Warsaw implementing the "Adaptcity" project, it covered 30% of the Polish population. As a result, the Urban Adaptation Plans written according to an identical pattern were developed. According to the adopted assumptions, the implementation of urban adaptation plans is to have a real impact on the lives of city residents. Modernised flood protection systems, effective water resource management schemes and the development of information and warning systems against threats are to make the inhabitants feel safer and benefit from the improvement of the aesthetics of cities. Green areas, important for the inhabitants' quality of life and reducing the nuisance resulting from urban heat islands, are to play an important role. When implementing the project, it was necessary to consider the specificity of individual cities resulting from their geographical location, historical heritage, and the diversity of contemporary development determinants. One of the project's objectives was to identify the main climate risk factors and the vulnerability of the socio-economic systems of individual cities to their impact.

In the study of 44 Urban Adaptation Plans, we turned our attention to chapters entitled *Adaptation Actions*. In general, adaptation plans included

organisational, educational, and information activities as well as technical activities aimed at increasing the resistance of cities:

• to higher maximum temperatures and heatwaves, magnified by the urban heat island phenomenon,
• to the occurrence of torrential rains and flash / urban floods,
• to the occurrence of periods without precipitation with high temperature,
• to strong and very strong winds and storms, including hailstorms.

All Urban Adaptation Plans were analysed in terms of urban gardening as an element strengthening the resilience of Polish cities to climate change. We were curious to what extent the city authorities and entities involved in the project are open to using urban gardening to strengthen cities' resilience to climate change. It turned out that this aspect of building city resilience has been completely ignored. If any, the references to allotment and home gardens only concerned the inventory of green areas (Białystok, Gdynia, Legnica, Lublin, Olsztyn, Poznań, Włocławek, Zabrze). The importance of ecosystem services provided by urban gardening has been entirely omitted. Likewise, no attention was paid to the potential of economic benefits for city budgets from reducing the costs of building and maintaining rainstorm infrastructure, reducing the nuisance of urban heat islands, which in turn may reduce the number of hospitalisations and deaths during heatwaves.

In Poland, the family allotment garden is a public utility by providing common access to the area of the family allotment garden and a plot facilitating gardening for one's own use as an improvement of the environmental standards of the environment. It satisfies the leisure, recreational and other needs of social members of local communities (https://stat.gov.pl/en/metainformation/glossary/terms-used-in-official-statistics/1376,term.html). As a green area, it is subject to the protection provided in regulations on the protection of rural and forest areas and provisions of the law on nature protection and environment protection. The history of the allotment gardeners movement in Poland dates back to the end of the 19th century. From 1900 to 1990, thousands of allotment gardens were established in Polish cities, where urban and suburban wastelands were successfully adapted for gardening. After World War II, the authorities came up with a slogan: "An allotment garden for every worker's family". The activists of the allotment gardeners movement managed to realise this postulate and transform such gardens into a public utility. State-owned enterprises granted plots as a kind of reward for 'good conduct'. After the transition to a market economy in 1990, the recreational function of allotments gradually began to displace gardening.

Moreover, plots in attractive locations have become the subject of interest of developers willing to build apartments, office buildings, and shopping

centres. Until 2005, the allotment gardens under the law were treated as agricultural land. After this year, the new act classified them as "green areas within the meaning of other acts" and this provision is in force today. In recent years, in Poland, especially in large cities, allotment gardens have become a topic of conflict. As a result, decisions regarding their future development are avoided in the spatial policy (Biegański, 2015).

It is a paradox that 12 out of 44 cities involved in the "Let's Feel the Climate" project are the cities from the Silesian Voivodeship, where the tradition of allotment gardens is old and strong (Bielsko Biała, Bytom, Chorzów, Czeladź, Częstochowa, Gliwice, Jaworzno, Katowice Mysłowice, Ruda Śląska, Sosnowiec and Zabrze). In 2019, out of 4,614 allotment gardens in Poland, as many as 657 were located in this voivodeship. They covered an area of 3490.6 ha, which accounted for almost 11% of allotment gardens in Poland (GUS, 2019). However, even in the Silesian Voivodeship, which has the highest rate of urbanisation in Poland (77.6%), and numerous ecological problems, including poor air quality, the potential of urban gardening in strengthening cities' resilience to climate change was not noticed or appreciated. It proves a stereotypical approach to adapting cities to climate change when the authorities prefer to spend money on grey infrastructure, educate and inform residents, but do not invite them to active cooperation.

Conclusions

Thanks to the results of many years of research, the awareness of urban gardening impact on human welfare and well-being is growing. This applies to various aspects of human life that can be assigned to the social, health, psychological, educational, and economic spheres from the individual's point of view. When looking at urban horticulture from the perspective of local authorities, there are also aspects related to adaptation to climate change, improving the population's living conditions, safety, and reducing the city's maintenance costs. Nowadays, we see a growing appreciation of nature-based solutions in city management. In many cities around the world, the potential of local communities to adapt to climate change and strengthen resilience through gardening activities is also appreciated. Both the inhabitants and the maintenance of cities benefit from gardening activities. Numerous examples of actions taken all over the world demonstrate this. Community gardens and micro plots strengthen residents' social bonds and relationships.

They can be used to enhance social dynamics by acting as a form of basic public infrastructure. Making vacant land available for gardening in cities can

develop local food production centres. By encouraging local production, several goals can be achieved at the same time: strengthening social ties and cities' resilience to the effects of climate change, creating production communities conducive to economic development, and reducing the carbon footprint of cities. It is worth referring to the inspiring experiences of cities which saw significant potential in adaptation to climate change in urban horticulture. This is supported not only by social and ecological but also by economic arguments. Strengthening the resilience of cities to climate change does not have to rely only on the development of infrastructure by local authorities but on the careful use of what the city gardens offer, so enthusiastically cultivated by the inhabitants. Urban gardening has the advantage of activating residents to take measures that are a source of external benefits in all its forms. Through their work and the money spent on establishing and maintaining gardens, city dwellers engage in adaptation to climate change. Gardens absorb and retain water and improve the microclimate and provide food and protect biodiversity. Unfortunately, cities in Poland have yet to recognise the benefits of urban gardening in increasing resilience to climate change. Local authorities have yet to learn this lesson.

Acknowledgements

References

Aiken, G., 2012. Community transition to Low Carbon Futures in the Transition Town Network (TTN), Geography Compass 6/2, 89-99, 10.1111/j.1749-8198.2011.00475.x.

Bauman, Z., 2001. Community: seeking safety in an insecure world. Cambridge: Polity.

Bentley, A., 1998. Eating for Victory: Food Rationing and the Politics of Domesticity, Urbana and Chicago: University of Illinois Press.

Biegański, L., 2015. Czy ogrody działkowe powinny być tematem polityki zagospodarowania przestrzennego? Ogród za oknem. Przyszłość ogrodów działkowych w miastach. Sztuka ogrodu, sztuka krajobrazu 3(13).

Branas, C.C., Cheney, R.A., MacDonald, J.M., Tam, V.W. Jackson T.D., Have, T.R., 2011. A difference-in differences analysis of health, safety, and greening vacant urban space, American Journal of Epidemiology 174(11), 296-1306, doi:0.1093/aje/kwr273.

De Groot, R.S., Wilson, M., Boumans, R., 2002. A typology for the description, classification and valuation of ecosystem functions, goods and services. Ecological Economics 41, 393-408.

Dell, M., Jones, B.F., Olken, B.A., 2014. What Do We Learn from the Weather? The New Climate–Economy Literature, Journal of Economic Literature 52(3), 740–798. http://dx.doi.org/10.1257/jel.52.3.740.

Della-Marta, P.M., Haylock, M.R., Luterbacher, J., Wanner, H., 2007. Doubled length of western European summer heat waves since 1880. Journal of Geophysical Research 112, D15103 https://doi.org/10.1029/2007JD008510.

Eating for Victory: Food Rationing and the Politics of Domesticity, 1999. The Annals of Iowa 58, 444-446. https://doi.org/10.17077/0003-4827.10306.

Goldstein, B., Hauschild, M., Fernández, J., Birkved, M., 2016. Testing the environmental performance of urban agriculture as a food supply in northern climates, Journal of Cleaner Production Volume 135, 984-994, https://doi.org/10.1016/j.jclepro.2016.07.004.

Gómez-Baggethun, E., Barton, D.N., 2013. Classifying and valuing ecosystem services for urban planning, Ecological Economics 86, 235-245, https://doi.org/10.1016/j.ecolecon.2012.08.019.

Graczyk, D., Kundzewicz, Z.W., Choryński, A., Førland, E.J., Pińskwar, I., Szwed, M., 2019. Heat-related mortality during hot summers in Polish cities. *Theoretical* and *Applied Climatology* 136, 1259-1273. https://doi.org/10.1007/s00704-018-2554-x.

Guitart, D., Pickering, C., Byrne, J., 2012. Past results and future directions in urban community gardens research. Urban Forestry & Urban Greening, 11(4), 364-373.

GUS, 2019. https://bdl.stat.gov.pl/BDL/dane/podgrup/tablica (access June 15, 2021).

http://44mpa.pl/miejskie-plany-adaptacji/ (access June 15, 2021).

https://stat.gov.pl/en/metainformation/glossary/terms-used-in-official-statistics/1376,term.html (access June 12, 2021).

https://www.dezeen.com/2013/09/12/pasona-urban-farm-by-kono-designs/ (access June 12, 2021).

https://www.foodurbanism.org/urban-strategies/ (access June 15, 2021).

https://www.nparks.gov.sg/gardening/allotment-gardens (access June 12, 2021).

https://www.nparks.gov.sg/gardening/community-in-bloom-initiative (access June 20, 2021).

https://www.nparks.gov.sg/gardening/gardening-with-edibles (access June 12, 2021).

https://www.statista.com/statistics/270860/urbanization-by-continent/ (access September 22, 2021).

Kabisch, N., Qureshi, S., Haase, D., 2015. Human-environment interactions in urban green spaces – A systematic review of contemporary issues and prospects for future research, Environmental Impact assessment review 50, https://doi.org/10.1016/j.eiar.2014.08.007.

Kuprys-Lipińska, I., Kuna, P., Wagner, I., 2014. Woda w przestrzeni miejskiej a zdrowie mieszkańców, Zrównoważony Rozwój – Zastosowania. Nr 5/2014: Fundacja Sendzimira, Kraków.

Lamond, J., Everett, G., 2019. Sustainable Blue-Green Infrastructure: A social practice approach to understanding community preferences and stewardship, Landscape and Urban Planning. Volume 191, 103639. https://doi.org/10.1016/j.landurbplan.2019.103639.

Langemeyer, J., Camps-Calvet, M., Calvet-Mir, L., Barthel, S., Gómez-Baggethun, E., 2018. Stewardship of urban ecosystem services: understanding the value(s) of urban gardens in Barcelona. Landscape and Urban Planning, Volume 170, 79-89.

Melvin, J., 2018. Rus in urbe, unpacked: on countryside running through the heart of English cities, in: The Architectural Review, March 29.

Millennium Ecosystem Assessment, 2003. Ecosystems and human well-being. A framework for assessment. Island Press.

Robine, J.M., Cheung, S.L., Le Roy, S., Van Oyen, H., Herrmann, F.R., 2007. Report on excess mortality in Europe during summer 2003. EU Community Action Programme for Public Health.

SFA launches tender for the rental of 7 HDB MSCP rooftop sites for urban farming, 2021. https://www.sfa.gov.sg/docs/default-source/default-document-library/joint-sfa-hdb-media-release---sfa-launches-tender-for-the-rental-of-7-hdb-mscp-rooftop-sites-for-urban-farming.pdf. (access June 12, 2021).

TEEB (The Economics of Ecosystems and Biodiversity), 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London.

TEEB (The Economics of Ecosystems and Biodiversity), 2011. Manual for Cities: Ecosystem Services in Urban Management. UNEP and the European Commission.

Therborn, G., 2013. The Killing Fields of Inequality, Polity Press.

Wagner, I., Krauze, K., Zalewski, M., 2013. Błękitne aspekty zielonej infrastruktury. In: T. Bergier, J. Kronenberg, P. Lisiecki, Zrównoważony rozwój – Zastosowania nr 4, Fundacja Sendzimira, Kraków.

Walker, B.H., Salt, D., 2006. Resilience thinking: sustaining ecosystems and people in a changing world, Washington D.C., Island Press.

Wang, Y., Bakker, F., de Groot, R., Wörtche, H., 2014. Effect of ecosystem services provided by urban green infrastructure on indoor environment. A literature review. Building and environment 77, 88-100, 2014, https://doi.org/10.1016/j.buildenv.

World Urbanization Prospects: The 2018 Revision, 2018. United Nations Economic & Social Affairs.

Monika **PARADOWSKA**

REMOTE STUDY AND DECONSUMPTION – SUSTAINABLE MOBILITY VERSUS (UN)NECESSARY UNIVERSITY COMMUTING

Monika **Paradowska,** PhD (ORCID: 0000-0002-0861-1274) – *University of Wroclaw*

Correspondence address:
Koszarowa Street 3, 51-149, Wrocław, Poland
e-mail: monika.paradowska@uwr.edu.pl

ABSTRACT: Remote study was one of the many restrictions implemented during the COVID-19 pandemic. It resulted in a deconsumption of university commuting which, together with telecommuting, could be considered as a means to implement a sustainable mobility policy. Within this context, this paper investigates student's perceptions of the advantages and disadvantages of daily travel before the online learning started with focus on the resultant satisfaction from the use of given means of transport. In this context, we examined the potential for developing more sustainable mobility and possibilities for further deconsumption of transport processes. This was based on the results of a preliminary survey the author conducted online among students of two public universities in Poland. The results obtained, revealed that the respondents associated commuting to university with more advantages than disadvantages. However, these perceptions differed dependent on the most frequently used transport mode. Car users hardly benefited from commuting compared to other transport users and were the group least likely to resign from individual motorisation. Pedestrians and cyclists perceived most benefits and were most satisfied. In general, students expected to continue commuting using the transport modes they used prior to the pandemic. Nevertheless, when students were asked about their "dream transport mode" which enabled the possibility for deconsumption of commuting by way of a cheap and commonly available teleportation, private car turned out to be a better option than teleportation among students commuting either by car or by urban public transport. In such a hypothetical situation, only car users and active commuters were not prepared to change their transport behaviour.

KEYWORDS: remote learning, deconsumption, sustainable mobility, commuting to university, COVID-19 pandemic

Introduction

A new variant of coronavirus that emerged in China in 2019 quickly spread all over the world causing the coronavirus (COVID-19) outbreak. At the beginning of March 2020, WHO announced a global COVID-19 pandemic (WHO, 2020) which irreversibly changed most lives. One of the first effects of the pandemic in Poland was a government decision to move from traditional to remote study (Regulation of the Minister of National Education..., 2020). Although this change in the form of learning was expected to be temporary, the lockdown has lasted, with some breaks (eg. in October 2020) and exceptions, more than one academic year.

Multiple studies have been conducted so far to investigate distinct challenges related to remote learning in higher education during the pandemic (e.g. Souza et al., 2020; Zawadka et al., 2021; Ho et al., 2021; Razami and Ibrahim, 2021; Camilleri, 2021). This study however, provides new insights on distance learning, as it prescinds from analysing different aspects of the study process and focuses strictly on another issue resulting from lockdown, namely on obligatory deconsumption of university commuting. On the one hand, reduction of commuting can be considered a shift towards more sustainable urban mobility and a gradual reduction of negative transport externalities (e.g. Mokhtarian and Salomon, 1995, 1997; Lier et al., 2012; Nilles, 1976; Hopkins and McKay, 2019; Ahvenniemi et al., 2017). On the other hand, the question arises, whether daily travels to university were rather a necessary but stressful and irksome nuisance (e.g. Maguire and Morris, 2018; Chappell et al., 2020). It can be also the case that students could have enjoyed some benefits in commuting (e.g. Mokhtarian et al., 2001; Páez and Whalen, 2010; Shaw et al., 2019). Understanding these behavioural patterns plays an important role in sustainable mobility policy in terms of advantages and disadvantages of commuting to university perceived by students using different means of transport. Firstly, the satisfaction derived from the balance of advantages and disadvantages can affect present and future transport choices. Secondly, it could be an alternative measure of the attractiveness of transport modes for students in addition to the so-called transport demands (Marszałek, 2001), regarded as required qualitative attributes of different means of transport (e.g. Paradowska, 2020; Cattaneo et al., 2018, Romanowska et al., 2019).

Having said this, the goal of the paper is to investigate students' perceptions on the advantages and disadvantages of day-to-day commuting before the start of online learning with a focus on the resultant satisfaction from the use of different means of transport. In this context, we examined the propensity for a more sustainable mobility and the potential, theoretical further

deconsumption of transport processes. We based our research on empirical results from an online survey conducted among students of two public universities in Poland covering five research questions:

- To what extent students associated daily commuting to university in pre-pandemic times with advantages and disadvantages related to travelling?
- Were there any differences in advantages and disadvantages perceived by commuters using particular transport modes?
- To what extent diverse groups of commuters were likely to give up their private cars in order to take care of the local community and the environment?
- What are the most likely and the "dream modes" of commuting among disparate groups of transport users after the pandemic?
- If there was such a possibility, would students demonstrate a deconsuming attitude and use a teleport to reach the university or maybe they would prefer to commute by a particular mean of transport?

Literature review

Urban areas worldwide are facing growing problems resulting from non-sustainable mobility based predominantly on motor vehicles. These have an social, economic, and environmental impact through negative transport externalities (e.g. UN-Habitat, 2013; WHO Regional Office for Europe, 2017; European Commission, 2019, Ricardo-AEA, 2014, Paradowska, 2011). For this reason, for decades there has been a strong focus on the development of effective sustainable urban mobility tools aiming at a shift in transport behaviour towards more sustainable modes and a reduction in their negative externalities (e.g. European Union, 2017; UNECE, 2020; UN-Habitat, 2013; European Union, 2020; OECD, 2002; Werland, 2020; OECD, 1996; European Platform on Sustainable Urban Mobility Plans, 2019a, 2019b). Simultaneously, extensive research has been conducted on the efficiency of sustainable modes of urban mobility (e.g. Dedele and Miskinyte, 2021; Fonseca et al., 2021; Cornagoi, 2019; Enochsson et al., 2021; Morfoulaki and Papathanasiou; 2021; Paradowska, 2019a, Mayes, 1996; Meijer, 2017; Acheampong et al., 2021; Meng et al., 2017; Trela, 2017) in line with studies on multiple factors influencing more sustainable transport choices (e.g. Grison et al., 2016; Ramezani et al., 2018; Paradowska, 2014; Schwanen and Lucas, 2011; Schneider, 2011; Litman, 2008; Chee and Fernandez, 2013; Scheepers et al., 2016; Ye and Titheridge, 2017; Christiansen et al., 2016, De Jong and Van de Riet, 2008; De Vos et al., 2016; Setiawan et al., 2015; Kuppam et al., 1999;

Popuri et al., 2011). These issues have gained traction, as car users are hardly likely to resign from cars, and people in general are more prone to switch from public transport to a car than the other way round (e.g. Platje et al., 2018; Paradowska, 2019b, Setiawan et al., 2015; Beirão and Sarsfield Cabral, 2007).

Phenomena related to a shift towards sustainable urban mobility and more sustainable transport choices can be investigated through the theoretical lens of deconsumption, which, in turn, is considered a form of sustainable consumption (e.g. Cherrier et al., 2010; Lee et al., 2009; Łuczka and Smoluk-Sikorska, 2017; Bylok, 2017; Burgiel and Zrałek, 2015). Some authors define deconsumption (aka: anti-consumption, non-consumption) as the opposite of consumerism being characterised by a more conscious consumption (Leonard and Conrad, 2011; Bywalec and Rudnicki, 2002) or by rational, conscious, responsible and ethical consumption (Szul, 2012), or simply by numerous ways of consumption reduction, including sharing products, etc. (Patrzałek, 2019). One of the clearest and most distinct forms of deconsumption of transport processes is telecommuting, as it involves no regular, frequent, and obligatory physical transport caused by needs to reach workplaces, universities or schools. In the pre-pandemic era, telecommuting could be understood as "intentional non-consumption" or "incidental non-consumption" (Cherrier et al., 2011), as people consciously and voluntarily would give up working in an office and/or chose e-learning (e.g. Ismail et al., 2016; Hartman et al., 1991; Yen et al., 1994). This changed during the COVID-19 pandemic. In most countries, telework and remote learning replaced traditional ways of working and studying, fitting more to "ineligible non-consumption".

Many studies conducted before and during the COVID-19 pandemic underline social and environmental benefits resulting from telecommuting in terms of a reduction of negative transport externalities (e.g. Hopkins and McKay, 2019; Mokhtarian and Salomon, 1995, 1997; Lier et al., 2012; Ahvenniemi, 2017, Bieser et al., 2021; Bojovic et al., 2020, Irwin, 2004; Belzunegui-Eraso and Erro-Garcés, 2020) with not much attention paid to various personal advantages and disadvantages resulting from daily commuting (e.g. Mokhtarian and Salomon, 1995, 1997, 2001; Mokhtarian et al., 2015; Páez and Scott, 2007; Páez and Whalen, 2010; Harvey and Taylor, 2000; Shaw et al., 2019) or to the impact of telecommuting on future transport choices (e.g. Moslem et al., 2020; Conway et al., 2020). Though multiple studies have been conducted to investigate different aspects of remote learning in higher education, including teaching quality, factors influencing effectiveness of remote studying, students' satisfaction or barriers faced by students and teachers (e.g. Rahiem, 2020; Kisanga and Ireson, 2015; Azzahra, 2020; Souza et al.,

2020; Zawadka et al., 2021; Ho et al., 2021; Razami and Ibrahim, 2021; Ferri et al., 2020), little research has been devoted to the role of commuting. This study attempts to narrow this research gap not only by examining the importance of daily commuting for students before the COVID-19 pandemic in terms of perceived advantages and disadvantages. Another open area refers to the willingness of commuting in the future, especially considering expected deconsumption, likely resignation from car use and more sustainable transport choices. To the author's best knowledge, no empirical study to date has dealt with the differences between perceptions on advantages and disadvantages of commuting to the university before the COVID-19 pandemic and willingness to deconsume commuting in the future depending on the most frequently used transport mode The new insights provided in this paper focus not only on the links between perceived satisfaction from commuting by given transport mode resulting from benefits and drawbacks of the transport process but also on future transport choices. An important exploratory aspect of this study is related to the attitude-behaviour gap revealing low propensity to deconsume commuting and resign from a car in a hypothetical situation. These issues fit in with discussions around developing effective instruments supporting sustainable transport attitudes and behaviours (e.g. European Union, 2017; UNECE, 2020; European Union, 2020; European Platform on Sustainable Urban Mobility Plans, 2019a, 2019b), including sustainable transport choices made by students (dell'Olio et al., 2019; Rotaris and Danielis 2014, 2015; Setiawan et al., 2015; Cattaneo et al., 2018; Romanowska et al., 2019; Paradowska, 2019b), the problem of knowledge–attitude–behaviour gaps in developing sustainable consumption (e.g. Burgiel, 2020; Terlau and Hirsch, 2015; Bernardes et al., 2018; Luchs et al., 2015), as well as the low demand elasticity of travelling by car (e.g. Berri, 2009; McCarthy, 1996; EIA, 2014; Dong et al., 2012).

There are, however, some limitations. First, we conducted the survey one year after remote studying had been introduced, which could have resulted in respondents' opinions on the perceived meaning of commuting much more declarative. Second, the survey questions did not include all factors influencing transport choices, as the questionnaire was subordinated to the research problem which focussed on the advantages and disadvantages of commuting as well as on future ways of reaching the university in the context of sustainable mobility. Third, this is a case study of two public universities in Poland. Because of the size and characteristics of the sample, findings cannot be extended to the total population, and future research is necessary to investigate students' transport behaviour after the pandemic ends.

Research methods

The primary tool for collecting data was an online survey designed and completed in April 2021 among students of the Institute of International Studies (IIS UWr) at the Faculty of Social Sciences (University of Wroclaw, Poland) and among students of the Faculty of Economics at the University of Opole (FE UO, Poland). The questionnaire comprised five key parts aimed at discovering respondents' preferences in following areas:
- the most frequently used means of transport while commuting to the university before the pandemic,
- advantages and disadvantages of commuting[1],
- propensity to resign from commuting by car for environmental and social (local community) reasons,
- the most likely and "dream modes" of future commuting,
- propensity to replace physical commuting to the university by teleportation.

Quota, convenience, and purposive sampling as techniques of non-probability sampling (Ackoff, 1953; Davis, 2005; Taherdoost, 2016) were used in the study. Selecting respondents, the author set the following criteria: accessibility and readiness to take part in the research, expected distribution of characteristics related to commuting (e.g.: means of transport, distance to the university, availability of a car, driving licence) in subpopulations of students from both selected universities, expected reliability and honesty answering survey questions. Due to the size of Wrocław and Opole, location of IIS UWr and FE UO, availability, organisation of public transport and the level of congestion[2], we expected distinct survey results from students' subpopulations in terms of their commuting patterns. This, in turn, should provide valuable insights into the variety of respondents' perceptions of advan-

---

[1]   There were 19 variables related to advantages and 15 variables related to disadvantages included in the survey questionnaire, based on own experience of the author and studies performed by Mokhtarian and Salomon (1995, 1997, 2001); Mokhtarian et al. (2015), Páez and Scott (2007), Harvey and Taylor (2000), Shaw et al. (2019), Maguire and Morris (2018), and Chappell et al. (2020).

[2]   Wrocław is the fourth largest city in Poland in terms of the population and fifth in terms of the area. It is the capital of the Lower Silesia Voivodship and of the developing Wrocław Agglomeration (Encyklopedia PWN). In the ranking prepared by Globalization and World Cities Research Network (2020) Wrocław was classified in the IX category Gamma which was the second best ranking position (after Warsaw) among Polish cities. It is one of the Polish cities with the largest economic and social potential, developed public transportation and cycling infrastructure, but at the same time facing traffic congestion. Opole is the twenty-seventh largest city in Poland in terms of the population and fifteenth in terms of the area. It is the capital of the Opole Voivodship, which is the smallest from 16 Polish provinces both in terms of the population and the area (Encyklopedia PWN).

tages and disadvantages of commuting by different transport modes, as well as into their future behavioural transformation. However, as mentioned above, this is only a preliminary research, hence the sample can only be treated as an experimental group. The analysis of empirical results was carried out in SPSS software mainly by applying Pearson chi-squared tests and comparison of relative shares in answers.

Research results

Among 404 respondents, there were 39.9% (161) students from IIS UWr and 60.1% (243) from FE UO. Respondent age range varied from 17 to 35 with those aged 19 (44, 10.9%), 20 (110, 27.4%), 21 (98, 24.4%) and 22 (59, 14.7%) prevailing. Females (275, 68.1%) outnumbered males (127, 31.4%) in the total sample. What is also important, is that there were statistically significant differences[3] between respondents representing IIS UWr and FE UO both in terms of basic attributes (such as gender and age), as well as in characteristics related to commuting. On average, FE UO students were slightly older with a significant predominance of females (176, 72.4% from all respondents representing FE UO) over males (65 and 26.7%), whereas in the case of IIS UWr, there were 38.5% (62) of males and 61.5% (99) of females. Another characteristic feature was that the IIS UWr students commuted up to 10 km (less than 3 km – 32, 19.9%, 4-5 km – 37, 23%, 5-10 km – 45, 28%), whereas at the FE UO, short- and long-distance commutes predominated (less than 3 km – 86, 35.4%, over 30 km – 74, 30.5%). Commuting time for the largest group of IIS UWr respondents was between 10 and 60 minutes (11 to 30 – 64, 39.8%, 31 to 60 minutes - 60, 37.2%) with only 11.8% (19) spending 10 minutes or less on their commute. FE-UO student commutes also took mostly between 11 and 60 minutes (11 to 30 – 77, 31.7%, 31 to 60 – 66, 27.1%). However, comparing commuting times between the two universities, larger groups for FE UO took either 10 minutes or less (57, 23.5%) or over one hour (43, 17.7%). In the total sample, the largest groups commuted from a rented room/apartment (156, 38.6%) or family home in another city/countryside (145, 35.9%). Most IIS UWr students (101, 62.7% of IIS UWr respondents) commuted to the university from a rented room/apartment, 18% (29) from a family home in another city/countryside with 12.4% (20) from a family home in the city where the university is located. The proportions among respondents from FE UO were: rented room/apartment – 22.6% (55), family home in another city/countryside – 47.7% (116),

---

3   The chi square test showed statistically significant differences between the variables at the significance level $p < 0.05$.

family home in the city where the university is located – 12.3% (30). 83.2% of all respondents (336) had a driving licence, while 13.6% (55) declared they would get one in the foreseeable future. A visibly higher share of students at FE UO (213, 87.7% of respondents from FE UO) had a driving licence than at IIS UWr (123, 76.4% of respondents from IIS UWr). 39.6% (160) of all respondents had their own car with the same number driving someone else's car, while 13.9% (56) planned to buy one in the future. We also observed greater car availability among respondents studying at FE UO (204, 84% of FE UO students surveyed) than at IIS UWr (116, 72.1% respectively). As mentioned above, these differences, resulting from distinctive characteristics of both cities and universities, were expected to give better insights into diversified respondent perceptions on advantages and disadvantages of commuting to the university by a particular means of transport.

High car availability with the majority having a driving license did not translate into a modal split of the university commuters. As presented in table 1, the most frequently used means were urban public transport (118, 29.2% of all respondents), active transport modes (84, 20.8%), car (70, 17.3%), and regional public transport (68, 16.8%). 15.1% of students surveyed (61) used multimodal options. Only 3 respondents (0.7%) commuted by other means of transport, thus their answers were not included in the further analysis. Respondents travelling to the university by urban public transport covered mostly an average distance of 4-10 km with travel time varying from 11-20 to 41-50 minutes. Students who preferred walking to the campuses were short-distance commuters who rather indicated shorter travel times. Students commuting from a rented room/apartment prevailed in both groups of respondents. As far as car users are concerned, there were two dominant groups: students who commuted on average 5-15 km and those living over 30 km from the university. Regional public transport was the mode relatively often preferred by respondents commuting from family homes in another city or in the countryside located over 21 km from the university. Among respondents using multiple modes, long-distance commutes and those of 4-10 km prevailed.

There were 19 variables selected in the study to investigate respondents' perceptions on the advantages of commuting to the university before the COVID-19 pandemic (table 2). Chi-squared tests showed statistically significant differences between respondents commuting by distinct transport modes for 15 variables (significance level p < 0.05). Planning time after classes and possibility of getting different things done on the way were considered the most important benefits among all groups of commuters. However, for car users it was rather an opportunity to ensure a psychological distance between home and university. Respondents commuting by urban

Table 1. Characteristics of respondents commuting by a particular mean of transport

Variable	% of respondents commuting by a particular mean of transport:				
	car[a]	urban public transport	regional public transport	on foot/ bicycle[b]	multiple modes[c]
Percentage of all respondents	17.3	29.2	16.8	20.8	15.1
University*					
- IIS UWr	11.8	50.9	4.3	11.8	21.1
- FE UO	21.0	14.8	25.1	26.7	11.1
Distance to university*					
- less than 1 km	2.9	3.4	5.9	59.5	3.3
- 1-3 km	8.6	9.3	8.8	38.1	1.6
- 4-5 km	8.6	31.4	4.4	2.4	14.8
- 5-10 km	15.7	33.1	2.9	0.0	14.8
- 11-15 km	14.3	9.3	1.5	0.0	1.6
- 16-20 km	2.9	4.2	8.8	0.0	6.6
- 21-30 km	11.4	3.4	25.0	0.0	6.6
- more than 30 km	35.7	5.9	42.6	0.0	50.8
Commuting time*					
- less than 5 min.	4.3	2.5	1.5	14.3	1.6
- 6-10 min.	7.1	2.5	4.4	52.4	1.6
- 11-20 min.	18.6	22.0	13.2	31.0	1.6
- 21-30 min.	21.4	32.2	7.4	1.2	9.8
- 31-40 min.	14.3	15.3	16.2	0.0	9.8
- 41-50 min.	8.6	18.6	5.9	0.0	16.4
- 51-60 min.	5.7	2.5	27.9	0.0	19.7
- more than 1 hour	20.0	4.2	23.5	1.2	39.3
Place of residence*					
- family home in city where university is located	22.9	16.9	1.5	10.7	4.9
- family home in another city/country-side	55.7	11.0	83.8	0.0	57.4
- dormitory	2.9	5.9	5.9	27.4	4.9
- rented room/apartment	17.1	62.7	4.4	59.5	27.9
- others	1.4	3.4	4.4	2.4	4.9

Driving licence*					
- yes	98.6	78.8	83.8	82.1	75.4
- no, but plans to get a driving licence in the future	1.4	16.9	13.2	15.5	18.0
- no, no plans to get a driving licence	0.0	4.2	2.9	2.4	6.6
Availability of a car					
- driving own car	78.6	29.7	26.5	32.1	36.1
- driving someone else's car	20.0	42.4	48.5	47.6	37.7
- no car available, plans to buy one	1.4	16.9	17.6	15.5	16.4
- no car available, no plans to buy any in the future	0.0	11.0	7.4	4.8	9.8

a – both car drivers (62, 15.3% of all respondents) and car passengers (7, 1.7% of all respondents), b – pedestrians accounted for 20% (81) while cyclists only for 0.7% (3) of all respondents, c – different means of transport during one travel to/from the university.

* - there were statistically significant differences between this characteristic of respondents commuting by a particular mean of transport at the significance level $p < 0.05$.

Source: author's work based on the survey research.

and regional public transport appreciated the fact that they had time for relaxation, while both urban public transport users and those walking or cycling benefited from contacts with fellow students or with other people. Physical activity was one of the most important advantages for active travellers, whereas long distance or multimodal commuters used their commuting time to study before classes. The most striking feature is that car drivers and passengers perceived the lowest levels of advantages compared to the other transport users. The most satisfied group were active commuters who recognised numerous personal benefits.

Table 2. Opinions on advantages of commuting depending on the most frequently used transport mode

Advantages	Total opinions				car				urban public transport				regional public transport				on foot/bicycle				multiple modes			
	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation
Planning time after classes*	1	14.7	12.0	73.3	2	17.1	14.3	68.6	1	11.0	5.1	83.9	1	17.6	7.4	75.0	2	9.5	9.5	81.0	1	19.7	4.9	75.4
Getting different things done on the way*	2	14.2	13.2	72.6	1	7.1	7.1	85.7	2	16.1	7.6	76.3	2	16.2	16.2	67.6	1	4.8	10.7	84.5	2	19.7	6.6	73.8
Planning the day at the university	3	20.0	19.7	60.3	3	22.9	12.9	64.3	6	26.3	16.9	56.8	4	17.6	19.1	63.2	7	20.2	14.3	65.5	4	18.0	21.3	60.7
Time for relax*	4	27.2	15.0	57.9	9	50.0	12.9	37.1	3	24.6	8.5	66.9	3	19.1	16.2	64.7	14	21.4	21.4	57.1	6	36.1	9.8	54.1
Distancing from home matters and focusing on studies	5	26.7	18.5	54.9	4	25.7	17.1	57.1	7	31.4	11.9	56.8	12	27.9	20.6	51.5	6	14.3	19.0	66.7	9	37.7	16.4	45.9
Benefitting from contacts with other people*	6	25.4	20.0	54.6	11	42.9	24.3	32.9	5	23.7	15.3	61.0	6	26.5	14.7	58.8	5	17.9	14.3	67.9	5	26.2	18.0	55.7
Benefiting from contacts with fellow students*	7	25.4	20.4	54.1	10	50.0	14.3	35.7	4	22.9	16.1	61.0	7	22.1	22.1	55.9	4	15.5	11.9	72.6	7	24.6	23.0	52.5
Learning before classes*	8	32.2	15.2	52.6	15	70.0	10.0	20.0	8	38.1	10.2	51.7	5	20.6	17.6	61.8	19	64.3	21.4	14.3	3	18.0	9.8	72.1

Opinions of respondents commuting by a particular means of transport (%):

Distancing from studying and focusing on home matters*	9	28.9	20.7	50.4	5	30.0	21.4	48.6	10	34.7	16.1	49.2	8	22.1	23.5	54.4	12	19.0	22.6	58.3	14	47.5	14.8	37.7
An important and useful home-university boundary	10	28.4	23.7	47.9	6	34.3	18.6	47.1	9	29.7	20.3	50.0	14	35.3	26.5	38.2	10	11.9	28.6	59.5	11	34.4	26.2	39.3
An excellent opportunity for physical activity*	11	29.4	24.7	45.9	14	62.9	12.9	24.3	11	28.8	22.9	48.3	10	22.1	26.5	51.5	3	9.5	13.1	77.4	10	24.6	34.4	41.0
Better physical fitness*	12	32.4	23.2	44.4	13	58.6	15.7	25.7	12	33.1	24.6	42.4	9	27.9	19.1	52.9	11	13.1	27.4	59.5	12	34.4	26.2	39.3
Benefiting from contact with nature*	13	33.2	24.9	41.9	12	47.1	22.9	30.0	13	35.6	23.7	40.7	13	32.4	26.5	41.2	8	14.3	22.6	63.1	15	42.6	23.0	34.4
Better preparation for classes*	14	35.4	23.2	41.4	17	62.9	18.6	18.6	16	43.2	23.7	33.1	11	25.0	23.5	51.5	17	56.0	26.2	17.9	8	32.8	19.7	47.5
Commuting as a satisfaction in itself*	15	32.9	25.9	41.1	7	35.7	17.1	47.1	14	36.4	25.4	38.1	16	33.8	38.2	27.9	13	14.3	28.6	57.1	16	50.8	19.7	29.5
Stress reduction*	16	37.9	22.9	39.2	8	47.1	14.3	38.6	15	39.8	22.9	37.3	17	44.1	29.4	26.5	9	20.2	19.0	60.7	17	52.5	18.0	29.5
Useful time*	17	39.9	25.4	34.7	16	58.6	22.9	18.6	17	51.7	23.7	24.6	15	35.3	29.4	35.3	15	32.1	27.4	40.5	13	39.3	23.0	37.7
Additional development activities*	18	50.4	20.9	28.7	18	68.6	14.3	17.1	18	61.9	16.1	22.0	18	47.1	30.9	22.1	18	57.1	27.4	15.5	19	63.9	16.4	19.7
Time for activities otherwise not done	19	48.9	23.4	27.7	19	67.1	21.4	11.4	19	55.9	23.7	20.3	19	54.4	23.5	22.1	16	46.4	31.0	22.6	18	59.0	18.0	23.0
Overall perceptions of advantages of commuting*	-	30.7	20.7	48.6	-	45.2	16.5	38.3	-	33.9	17.6	48.4	-	28.8	22.7	48.5	-	24.3	20.9	54.8	-	35.9	18.4	45.7

* statistically significant differences between opinions of respondents commuting by a particular mode of transport with significance level p < 0.05.

Source: author's work based on the survey research.

Table 3. Opinions on disadvantages of commuting depending on the most frequently used transport mode

Disadvantages*	Total opinions				car				urban public transport				regional public transport				on foot/bicycle				multiple modes			
	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation	Rank	Negation	Neutral	Confirmation
Too long due to traffic jams	1	22.4	20.7	56.9	1	21.4	17.1	61.4	1	28.0	11.0	61.0	7	35.3	25.0	39.7	14	81.0	9.5	9.5	3	13.1	27.9	59.0
Waste of time	2	26.7	17.7	55.6	2	38.6	17.1	44.3	3	39.8	11.0	49.2	1	22.1	19.1	58.8	1	64.3	10.7	25.0	1	13.1	14.8	72.1
Commuting to university was very tiring	3	28.9	20.4	50.6	7	41.4	28.6	30.0	2	34.7	15.3	50.0	4	35.3	14.7	50.0	3	73.8	7.1	19.0	2	19.7	16.4	63.9
Something to "kill time"	4	31.9	20.4	47.6	10	70.0	11.4	18.6	4	30.5	22.0	47.5	2	26.5	16.2	57.4	5	65.5	17.9	16.7	5	24.6	21.3	54.1
Fewer opportunities to rest after classes	5	36.4	18.7	44.9	4	45.7	17.1	37.1	8	55.9	15.3	28.8	3	35.3	13.2	51.5	11	76.2	13.1	10.7	4	23.0	19.7	57.4
Big financial burden	6	36.7	20.7	42.6	3	41.4	15.7	42.9	9	56.8	14.4	28.8	6	33.8	25.0	41.2	13	79.8	9.5	10.7	6	29.5	23.0	47.5
Only useful aspect being to get to university/home	7	38.2	20.7	41.1	6	48.6	18.6	32.9	5	50.0	14.4	35.6	8	44.1	19.1	36.8	4	69.0	13.1	17.9	7	32.8	26.2	41.0
Unnecessary pollution and waste of non-renewable fossil fuels.	8	36.2	24.7	39.2	5	44.3	20.0	35.7	7	49.2	20.3	30.5	9	38.2	27.9	33.8	6	67.9	16.7	15.5	8	32.8	29.5	37.7
Very tiring noise levels	9	42.6	18.5	38.9	11	70.0	12.9	17.1	6	52.5	11.9	35.6	5	38.2	16.2	45.6	2	71.4	9.5	19.0	10	39.3	26.2	34.4

Opinions of respondents commuting by a particular means of transport (%):

Increased levels of stress	10	43.4	23.7	32.9	9	54.3	24.3	21.4	10	61.0	16.1	22.9	14	47.1	27.9	25.0	10	76.2	11.9	11.9	9	36.1	26.2	37.7
Negative feelings regarding home matters	11	44.6	22.4	32.9	8	54.3	21.4	24.3	11	60.2	20.3	19.5	11	44.1	23.5	32.4	7	67.9	19.0	13.1	11	49.2	18.0	32.8
Negative feelings regarding study matters	12	47.4	21.4	31.2	12	58.6	27.1	14.3	13	64.4	16.9	18.6	10	48.5	17.6	33.8	12	78.6	10.7	10.7	12	49.2	18.0	32.8
"Dying" of boredom	13	48.4	21.9	29.7	13	62.9	22.9	14.3	12	61.9	19.5	18.6	12	52.9	14.7	32.4	15	77.4	15.5	7.1	13	50.8	24.6	24.6
Irritating contact with other people	14	50.9	22.9	26.2	15	74.3	21.4	4.3	14	67.8	15.3	16.9	13	42.6	27.9	29.4	9	76.2	11.9	11.9	14	54.1	26.2	19.7
Fear for own safety	15	55.6	21.2	23.2	14	70.0	20.0	10.0	15	78.0	8.5	13.6	15	61.8	20.6	17.6	8	76.2	10.7	13.1	15	49.2	37.7	13.1
Overall perceptions of disadvantages of commuting	-	39.4	21.1	39.6	-	53.0	19.7	27.2	-	52.7	15.5	31.8	-	40.4	20.6	39.0	-	73.4	12.5	14.1	-	34.4	23.7	41.9

* Statistically significant differences between opinions on disadvantages of commuting by a particular mean of transport at significance level $p < 0.05$.

Source: author's work based on the survey research.

Table 4. Satisfaction with commuting and pro-social and pro-environmental attitudes of respondents depending on the most frequently used transport mode

Statements	Total opinions			Opinions of respondents commuting by a particular means of transport (%):														
				car			urban public transport			regional public transport			on foot/bicycle			multiple modes		
	Negative	Neutral	Positive	Negation	Neutral	Confirmation	Negation	Neutral	Confirmation	Negation	Neutral	Confirmation	Negation	Neutral	Confirmation	Negation	Neutral	Confirmation
I am satisfied commuting by the means of transport I use to reach the university	25.2	23.7	51.1	18.6	21.4	60.0	24.6	22.9	52.5	30.9	23.5	45.6	3.6	8.3	88.1	45.9	21.3	32.8
I would prefer to teleport rather than commute to the university	22.2	20.2	57.6	34.3	15.7	50.0	26.3	11.0	62.7	20.6	27.9	51.5	45.2	23.8	31.0	16.4	23.0	60.7
I try to take care of the environment while commuting	18.7	38.4	42.9	38.6	44.3	17.1	15.3	33.1	51.7	16.2	45.6	38.2	4.8	26.2	69.0	14.8	47.5	37.7
I try to take care of the local community while commuting	18.5	42.6	38.9	28.6	45.7	25.7	15.3	42.4	42.4	20.6	54.4	25.0	9.5	39.3	51.2	19.7	45.9	34.4
I am ready to resign from commuting by car to care for the local community	28.2	26.9	44.9	70.0	15.7	14.3	18.6	22.9	58.5	20.6	39.7	39.7	6.0	23.8	70.2	29.5	31.1	39.3
I am ready to resign from commuting by car to care for the environment	29.7	28.9	41.4	68.6	17.1	14.3	19.5	27.1	53.4	29.4	36.8	33.8	14.3	23.8	61.9	29.5	37.7	32.8
I am ready to incur additional costs to commute by car	41.6	25.4	32.9	21.4	27.1	51.4	60.2	19.5	20.3	51.5	29.4	19.1	60.7	26.2	13.1	59.0	26.2	14.8

Source: author's work based on the survey research.

As opposed to the perceptions on advantages, the respondents associated commuting with moderate or low levels of disadvantages (table 3). There were statistically significant differences between respondents commuting by a particular mean of transport at the significance level $p < 0.05$ for all 15 variables relating to the various negative aspects of specific commuting modes. In general, long travel times due to traffic jams, waste of time and fatigue were considered to be the most significant drawback. However, car users also revealed financial costs and were aware (to some extent) of negative environmental consequences. Long-distance commuters and those using urban public transport tried to find ways to pass the time and had the least opportunities to rest after classes. What is important in this context is that most active commuters did not experience any disadvantages, whereas car users were the second group that paid least attention to the different negative aspects of commuting.

It is also worthwhile emphasising the fact that active commuters perceived the most advantages and the fewest disadvantages, whilst drivers and car passengers the fewest advantages but with very low levels of commuting disadvantages. However, both groups of respondents showed the highest satisfaction from their preferred ways of commuting (table 4), and were least likely to switch their chosen transport mode to a cheap and commonly available teleportation (assuming this would be possible after the pandemic). It turned out that multiple mode respondents and students commuting by regional public transport were the least satisfied groups and therefore teleportation would be most preferred by urban public transport passengers and multiple mode commuters. Non-car users were the most likely to demonstrate pro-social and pro-environmental transport attitudes, with active commuters being the most concerned about the local community and the environment as well as being least willing to incur additional costs for commuting by car. Car users, in turn, were most likely to pay more for their transport mode and were least likely to give up their current behaviour because of social or environmental concerns.

In the total sample, 47.8% (193) of respondents wanted remote studying to end as soon as possible, 28.2% (114) preferred to continue learning from home and 24% (97) were undecided. This means that almost 50% of the students were ready to "consume" commuting in the future. In the last part of the questionnaire, there were additional questions on opinions regarding future deconsumption of commuting to and from the university via teleportation. Students indicated their most likely and "dream" future means of transport. In all groups, the most likely future commuting mode was the same as before the pandemic. However, the respondents made different

choices regarding the hypothetical situation, if nothing would restrict them and they could choose the most desirable, "dream" transport mode (including teleportation). Although in the earlier part of the questionnaire the majority of students (57.6%) confirmed they would prefer to use teleportation rather than to commute after the pandemic (table 4), in general commuting by car turned out to be a more desired solution, (even compared to teleportation), especially among car users and passengers of urban public transport (table 5). Only multiple mode respondents preferred teleportation (35.4%) to using a car (26%), whereas for commuters using regional public transport these two "dream" modes had the same popularity rank (33.1% of answers given both to a car and teleportation). The most satisfied group of respondents, namely active commuters, would not like to change their transport behaviour. Whereas, walking and cycling (considered as the most sustainable transport modes), were the third-best "dream" transport modes among all respondents.

Table 5. The most likely and "dream" university commuting modes after the COVID-19 pandemic

The means of transport used to commute to the university in the future	Total opinions		Opinions of respondents commuting by a particular means of transport (%):									
			car		urban public transport		regional public transport		on foot/ bicycle		multiple modes	
	The most likely	Dream	The most likely	Dream	The most likely	Dream	The most likely	Dream	The most likely	Dream	The most likely	Dream
teleportation	0.0	31.0	0.0	34.7	0.0	29.1	0.0	33.1	0.0	25.0	0.0	35.4
car	28.6	32.8	69.7	50.8	19.5	34.2	28.3	33.1	22.0	19.7	14.6	26.0
urban public transport	28.5	9.3	13.8	4.8	57.1	19.4	10.4	5.9	14.0	3.0	18.8	4.7
regional public transport	8.2	2.6	1.8	0.8	1.3	0.4	38.7	7.6	6.0	2.3	2.1	3.9
walking or cycling	20.4	19.2	8.3	8.1	16.0	13.9	10.4	14.4	49.3	47.0	10.4	15.7
multiple modes	14.3	5.0	6.4	0.8	6.1	3.0	12.3	5.9	8.7	3.0	54.2	14.2

Source: author's work based on the survey research.

Discussion

The findings relating to satisfaction with commuting by particular means of transport correspond to results obtained by Páez and Whalen (2010). However, these scholars placed an emphasis only on aspects related to travel (e.g. travel time or willingness to travel alone). There were no insights into the opinions of students as commuters to/from university. In other studies, next to car drivers, active commuters turned out to be the most satisfied transport users whist urban public transport users were most often the least satisfied group or even unhappy with this way of travelling (e.g. Devi, 2017; Lades et al.; 2020; Rissel et al., 2016; De Vos, 2018; De Vos et al., 2016, 2019; Shannon et al., 2006). To some extent, perceptions of its advantages and disadvantages can determine overall satisfaction with commuting by a given transport mode (Páez and Whalen, 2010; Mokhtarian and Salomon, 2001), and can play a key role in shaping more sustainable transport behaviour as travel experience and satisfaction are likely to influence e.g. decisions on car ownership and use (De Vos et al., 2016, 2019). This point is of relevance not only because active commuters are least likely to switch from walking to a car or even teleportation, but also in terms of the fairly large interest in walking/cycling as preferred modes of commuting after the pandemic among other groups of respondents.

Despite the opinions of active and multiple mode travellers, the results of this study reveal discrepancies between declared satisfaction with a transport mode, the perceived levels of advantages and disadvantages, as well as the "dream" means of commuting after the pandemic. For example, passengers of urban public transport were on average fairly content with their way of commuting. However, they also experienced low levels of benefits and moderate levels of drawbacks of commuting in this manner. Therefore, they remained most likely to switch from public transit to a car not choosing teleportation. Car users, in turn, did not think they largely benefited from or lost due to commuting, but were the second most satisfied group of commuters with the greatest tendency to use a car in the future, even if they were able to teleport to the university. These differences in the opinions stem from a variety of factors influencing mode choices (e.g. Zhou, 2012; Zhou et al., 2018; Cattaneo et al., 2018; Romanowska et al., 2019; Ramezani et al., 2018; Paradowska, 2014). In particular, distance and travel time, mode-specific costs, car availability and accessibility of alternatives to a car are considered the strongest factors (Zhou, 2012; Cattaneo et al., 2018; Romanowska et al., 2019; Lavery et al., 2013). For instance, many studies have shown that walking is the most popular choice for close distances, while the popularity of using a car dynamically increases over medium and long distances. Built-up environments with high availability of public transport make this transport

mode a convenient alternative to a car, especially when more and more restrictions on the use of cars are debated and implemented (Searcy et al., 2018; Lavery et al., 2013; Cattaneo et al., 2018; Romanowska et al., 2019; Vale et al., 2018). Moreover, long distance and extended travel time usually decrease overall satisfaction from commuting (e.g. Páez and Whalen, 2010; De Vos et al., 2016; Cattaneo et al., 2018). This finding can to some extent be reflected in the results obtained in this study in terms of respondents commuting by regional public transport and using multiple modes. Experiencing some advantages, for example extra time for learning before classes, resting after classes etc., can be related to a long travel time and willingness to simply fill the time available (e.g. Shaw et al., 2019; Mokhtarian et al., 2015; Singleton, 2018). As a previous study confirmed, car drivers perceive low levels of advantages resulting from travelling (Shaw et al., 2019). However, on the other hand, personal positive feelings related to driving, including a passion to drive or being emotionally attached to someone's own car can have a significant impact on "car addiction" (Steg et al., 2001a, 2001b; Steg, 2005). Similar effects derive from the fact that car travels satisfy significant transport demands to a higher extent (e.g. reliability, directness, comfort or independence, etc.) than other non-active transport modes (e.g. Cattaneo et al., 2018; Romanowska et al., 2019, Paradowska, 2020; Steg, 2003).

The above mentioned factors influencing high levels of satisfaction from commuting by car are probably key reasons for a high ranking of car transport as "dream" mode after the pandemic among respondents commuting by car as well as by those using urban and regional public transport. Analysis of the survey results also indicated that active commuters also gave a similar high ranking to walking/cycling as "dream" mode after the pandemic. Teleportation was considered a better option than a car only by multiple mode long distance commuters, which can be a consequence of higher stress levels and psychological fatigue related to driving long distances before and after a busy day at the university (e.g. Mokhtarian et al., 2015).

Last but not least, the findings also demonstrated a psychological gap between attitudes and actual behaviour/everyday decisions (e.g. Burgiel, 2020; Terlau and Hirsch, 2015; Jin et al., 2021; Prillwitz and Barr, 2011; Vincent, 2019) among respondents commuting by urban and regional public transport, and those using multiple modes. These groups of commuters tended to confirm a willingness and readiness to reduce/give up travelling by car to take more care of the environment and local communities. Likewise, they were not ready to incur additional costs for commuting by car. However, public transport users preferred commuting by car to the university rather than benefitting from affordable and easily available teleportation, whilst a car was the second-best "dream" means of transport among multiple mode commuters.

Conclusions

In this study, based on online survey research conducted one year after remote studying started, we investigated to what extent students perceived advantages and disadvantages of daily commuting to the university before the COVID-19 pandemic in the context both of satisfaction from the use of a distinct mode of transport and of attitudes towards more sustainable transport choices which could make possible future deconsumption in this area. Considering the findings, the following conclusions can be drawn:

Respondents associated commuting to the university with more advantages than disadvantages with statistically significant differences between students' perceptions about commuting by a distinct means of transport. In general, car users expressed low levels of advantages and moderate levels of disadvantages to commuting and active commuters turned out to be the most satisfied.

Non-car users, with active commuters in particular, declared the highest level of social and environmental concerns, as well as the greatest propensity to give up commuting by car in the future. Drivers and car passengers demonstrated the least pro-social and pro-ecological attitudes and were most likely to incur additional costs to commute by car.

Except for active commuters, perceptions on advantages and disadvantages of commuting, satisfaction with the means of transport, as well as pro-social and pro-environmental attitudes translated neither into a willingness to deconsume commuting in the future nor into more sustainable transport choices in a hypothetical situation of having access to a "dream" transport mode (even teleportation).

Most respondents confirmed they would prefer teleportation over continuously commuting to the university, which can be considered a propensity for deconsumption of transport processes. However, use of a car turned out to be the first, followed by teleportation as the second-best "dream" means of commuting among respondents who commuted by car or by urban public transport before the pandemic. Multiple mode commuters strongly preferred teleportation, while for respondents using regional public transport both car transport and teleportation were equally popular. Thus, sustainable mobility did not seem to be a "dream" alternative for young people entering their adult life. Only active commuters would keep to their original transport mode and behaviour. In the total sample, respondents considered a car a slightly better option than teleportation, while active commuting remained the third-best solution.

The results may be of a practical value and can have implications for policy making. These refer to three primary streams of public activities. First,

both universities and local authorities could strive to implement policies and cooperate actions supporting active commuting. Accessible solutions could be (for instance) provision of affordable accommodation near campuses, improvements in walking and cycling infrastructure, other incentives encouraging students to switch from motorised transport modes, promotion and education for sustainable development. Second, there is still a strategic necessity for improvements in public transport, especially in terms of its availability in regions with academic centres, travel time reduction, and enhancing multitasking possibilities. Separate bus and tram lanes or, more broadly, a thorough re-organisation of urban traffic could help reduce public transit delays due to traffic jams, which would increase its attractiveness. Free, high-bandwidth and safe wi-fi or less crowded vehicles would, in turn, offer better conditions for students and those who perceive commuting as a waste of time. Cheaper or free public transport for students could also be enforced as a measure to make university commuting more sustainable. Finally, more restrictions on commuting by car should be considered, discussed, and systematically implemented. Examples are limiting parking space, higher fees/charges for parking or street transformations into walking and cycling lanes, or by improving public transit infrastructure.

References

Acheampong, R.A. et al., 2021. Can autonomous vehicles enable sustainable mobility in future cities? Insights and policy challenges from user preferences over different urban transport options. Cities, 112, 103134, https://doi.org/10.1016/j.cities.2021.103134.

Ackoff, R.L., 1953. The Design of Social Research. University of Chicago Press, Chicago.

Ahvenniemi, H. et al., 2017. What are the differences between sustainable and smart cities? Cities, 60, 234-245, https://doi.org/10.1016/j.cities.2016.09.009.

Azzahra, N.F., 2020. Addressing Distance Learning Barriers in Indonesia Amid the Covid-19 Pandemic. Center for Indonesian Policy Studies, https://doi.org/10.35497/309162.

Beirão, G., Sarsfield Cabral, J.A., 2007. Understanding attitudes towards public transport and private car: A qualitative study. Transport Policy, 14(6), 478-489, https://doi.org/10.1016/j.tranpol.2007.04.009.

Belzunegui-Eraso, A., Erro Garcés, A., 2020. Teleworking in the Context of the Covid-19 Crisis. Sustainability, 12(9), 3662, https://doi.org/10.3390/su12093662.

Bernardes, J.P. et al., 2018. "Do as I say, not as I do" – a systematic literature review on the attitude-behaviour gap towards sustainable consumption of Generation Y. IOP Conference Series: Materials Science and Engineering, 459, 459 012089.

Berri, A., 2009. A cross-country comparison of household, car ownership: A Cohort Analysis. IATSS Research, 33(2), 21-38, https://doi.org/10.1016/S0386-1112(14)60242-9.

Bieser, J.C.T. et al., 2021. Impacts of telecommuting on time use and travel: A case study of a neighborhood telecommuting center in Stockholm. Travel Behaviour and Society, 23, 157-165, https://doi.org/10.1016/j.tbs.2020.12.001.

Bojovic, D. et al., 2020. What we can learn from birdsong: Mainstreaming teleworking in a post-pandemic world. Earth System Governance, 5, 100074, https://doi.org/10.1016/j.esg.2020.100074.

Burgiel, A., 2020. Luka między postawami a zachowaniami konsumentów i jej konsekwencje dla upowszechnienia zrównoważonej konsumpcji. Prace Naukowe / Uniwersytet Ekonomiczny w Katowicach "Zrównoważona konsumpcja w polskich gospodarstwach domowych – postawy, zachowania, determinanty", 222-248.

Burgiel, A., Zrałek, J., 2015. Is Sustainable Consumption Possible in Poland? An Examination of Consumers' Attitudes Toward Deconsumption Practices. Acta Scientiarum Polonorum. Oeconomia, 14(2), 15-25.

Bylok, F., 2017. Intricacies of modern consumption: Consumerism vs. deconsumption. Annales. Ethics in Economic Life, 20(8), 61-74, http://dx.doi.org/10.18778/1899-2226.20.8.06.

Bywalec, C., Rudnicki, L., 2002. Konsumpcja. Polskie Wydawnictwo Ekonomiczne, Warszawa.

Camilleri, M.A., 2021. Evaluating service quality and performance of higher education institutions: a systematic review and a post-COVID-19 outlook. International Journal of Quality and Service, 13(2), 268-281, https://doi.org/10.1108/IJQSS-03-2020-0034.

Cattaneo, M. et al., 2018. Students' mobility attitudes and sustainable transport mode choice. International Journal of Sustainability in Higher Education, 19(5), 942-962. https://doi.org/10.1108/IJSHE-08-2017-0134.

Chappell, A. et al., 2020. The Experiences of Undergraduate Commuter Students. Brunel University London, https://www.brunel.ac.uk/about/administration/access-and-participation/documents/pdf/The-Experiences-of-Undergraduate-Commuter-Students-Report.pdf [12.06.2021].

Chee, W.L., Fernandez J.L., 2013. Factors that Influence the Choice of Mode of Transport in Penang: A Preliminary Analysis. Procedia – Social and Behavioral Sciences, 91, 120-127, https://doi.org/10.1016/j.sbspro.2013.08.409.

Cherrier, H. et al., 2011. Intentional non-consumption for Sustainability. Consumer resistance and/or anti-consumption? European Journal of Marketing, 45(11), 1757-1767, https://doi.org/10.1108/03090561111167397.

Christiansen, L.B. et al., 2016. International comparisons of the associations between objective measures of the built environment and transport-related walking and cycling: IPEN adult study. Journal of Transport & Health, 3(4), 467-478, https://doi.org/10.1016/j.jth.2016.02.010.

Conway, M.W. et al., 2020. How Will the COVID-19 Pandemic Affect the Future of Urban Life? Early Evidence from Highly-Educated Respondents in the United States. Urban Science, 4(4), 50, https://doi.org/10.3390/urbansci4040050.

Cornagoi, E. et al., 2019. Evaluating the Impact of Urban Road Pricing on the Use of Green Transport Modes: The Case of Milan. OECD Environment Working Papers, 143, https://doi.org/10.1787/ddaa6b25-en.

Davis, D., 2005. Business Research for Decision Making. Thomson South-Western, Australia.

De Jong, G., Van de Riet, O., 2008. The driving factors of passenger transport. European Journal of Transport and Infrastructure Research, 8(3), 227–250.

De Vos, J. et al., 2016. Travel mode choice and travel satisfaction: bridging the gap between decision utility and experienced utility. Transportation, 43(5), 771-796, https://doi.org/10.1007/s11116-015-9619-9.

De Vos, J. et al., 2019. Do satisfying walking and cycling trips result in more future trips with active travel modes? An exploratory study. International Journal of Sustainable Transportation, 13(3), 180-196, https://doi.org/10.1080/15568318.2018.1456580.

De Vos, J., 2018. Do people travel with their preferred travel mode? Analysing the extent of travel mode dissonance and its effect on travel satisfaction. Transportation Research Part A: Policy and Practice, 117, 261-274, https://doi.org/10.1016/j.tra.2018.08.034.

Dedele, A., Miskinyte, A., 2021. Promoting Sustainable Mobility: A Perspective from Car and Public Transport Users. International Journal of Environmental Research and Public Health, 18(9), 4715, https://doi.org/10.3390/ijerph18094715.

dell'Olio, L. et al., 2019. A methodology based on parking policy to promote sustainable mobility in college campuses. Transport Policy, 80, 148-156, https://doi.org/10.1016/j.tranpol.2018.03.012.

Devi, M.K., 2017. Potential to increase active commuting level in university area (case study: Universitas Gadjah Mada). IOP Conference Series: Earth and Environmental Science, 70, 012022, https://doi.org/10.1088/1755-1315/70/1/012022.

Dong, J. et al., 2012. Analysis of Automobile Travel Demand Elasticities With Respect To Travel Cost. Report prepared for Federal Highway Administration Office of Highway Policy Information, https://www.fhwa.dot.gov/policyinformation/pubs/hpl-15-014/TCElasticities.pdf [15.07.2021].

EIA (The U.S. Energy Information Administration), 2014. Gasoline prices tend to have little effect on demand for car travel. U.S. Energy Information Administration, https://www.eia.gov/todayinenergy/detail.php?id=19191 [2.07.2021].

Encyklopedia PWN, https://encyklopedia.pwn.pl [5.07.2021].

Enochsson, L. et al., 2021. Impacts of the Sharing Economy on Urban Sustainability: The Perceptions of Municipal Governments and Sharing Organisations. Sustainability, 13(8), 4213, https://doi.org/10.3390/su13084213.

European Commission, 2019. Handbook on the external costs of transport. Version 2019–1.1, https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1 [15.06.2021].

European Platform on Sustainable Urban Mobility Plans, 2019a. Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan (Second Edition). European Commission, https://www.eltis.org/sites/default/files/guidelines_for_developing_and_implementing_a_sustainable_urban_mobility_plan_2nd_edition.pdf [12.06.2021].

European Platform on Sustainable Urban Mobility Plans, 2019b. Sustainable urban mobility planning in metropolitan regions. Sustainable urban mobility planning and governance models in EU metropolitan regions, European Commission, https://sumps-up.eu/fileadmin/user_upload/Tools_and_Resources/Publications_and_reports/Topic_Guides/sump_metropolitan_region_guide_v2.pdf [12.06.2021].

European Union, 2017. Sustainable Urban Mobility: European Policy, Practice and Solutions, https://ec.europa.eu/transport/sites/default/files/2017-sustainable-urban-mobility-european-policy-practice-and-solutions.pdf [15.06.2021].

European Union, 2020. Sustainable Urban Mobility in the EU: No substantial improvement is possible without Member States' commitment. Special Report, https://www.eca.europa.eu/Lists/ECADocuments/SR20_06/SR_Sustainable_Urban_Mobility_EN.pdf [15.06.2021].

Ferri, F. et al., 2020. Online Learning and Emergency Remote Teaching: Opportunities and Challenges in Emergency Situations. Societies, 10(4), 86, https://doi.org/10.3390/soc10040086.

Fonseca, F. et al., 2021. Built environment attributes and their influence on walkability. International Journal of Sustainable Transportation, https://doi.org/10.1080/15568318.2021.1914793.

Globalization and World Cities Research Network, 2020. The World According to GaWC 2020, https://www.lboro.ac.uk/gawc/world2020t.html [2.07.2021].

Grison, E. et al., 2016. Exploring factors related to users' experience of public transport route choice: influence of context and users profiles. Cognition, Technology & Work, 18(2), 287-301, https://doi.org/10.1007/s10111-015-0359-6.

Hartman, R. et al., 1991. An Investigation of Selected Variables Affecting Telecommuting Productivity and Satisfaction. Journal of Business and Psychology, 6(2), 207-225.

Harvey, A.S., Taylor, M.E., 2000. Activity settings and travel behavior: a social contact perspective. Transportation, 27(1), 53-73, https://doi.org/10.1023/A:1005207320044.

Ho, I.M.K. et al., 2021. Predicting student satisfaction of emergency remote learning in higher education during COVID-19 using machine learning techniques. Plos One, 16(4), https://doi.org/10.1371/journal.pone.0249423.

Hopkins, J.L., McKay, J., 2019. Investigating 'anywhere working' as a mechanism for alleviating traffic congestion in smart cities. Technological Forecasting & Social Change, 142, 258–272, https://doi.org/10.1016/j.techfore.2018.07.032.

Irwin, F., 2004. Gaining the Air Quality and Climate Benefit from Telework. Environmental Protection Agency and the AT&T Foundation, http://pdf.wri.org/teleworkguide.pdf [20.06.2021].

Ismail, F.D. et al., 2016. Factors Influencing the Stated Preference of University Employees towards Telecommuting in International Islamic University Malaysia. Transportation Research Procedia, 17, 478-487, https://doi.org/10.1016/j.trpro.2016.11.097.

Jin et al., 2021. Zoom in the attitude-behaviour gap: low carbon travel behaviour. E3S Web of Conferences, 275, 02016, 2021, https://doi.org/10.1051/e3sconf/202127502016.

Kisanga, D., Ireson, G., 2015. Barriers and strategies on adoption of e-learning in Tanzanian higher learning institutions: Lessons for adopters. International Journal of Education and Development using Information and Communication Technology (IJEDICT), 11(2), 126-137.

Kuppam, A. et al., 1999. Analysis of the role of traveller attitudes and perceptions in explaining mode-choice behaviour. Transportation Research Record: Journal of the Transportation Research Board, 1676, 68-76.

Lades, L.K. et al., 2020. Why is active travel more satisfying than motorized travel? Evidence from Dublin. Transportation Research Part A: Policy and Practice, 136, 318-333, https://doi.org/10.1016/j.tra.2020.04.007.

Lavery, T.A. et al., 2013. Driving out of choices: An investigation of transport modality in a university sample. Transportation Research Part A: Policy and Practice, 57, 37–46, https://doi.org/10.1016/j.tra.2013.09.010.

Lee, M.S.W. et al., 2009. Anti-consumption: An overview and research agenda. Editorial. Journal of Business Research 62, 145-147.

Leonard, A., Conrad, A., 2011. The story of stuff: The impact of overconsumption on the planet, our communities, and our health – and how we can make it better. Free Press, New York.

Lier van, T. et al., 2012. The impact of telework on transport externalities: the case of Brussels Capital Region. Procedia - Social and Behavioral Sciences, 54, 240-250, https://doi.org/10.1016/j.sbspro.2012.09.743.

Litman, T., 2008. Valuing Transit Service Quality Improvements. Journal of Public Transportation, 11(2), 43-63, https://doi.org/10.5038/2375-0901.11.2.3.

Luchs, M.G. et al., 2015. Exploring consumer responsibility for sustainable consumption. Journal of Marketing Management, 31 (13-14), 1449-1471, https://doi.org/10.1080/0267257X.2015.1061584.

Łuczka, W., Smoluk-Sikorska, J., 2017. Sustainable consumption – between theory and practice. In: Raupelienė, A. (Ed.), Proceedings of the 8th International Scientific Conference Rural Development 2017. Aleksandras Stulginskis University, 1161-1166, https://doi.org/10.15544/RD.2017.134.

Maguire, D., Morris, D., 2018. Homeward Bound: Defining, understanding and aiding 'commuter students'. HEPI Report 114. Higher Education Policy Institute, https://www.hepi.ac.uk/wp-content/uploads/2018/12/HEPI-Homeward-Bound-Defining-understanding-and-aiding-%E2%80%98commuter-students%E2%80%99-Report-11429_11_18Web.pdf [20.05.2021].

Marszałek, S., 2001. Ekonomika, organizacja i zarządzanie w transporcie (Economics, organisation and management in transport). Wydawnictwo Śląskiej Wyższej Szkoły Zarządzania, Katowice.

Mayes, M. et al., 1996. A qualitative assessment of attitudes to cycling. Transport policy and its implementation, London.

McCarthy, P.S., 1996. Market Price and Income Elasticities of New Vehicle Demands. The Review of Economics and Statistics, 78(3), 543-547.

Meijer, L.L.J. et al., 2017. The roles of business models in sustainability transitions: Car sharing in Sydney. In: R. Rauter et al. (Eds.), Exploring a changing view on organizing value creation: developing new business models: contributions to the 2nd international conference on new business models (Institute of Systems Science, Innovation and Sustainability Reports, Vol. 8), Graz, 72-76.

Meng, M. et al., 2017. Impact of traveller information on mode choice behaviour. In: Proceedings of the Institution of Civil Engineers - Transport, 171(TR1), 11-19, https://doi.org/10.1680/jtran.16.00058.

Mokhtarian, P.L. et al., 2015.What makes travel pleasant and/or tiring? An investigation based on the French National Travel Survey. Transportation, 42(6), 1103-1128, https://doi.org/10.1007/s11116-014-9557-y.

Mokhtarian, P.L., Salomon, I., 1995. Modeling the Preference for Telecommuting: Measuring Attitudes and Other Variables. Research Report Number UCD-rr$-RR-95-17. Institute of Transportation Studies. University of Cafifornia, https://

citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.294.4294&rep=rep1&type =pdf [20.05.2021].

Mokhtarian, P.L., Salomon, I., 1997. Modeling the desire to telecommute: the importance of attitudinal factors in behavioral models. Transportation Research Part A: Policy and Practice, 31(1), 35-50.

Mokhtarian, P.L., Salomon, I., 2001. How derived is the demand for travel? Some conceptual and measurement considerations. Transportation Research Part A – Policy and Practice, 35(8), 695-719.

Morfoulaki, M., Papathanasiou, J., 2021. Use of the Sustainable Mobility Efficiency Index (SMEI) for Enhancing the Sustainable Urban Mobility in Greek Cities. Sustainability, 13(4), 1709, https://doi.org/10.3390/su13041709.

Moslem, S., 2020. Best–Worst Method for Modelling Mobility Choice after COVID-19: Evidence from Italy. Sustainability, 12(17), 6824, https://doi.org/10.3390/su12176824.

Nilles, J., 1976. Telecommuting - an alternative to urban transportation congestion. IEEE Transactions on Systems, Man and Cybernetics, 6(2), 77-84.

OECD (The Organisation for Economic Co-operation and Development), 1996. OECD Proceedings. Towards Sustainable Transportation. The Vancouver Conference, Vancouver, British Columbia, 24-27 March 1996, https://www.oecd.org/greengrowth/greening-transport/2396815.pdf [15.07.2021].

OECD (The Organisation for Economic Co-operation and Development), 2002. Implementing Sustainable Urban Travel Policies. ECMT – OECD, https://www.itf-oecd.org/sites/default/files/docs/02urbfinal.pdf [20.06.2021].

Páez, A., Scott, D.M., 2007. Social influence on travel behavior: a simulation example of the decision to telecommute. Environment and Planning A, 39, 647-665, DOI:10.1068/a37424.

Páez, A., Whalen, K., 2010. Enjoyment of commute: A comparison of different transportation modes. Transportation Research Part A: Policy and Practice, 44(7), 537–549, https://doi.org/10.1016/j.tra.2010.04.003.

Paradowska, M., 2011. Rozwój zrównoważonych systemów transportowych polskich miast i aglomeracji w procesie integracji z Unią Europejską - przykład aglomeracji wrocławskiej (The Development of Sustainable Transport Systems in Polish Cities and Agglomerations in the Context of European Integration – the Case of the Wroclaw Agglomeration). Wydawnictwo Uniwersytetu Opolskiego, Opole.

Paradowska, M., 2014. The creation of instruments for sustainable transport behaviour. Zeszyty Naukowe Wyższej Szkoły Bankowej we Wrocławiu, 39, 255-275.

Paradowska, M., 2019a. The impact of rivalry and excludability on transport choices: a preliminary research. Ekonomia i Środowisko. Economics and Environment, 69(2), 160-178, https://doi.org/10.34659/2019/2/28.

Paradowska, M., 2019b. Rivalry, excludability and positive transport externalities - case study of a private university in Poland. International Journal of Sustainability in Higher Education, 20(7), 1290-1312, https://doi.org/10.1108/IJSHE-10-2018-0187.

Paradowska, M., 2020. Postrzegana dostępność i postulaty transportowe jako wyznaczniki miejskiej i regionalnej polityki transportowej – badania pilotażowe dwóch wrocławskich uczelni wyższych (Perceived accessibility and transport demands as determinants of the urban and regional transport policy – pilot research of two Wrocław universities). Studia Miejskie, 39, 2020, 29-59. https://doi.org/10.25167/sm.1965.

Patrzałek, W., 2019. Dekonsumpcja. Motywy. Cele. Funkcje (Deconsumption. Motives. Goals. Functions). Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław.

Platje, J. et al., 2018. Ekonomika transportu: teoria dla praktyki (Transport Economics: theory for practice). Wyższa Szkoła Bankowa we Wrocławiu, Wrocław.

Popuri, Y. et al., 2011. Importance of traveller attitudes in the choice of public transportation to work: findings from the Regional Transportation Authority Attitudinal Survey. Transportation, 38(4), 643-661, https://doi.org/10.1007/s11116-011-9336-y.

Prillwitz, J., Barr, S., 2011. Moving towards sustainability? Mobility styles, attitudes and individual travel behaviour. Journal of Transport Geography, 19(6), 1590-1600, https://doi.org/10.1016/j.jtrangeo.2011.06.011.

Rahiem, M.D.H., 2020. Technological Barriers and Challenges in the Use of ICT during the COVID-19 Emergency Remote Learning. Universal Journal of Educational Research 8(11B), 6124-6133, https://doi.org/10.13189/ujer.2020.082248.

Ramezani, S. et al., 2018. An integrated assessment of factors affecting modal choice: towards a better understanding of the causal effects of built environment. Transportation, 45, 1351–1387, https://doi.org/10.1007/s11116-017-9767-1.

Razami, H.H., Ibrahim, R., 2021. Distance Education during COVID-19 Pandemic: The Perceptions and Preference of University Students in Malaysia Towards Online Learning. International Journal of Advanced Computer Science and Applications 12(4), 118-126, https://doi.org/10.14569/IJACSA.2021.0120416.

Regulation of the Minister of National Education of March 11, 2020 on the temporary limitation of the functioning of the units of education system regarding the prevention, countermeasure and combating of COVID-19 (Journal of Laws of 2020, item 410).

Ricardo-AEA, 2014. Update of the Handbook on External Costs of Transport. Final Report for the European Commission, https://ec.europa.eu/transport/sites/default/files/themes/sustainable/studies/doc/2014-handbook-external-costs-transport.pdf [15.06.2021].

Rissel, C. et al., 2016. Satisfaction with transport and enjoyment of the commute by commuting mode in inner Sydney. Health Promotion Journal of Australia, 27, 80–83, https://doi.org/10.1071/HE15044.

Romanowska, A. et al., 2019. A study of transport behaviour of academic communities. Sustainability, 11(13), 3519, https://doi.org/10.3390/su11133519

Rotaris, L., Danielis, R., 2014. The impact of transportation demand management policies on commuting to college facilities: A case study at the University of Trieste, Italy. Transportation Research Part A: Policy and Practice, 67, 127-140, https://doi.org/https://doi.org/10.1016/j.tra.2014.06.011.

Rotaris, L., Danielis, R., 2015. Commuting to college: The effectiveness and social efficiency of transportation demand management policies. Transport Policy, 44(C), 158-168, https://doi.org/10.1016/j.tranpol.2015.08.001.

Scheepers, C.E. et al., 2016. Perceived accessibility is an important factor in transport choice — Results from the AVENUE project. Journal of Transport & Health, 3, 96–106, https://doi.org/10.1016/j.jth.2016.01.003.

Schneider, R. J., 2011. Understanding sustainable transportation choices: shifting routine automobile travel to walking and bicycling, Ph.D. dissertation, University of California, Berkeley.

Schwanen, T., Lucas, K., 2011. Understanding auto motives. In: Lucas, K., Blumenberg, E., Weinberger, R., (Eds.), Auto Motives: Understanding Car Use Behaviours, Bradford, 3-38.

Searcy, S. E. et al., 2018. Effect of residential proximity on university student trip frequency by mode. Travel Behaviour and Society, 12, 115-121, https://doi.org/10.1016/j.tbs.2017.12.007.

Setiawan, R. et al., 2015. Effect of habit and car access on student behavior using cars for travelling to campus. Procedia Engineering, 125, 571-578, https://doi.org/10.1016/j.proeng.2015.11.063.

Shannon, T. et al., 2006. Active commuting in a university setting: assessing commuting habits and potential for modal change. Transport Policy, 13(3), 240–253, https://doi.org/10.1016/j.tranpol.2005.11.002.

Shaw, F.A. et al., 2019. It's not all fun and games: An investigation of the reported benefits and disadvantages of conducting activities while commuting. UC Davis, https://doi.org/10.1016/j.tbs.2019.05.008.

Singleton, P. A., 2018. How useful is travel-based multitasking? Evidence from commuters in Portland, Oregon. Transportation Research Record: Journal of the Transportation Research Board, 2672(50),11-22, https://doi.org/10.1177/0361198118776151.

Souza, G.H.S. et al., 2020. Brazilian students' expectations regarding distance learning and remote classes during the COVID-19 pandemic. Educational Sciences: Theory and Practice, 20(4), 65-80, https://doi.org/10.12738/jestp.2020.4.005.

Steg, L. et al., 2001a. The effects of motivational factors on car use: a multidisciplinary modelling approach. Transportation Research Part A: Policy and Practice, 35, 789-806.

Steg, L. et al., 2001b. Instrumental-reasoned and symbolic-affective motives for using a motor car. Transportation Research Part F: Traffic Psychology and Behaviour, 4, 151-169.

Steg, L., 2003, Can public transport compete with the private car? IATSS Research, 27(2), 27-35, https://doi.org/10.1016/S0386-1112(14)60141-2.

Steg, L., 2005. Car use: lust and must. Instrumental, symbolic and affective motives for car use. Transportation Research Part A, 39, 147–162, https://doi.org/10.1016/j.tra.2004.07.001.

Szul, E., 2012. Dekonsumpcja – moda czy sposób na kryzys. Nierówności Społeczne a Wzrost Gospodarczy, 24, 316-328.

Taherdoost, H., 2016. Sampling Methods in Research Methodology; How to Choose a Sampling Technique for Research. International Journal of Academic Research in Management (IJARM), 5(2), 18-27, https://doi.org/10.2139/ssrn.3205035.

Terlau, W., Hirsch, D., 2015. Sustainable Consumption and the Attitude-Behaviour-Gap Phenomenon - Causes and Measurements towards a Sustainable Development. Journal on Food System Dynamics, 6(3), 1-16, https://doi.org/10.18461/ijfsd.v6i3.634.

Trela, M., 2017. Electric road transport in Poland – an analysis of external costs. Ekonomia i Środowisko, 63(4), 156-165, https://ekonomiaisrodowisko.pl/journal/article/view/340 [20.06.2021].

UNECE (The United Nations Economic Commission for Europe), 2020. A Handbook on Sustainable Urban Mobility and Spatial Planning Promoting Active Mobility, https://thepep.unece.org/sites/default/files/2020-10/Handbook%20on%20

Sustainable%20Urban%20Mobility%20and%20Spatial%20Planning.pdf [12.06.2021].

UN-Habitat, 2013. Planning and design for sustainable urban mobility. Global report on human settlements 2013, Routledge, Oxon, New York.

Vale, D. S. et al., 2018. Different destination, different commuting pattern? Analyzing the influence of the campus location on commuting. Journal of Transport and Land Use, 11(1), 1-18, https://doi.org/10.5198/jtlu.2018.893.

Vincent, L., 2019. The Attitude-Behaviour Gap of Academia: Exploring the Paradox of Hypermobility and Environmental Concerns. A Research Paper presented in partial fulfilment of the requirements for obtaining the degree of Master of Arts in Development Studies. International Institute of Social Sciences. The Hague, The Netherlands, https://thesis.eur.nl/pub/51335/Vincent-Lara_MA-_2018_19_AFES.pdf [14.07.2021].

Werland, S., 2020. Diffusing Sustainable Urban Mobility Planning in the EU. Sustainability, 12, 8436, https://doi.org/10.3390/su12208436.

WHO (World Health Organization) Regional Office for Europe, 2017. Towards more physical activity: Transforming public spaces to promote physical activity – a key contributor to achieving the Sustainable Development Goals in Europe, https://www.euro.who.int/__data/assets/pdf_file/0018/353043/2017_WHO_Report_FINAL_WEB.pdf [20.06.2021].

WHO (World Health Organization), 2020. WHO Director-General's opening remarks at the media briefing on COVID-19 – 11 March 2020, https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020 [15.05.2021].

Ye, R., Titheridge H., 2017. Satisfaction with the commute: The role of travel mode choice, built environment and attitudes. Transportation Research Part D: Transport and Environment, 52, Part B, 535-547, https://doi.org/10.1016/j.trd.2016.06.011.

Yen, J.R. et al., 1994. Employer Attitudes and Stated Preferences Toward Telecommuting: An Exploratory Analysis. Transportation Research Record, 1463, 15-25.

Zawadka, J. et al., 2021. Remote learning among students with and without reading difficulties during the initial stages of the COVID-19 pandemic. Education and Information Technologies, https://doi.org/10.1007/s10639-021-10559-3.

Zhou, J. et al., 2018. Mode choice of commuter students in a college town: An exploratory study from the United States. Sustainability, 10(9), 1-18, https://doi.org/10.3390/su10093316.

Zhou, J., 2012. Sustainable commute in a car-dominant city: Factors affecting alternative mode choices among university students. Transportation Research Part A: Policy and Practice, 46(7), 1013-1029, https://doi.org/10.1016/j.tra.2012.04.001.

Igor PETRUŠKA • Jana CHOVANCOVÁ • Eva LITAVCOVÁ

DEPENDENCE OF CO2 EMISSIONS ON ENERGY CONSUMPTION AND ECONOMIC GROWTH IN THE EUROPEAN UNION: A PANEL THRESHOLD MODEL

Igor **Petruška,** DSc (ORCID: 0000-0002-2005-3500)
Jana **Chovancová,** PhD (ORCID: 0000-0002-6699-1244)
Eva **Litavcová,** Assoc. prof., PhD (ORCID: 0000-0002-5323-4359)

– *Faculty of Management, University of Prešov, Prešov, Slovakia*

Correspondence address:
Konštantínova 16, 08001 Prešov, Slovakia
e-mail: jana.chovancova@unipo.sk

ABSTRACT: This work aims to analyse the dependence of carbon dioxide (CO_2) emissions on primary energy consumption at different Gross Domestic Product (GDP) levels in 28 European countries. Data for the years 1995-2019 were used to develop the models. Random Effects, Fixed Effects, a nonlinear panel threshold model and a continuous kink model were used in the panel data analysis. The work shows that the dependence of CO_2 emissions on energy consumption varies at different levels of GDP. The model with two threshold values, which determine three modes of behaviour, proves to be the most suitable. As GDP levels increase, the regression coefficient of the dependence of CO_2 emissions on energy consumption decreases. Understanding the relationship between these variables is essential for informed and evidence-based decision-making and adopting new or revision of existing energy and climate policies and strategies at the EU and national levels.

KEYWORDS: energy consumption, economic growth, CO_2 emissions, panel threshold model, kink model

Introduction

Energy plays a crucial role in determining our ability to achieve global sustainability in the short and long run. It is dependent on natural resources and is one of the most important drivers of environmental impacts on the Earth's ecological systems. Easy access to energy was a prerequisite for the rapid improvement of people's living conditions and the rapid growth of the world's population, which began at the beginning of the industrial revolution. Empirical evidence shows that in the mid-1950s, there was a trend called "The Great Acceleration", which is characterised by the exponential use of natural resources and ecosystems and is closely linked to economic growth and growth of global population and energy consumption (Steffen et al., 2007). Negative effects also accompany the increased energy consumption on the environment. Probably the most threatening of these impacts is the significant increase in atmospheric concentrations of greenhouse gases, especially CO_2, associated with global climate change (Knutti et al., 2016). Observations of rising global surface temperatures provide evidence that more intense anthropogenic greenhouse gas emissions are causing climate change. The rate of change has been steadily increasing over the last century (IPCC, 2007). Increasing energy consumption per capita and related air pollution, which have historically acted at the local or regional level, now pose a global threat in the form of climate change.

Despite the European Union's growing initiatives to decarbonise the economy and its strong commitment to meet the international goals of the Paris Agreement and the United Nations´ Agenda 2030, the energy sector is at the forefront of EU greenhouse gas emissions producers (EEA, 2019).

The aim of the paper is to investigate the linkage among three variables: carbon dioxide (CO_2) emissions per capita, primary energy consumption (PEC) per capita and gross domestic product (GDP) per capita in 28 EU countries in the period of 1995-2019 using panel threshold models. Panel data offer advantages over cross-sectional data or time series, mainly because they make it possible to compare mutual deviations between individual cross-sectional units and also deviations in time evolution. Panel analysis enables better control of the influence of unclassified variables, easier detection of homogeneity or heterogeneity in the data and easier observation of the dynamics of changes. The obtained threshold values make it possible to assess at what degree of economic growth we can expect mitigation of the negative environmental effects, such as a reduction in CO_2 emissions. LSDV regression model allows the comparisons of the development between countries. The analysis' results can be used to help individual stakeholders make

educated and responsible decisions, as well as to harmonise environmental, energy, and economic policies.

The paper is organised as follows. First, literature and policy background is described, with the focus on previous studies in the field of energy, economy and CO_2 emissions nexus and recent policy initiatives of the EU in the field of climate and energy policy. The research methods and data are described in Section 2. The results are presented in the third section, which is followed by a discussion of the findings in the fourth section. The last section concludes the paper.

Literature and policy review

The environmental economy is particularly interested in the relationship between economic growth, energy consumption, and the production of anthropogenic greenhouse gas emissions. Many authors investigate and discuss the topic of economy-energy-emissions nexus, both at the country and international level, and they use a diverse methodological apparatus. International studies were carried out by, e.g. (Ozcan & Ari, 2017) for OECD countries, where they investigated nuclear energy-economic growth nexus using panel data analysis. (Chang, 2015) employed data envelopment analysis to investigate energy intensity, emissions intensity and carbonisation value in G7 and BRICS (Brazil, Russia, India, China, and South Africa) countries and to suggest the possibilities for improvement in both groups. (Kahouli, 2018) scrutinise the causal relationship between electricity consumption, carbon emissions, investments in research and development and economic growth in Mediterranean countries. (Balcilar et al., 2020) took a historical perspective on the G7 countries and investigated the causality between CO_2 emissions, energy consumption and economic growth. Nexus between the three variables in the Next 11 countries was investigated by (Shahbaz et al., 2016). Evidence of cointegration among CO_2 emissions, energy consumption and economic growth in Danube region countries was provided by Litavcová & Chovancová (2021). The relationship between economic growth, CO_2 emissions and energy consumption in V4 was scrutinised by Chovancová & Vavrek (2020), where decoupling analysis was performed, and evidence of mitigation effect of renewable sources was confirmed.

A comparative study of the relationship among economic growth, trade, urbanisation, renewable energy and CO_2 emissions for Australia and Canada was performed by (Rahman & Vu, 2020), which provides evidence of the long-run relationships amongst the variables.

A worldwide perspective was taken by (Armeanu et al., 2021), who scrutinise a link between economic growth, renewable energy, CO_2 emissions, and urbanisation in 106 countries and confirm the long-term relationship among these variables.

Similar studies in the country level were performed by, e.g. (Han et al., 2018; S. Wang et al., 2016; Zhang & Cheng, 2009) for China, for (Ahmad et al., 2016; Alam et al., 2011) for India, (Gökmenoğlu & Taspinar, 2016) for Turkey, (Robalino-López et al., 2015) for Venezuela, (Khan et al., 2019) for Pakistan, etc.

Efforts to decarbonise the economy and the associated climate change mitigation are also a central theme in the European Union. Over the last decade, this approach has been embedded in important policy initiatives, such as climate and energy policies for 2030 and 2050, circular and bio-economy packages, as well as research and innovation programs. In addition, the 7th EAP is fully in line with global objectives such as the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change.

Proposed long-term strategy European Green Deal, which aims to achieve carbon neutrality by 2050, emphasises that the options it proposes "radically transform energy systems as well as the agricultural sector and modernise industrial infrastructure along with transport systems and cities and affect all activities of the whole society". This long term strategy also recognises the need for a "transition to a low-carbon, climate-neutral, resource-efficient economy" (EC, 2019), which is fully in line with the United Nations Agenda 2030 and its seventeen sustainable development goals.

In the light of these challenges, there is a need for regular monitoring, analysis and evaluation of the development of key economic, energy and environmental indicators as well as the relationships between them. Due to the complexity of this assessment, statistical tools must be used to collect and evaluate selected characteristics (indicators), which provide a solid knowledge base for making informed and responsible decisions, including those related to energy and climate protection policies.

Research methods

The paper investigates the relationship between economic growth, primary energy consumption and carbon dioxide emissions in the EU 28 during 1995-2019. Data were drawn from several sources: GDP per capita in purchasing power parity (thousands of current international $) from The World Bank Database, primary energy consumption per capita (MWh) from BP Sta-

tistical Review of World Energy and carbon dioxide emissions per capita (tons) from the Global Carbon Project.

The data used in the panel structure consist of: number of countries $N = 28$, number of periods (years) $T = 25$, number of monitored variables $k = 3$. Total 2100 data. The models were developed using Stata 15.1 software.

A panel data regression differs from a regular time-series or cross-section regression - it has double subscript on its variables (Baltagi, 2005):

$$y_{it} = \alpha + X'_{it}\beta + \mu_i + \nu_{it}, \ \ t = 1, \dots, T, \ \ i = 1, \dots, N, \qquad (1)$$

with i denoting individuals – individuals, firms, countries (cross-section dimension), t denoting time (time-series dimension), α is a scalar, β is $K \times 1$ vector and X_{it} is the i-th observation on K explanatory variables. The character μ_i denotes the unobservable time-invariant individual-specific effect, ν_{it} denotes the remainder disturbance, y_{it} denotes it-th value of a dependent variable. The assumption is the independence of X_{it} and ν_{it}, disturbances are independent of each other. Random errors ν_{it} are independent random variables with constant variance. For a model with fixed effects (FE) the assumption of a correlation between the entity's error term (individual-specific) and the prediction variables is expected to be met (Litavcová et al., 2020). FE removes the effect of those time-invariant characteristics. For model with random effects (RE): can be assumed random have to be fulfilled the assumptions: $\mu_i \sim IID(0,\sigma_\mu^2)$, $\upsilon_{it} \sim IID(0,\sigma_\mu^2)$, they do not depend on each other, nor with prediction variable.

Panel data are measurements of the considered variable for the same set of N cases (entities, individuals, countries) in several time points T, that allow the identification and control of individual effects and dynamics. A limitation of the linear model is the assumption that a monotone change in a predictor variable leads to a monotone change in the dependent variable. If we assume a change in the behaviour of the model after passing a certain threshold value of a variable, then a linear panel regression is not sufficient. A suitable tool then is a panel threshold model with fixed effects. Threshold models are used in the nonlinear modelling of time series.

Hansen (1999) proposed least squares estimation of the threshold and regression slopes using fixed-effects transformations. Wang (2015) introduced a command (xthreg) for implementing this model in Stata.

$$y_{it} = X'_{it}\beta_1 \times I(trv_{it} \le r) + X'_{it}\beta_2 \times I(trv_{it} > r) + \mu_i + \eta_t + \varepsilon_{it}, \quad (2)$$

where:

β_1, β_2 –   are vectors of coefficients, trv – threshold variable, r – threshold value, I – unit function,

μ_i –   unit effect, μ_t – time effect, ε_{it} – IID across countries and year, i – country $i = 1,...,N$, t - time (year) $t = 1, ...T$.

The standard least-squares approach (Hansen, 2000) requires the heterogeneity of all regressors. Caner & Hansen (2004) relaxed this requirement for endogenous regressors, but the assumption of heterogeneity of the threshold variable remained. Seo et al. (2019) propose a general GMM approach based on first-difference (FD) transformation. They allow both threshold variable and regressors to be hetengenous. Seo et al. (2019) developed Stata command (xthenreg) to implement the first-differenced GMM estimation of the dynamic panel threshold model proposed by Seo & Shin (2016).

The threshold models we have mentioned so far contain discontinuities, which is why we also call them jump models. If we replace one of the members containing the difference coefficient in relation (2) with the expression we get the kink model (Hansen, 2017):

$$y_{it} = \beta \, trv_{it} + k(trv_{it} - r)I(trv_{it} > r) + \mu_i + \varepsilon_{it}. \tag{3}$$

Seo et al. (2019) derive the asymptotic variance formula for a kink constrained GMM estimator of dynamic threshold model and include an estimation algorithm. It follows from the shape of this model that the threshold variable is the only mode variable of this continuous model.

To test the suitability and validity of the models, these statistical tests ($\alpha = 0.05$) were performed:
- F test of significance of the FE model,
- Wald test of significance of the RE model,
- F test that all = 0,
- t test of significance of regression coefficients,
- Hausman FE RE test,
- Breusch and Pagan Lagrangian multiplier test for random effects,
- Pesaran test of cross sectional independence,
- Modified Wald test for groupwise heteroscedasticity in FE model,
- Confidence interval of threshold value test,
- Threshold effect test (bootstrap).

Results of the research

Our goal is to find the dependence of CO_2 on economic growth (GDP) and primary energy consumption (PEC). Therefore, we will consider CO_2 as a dependent variable and GDP and PEC as independent variables. At the beginning of the search for suitable models, a simple descriptive statistic of the analysed data was performed. Descriptive statistics, including the variable's name, units, the number of observations, mean values, standard deviation and minimum and maximum values, are summarised in table 1.

Table 1. Descriptive statistics of analysed variables

Variable	Abb	Unit	Obs	Mean	Std.Dev	Min	Max
Carbon dioxide emissions	CO_2	tons per cap	700	8.180	3.556	2.963	26.431
Gross Domestic Product	GDP	th EUR per cap	700	29.815	16.438	5.415	124.590
Primary Energy Consumption	PEC	MWh per cap	700	35.958	16.946	17.565	119.260

Source: own processing – in Stata.

It is also useful to know the scatterplots of the pairs of variables appearing in the model. The relationship between the variables CO_2, GDP and PEC is shown in figure 1.

The strongest link appears to be between the PEC and CO_2. The values of the correlation coefficients in the correlation matrix also correspond to this (table 2). All correlation coefficients are significant (p–value = 0.00).

Table 2. Correlation matrix

	GDP	CO_2	PEC
GDP	1.00		
CO_2	0.4323	1.00	
PEC	0.5857	0.8146	1.00

Source: own processing – in Stata.

The initial analysis of the data and the results of the descriptive statistics show a strong heterogeneity of the countries studied.

The highest heterogeneity is recorded in the variable PEC, where are significant differences between countries. The countries with the lowest primary energy consumption per capita are Romania, Malta and Croatia, where the PEC in 2019 was 19,209 kWh, 20,129 kWh and 23,474 kWh, respectively.
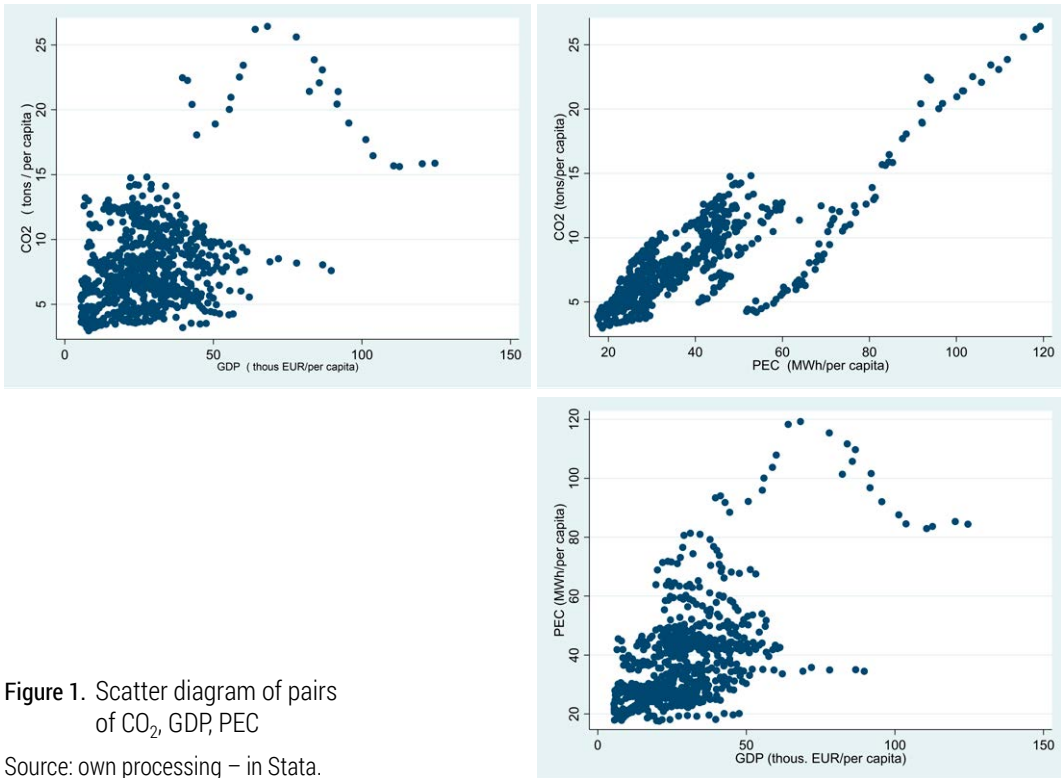
Figure 1. Scatter diagram of pairs of CO_2, GDP, PEC

Source: own processing – in Stata.

The largest consumers of primary energy in 2019 were Luxembourg, Finland and Sweden, where the PEC reached the level of 84,425 kWh, 67,543 kWh and 51,765 kWh, respectively.

GDP per capita also has a high heterogeneity of data. Luxembourg, Ireland and Denmark were at the top of the GDP in 2019, with per capita GDP of € 124,950, € 89,684 and € 62,090, respectively. On the other side of the spectrum were Bulgaria, Croatia and Greece, with a GDP per capita of € 25,312, € 31,311, € 32,506 recpectively.

Low heterogeneity was recorded in the amount of CO_2 emissions produced per capita. For example, Sweden has the lowest CO_2 emissions per capita (4.25 t) and Luxembourg the highest (15.88 t).

The Stata-xtreg module was used to calculate the regression coefficients of the panel threshold models (Fixed Effects, Random Effects). Next, the parameters of the Pooled model (OLS) were compared with the panel data analysis models. The results show that all coefficients of the calculated models (except the absolute term in the Random effects model) are significant. Slope coefficients (GDP, PEC) have the same sign.

Table 3. Panel data models

CO_2	Pooled model		Fixed Effects		Random Effects	
	Coef	p-value	Coef	p-value	Coef	p-value
GDP	-0.0147	0,012	-0.0407	0.000	-0.0412	0.000
PEC	0.1793	0.000	0.2544	0.000	0.2510	0.000
Cons	1.634	0.000	-0.5183	0.025	-0.3693	0.397
F test	696.69	0.000	1895.11	0.000		
Wald test					3780.2	0.000
F test that all = 0			459.67	0.000		

Source: own processing – in Stata.

Tests (F test, Wald test and F test that all = 0) showed that all three models are relevant (p-value is less than 0.05).

We can say that in all three cases, GDP growth causes a decrease in CO_2, and an increase in energy consumption (PEC) causes higher CO_2 production.

The coefficient of determination (R-squared) in the case of the Pooled model reaches the size of 0.666 and corr (μ_i, Xb) = -0.4668 (Fixed effects). In the next step, we will choose the most suitable model from these three models. Breusch and Pagan Lagrangian multiplier test for random effects helps us to decide between random effects regression and simple OLS (Pooled model) regression (H0: No panel effects - Var = 0). Since the p-value is less than 0.05, this means that we reject the Pooled model (OLS) and state that panel effects are applied in the model.

Table 4. Panel data model tests

Test	p-value
Breusch and Pagan Lagrangian multiplier test for random effects	0.000
Hausman FE RE test	0.0179
Pesaran test of cross-sectional independence	0.0141
Modified Wald test for groupwise heteroskedasticity in FE model	0.000

Source: own processing – in Stata.

To decide between fixed or random effects, we can run Hausman test where the null hypothesis is that the preferred model is random effects vs the alternative fixed effects. The P-value in the case of this test is 0.0179 < 0.05,

which means that we choose a fixed-effects model, which can be expressed by the following relation:

$$CO_2 = -0.5183 - 0.0407\ GDP + 0.2544\ PEC \qquad (4)$$

According to this model, if energy consumption is increased by 1 MWh per capita, CO_2 emissions per capita will increase by 0.25 tons per capita, and an increase in GDP per capita (thousand €) represents a decrease in CO_2 emissions by 0.0407 tons per capita.

We can also differentiate individual countries using the specific constant μ_i. Specific constants obtained by the Least Squares Dummy Variable Model (LSDV) are given in table 5.

Table 5. Least Squares Dummy Variable Model

Country	Coef	p-value	Country	Coef	p-value
AUT (cons)	- 0.910	0.001	ITA	1.468	0.000
BEL	-0.711	0.000	LTA	-0.799	0.000
BGR	0.699	0.000	LT	-0.634	0.000
HRV	0.540	0.003	LUX	-0.195	0.577
CYP	2.266	0.000	MLT	1.750	0.000
CZE	1.724	0.000	NLD	0.878	0.000
DNK	1.371	0.000	POL	3.118	0.000
EST	2.900	0.000	SVN	-0.067	0.627
FIN	-5.270	0.000	SVK	0.120	0.413
FRA	-2.819	0.000	ESP	0.812	0.000
DEU	1.628	0.000	ROU	0.999	0.000
GRC	3.376	0.000	PRT	1.102	0.000
HUN	0.020	0.899	SWE	-7.067	0.000
IRL	3.020	0.000	GBR	0.756	0.000

Source: own processing – in Stata.

As a reference country, we chose AUT, which corresponds to the absolute term - 0.910. Regression coefficients for the variables GDP and PEC are given in Table 3 for Fixed effects. Country-specific constants are obtained by adding the number given in the table (Coef) to the number -0.910. Again, we can say that these are very heterogeneous data because the differences are signif-

icant with up to 4 exceptions: Hungary, Luxembourg, Slovenia, and Slovakia. The largest positive differences with the reference country (AUT) were recorded in Cyprus, Estonia, Greece, Ireland and Poland. These countries have a high share of CO_2 emissions per capita. These are countries whose economies are carbon-intensive, and low-carbon energy sources are under-represented in their energy mix. For example, in Poland, despite the declining trend of the main air pollutants (Pakulska, 2021) and stringent environmental policy (Godawska, 2021); in terms of the amount of CO_2 emissions produced per capita, this country is one of the most polluted among the EU countries, mainly due to extensive use of coal as an energy source.

On the other hand, the largest negative differences are in Finland, France and Sweden, i.e. they are the countries with the lowest share of CO_2 emissions per capita. Sweden and Finland are at the forefront of renewable energy; in the case of Sweden, renewable energy sources have a 56.4% share in the energy mix and in the case of Finland, it is 43.1% in 2019. In France, the dominant source is nuclear energy, which is 71.6% of the country's energy mix. As it is also low-carbon energy in a way, it has secured France's prominent position in terms of per capita CO_2 emissions.

In the next part, we will deal with the analysis of residues obtained using fixed effects. The Pesaran CD (cross-sectional dependence) test is used to test whether the residuals are correlated across entities (countries). Cross-sectional dependence can lead to bias in test results (also called contemporaneous correlation). The null hypothesis is that residuals are not correlated. According to the p-value in table 4, we reject the null hypothesis. Modified Wald test for groupwise heteroscedasticity in FE model has null hypothesis – homoscedasticity (or constance variance). Above we reject the null and conclude heteroscedasticity.

We will use the threshold model in the following analysis since the Fixed effects model shows signs of cross-correlation and heteroscedasticity. As it describes the jump character or structural breaks in the relationship between variables, we also call them jump models. For simplicity, we will only present a panel threshold model with one threshold value.

$$CO_{2it} = \beta_0 + \beta_1 PEC_{it} I(GDP_{it} \leq r)$$
$$+ \beta_2 PEC_{it} I(GDP_{it} > r) + \mu_i + \varepsilon_{it} \tag{5}$$

where :
β_1, β_2 coefficients, r – threshold value,
I – unit function, μ_i – country effect,
ε_{it} – IID across countries and year.

This means that the threshold model in our case has one regional (regime) variable – PEC and one threshold variable – GDP. Assume that this model can have up to three thresholds. An estimate of these thresholds with confidence intervals is given in table 6.

Table 6. Threshold estimator

Model	Threshold	Lower	Upper
Th - 1	30.788	30.588	30.818
Th - 21	41.493	41.297	41.643
Th - 22	22.641	22.480	22.688
Th - 3	30.952	30.582	30.926

Source: own processing – in Stata.

The bootstrap test for the threshold effect is shown in table 7. Since the Single and Double options have a p-value less than 0.05 and the Triple option greater than 0.05, then we will select a model with two threshold values (22,641 € and 41,493 € respectively) for the model we are looking for. The model will therefore have three modes (table 7).

Table 7. Threshold effect test (bootstrap = 300 300 300)

Threshold	F-stat	p-value
Single	223,19	0,0067
Double	118.60	0.0267
Triple	67.27	0.733

Source: own processing – in Stata.

The Stata-xthreg module was used to calculate the regression coefficients of the panel threshold model. The regression coefficients for individual modes are given in table 8.

Table 8. Panel threshold model

CO_2	Region	GDP	Coef	t	p - value
PEC	Region1	GDPit ≤ 22.641	0.298	51.17	0.000
	Region2	22.641 < GDPit ≤ 41.493	0.277	50.22	0.000
	Region3	41.493 < GDPit	0.260	43.35	0.000
cons			-2.681	-12.11	0.000

Source: own processing – in Stata.

If GDP per capita is less than or equal to € 22,642, then an increase in energy consumption by 1 MWh per capita will cause an increase in CO_2 emissions by 0.298 tons per capita. If GDP is in the range of € 22,641 to € 41,493, an increase in energy consumption of 1 MWh means an increase in CO_2 emissions of 0.277 tons per capita. In the third case, if GDP exceeds the level of € 41,493, an increase in energy consumption by 1 MWh pc will cause an increase in emissions by 0.26 tons per capita. According to this model, countries with higher GDP are less sensitive to an increase in CO_2 emissions in case of an increase in energy consumption.

The panel threshold model shows that we can consider the regression coefficients as significant in all three modes. Another interesting fact is that as the value of the threshold variable (GDP) increases, the regression coefficient for PEC decreases. Thus, with the increase in GDP, the impact of the growth of energy consumption (PEC) on the growth of CO_2 emissions decreases.

The previous model is a discontinuous threshold model (Jump model). Next, we will use a continuous panel threshold model (Kink model).

$$CO_{2it} = \beta * GDP_{it} + k(GDP_{it} - r)I(GDP_{it} > r) + \mu_i + \varepsilon_{it} \qquad (6)$$

Again we will use the module Stata - xthreg. The model parameters are listed in table 9.

Table 9. Kink model

CO_2	Coef	z	p − value
GDP_b	0.066	10.08	0.000
Kink slope	-0.2613	-22.12	0.000
r	40.226	79.44	0.000

Source: own processing − in Stata.

$$CO_{2it} = 0.066\, GDP_{it} - 0.2613\, (GDP_{it} - 40.226)\, I\, (GDP_{it} > 40.226) \qquad (7)$$

All parameters of the kink model are significant. The threshold value of the 40.226 kink model is close to the second limit value of the jump model (41.93). The model has an inverted V shape with a vertex at point 40. 226. As GDP grows, so does CO_2 emissions (coefficient 0.66), but after exceeding the threshold value of 40.226, CO_2 emissions begin to decline. This supports the EKC's hypothesis that economic growth is not necessarily linked to

increasing environmental pollution and after reaching a certain level of economic development, the rate of environmental pollution, e.g. in the form of CO_2 emissions, is mitigating. This could be due to the transformation of the economy from a production-oriented to a service economy and greater opportunities for investment in innovation, efficiency, and decarbonisation measures.

Conclusions

Climate change is increasingly affecting the life and functioning of society as a whole. Current initiatives to adopt and implement policies to mitigate and adapt to climate change, whether at a global or regional level, also respond to this challenge. The European Union, which is considered a leader in the fight against climate change, is adopting ambitious climate and energy policies and strategies that should make Europe the first carbon-neutral continent. In the light of these initiatives, the question of the interconnection and relationship between economic growth, energy consumption and greenhouse gas emissions is raised.

Based on the analysis of panel data, we created a model of the dependence of these three variables for the 27 EU Member States in the period 1995-2019.

In the first stage, we used a linear approach - panel data analysis - Fixed effects model. All coefficients in this model are significant. The model shows that with the growth of primary energy consumption, CO_2 emissions increase, but with GDP growth, CO_2 emissions decrease. Since the Fixed effects model shows signs of heteroscedasticity and cross-correlation, we used a nonlinear approach in another – the panel threshold model. We chose the GDP variable as a threshold variable. A model with two threshold values proves to be optimal. It can be seen from the calculated parameters of the model that the regression coefficient at PEC decreases with the increasing value of the threshold variable (GDP). Thus, as GDP increases, the impact of energy consumption (PEC) on CO_2 emissions decreases.

Finally, a continuous Kink model was used, where the threshold variable is at the same time an independent variable. GDP was chosen as the threshold variable. The threshold value of the Kink model is close to the second threshold value of the Jump model. The kink model (function) has the shape of an inverted V, i.e. the function increases up to the threshold value (the effect of GDP on CO_2 is positive) and from the threshold value, the function decreases (the effect of GDP on CO_2 is negative).

Economic growth is linked to energy consumption, which often causes greenhouse gas emissions. However, the results of our analysis provide evidence that after reaching a certain level of economic growth, the production of CO_2 emissions is reduced.

Based on the literature and policy review and the findings of the analysis, the following practical implications emerge:
- The results suggest that there is a high heterogeneity between the countries and that there is a gap, especially in terms of the share of CO_2 emissions per capita. More activities should be implemented to increase cohesion and cooperation between countries and better transfer of know-how and BAT (Best Available Techniques).
- Decision-makers should review existing or adopt new policies to optimise the energy mix, with a greater emphasis on low-carbon and renewable energy sources.
- Governments (whether at the EU or national level) should support research and development of technologies to use new, renewable and low-carbon energy sources and support their practical application.
- Businesses should be motivated to invest in increasing energy efficiency and developing and implementing new low-carbon technologies.

The analysis results can serve as a springboard for further research on the relationship between the economy and the environment, e.g., the extension of the spectrum of variables such as renewable sources, research and development, and economic openness.

Acknowledgements

The contribution of the authors

Each author participated equally in conception, development, literature review, data acquisition, analysis and interpretation of data.

References

Ahmad, A., Zhao, Y., Shahbaz, M., Bano, S., Zhang, Z., Wang, S., Liu, Y., 2016. Carbon emissions, energy consumption and economic growth: An aggregate and disaggregate analysis of the Indian economy, Energy Policy, 96, 131-143, https://doi.org/10.1016/j.enpol.2016.05.032.

Alam, M. J., Begum, I. A., Buysse, J., Rahman, S., Van Huylenbroeck, G., 2011. Dynamic modeling of causal relationship between energy consumption, CO_2 emissions and economic growth in India. Renewable and Sustainable Energy Reviews, 15(6), 3243-3251.

Armeanu, D. S., Joldes, C. C., Gherghina, S. C., Andrei, J. V., 2021. Understanding the multidimensional linkages among renewable energy, pollution, economic growth and urbanisation in contemporary economies: Quantitative assessments across different income countries' groups. Renewable and Sustainable Energy Reviews, 142(February), https://doi.org/10.1016/j.rser.2021.110818.

Balcilar, M., Ozdemir, Z. A., Tunçsiper, B., Ozdemir, H., Shahbaz, M., 2020. On the nexus among carbon dioxide emissions, energy consumption and economic growth in G-7 countries: new insights from the historical decomposition approach. Environment, Development and Sustainability, 22, 8097–8134, https://doi.org/10.1007/s10668-019-00563-6.

Baltagi, B. H., 2005. Econometric Analysis of Panel data. John Wiley & Sons.

Caner, M., Hansen, B. E., 2004. Instrumental variable estimation of a threshold model. Econom Theory, 20, 813-843, https://doi.org/10.1017/S0266466604205011.

Chang, M. C., 2015. Room for improvement in low carbon economies of G7 and BRICS countries based on the analysis of energy efficiency and environmental Kuznets curves. Journal of Cleaner Production, 99, 140-151, https://doi.org/10.1016/j.jclepro.2015.03.002.

Chovancová, J., Vavrek, R., 2020. (De)coupling Analysis with Focus on Energy Consumption in EU Countries and Its Spatial Evaluation. Polish Journal of Environmental Studies, 29(3), 2091-2100, https://doi.org/10.15244/pjoes/110613.

EC, 2019. Towards a sustainable Europe by 2030, Reflection paper, European Commission.

EEA, 2019. Trends and projections in Europe 2020, https://www.eea.europa.eu/publications/trends-and-projections-in-europe-1.

Godawska, J., 2021. Environmental policy stringency and its impact on air pollution in Poland. Ekonomia i Środowisko-Economics and Environment, 76(1), 52-67, https://ekonomiaisrodowisko.pl/journal/article/view/359.

Gökmenoğlu, K., Taspinar, N., 2016. The relationship between CO_2 emissions, energy consumption, economic growth and FDI: the case of Turkey. The Journal of International Trade & Economic Development, 25(5), 706-723, https://doi.org/10.1080/09638199.2015.1119876.

Han, J., Du, T., Zhang, C., Qian, X., 2018. Correlation analysis of CO_2 emissions, material stocks and economic growth nexus: Evidence from Chinese provinces. Journal of Cleaner Production, 180, 395-406, https://doi.org/10.1016/j.jclepro.2018.01.168.

Hansen, B. E., 1999. Threshold effects in non-dynamic panels: estimation, testing, and inference. Econom, 93, 345-368, https://doi.org/10.1016/S0304-4076(99)00025-1.

Hansen, B. E., 2017. Regression Kink with an unknown threshold. Journal of Business & Economic Statistics, 35(2), 228-240, https://doi.org/10.1080/07350015.2015.1073595.

IPCC, 2007. Climate Change 2007 Synthesis Report. In Intergovernmental Panel on Climate Change [Core Writing Team IPCC, https://doi.org/10.1256/004316502320517344.

Kahouli, B., 2018. The causality link between energy electricity consumption, CO_2 emissions, R&D stocks and economic growth in Mediterranean countries (MCs). Energy, 145, 388–399. https://doi.org/10.1016/j.energy.2017.12.136.

Khan, M. K., Teng, J. Z., Khan, M. I., Khan, M. O., 2019. Impact of globalisation, economic factors and energy consumption on CO_2 emissions in Pakistan. Science of the Total Environment., 688, 424-436, https://doi.org/10.1016/j.scitotenv.2019.06.065.

Knutti, R., Rogelj, J., Sedláček, J., Fischer, E. M., 2016. A scientific critique of the two-degree climate change target. Nature Geoscience, 9(1), 13-18, https://doi.org/https://doi.org/10.1038/ngeo2595.

Litavcová, E., Popovičová, M., etruška, I., 2020. Threshold analysis of tourism indicators of selected countries of EU. 38th International Conference on Mathematical Methods in Economics. Electronic Conference Proceedings (Eds. Svatopluk Kapounek, Hana Vránová). Mendelova Univerzita v Brně., 350-356.

Litavcová, Eva, Chovancová, J., 2021. Economic development, CO_2 emissions and energy use nexus-evidence from the danube region countries. Energies, 14(11), https://doi.org/10.3390/en14113165.

Ozcan, B., Ari, A., 2017. Nuclear energy-economic growth nexus in OECD countries: a panel data analysis. Journal of Economic & Management Perspectives, 11(1), 138-154.

Pakulska, J., 2021. Emissions of major air pollutants as an indicator of quality of life in Poland in 1990-2017. Ekonomia i Środowisko-Economics and Environment, 76(1), 106-119, https://doi.org/10.34659/2021/1/6.

Rahman, M. M., Vu, X. B., 2020. The nexus between renewable energy, economic growth, trade, urbanisation and environmental quality: a comparative study for Australia and Canada. Renewable Energy, 155, 617-627, https://doi.org/10.1016/j.renene.2020.03.135.

Robalino-López, A., Mena-Nieto, Á., García-Ramos, J. E., Golpe, A. A., 2015. Studying the relationship between economic growth, CO_2 emissions, and the environmental Kuznets curve in Venezuela (1980–2025). Renewable and Sustainable Energy Reviews, 41, 602–614, https://doi.org/10.1016/j.rser.2014.08.081.

Seo, M., Kim, S., Kim, Y. J., 2019. Estimation of Dynamic Panel Treshold Model using Stata. Stata Journal, 19(3), 685-697, https://doi.org/10.1177/1536867X19874243.

Seo, M., Shin, Y., 2016. Dynamic panels with treshold effect and endogeneity. Journal of Econometrics, 195, 169-186, https://doi.org/10.1016/j.jeconom.2016.03.005.

Shahbaz, M., Mahalik, M. K., Shah, S. H., Sato, J. R., 2016. Time-varying analysis of CO_2 emissions, energy consumption, and economic growth nexus: Statistical experience in next 11 countries. Energy Policy, https://doi.org/10.1016/j.enpol.2016.08.011.

Steffen, W., Crutzen, J., McNeill, J. R., 2007. The Anthropocene: Are humans now overwhelming the great forces of Nature? Ambio, 36(8), 614-621, https://doi.org/10.1579/0044-7447.

Wang, Q., 2015. Fixed-effect panel threshold model using Stata. The Stata Journal, 15(1), 121-134, https://www.stata-journal.com/article.html?article=st0373.

Wang, S., Li, Q., Fang, C., Zhou, C., 2016. The relationship between economic growth, energy consumption, and CO_2 emissions: Empirical evidence from China. Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2015.10.027.

Zhang, X. P., Cheng, X. M., 2009. Energy consumption, carbon emissions, and economic growth in China. Ecological Economics, 68, 10, 2706-2712, https://doi.org/10.1016/j.ecolecon.2009.05.011.

STUDIES
AND MATERIALS

STUDIA
I MATERIAŁY

Jakub **BARTAK** • Dariusz **FIRSZT** • Marek **JABŁOŃSKI** • Łukasz **JABŁOŃSKI**

THE QUALITY OF SELECTED MUNICIPAL SERVICES DURING THE COVID-19 PANDEMIC IN THE OPINION OF STUDENTS OF CRACOW UNIVERSITIES

Jakub **Bartak**, PhD (ORCID: 0000-0001-7997-2432)

Dariusz **Firszt**, PhD (ORCID: 0000-0003-3156-1452)

Marek **Jabłoński**, PhD, DSc (ORCID: 0000-0002-5464-7147)

Łukasz **Jabłoński**, PhD (ORCID: 0000-0001-6922-0501)

 – *Cracow University of Economics*

Correspondence address:
ul. Rakowicka 27, 31-510, Kraków, Poland
e-mail: firsztd@uek.krakow.pl

ABSTRACT: The paper aims to present the results of surveys of students' opinions on the quality of municipal services available in Krakow and its changes during the Covid-19 pandemic. The analysis covered most basic municipal services, in particular water, heat, and public transport. Opinions on the public services were collected through surveys carried out twice, in 2019 and 2021, on a representative group of students of several major Cracow universities. The analysis revealed that, despite the challenges associated with the Covid-19 pandemic, the municipal services' general quality has not deteriorated.

KEYWORDS: municipal services quality, Covid-19, perception of public services

Introduction

Municipal services as a part of public services are an important determinant of citizens' quality of life (Castelli et al., 2009, Stiglitz, 2007) and provide public infrastructure regarded as the public intermediate input (Altenburg, 1987; Suga and Tawada, 2007). Although they are often recognized as traditional activities, and their set is relatively permanent, they might be subject to changes in the forms of provision. As a result of these changes, the needs of local community members might be better responded to. The modernization of the municipal sector[1] is primarily determined by supply factors, such as budgetary conditions, legal regulations, and the technical and organizational capacity of local governments. However, the expectations of stakeholders are also taken into account in the management of municipal entities. In particular, in an outcome of the spread of the New Public Management concept, there has been growing interest in both measuring the quality of public services and raising their standards to match better customer expectations (Hood, 1991; Sewart and Walsh, 1992; Zawicki, 2011, Ropret and Aristovnik, 2019).

The quality of municipal services can be defined in at least two ways (Błoński, 2015, p. 41). Firstly, this type of service might be recognized as an objective and measurable category and thus determined based on technical and organizational criteria (e.g. timeliness of communication, drinking water parameters). Secondly, municipal services might be recognized as a subjective category and, therefore, equated with consumers' perception, who confront their expectations about how a given service is provided with an assessment of the facts (Ruud, 2017). The latter approach to municipal services is applied in this paper, which is aimed at investigating the perception of municipal services provided in Cracow (Poland).

It is worth emphasizing that the research was carried out in Cracow, which is one of the key locations of shared services centres in Poland (ABSL, 2019, p. 6). Poland has recently held the third position (together with China and Mexico) among the most frequently indicated countries for locating shared services centres, after the United States (14% of the indications) and India (12%) (Deloitte, 2017, p. 6). The survey was conducted among students of Cracow universities, who constitute a large percentage of recipients of municipal services provided in the city. On the other hand, students of Cracow constitute a crucial part of the labour supply for shared service centres.

The questionnaire research was completed in two rounds, i.e. in 2019 and 2021. Therefore, the spread between the first and second round enables

---

[1]   "The municipal sector is about creating a favourable framework that facilitates human and economic activity, while protecting the physical" (*Municipal*... 2012, p. 25).

us to check whether the changes in conditions of providing these services and, on the other hand, customers' way of life during the pandemic affected the perception of municipal services' receivers. In particular, our study aims to test the hypothesis according to which the target group's assessment of the quality of municipal services has deteriorated during the Covid-19 pandemic.

The study does not consider all of the municipal services provided in Cracow, but only the majority of them: the supply of drinking water, domestic hot water, wastewater collection, domestic central heating, public transport (buses, minibuses, trams, railway), and city bikes.

The rationale for changing the quality of municipal services and their perception during the Covid-19 pandemic

Municipal services are provided by local service providers organized as publicly-owned joint-stock companies, recognized as municipal companies. A municipal company is an autonomous organization owned by municipalities outside the local bureaucracy. Such enterprises have tariffs and commercial revenues and produce and deliver local public services (Voorn et al., 2017, p. 820). Municipal companies have several specific characteristics, i.e. 1) they are based by public law institutions (municipality); 2) Supervisory Board and Chief Executive Officer (CEO) is approved by the municipality; 3) they must deliver public service – private service delivery by municipal enterprises is considered as a competition restriction on the market and is not feasible; 4) the municipal enterprise is accountable to the founder (municipality); 5) The public enterprise is required transparency and accountability, as well as corporate social responsibility; 6) Audit and control of the public enterprise are carried out by the municipality (Narmania, 2018).

Since the Covid-19 pandemics has not finished yet, it is difficult to expect a comprehensive and clear assessment of its impact on the municipal services sector. However, the analyses have been emerging, mainly of a practical nature, concerning the functioning of its various segments under pandemic conditions (e.g., Anantharama and Kulkarni 2020; Krawczyk, 2021; Padovani et al., 2021, Tamm, 2020). In particular, these studies seem to be sufficient to identify the crucial challenges to be faced by municipal companies at that time. In creating a set of the main concerns of the municipal sector under the conditions of the epidemic regime, the following issues can therefore be mentioned, inter alia:
- ensuring the safety of employees involved in the provision of services;

- adapting to sudden changes in demand resulting from a different way of life of residents,
- organization of work ensuring the uninterrupted provision of services in conditions of increased absenteeism (e.g. due to illness, quarantine, childcare);
- ensuring the cybersecurity of remote work (in particular the protection of numerous sets of personal data of stakeholders);
- organization of effective contacts with customers (e.g. administration of new water and sewerage connections);
- ensuring liquidity (cushioning the effects of high costs of staff sanitation, reduced demand for certain services, and a possible increase in the back-log of municipal service charges).

When analyzing the impact of a pandemic on the conditions of provision of municipal services, it is worth noting their specific characteristics. They must be provided reliably (i.e. on an ongoing and continuous basis, as municipal goods cannot be stored), absolutely, and universally (Sadowska, 2018, p. 132). This puts municipal companies in a more difficult position than a significant part of the private and even public sectors (education, administration), where the possibilities for adapting flexibly to the new situation are much greater. It might be due to the fact that the scale and extent of changes during the pandemic were unprecedented. Changes in the municipal sector tend to be slow, evolutionary. If there is a need for radical changes (e.g. in the case of the establishment of new legal bases), it applies mostly to the selected municipal services. Crises resulting from accidents or natural disasters are usually short-term. Covid 19, on the other hand, has changed the operating conditions for the whole sector, and its implications seem to be observable in, at least, mid-term perspective.

The circumstances described above show that the pandemic was the source of significant impediments to the sector's functioning. Its effects on the quality of services should be neutral at most – maintaining existing standards can be considered a challenge for municipal plants.

It is much more difficult to formulate assumptions about changes in the social perception of municipal services during the pandemic. It should be stressed that, even under normal circumstances, objectivity related to facts does not have to be fully reflected in the customers' opinions. In particular, customers making the assessment may not have the complete information on technical parameters of the services provided and evaluate them based on subjective perception. Moreover, subjective assessment depends also on stakeholders' expectations – their increase may result in a deterioration in the assessments of the municipal sector, even if its objective standards do not

change. In the particular period of the pandemic, both subjective perception and expectations may have changed in unpredicted directions.

Unfortunately, theoretical settlements in this regard are absent in the literature. The analyses on the social impact of Covid 19, which have already been published, tend to address issues directly related to the pandemic (e.g. remote work). The perception of the public and, in particular, municipal services seems to be too specific. We still have to wait for a broad scientific discussion of this problem. This means that research hypotheses about stakeholder attitudes must be intuitive.

One of the most obvious social consequences of the pandemic was that society spent more time at home. Some municipal services are directly related to this fact (e.g. drinking water, heating). This is especially true for students who have pursued remote learning. So it can be assumed that customers had more opportunities to observe the quality of some public services than when they spent most of their time away from home. Simultaneously, there was a strong increase in the amount of free time in the lockdown (at least in some professions), so there was a greater chance of leisure in this area. Under these conditions, it seems reasonable to believe that recipients of municipal services will, in their view, be more critical than before the pandemic.

Pandemic establishes a testing ground for many solutions in communication, work organization, and customer service for both private and public sector entities, including municipal enterprises. Undoubtedly, in such situations, the private sector takes advantage in terms of flexibility and pace of implementation of improvements. Thus, against the backdrop of an innovative private sector, the municipal sector could have fared slightly worse. Although this is merely a conjecture, a reverse option in which the public sector would be a role model in terms of the dynamics of adaptation to the new conditions seems less likely. Therefore, the theoretical considerations show that there are indications that the assessment of municipal services by stakeholders during the pandemic period is lower than before it began.

Research methods

The source of information on the assessments of municipal services available in Cracow presented in the study was a survey conducted on a representative group of students of Cracow universities. The size of the research population was based on the 2019 City State Report (UMK, 2020). It shows that the total number of students studying in Cracow, including full-time and part-time students, engineering, master's, doctoral and postgraduate studies,

was app. 143 thousand. The following sample selection parameters were adopted: 95% confidence interval, 0.5 fraction size, 3% statistical error. It was assumed that students are a homogeneous group in the context of the problem under question. On this basis, it was determined that 1061 respondents are required for the survey to meet the criterion of representativeness for the entire population.

The diagnostic tool used in the study was a survey questionnaire. Besides the questions about municipal services, the questionnaire also contains additional questions that help interpret the results, e.g., the place of residence and the number of days a week in which the interviewee stays in Cracow. The correctness of the questionnaire was verified as part of a pilot study conducted in a group of several dozen students of the Cracow University of Economics.

The survey was conducted in two rounds: January and February 2019 and March and April 2021. We collected answers from 1760 and 1067 students, so the minimum sample size requirement representative of the entire student population was met in both rounds. Although both samples are different in terms of the number of collected and completed questionnaires, they satisfy the statistical criteria for research sample representation, such as confidence interval (95%), fraction size (0.5), and statistical error (3%). Therefore, both samples provide reliable information representing the feature of the population under investigation. In Round 1, the surveys were collected during classes in lecture halls. Paper questionnaires were distributed to students with a brief oral instruction. In Round 2, this method was modified due to sanitary restrictions. Respondents received a link to the questionnaire and filled it out during online lectures. The interviewer had real-time contact with the interviewees through a video application used in the class.

For the 2019 and 2021 surveys, the analysis of the results was based on comparing the frequencies of individual answers. To objectize these comparisons, we use a chi-squared test for equal proportions, which tests the null hypothesis that the percentages for a given response in 2019 and 2021 are equal. On this basis, statistically significant differences in the opinions of the respondents were identified. Statistically significant differences were considered to be those for which the p-value of the test does not exceed 0,05. We consider our data to be measured on the ordinal scale; we thus refrain from calculating averages of the responses and from performing any tests designed for interval scale variables. This choice is evident in the case of the question on the opinions on innovations in the public sector. In the case of the questions on the quality of municipal services, we follow the literature on the subject (e.g. Joshi et al., 2015), and we also treat such a scale as an ordinal one.

Results of the research

During the pandemic, students' lifestyles and the extent to which they used municipal services provided by the city of Cracow may have drastically changed. Therefore, the first step of the analysis was to check how often the respondents were present in the city. Answers to this question are illustrated in figure 1.
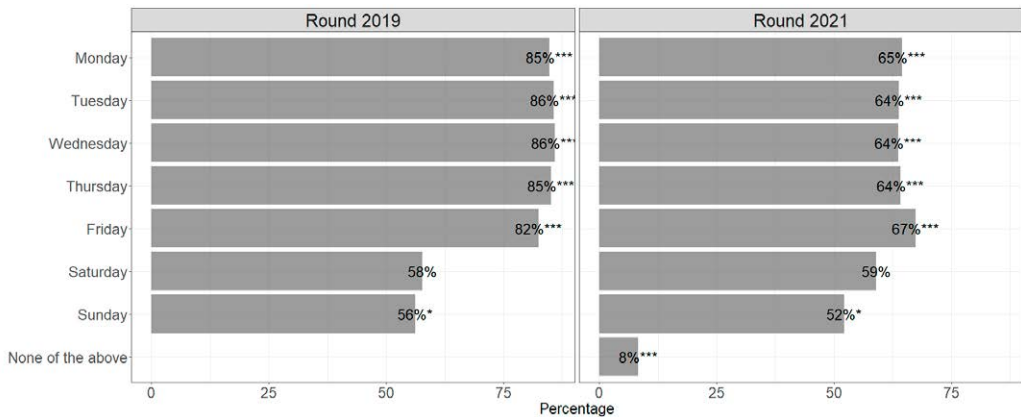

Figure 1. Answers to the question: On which days a week do you usually stay in Cracow this semester?
Notes: *** for p < 0,001; ** for p < 0.01; * for p < 0.05. The p-value was calculated for the chi-squared test of equal proportions for each row of the graph

Source: own study.

The results show that the frequency of students' stay in Krakow has significantly decreased. On Monday-Friday, about 85% of those surveyed were in Krakow in 2019. This proportion in 2021 was 20 percentage points lower than in the previous round of the survey. In regards to the weekends, there were almost no significant changes. In 2021, some people did not need to come to Krakow – app. 8% of those surveyed. These changes are not surprising due to the proliferation of remote education. However, they do not seem to be large enough for respondents in 2021 to be able to reliably assess the municipal services available in Krakow. A comparison of the results from rounds 1 and 2 is eligible. However, the share of 'no opinion' responses in the 2021 study can be expected to increase.

The results of the survey indicate an unequivocally positive assessment of municipal services. The lump-sum responses for 2019 and 2021 are illustrated in figure 2. It follows that the highest-rated service was the supply of drinking water. 85% of respondents rated it positively, only 5% negatively. Bus and bus services were rated the lowest, but also in this case, positive ratings prevailed.
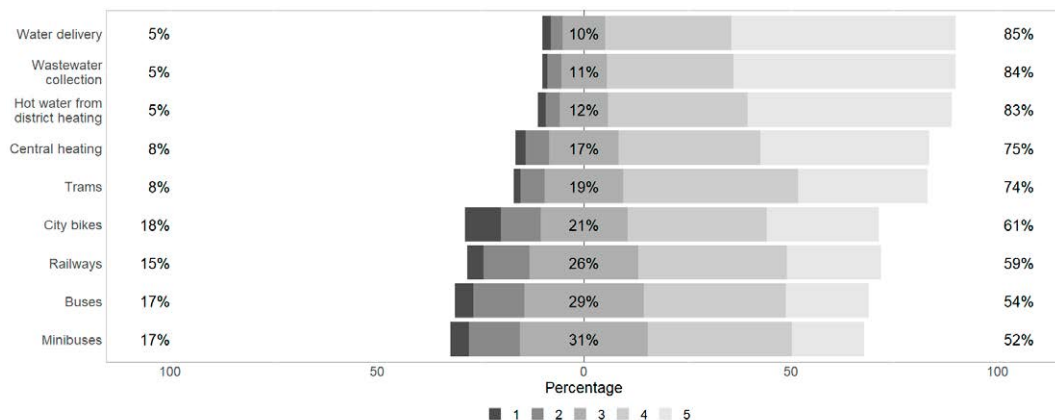
Figure 2. Opinions on municipal services in Cracow, measured on a scale from 1 (very bad) to 5 (very good). Round 2019 and 2021 combined

Source: own study.

It is worth noting that with the decrease in the percentage of positive ratings for individual services, there was primarily an increase in the percentage of "I don't know" responses and not in extremely negative responses. As a result, even for the worst-rated services, the percentage of people assessing them poorly or very badly did not exceed 17%.

When comparing the results of the 2019 and 2021 surveys, it should be noted that the general assessment of municipal services has not deteriorated. The overall rating for all services in both rounds is similar. Thus, according to the respondents, it was possible to maintain the standards for providing these services before the pandemic, despite the difficulties associated with sanitary restrictions.

By analyzing the different services separately (see table 1), there are slight changes. The pandemic study shows a slight improvement in the quality assessment of water supply and rail and bus services. The percentage of very good ratings has increased slightly, and the share of the most critical assessments has also decreased. The answer to another question also confirms a positive assessment of the water supply service. It turned out that during the pandemic, the percentage of people who were sceptical about drinking this water straight from the tap decreased (table 2). In the case of rail and bus services, the observed improvement may result from the increasing comfort of travelling due to the reduced number of passengers and less traffic.

Table 1. Evaluation of selected public services in 2019 and 2021

Opinions on the municipal services on scale from 1 (very bad) to 5 (very good).		
Opinion	Round 2019	Round 2021
Wastewater collection		
Don't know	28% ***	40%***
5 (very good)	37%	35%
4	23%***	16%***
3	8%	7%
2	3%	2%
1 (very bad)	1%	1%
Water delivery		
Don't know	17%***	23%***
5 (very good)	43%	45%
4	27%***	20%***
3	8%	8%
2	3%	3%
1 (very bad)	2%	1%
Trams		
Don't know	6%	6%
5 (very good)	29%	31%
4	40%	39%
3	19%	16%
2	5%	6%
1 (very bad)	2%	1%
Railways		
Don't know	25%	28%
5 (very good)	15%***	19%***
4	28%	25%
3	20%	18%
2	9%	8%
1 (very bad)	3%	3%
Busses		
Don't know	5%**	7%**
5 (very good)	18%*	21%*
4	32%	33%

3	29%*	25%*
2	12%	10%
1 (very bad)	5%	3%
Minibusses		
Don't know	29%*	32%*
5 (very good)	13%	11%
4	26%*	22%*
3	22%	21%
2	8%*	10%*
1 (very bad)	3%	4%
City bikes		
Don't know	41%*	45%*
5 (very good)	19%***	10%***
4	23%***	14%***
3	12%	12%
2	4%***	8%***
1 (very bad)	2%***	10%***
Central heating		
Don't know	26%***	35%***
5 (very good)	29%	28%
4	27%***	20%***
3	12%	11%
2	4%	4%
1 (very bad)	2%	2%
Hot water from district heating		
Don't know	20%***	30%***
5 (very good)	38%	37%
4	28%***	22%***
3	9%	8%
2	3%	2%
1 (very bad)	2%	1%

Notes: *** for $p < 0,001$; ** for $p < 0.01$; * for $p < 0.05$. The p-value was calculated for the chi-squared test of equal proportions for each row of the table.

Source: own study.

Table 2. Water quality assessment in 2019 and 2021

Do you agree with the opinion that you can drink tap water in Cracow?		
Answer	Round 2019	Round 2021
Definitely yes	13%	13%
Yes	13%	12%
Rather yes	20%***	25%***
Neither yes, neither no	15%	14%
Rather no	19%	19%
No	8%	7%
Definitely no	13%***	9%***

Notes: as below Table 1.
Source: own study.

Services which rating in the pandemic has deteriorated are minibuses and city bikes. The interpretation of these results is quite obvious. During the period of epidemic danger, the minibus was probably considered an unsafe means of transport. As for the city bike, the operator of this service has completed its provision in Cracow. Therefore, the downgrading was likely because more and more respondents experienced a lack of availability of this mode of transport.

Between the first and second rounds, the assessment of services related to central heating, domestic hot water, and wastewater collection was not fundamentally changed. The changes in the way these services are provided are usually minor and thus are difficult for consumers to notice. If they were not radical (e.g. cumbersome outages), the opinions likely remain unchanged.

Respondents were also asked about their expectations of changes in public services (table 3).

The survey showed that the vast majority of students expect innovation in this sector. Moreover, during the pandemic, the proportion of respondents who saw the need to introduce them has increased. In particular, the proportion of people expressing the need for innovation to reduce the cost of services has almost doubled. The proportion of students pointing to the need for eco-innovation has increased markedly. Simultaneously, more than half of those surveyed expect pro-quality innovation. It is worth noting, however, that the question of innovation concerned public services in general and not only municipal services.

Table 3. Opinions on innovation in the public services sector in 2019 and 2021

Potential innovations in the public services sector should be directed to:		
Answer	Round 2019	Round 2021
Dissemination of ecological methods of providing public services	35%***	48%***
Lowering the costs of providing public services	35%***	62%***
Introducing new public services	30%***	40%***
Improving the quality of public services	46%**	52%**

Notes: as below Table 1.
Source: own study.

Conclusions

The pandemic is undoubtedly a period of major challenges facing the municipal sector. Problems regarding safety, management, and sudden changes in customer demand may have caused problems maintaining the quality of the services provided to date. The results of the research presented in this paper indicate that in the case of Cracow, these problems did not adversely affect their assessment by customers. A survey of a representative group of students, one of the largest recipients of these services, showed that they rated the municipal sector's functioning relatively well during the pandemic period. For some services, ratings in the pandemic were even slightly higher than before it exploded. However, it should be noted that the study was conducted amid epidemic restrictions (March-April 2021). Therefore, some of the negative effects may have manifested themselves after the survey was carried out. This means that only preliminary assumptions can be made based on the data obtained.

The reason for the positive assessment of the functioning of the municipal sector in the pandemic may be that it has coped with the challenges and has not lowered the standards of customer service. This is likely as no major failures or availability issues have been revealed so far. Confirmation of this assumption will be possible as further data on the functioning of Cracow municipal enterprises are made available in 2020 and 2021.

It is also possible that the results of the study reflect the pandemic-specific attitudes towards public services. The perception of the respondents is subjective and relative and reflects the relationship between expectations and facts. Thus, when assessing the quality of municipal services, our respondents might have taken into account the objective difficulties and

challenges associated with the pandemic. This could have translated into positive assessments even if minor shortcomings were identified.

The study revealed signs of increased expectations of innovation in the public sector. This thread of analysis seems particularly interesting and forward-looking. The quality of specific municipal services is largely a local issue. The degree of coping with the pandemic challenges can also depend on the quality of management in a given city or municipality. However, changing stakeholder expectations may be social. Therefore, the perception of the implementation of public services is an issue worth analyzing in subsequent studies, and it is advisable to check whether the trends revealed are temporary.

The contribution of the authors

Jakub Bartak – 25% (acquisition of data, data analysis and interpretation)
Dariusz Firszt – 25% (acquisition of data, writing – original draft preparation)
Marek Jabłoński – 25% (acquisition of data, conceptualization, writing – review and editing)
Łukasz Jabłoński – 25% (acquisition of data, conceptualization, writing – review and editing)

References

Altenburg, L., 1987. Production Possibilities with a Public Intermediate Good. The Canadian Journal of Economics / Revue canadienne d'Economique, 20(4), 715-734, https://doi.org/10.2307/135412.

Anantharama, V., Kulkarni, B. N., 2020. Repercussions of COVID-19 pandemic on municipal solid waste management: Challenges and opportunities. Science of The Total Environment, 743, https://doi.org/10.1016/j.scitotenv.2020.140693.

Błoński, K., 2015. Jakość usług publicznych w opinii respondentów w wybranych krajach Unii Europejskiej. Marketing i Rynek, 8.

Business Service Sector in Poland, 2019. Report prepared by the Association of Business Service Leaders (ABSL), ABSL 2019, acceced at: https://absl.pl/storage/app/uploads/public/5d0/7a1/406/5d07a140668f0191663458.pdf.

Castelli, A., Jacobs, R., Goddard, M., Smith, P.C., 2009. Exploring the Impact of Public Services on Quality of Life Indicators. ESRC Discussion Paper Series No. 0902.

Deloitte, 2017. Global Shared Services 2017 Survey Report. https://www2.deloitte.com/content/dam/Deloitte/us/Documents/process-and-operations/us-global-shared-services-report.pdf.

Hood, Ch., 1991. A public management for all seasons? Public Administration, 69, https://doi.org/10.1111/j.1467-9299.1991.tb00779.x.

Joshi, A., Kale, S., Chandel, S., Pal, D.K., 2015. Likert scale: Explored and explained. British Journal of Applied Science & Technology, 7(4), 396-403, https://doi.org/10.9734/bjast/2015/14975.

Krawczyk, B., 2021. Pandemia uderza w budżety samorządów. Przegląd komunalny, 1.

Municipal and Environmental Infrastructure. Sector Strategy, 2012. Document of the European Bank for Reconstruction and Development, approved by the Board of Directors at its Meeting on 26 June 2012, https://www.ebrd.com/downloads/sector/mei/mei.pdf.

Narmania, D., 2018. Efficient Management of Municipal Enterprises. European Journal of Multidisciplinary Studies, 7(2), https://doi.org/10.26417/ejms.v7i2.p76-79.

Padovani, E., Iacuzzi, S., Jorge, S., Pimentel, L., 2021. Municipal financial vulnerability in pandemic crises: a framework for analysis. Journal of Public Budgeting, Accounting & Financial Management, Ahead-of-print, https://doi.org/10.1108/JPBAFM-07-2020-0129.

Ramm, K., 2020. Wartość usług wodociągowych. Część 2. Technologia wody, 3-4 (71-72).

Ropret, M., Aristovnik, A., 2019. Public Sector Reform from the Post-New Public Management Perspective: Review and Bibliometric Analysis. Central European Public Administration Review, 17(2), 89-115, https://doi.org/10.17573/cepar.2019.2.05.

Ruud, O., 2017. Successful digital transformation projects in public sector with focus on municipalities. Central and Eastern European e|Dem and e|Gov Days 2017.

Sadowska, B., 2018. Rola usług komunalnych w rozwoju lokalnym. In: Klasik A., Kuźnik F (eds.), Rozwój lokalny i regionalny: teorie i zastosowania, Polska Akademia Nauk, Komitet Przestrzennego Zagospodarowania Kraju, Warszawa.

Stewart, J., Walsh K., 1992. Change in the management of public services. Public Administration, 70.

Stiglitz, J. E., 2007. Ekonomia sektora publicznego, Wydawnictwo Naukowe PWN, Warszawa.

Suga, N., Tawada, M., 2007. International Trade with a Public Intermediate Good and the Gains from Trade. Review of International Economics, 15(2), 284-293. https://doi.org/10.1111/j.1467-9396.2007.00648.x.

UMK, 2020. Cracow 2019 City State Report, Department for Strategy, Planning and Monitoring of Investment, Town Hall of Cracow, Cracow.

Baart, V., van Genugten, M. L., van Thiel, S., 2017. The Efficiency and Effectiveness of Municipally Owned Corporations: A Systematic Review. Local Government Studies, 43(5), 820–841, https://doi.org/10.1080/03003930.2017.1319360.

Zawicki, M., 2011. Nowe zarządzanie publiczne, PWE, Warszawa.

GENERAL ENVIRONMENTAL AND SOCIAL PROBLEMS

PROBLEMATYKA OGÓLNOEKOLOGICZNA I SPOŁECZNA

Roman NOVOTNY • Martin ROVNAK • Lenka STOFEJOVA •
Peter ADAMISIN • Matus BAKON

ANALYTICAL VIEW ON PERCEPTIONS OF SELECTED ENVIRONMENTAL PROBLEMS IN EASTERN SLOVAKIA: A GENERATIONAL PERSPECTIVE

Roman **Novotny**, PhD (ORCID: 0000-0001-9095-5633)
Martin **Rovnak**, PhD (ORCID: 0000-0003-3969-6482)
Lenka **Stofejova**, MsC (ORCID: 0000-0001-5695-4047)
Peter **Adamisin**, PhD (ORCID: 0000-0002-8077-4078)
Matus **Bakon**, PhD (ORCID: 0000-0002-8850-9738)
– *University of Presov in Presov, Faculty of Management, Department of Environmental Management*

Correspondence address:
Konstantinova 16, 080 01 Presov, Slovakia
e-mail: martin.rovnak@unipo.sk

ABSTRACT: The aim of the paper was to evaluate and compare respondents' views from eastern Slovakia on selected environmental issues from a generational perspective. The study used an online questionnaire survey to collect the data. According to the results, each generation views the severity of environmental problems differently, with Generation Y placing the highest priority on them and the Baby Boomers placing the lowest. Based on the performed statistical testing, we can confirm a statistically significant difference between individual generations of respondents on the question of the Covid-19 pandemic's positive impact on the environment, but no statistically significant difference between individual generations of respondents on whether they think waste sorting and recycling reduces the amount of waste deposited in landfills or whether they think waste sorting and recycling increases the amount of waste deposited in landfills.

KEYWORDS: environmental perceptions, environmental attitudes, environmental problems, generational perspective, eastern Slovakia

Introduction

In the current age of modern, rapidly changing social, economic, scientific and technical conditions, human society faces global environmental problems that have a destructive impact on nature and the planet in general (Shcheblyakov et al., 2019). The main environmental problems of mankind include air pollution, water pollution, soil contamination, climate change, depletion of natural resources, waste, illegal landfills, plastics in the oceans, noise pollution and others. The activities of human civilisation and their globalisation are the dominant actors in the constant changes of the global environment in the current scenario (Singh and Singh, 2017). The following sections list several studies that examine selected environmental problems in terms of perceptions of different groups of people.

Perception of the environment is one of the pillars of sustainable development and the state of the environment may be based on a series of indicators that can be assessed on an objective scale, such as the concentration of certain pesticides in groundwater, the concentration of particular air pollutants and the number of endangered species, but the consideration of public opinion about their environment is of high interest too and can be interpreted as a driving force for actions to improve the environment (Sachs, 2015; Carlsen and Bruggemann, 2020). An interesting source of such information can be found on the Numbeo (2021) website, based on information collected directly from people living in the area. Collected information is the basis for the study by Carlsen and Bruggemann (2020), which examined environmental perception in 33 European countries based on eight indicators through the application of partial ordering methodology. The results show that the most important factors for the overall environmental perception were found to be 'noise and light pollution' and 'dissatisfaction with green and parks in the city,' while 'water pollution,' 'dissatisfaction with garbage disposal' and 'air pollution' apparently play a less dominant role.

The need to recycle used materials has become an urgent environmental problem. Waste recycling has several positive effects on sustainable development and significantly reduces the demand for virgin raw materials and the amount of waste in landfills. Fiorillo (2013) analysed the determinants of household recycling in Italy with particular emphasis on social behaviour. Five different materials were examined: paper, glass, plastic, aluminium and food waste. The results of the probit regressions suggest that membership in non-profit associations, church participation, the habit of talking about politics and reading newspapers are significantly correlated with household recycling behaviour, while gender, age, education and household income play the most significant role. Findings also show that having waste recycling bins

in the home improves household recycling behaviour for all materials, whereas not having recycling bins has a negative impact on household recycling results. In the case of electrical waste, Islam, Dias and Huda (2021) used a questionnaire survey to examine young consumers' perceptions and patterns of disposing of waste electrical and electronic equipment. The results of the study showed that although consumers were aware of what e-waste is, there is a significant lack of knowledge about collection points and current recycling programs. It was also found that most respondents tended to dispose of e-waste in a correct way, suggesting that awareness-raising programs are necessary to prevent the incorrect disposal of this type of waste. The reasons for disposal and the frequency of buying new products were positively related to household income.

Regarding soil contamination as an environmental problem, much attention is paid to the problem of PCB soil contamination, for example, in the United Kingdom, USA, Canada, Japan, and Sweden. At present, one of the most curious topics in soil contamination in Slovakia is the company Chemko Strážske and its impact on the environment and human health. Currently, this area is one of the most contaminated areas in Europe. One of the production areas was also the production of PCBs. The expected source of pollution is around 2,750 tons of products based on PCBs, part of which was released into the environment mainly in the company's vicinity (in the form of production waste, improper storage or improper disposal). Contamination of sediments in the sewerage of the Laborec River and the Šírava Reservoir exceeds 1000 times the permitted limits of substances in the territory of the Slovak Republic. The content of the mentioned PCB substances caused a partial degradation of the soil. Contaminated soils are a source of environmental contamination and travel long distances in the form of steam or absorbed solids. The behaviour of PCBs in the soil affects the basic properties of the soil. The content of these substances in the soil is also affected by agricultural activity, namely tillage or application of sludge (Danielovič, Hecl and Danilovič, 2014)

Kusá and Piatrov (2020) state that natural resources are burdened by the amount of goods that arise from "hobby shopping", and few consumers are aware of the negative impact of their purchases on the planet, causing serious environmental problems. The generation C (digital lifestyle generation) subsegment, on the other hand, was identified as promising for its potential to adopt pro-environmental consumer behaviour as well as promote environmentally friendly values in other consumer segments. Consumers in the Generation C subsegment are concerned about environmental issues and consider issues related to this topic to be important. However, they think that this issue is inadequately presented and socially under-discussed. They also

think that sellers ignore this topic, which makes it possible to assume that Generation C wants brands and businesses to address this topic actively.

Environmental issues also affect areas such as food, and this trend has also affected consumer views. According to a survey conducted by Łuczka (2019), consumers are placing a greater emphasis on health and environmental concerns as reasons for purchasing organic food, indicating an increase in consumer awareness and a shift from an egoistic to an altruistic approach to how their purchasing decisions affect the natural environment when compared to previous research findings. An increase in the share of regular consumers, a key segment of the organic food market, as well as the fact that online sales are seen as a promising place to buy organic food, are among the identified positive developments.

It is necessary to define these generations because the paper is concerned with hypotheses about generational differences in terms of opinions on various environmental problems and issues. McCrindle (2014) and McCrindle and Fell (2020) divide the generations according to the following table (table 1).

Table 1. Individual generations by years of birth

Generation	Years of birth
Builders	From 1925 to 1945
Boomers	from 1946 to 1964
Generation X	from 1965 to 1979
Generation Y	from 1980 to 1994
Generation Z	from 1995 to 2009
Generation α	from 2010 − current generation of children

Source: author's work based on McCrindle; McCrindle and Fell [20-06-2021].

Gray et al. (2019) examined respondents' reactions from the United States, characterised by age and generational cohort, to the presentation of small and large hypothetical losses due to climate change. The same participants were then asked to indicate their support for future policy measures to halt these environmental losses. Overall, the results do not suggest that the younger generations experience potential losses as more acute as the older generations; neither age nor the generational group correlated with the perceived severity of environmental losses or the support of future measures to prevent them. A more robust predictor of both dependent variables was the orientation towards environmental values (biosphereism) and the political

orientation they themselves stated. A multi-country study to support measures to reduce the risk of climate change through geoengineering also found that the age of participants was not a factor (Visschers et al., 2017). On the contrary, Gifford and Nilsson (2014) suggest that older people are more interested in the environment and show a greater affinity for engaging in a wide range of small-scale pro-environmental behaviours (e.g., Fair Trade goods purchases or recycling). They suggest that this observation may be due to the generational cohort (not strictly age-related) differences.

The impact of Coronavirus infection (COVID-19) on the current situation must also be mentioned, because it is a major problem that not only affects the population's health, but also the environment in various ways. Shakil et al. (2020) reported that the current outbreak of COVID-19 has had a significant impact on environmental factors. Their study presented a critical analysis of 57 studies on the relationship between COVID-19 and the environment, published in nine journals by May 2020. They conclude that the COVID-19 pandemic has led to an improvement in the quality of the environment. However, these reductions were due to lockdown and were persistent during the lockdown period. It is not known whether the quality of the environment will persist in the long term.

Research methods

The study focuses on evaluating and comparing views of respondents from eastern Slovakia on selected environmental issues from a generational perspective. The study used a survey technique to collect the data. In order to find out the environmental awareness of individual generations and their views on environmental issues, we used a survey technique in the form of an online questionnaire to collect the data. The questionnaire contains 4 questions in which we wanted to find out socio-demographic data of the respondents and 17 questions about views and attitudes to selected environmental problems, which we dealt with in the theoretical background of the paper.

Since the contribution is focused on generations' attitudes to selected environmental problems, it was necessary to determine the age range of the examined generations. McCrindle (2014) and McCrindle and Fell (2020) introduced dividing into six generations: Builders, Boomers, Generation X, Generation Y, Generation Z and Generation α. Due to the current epidemiological situation and needed technical skills, it would be difficult to obtain a sufficient number of responses from respondents from the oldest generation (Builders), so this category was not included. The youngest generation, which is called Generation α, was also omitted. The reason for not including this generation is that the age is too young to understand the issue.

Between 07.02.2021 and 05.03.2021, an online questionnaire survey was conducted. The answers of the questionnaire survey were analysed using descriptive and inductive statistical methods. The obtained data were analysed using SPSS Statistics 27.0.1.0, a statistical programme.

Results of the research

Two hundred one respondents attended the online questionnaire survey. Most respondents (n = 52) were included in the Generation Z, followed by respondents from Generation X (n = 51) and Generation Y (n = 50). The least respondents were within the Boomers generation (n = 48). The percentages can be seen in figure 1.
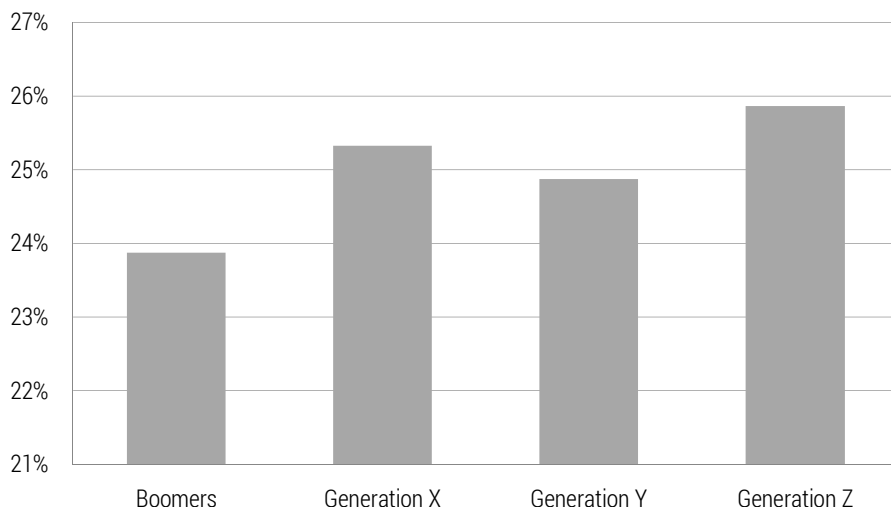

Figure 1. Percentage of respondents in individual categories of generations

Source: author's work.

Males made up 50.2 percent of the survey respondents, while females made up 49.8%. The location of respondents' residence was also inquired about. They could live in either a city or a rural area. Rural area was marked by 48.8% of respondents and city by 51.2% of respondents. Next, we were interested in the region in which the respondents live. As we determined in advance that our survey focuses only on eastern Slovakia, we distributed the questionnaire exclusively to respondents living in the Prešov and Košice regions. 52.7 percent of the addressed respondents who took part in the questionnaire survey were from the Preov Region and 47.3% from the Košice Region. These socio-demographic variables are further described in table 2.

Table 2. Frequency distribution of socio-demographic variables of respondents

Variable	Category	Boomers	Generation X	Generation Y	Generation Z	Frequency
Gender	Male	17	26	38	20	101
	Female	31	25	12	32	100
	Total	48	51	50	52	201
Residence	Rural area	21	26	21	30	98
	City	27	25	29	22	103
	Total	48	51	50	52	201
Region of residence	Prešov Region	25	29	28	24	106
	Košice Region	23	22	22	28	95
	Total	48	51	50	52	201

Source: author's work.

In the first question, we wanted respondents to prioritise individual environmental issues. Selected environmental problems could be assigned a priority from 1 – lowest priority to 5 – highest priority. Even though not all these problems are known or present in Slovakia, we wanted to find out the general view of generations. If we compare all the answers, regardless of the generation, we find that the largest number of respondents marked the lowest priority 1 to the problem of climate change, with the number of 32 respondents (15.9%). Most respondents marked priority 2 to noise pollution, with a number of 53 respondents (26.4%). Most respondents also assigned priority 3 to noise pollution, but in as many as 68 cases, representing 33.8% of all respondents. Priority 4 was mostly assigned to the environmental problem of polluted air, with 56 respondents (27.9%). Most respondents marked priority 5 to the water pollution, with 81 labels, representing 40.3% of respondents. In general, according to the previous information and the mean priority of individual environmental problems, it can be said that the respondents identified the biggest environmental problems as polluted air ($\bar{x} = 3.80$) and water pollution ($\bar{x} = 3.75$) and the least as noise pollution ($\bar{x} = 2.93$) and climate change ($\bar{x} = 3.46$). When we compare the individual generations and their assignment of priorities from 1 to 5, we find a difference in the answers. In the case of climate change, all generations had the highest number of priorities assigned to the number 5, but the largest difference can be seen between Generation X, which reached the mean score of 3.08, and Generation Z, which reached the mean score of 3.79. The intergenerational difference is not so notable in the case of waste, although 33.3%

(n = 16) of the oldest generation of respondents (Boomers) identified waste as priority 4, in contrast to generation X, where only 7.8% (n = 4) of respondents identified this option, based on the mean scores the largest difference is visible between Generation Z (3.44) and Generation Y (3.98). In the case of the illegal landfills, the biggest difference is between Generation X ($\bar{x}$ = 3.45) and Generation Y ($\bar{x}$ = 4.02) and in the case of plastics in the oceans, the biggest difference is between the Boomers generation ($\bar{x}$ = 3.13) and Generation Y ($\bar{x}$ = 4.00). Concerning the problem of air pollution, 41.7% (n = 20) of respondents from the Boomers generation indicated priority 4. In comparison, the same rating was given by only 9.8% (n = 5) of respondents from Generation X, but based on the mean scores biggest difference was found between Generation X (3.43) and Generation Z (4.13). In the case of the problem of soil contamination, the biggest difference is visible between the Boomers generation ($\bar{x}$ = 3.00) and the Generation Y ($\bar{x}$ = 3.92) and in the case of the water pollution problem between the Boomers generation ($\bar{x}$ = 3.42) and the Generation Y ($\bar{x}$ = 4.08). Noise pollution achieved the lowest mean score for all the generations examined, with the exception of Generation X, which achieved the lowest score for the climate change problem. The lowest score was achieved for noise pollution by Generation Z (2.58) and the highest by Generation Y (3.22). From the answers obtained, it is clear that each generation perceives the severity of environmental problems differently. When averaging the results, Generation Y gave the highest priority to environmental issues (3.84), followed by Generation Z (3.57), Generation X (3.38), and generation of Boomers gave the lowest priority to the mentioned environmental issues (3.33). The results of this question are shown in table 3.

Table 3. Priorities assigned to individual environmental problems

Priority	1	2	3	4	5	Mean priority
CLIMATE CHANGES						
Boomers	8	7	5	12	16	3.44
Generation X	11	7	13	7	13	3.08
Generation Y	6	3	18	5	18	3.52
Generation Z	7	3	8	10	24	3.79
Total	32	20	44	34	71	3.46
WASTE						
Boomers	6	5	7	16	14	3.56
Generation X	5	9	12	4	21	3.53
Generation Y	5	3	6	10	26	3.98

Priority	1	2	3	4	5	Mean priority
Generation Z	7	5	14	10	16	3.44
Total	23	22	39	40	77	3.63
ILLEGAL LANDFILLS						
Boomers	4	4	12	12	16	3.67
Generation X	7	6	14	5	19	3.45
Generation Y	4	5	3	12	26	4.02
Generation Z	2	7	15	13	15	3.62
Total	17	22	44	42	76	3.69
PLASTICS IN THE OCEANS						
Boomers	4	15	11	7	11	3.13
Generation X	9	6	13	5	18	3.33
Generation Y	4	2	12	4	28	4.00
Generation Z	6	7	7	17	15	3.54
Total	23	30	43	33	72	3.50
AIR POLLUTION						
Boomers	2	7	8	20	11	3.65
Generation X	7	7	13	5	19	3.43
Generation Y	2	3	9	17	19	3.96
Generation Z	2	3	7	14	26	4.13
Total	13	20	37	56	75	3.80
SOIL CONTAMINATION						
Boomers	4	18	9	8	9	3.00
Generation X	5	6	14	9	17	3.53
Generation Y	3	2	12	12	21	3.92
Generation Z	2	8	20	4	18	3.54
Total	14	34	55	33	65	3.50
WATER POLLUTION						
Boomers	3	6	18	10	11	3.42
Generation X	4	10	10	7	20	3.57
Generation Y	4	1	9	9	27	4.08
Generation Z	4	3	10	12	23	3.90
Total	15	20	47	38	81	3.75
NOISE POLLUTION						

Priority	1	2	3	4	5	Mean priority
Boomers	7	17	9	11	4	2.75
Generation X	3	10	21	10	7	3.16
Generation Y	2	11	21	6	10	3.22
Generation Z	10	15	17	7	3	2.58
Total	22	53	68	34	24	2.93

Source: author's work.

Based on the processing of primary data from the questionnaire survey, we performed analyses of differences and, from a generational perspective, verified hypotheses concerning differences within selected variables (questions).

Hypothesis H1 testing:

- Hypothesis 0: We assume that there is no statistically significant difference between individual generations of respondents and their attitude to whether they think that waste sorting and recycling reduces the amount of waste deposited in landfills.
- Hypothesis 1: We assume that there is a statistically significant difference between individual generations of respondents and their attitude to whether they think that waste sorting and recycling reduces the amount of waste deposited in landfills.

We used the Shapiro-Wilk W test to verify the normality, which showed that the variable does not have a normal distribution ($P = 0.0000$). Therefore we had to use the nonparametric Kruskal-Wallis test.

Based on the achieved level of significance of the Kruskal-Wallis test ($p = 0.0674$), we can say that there was no statistically significant difference between individual generations. Because the measured p-value is higher than the value of the test statistic value $p = 0.05$, we reject hypothesis H1 and accept hypothesis H0, assuming that there is no statistically significant difference between individual generations of respondents and their attitude to whether they think that waste sorting and recycling reduces the amount of waste deposited in landfills.

Hypothesis H2 testing:

- Hypothesis 0: We assume that there is no statistically significant difference between individual generations of respondents and their attitude to whether PCBs produced in the past by Chemko Strážske are currently a serious environmental problem.

- Hypothesis 1: We assume that there is a statistically significant difference between individual generations of respondents and their attitude to whether PCBs produced in the past by Chemko Strážske are currently a serious environmental problem.

The Shapiro-Wilk W test showed that the variable does not have a normal distribution (P = 0.0000), and therefore we had to use the nonparametric Kruskal-Wallis test.

Based on the achieved level of significance of the Kruskal-Wallis test (p = 0.0939), we can say that there was no statistically significant difference between the individual generations. Because the measured p-value is higher than the value of the test statistic value p = 0.05, we reject hypothesis H1 and accept hypothesis H0, assuming that there is no statistically significant difference between individual generations of respondents and their attitude to whether PCBs produced in the past by Chemko Strážske are currently a serious environmental problem.

Hypothesis H3 testing:

- Hypothesis 0: We assume that there is no statistically significant difference between individual generations of respondents in the question of the positive impact of the Covid-19 pandemic on the environment.
- Hypothesis 1: We assume that there is a statistically significant difference between individual generations of respondents in the question of the positive impact of the Covid-19 pandemic on the environment.

To test the hypothesis, we firstly used the Shapiro-Wilk W test to test normality, which showed us that the variable did not have a normal distribution (P = 0.0000). Therefore we had to use the nonparametric Kruskal-Wallis test.

Based on the achieved level of significance of the Kruskal-Wallis test (p = 0.0001), we can say that there was a statistically significant difference between individual generations. Because the measured p-value is lower than the test statistic value p = 0.05, we reject hypothesis H0 and accept hypothesis H1, assuming a statistically significant difference between individual generations of respondents in the question of the positive impact of the Covid-19 pandemic on the environment. According to the mean scores, it is clear that the most significant differences were achieved between the generation of Boomers, which achieved the lowest score, and Generation Y, which achieved the highest score.

Conclusions

Examining whether younger people, defined by age or generation, are more concerned about environmental issues than older people or generations is an important scientific topic in terms of targeting the right target group in environmental awareness campaigns. The paper aimed to evaluate and compare respondents' views from eastern Slovakia on selected environmental issues from a generational perspective. Based on the questionnaire survey results, it is clear that the severity of environmental problems is perceived differently by each generation, and in general, Generation Y gave them the highest priority, followed by Generation Z, Generation X, and generation of Boomers gave them the lowest priority. Based on the statistical testing, we can state that:

- there is no statistically significant difference between individual generations of respondents and their attitude to whether they think that waste sorting and recycling reduces the amount of waste deposited in landfills,
- there is no statistically significant difference between individual generations of respondents and their attitude to whether PCBs produced in the past by Chemko Strážske are currently a serious environmental problem,
- there is a statistically significant difference between individual generations of respondents in the question of the positive impact of the Covid-19 pandemic on the environment.

Acknowledgements

The contribution of the authors

Roman Novotny – 30% (literature review, data analysis, interpretation, language correction).

Martin Rovnak – 30% (conception, data analysis, conclusions).

Lenka Stofejova – 20% (literature review, language correction).

Peter Adamisin – 10% (data collection, data analysis).

Matus Bakon – 10% (literature review, data collection).

References

Carlsen, L., Bruggemann, R., 2020. Environmental perception in 33 European countries: an analysis based on partial order. Environment, Development and Sustainability, 22(3), 1873-1896, https://doi.org/10.1007/s10668-018-0267-z.

Danielovič, I., Hecl, J., Danilovič, M., 2014. Soil Contamination by PCBs on a Regional Scale: The Case of Strážske, Slovakia. Polish Journal of Environmental Studies, 23(5), 1547-1554.

Fiorillo, D., 2013. Household waste recycling: national survey evidence from Italy. Journal of Environmental Planning and Management, 56(8), 1125-1151, https://doi.org/10.1080/09640568.2012.709180.

Gifford, R., Nilsson, A., 2014. Personal and social factors that influence pro-environmental concern and behaviour: A review. International Journal of Psychology. 49(3), 141–157, https://doi.org/10.1002/ijop.12034.

Gray, S.G., Raimi, K.T., Wilson, R., Árvai, J., 2019. Will Millennials save the world? The effect of age and generational differences on environmental concern. Journal of environmental management, 242, 394-402, https://doi.org/10.1016/j.jenvman.2019.04.071.

Islam, M.T., Dias, P., Huda, N., 2021. Young consumers' e-waste awareness, consumption, disposal, and recycling behavior: A case study of university students in Sydney, Australia. Journal of Cleaner Production, 282, 124490, https://doi.org/10.1016/j.jclepro.2020.124490.

Kusá, A., Piatrov, I., 2020. Perception of global environmental problems by Generation C and its marketing communication preferences. SHS Web of Conferences, 74(3), 01021, https://doi.org/10.1051/shsconf/20207401021.

Łuczka, W., 2019. Changes in the behavior of organic food consumers. Ekonomia i Środowisko, 70(3), 140-153, https://doi.org/10.34659/2019/3/40.

McCrindle, M., 2014. The ABC of XYZ; Understanding the Global Generations. Bella Vista: McCrindle Research Pty Ltd.

McCrindle, M., Fell, A., 2020. Understanding Generation Alpha. Solent Circuit: McCrindle Research Pty Ltd.

Numbeo, 2021. Pollution, https://www.numbeo.com/pollution/, [20-06-2021].

Sachs, J.D., 2015. The age of sustainable development. New York: Columbia University Press.

Shakil, M.H., Munim, Z.H., Tasnia, M., Sarowar, S., 2020. COVID-19 and the environment: A critical review and research agenda. Science of the Total Environment, 745, 141022, https://doi.org/10.1016/j.scitotenv.2020.141022.

Shcheblyakov, E.S., Ivanova, N.G., Melnikova, T.V., Farafontova, E.L., 2019. The main environmental problems of mankind and possible solutions. IOP Conference Series: Earth and Environmental Science, 315(2), 022083, https://doi.org/10.1088/1755-1315/315/2/022083.

Singh, R.L., Singh, P.K., 2017. Global environmental problems. In: Principles and applications of environmental biotechnology for a sustainable future, 13-41. Springer: Singapore, https://doi.org/10.1007/978-981-10-1866-4_2.

Visschers, V.H., Shi, J., Siegrist, M., Arvai, J., 2017. Beliefs and values explain international differences in perception of solar radiation management: insights from a cross-country survey. Climatic Change, 142(3), 531-544, https://doi.org/10.1007/s10584-017-1970-8.

DISCUSSION
AND REVIEWS

Katarzyna DEMBOWSKA

NON-FINANCIAL REPORTING REGARDING NATURAL ENVIRONMENT IN PUBLIC COMPANIES IN THE ENERGY, FUEL AND GAS SECTOR IN 2019

Katarzyna **Dembowska**, MSc. (ORCID: 0000-0001-6471-6583) – *Warsaw School of Economics*

Correspondence address:
Nowiec Street 27, 80-293, Gdańsk, Poland
e-mail: kdembowska1@gmail.com

ABSTRACT: The article's objective is a presentation of the non-financial reporting practice in the scope of issues regarding the natural environment in public companies based on the example of the energy, fuel and gas sectors. The study covers WIG20, WIG30 and mWIG40 companies listed on the Warsaw Stock Exchange in 2019. The research method applied in the article is based on a case study. The article starts with the theoretical part regarding the disclosure of non-financial information. The second part presents non-financial reporting with special consideration given to the natural environment, based on public companies operating in the energy, fuel and gas sector.

KEYWORDS: non-financial reporting, corporate social responsibility, natural environment, Directive 2014/95/EU, public companies

Introduction

In light of the concept of corporate social responsibility, the requirements for public companies in terms of access to information about them have been increasing for years – both in terms of information about their ongoing business activity as well as their commitment to environmental issues, human rights, or local communities. Currently, the financial statements prepared by economic entities are already insufficient. Therefore, an increasing number of enterprises is introducing corporate social responsibility rules in their business (Krzysztofek, 2016, p. 334-346).

Despite the fact that the first non-financial reports appeared in the 1980s (EY, 2016), changes in the scope of standards or verification of this reporting have appeared only in the last ten years. Furthermore, the development of reporting is also supported by the implementation of standards (e.g. GRI, IIRC) and regulatory changes (e.g. Directive 2014/95/EU) (Aluchna, 2018, p. 9-27).

Similarly to other scientific studies devoted to the issue of non-financial reporting, this article uses the terms 'non-financial reporting' and 'disclosure of non-financial information' interchangeably. It must be noted that the said terms are frequently limited to the information prepared in response to the regulations of Directive 2014/95/EU and the amended Accounting Act (Monciardini, 2016, p. 76-89). On the other hand, corporate social and environmental reporting and corporate sustainability reporting mean publication of information according to GRI standards (Hahn, Kuchnen,2013, p. 5-21; Tschopp, Huefner,2015, p. 565-577). Integrated reporting applies to a special for of reports combining three types of information (financial, environmental, social) and is most commonly prepared based on IIRC (Aluchna, 2018, p. 9-27).

The article's objective is to present the non-financial reporting practice in the scope of issues regarding the natural environment in public companies based on the example of the energy, fuel and gas sector. The study covers WIG20, WIG30 and mWIG40 companies listed on the Warsaw Stock Exchange in 2019. The research method applied in the article is based on a case study. The article starts with the theoretical part regarding the disclosure of non-financial information. The second part presents non-financial reporting with special consideration given to the natural environment, based on the example of public companies operating in the energy, fuel and gas sector.

Non-Financial Reporting

In 2014, the European Parliament adopted Directive 2014/95/EU amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups (Ministerstwo Rozwoju, 2017). The subject directive was implemented in the Polish legal system by means of two legal acts:

- requirements in the scope of extended non-financial reporting – the amendment of the Accounting Act (Act of 15.12.2016 on Amendment of the Accounting Act, Journal of Laws of 2017, item 61),
- requirements in the scope of disclosure of information on the diversity policy as regards members of corporate bodies – the amendment of the Regulation on Current and Periodical Information (Regulation of the Minister of Finance of 25.05.2016 Amending the Regulation on Current and Periodical Information Disclosed by Issuers of Securities and Terms of Considering Information Required under the Laws of a Non-EU Member State Equivalent, Journal of Laws of 2016, item 860).

The said regulations imposed the obligation of extended non-financial reporting on the Public Interest Entities (PIE), i.e. (CSR, 2020):

- Enterprises preparing separate financial statements – having the form of commercial companies, limited joint-stock partnerships or such registered partnerships or limited partnerships whose all partners bearing unlimited liability are commercial companies or limited joint-stock partnerships or companies from other countries having a similar legal form, and if they exceed the following values in the financial year and prior financial year: average annual employment of 500 persons, total balance sheet assets amounting to PLN million 85 or net sales of goods for resale and products amounting to PLN 170 million,
- Enterprises preparing consolidated financial statements – having a legal as specified above, being the parent entities in the capital group if the capital exceeded the following values in the financial year and prior financial year: average annual employment of 500 persons and, less consolidation exclusions: total balance sheet assets amounting to PLN million 85 or net sales of goods for resale and products amounting to PLN 170 million (or: prior to consolidation exclusions: PLN 102 million or PLN 204 million, respectively).

Therefore, entities obliged to prepare extended non-financial reporting must prepare disclosures of non-financial information (as part of the report on operation) or a separate report devoted to it. Regardless of the selected form, such a document must contain, pursuant to Art. 49b, Para. 2 of the

Accounting Act of 29 September 1994 and amended with the Act of 15 December 2016 (Journal of Laws of 2017, item 61):

• Business model – a brief description of the entity's business model,
• Indicators – key non-financial performance indicators related to the entity's operation,
• Policies – description of the policies applied by the entity in relation to social, employment, environmental issues as well as respecting human rights and counteracting corruption, and a description of results of the application of such policies,
• Procedures – description of due diligence procedures applied by the company under the policies referred to in the item above,
• Risks – description of material risks related to the entity's operation that could affect the issues referred to in the item "Policies", including risks related to the company's products or its relations with external surroundings, including contractors, and a description of risk management methods.
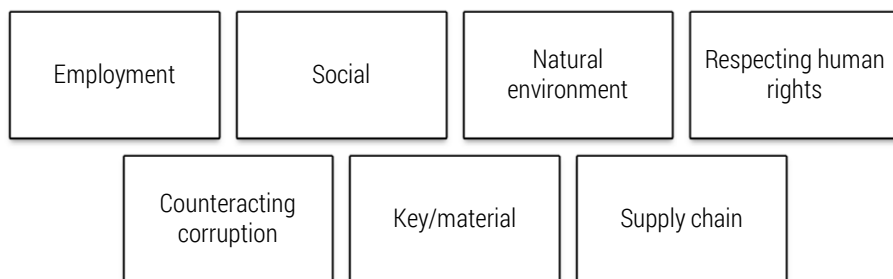• Non-financial issues are presented in figure 1 below.

Figure 1. Non-Financial Issues

Source: own study based on: obligations resulting from Directive 2014/95/EU implemented in the Polish law by way of the Act of 15 December 2016 (Journal of Laws of 2017, item 61).

As regards non-financial employment issues, the following can be distinguished: issues of diversity in terms of age, sex, sexual orientation, religion, disability, such as issues of participation (participation and commitment of employees); terms and conditions of employment and work; relations with trade unions and respecting freedom of association; human capital management; career and recruitment management; training/education systems; occupational health and safety (Ministerstwo Rozwoju, 2017).

As regards social issues, the following can be distinguished: customer relations; monitoring of the satisfaction level, information on the possible impact of products on health and safety; responsible marketing and research; community relations (Ministerstwo Rozwoju, 2017).

Regarding non-financial issues in the scope of counteracting corruption, the following can be distinguished: policies, procedures, management tools and systems preventing corruption and bribery; training and education in this scope; functioning of a whistleblower mechanism (Ministerstwo Rozwoju, 2017).

As regards non-financial issues in the scope of the natural environment, the following can be distinguished: issues of the natural environment, i.e. pollution control and prevention; impact on the environment resulting from use of energy; direct and indirect emissions to the atmosphere, protection of biodiversity and water sources; waste management; impact on the environment resulting from transport; impact on the environment resulting from use of services and products as well as their disposal (Ministerstwo Rozwoju, 2017).

As regards non-financial issues in the scope of respecting human rights, the following can be distinguished: company's expectations in terms of respecting human rights set for the employees and business partners; issues of human rights, including but not limited to the employees' rights, rights of persons employed for a definite term, children, native communities, owners of small farms, migrants, employees' families (Ministerstwo Rozwoju, 2017).

In terms of key/material non-financial issues, the company must examine the materiality of specific non-financial issues, which means: if the non-financial issue has a material impact on the company; if the company has a material impact on the given issue. The materiality of information must be assessed in context, i.e. the analysis must be carried out from the point of view of the company and its various groups of stakeholders (Ministerstwo Rozwoju, 2017).

As regards the supply chain, the Act refers to it as "relations with external surroundings, including contractors". This requires presenting at least the basic structure of the supply chain and the significance of non-financial information derived from it. Information that allows for an assessment of how and to what extent the supply chain affects the company's development, efficiency, and position and the impact exerted by it must be disclosed (Ministerstwo Rozwoju, 2017).

Public Companies from the Energy, Fuel and Gas Sector in 2019 – Disclosure of Non-Financial Information

The study analyses companies from the energy, fuel, and gas sector covered by WIG20, WIG30 and mIG40 indices and listed on the Warsaw Stock Exchange in 2019. The study analysed 6 companies reporting non-financial

data: Enea Spółka Akcyjna (ENA), Grupa Lotos Spółka Akcyjna (LTS), PGE Polska Grupa Energetyczna Spółka Akcyjna (PGE), Polski Koncern Naftowy Orlen Spółka Akcyjna (PKN), Polskie Górnictwo Naftowe i Gazownictwo Spółka Akcyjna (PGN) and Tauron Polska Energia Spółka Akcyjna (TPE).

Table 1 below presents data regarding companies by capitalisation as of 31 December 2019. As one can see, the undisputed leader in terms of capitalisation is PKNORLEN (PLN 36,705.99 million), followed by PGNIG (PLN 25,008.55 million) and LOTOS (PLN 15,451.72 million). Furthermore, only the companies listed above paid out dividends for 2019. On the other hand, in terms of book value, three companies exceeding PLN 30 million can be differentiated: PGE (48,177.00), PKNORLEN (PLN 38,216.00 million) and PGNIG (PLN 37,757.00 million). Furthermore, if we look at the P/E ratio, i.e. the price-to-earnings ratio for the last 4 quarters, it turns out that the most attractive companies (the least overinvested) are ENEA (3.5), PGE (7.5) and PKNORLEN (8.3). As regards the P/BV ratio (Pomykalska, Pomykalski, 2017), i.e. the price-to-book ratio at the end of the last calendar quarter, one can see that all companies except for LOTOS have a very low company price.

Table 1. Public companies from the energy, fuel and gas sector in 2019

Security name	Shares outstanding (million)	Market capitalisation			Book value (PLN million)	P/E	P/BV	Dividend yield (%)
		PLN million	EUR million	(%)				
PKNORLEN	427.71	36,705.99	8,618.86	6.67	38,216.00	8.3	0.96	4.1
PGNIG	5,778.31	25,008.55	5,872.21	4.55	37,757.00	14.5	0.66	2.5
LOTOS	184.87	15,451.72	3,628.19	2.81	12,275.50	17.2	1.26	3.6
PGE	1,869.76	14,883.30	3,494.72	2.70	48,711.00	7.5	0.31	---
ENEA	441.44	3,494.02	820.42	0.63	14,985.73	3.5	0.23	---
TAURONPE	1,752.55	2,874.18	674.88	0.52	19,168.28	13.9	0.15	---

Source: own study based on: https://www.gpw.pl/.

Public Companies from the Energy, Fuel and Gas Sector in 2019 – Case Study

The article discusses in most detail the non-financial issues related to the natural environment. The research method was based on a case study. In order to ensure study objectivity, a group of cases from the sale sector (energy, fuel and gas) for the same year was selected. The study's main objective is to verify how public companies from the energy, fuel and gas sector report non-financial data in the scope of the environment. Public companies

operating in the energy, fuel and gas sector in 2019 are presented below in the context of non-financial reporting regarding the natural environment in alphabetical order.

ENEA (7 pages)

The report regarding issues related to the national environment contains 7 pages. The company's performance indicators related to the natural environment include, without limitation, fuel, water, and waste. In ENEA Group, the management of impact on the natural environment is regulated by the Integrated Quality, Environment and OHS System Policy. Specific companies have policies, procedures, instructions, and regulations adjusted to their specifics, obliging them to protect and use the environment in a sustainable manner and monitor and document specific impacts on the environment and obtained results of pro-environmental activities. Selected rules, e.g. determining procedures for generated waste, must also be followed by third-party companies performing works in areas belonging to and for the benefit of ENEA. Internal regulations include, first and foremost, the Code of Ethics of ENEA Group as well as Compliance Policy of ENEA Group, obliging the entities, among other things, to care for the natural environment and take all actions needed to protect it, regardless of the place and type of performed work, use the natural resources and energy reasonably, minimise pollution emission, use environmentally-friendly technology, prevent failures posing a threat to the environment, participate actively in ecological education actions (ENEA,2019).

LOTOS (9 pages)

The scale of operation of LOTOS Capital Group entails great responsibility for the impact on the environment and local communities neighbouring the oil refinery and employment establishments. To properly manage its impact and mitigate the associated risks, the organisation has developed "eco-responsibility" rules to be followed in its daily business. Rules of "Eco-Responsibility": minimisation of the company's impact on the environment – in addition to compliance with the law, the company also tries to be proactive in environmental protection management; approach to protection of the natural environment extended with contractors and impact – the group takes responsibility for the impact on the environment exerted by the companies cooperating with it, only entities holding environmental protection licences and operate in compliance with the law in terms of waste management and storage of dangerous substances can be partners of the group; the company makes sure it complies with environmental protection requirements on

every step by use of the most environmentally-friendly technical solutions, reasonable use of natural resources, preventing pollution already at the facility stage, observance of restrictive environmental standards; another important aspect for the company is increasing ecological awareness of its employees, the issues of environmental protection and its significance in the context of the local and global business of LOTOS Capital Group are presented by means of internal communication and trainings – the idea of such actions is also encouraging the employees to gain knowledge and implement pro-environmental actions in their private lives. Regarding performance indicators related to the natural environment, the following can be distinguished: greenhouse gas emission, production and use of energy, energy efficiency, raw material and material consumption, waste, water and wastewater, other emissions to the atmosphere (Lotos, 2019).

PGE (42 pages)

The report regarding issues related to the national environment consists of 42 pages. The PGE Group's targets include, without limitation: limiting pollution emission to the atmosphere, limiting pollution emission to wastewater, municipal waste management, limiting noise emission, animal protection. Regarding performance indicators related to the natural environment, PGE distinguishes, among other things: water, biodiversity, greenhouse gas emission, wastewater, waste. PGE Group is the largest electricity and heat producer in Poland. It is also the biggest green energy producer in the country. Thus, it actively pursues the climate policy targets, including CO_2 emission reduction and gradual resignation from fossil fuels. In recent years, most conventional asset investments have been made to reduce the environmental impact of those entities, either directly through the construction of desulphurisation, denitrification, and dedusting installations or indirectly through modernisation that improves production efficiency. Due to consistent pro-environmental investments, the Group's power plants in Bełchatów, Turów, Opole, Dolna Odra and Rybnik gradually decrease the level of emission of nitrogen oxides, sulphur dioxide and dust to the atmosphere. The most important issues in the area of environmental protection include continuous improvement of qualifications and building of employees' awareness in the area of environmental protection, use of environmentally-friendly technology, effective use of fuels and natural resources, taking remediation and reclamation activities, supervising contractors' works, monitoring of the environmental impact of the Group's activities (PGE, 2019).

PGNIG (11.5 pages)

The report regarding issues related to the national environment consists of 11.5 pages. Due to the complexity of processes performed in the specific segments, PGNIG impacts the environment in varying degrees and scales. PGNIG takes pro-environmental actions and initiatives adequate to the specifics of its business. The environmental area is regulated in PGNIG by two leading documents. The first one is the implemented QHSE Policy that is an expression of responsibility for the conducted business activity in the light of the global sustainable development challenges. The other document is the Sustainable Development Strategy of PGNiG Capital Group for 2017-202, the provisions of which emphasise the significance of the environmental area in the responsible functioning of the Group. The companies' business activities are inseparably related to interference with the surroundings, bearing in mind the potential negative impact on the environment and people. PGNiG aims to minimise its impact through analysis of environmental risks, continuous monitoring of the quality of air, surface and ground waters, soil surface, and application of state-of-the-art pro-environmental technologies. It must be noted that the Group described multiple performance indicators in relation to the environment (materials and raw materials used, energy use, water use, impact on biodiversity, direct CO2 emission, reduction of greenhouse gas emission, total wastewater quantity, waste management, closed economy). The most important issues in the area of environmental protection include continuous improvement of qualifications and building of employees' awareness in the area of environmental protection, use of environmentally-friendly technology, effective use of fuels and natural resources, taking remediation and reclamation activities, supervising contractors' works, monitoring of the environmental impact of the Group's activities (PGNIG, 2019).

PKN ORLEN (9 pages)

The report contains 9 pages regarding the environment. Limitation of the impact on the environment is one of the top priorities of ORLEN Group. The approach to management in environmental protection is based on the Corporate Social Responsibility rules and considering ecological criteria. The company aims to balance its targets in relation to its stakeholders and reports its environmental performance. The environmental targets are defined in the Integrated Environmental Policy adopted by PKN ORLEN. Responsibility for creating the environmental protection policy, promoting issues related to environmental protection, and developing a positive green image lies with the Environmental Protection Area. Its responsibilities also include monitoring, balancing and optimisation of greenhouse gas emissions as well as

ensuring effective, compliant with the applicable laws, obtaining of gratuitous rights to carbon dioxide emission for installations covered by EU ETS, ensuring required ecological authorisations, conducting organisational and control activities aiming at compliance with the determined environmental standards, implementation and maintenance of the Leak Detection And Repair (LDAR) system in the Production Facility in Płock and PTA in Włocławek, assessing and payment environmental fees, consultation and substantive oversight over the scope and course of remediation works in the facilities of PKN ORLEN. Moreover, the key companies of ORLEN Group have Integrated Management Systems or Environmental Management System Policies in place, expressing their commitment to environmental protection, including prevention of pollution and other specific commitments material from the point of view of the operation of these entities. Environmental performance indicators distinguished by Orlen include, without limitation: waste, wastewater, water, emission to the atmosphere, low-emission economy and closed economy (PKN ORLEN, 2019).

TAURON PE (12 pages)

TAURON Group's Environmental Policy, adopted by the Company's Management Board in 2017, determines TAURON Capital Group's approach to environmental management, including the direction of its environmental activities and the rules it will follow in environmental matters. The environmental policy is a reference point based on which all activities of the TAURON Capital Group companies in the area of environmental protection and environmental management are assessed. The environmental policy documents the values and vision followed by TAURON Capital Group in the scope of impact on the natural environment. The main principle of the Environmental Policy is the limitation of both direct and indirect impact on the environment as well as effective communication ensuring understanding of the activities of TAURON Capital Group that could have an impact on the environment. TAURON Capital Group, according to the laws and administrative practice effective in the area of its operation, takes into consideration the needs related to environmental protection and acts in a manner contributing to the accomplishment of the broader goal, i.e. sustainable development, including but not limited to implementation of a closed economy. The most important environmental performance indicators distinguished by TAURON Capital Group include, among other things: the share of electricity, direct emission of greenhouse gases, waste. It must be noted that non-financial reporting in the scope of the environment is less clear for the readers than other reports (TAURON PE, 2019).

The above summaries show non-financial reporting in public companies from the energy, fuel and gas sector in 2019. One can see that all analysed companies have: a description presented above depicts non-financial reporting in public companies from the energy, fuel and gas sector in 2019. Furthermore, one can see that all analysed companies have: a description of their business model, a description of policies concerning social issues, employment issues, the natural environment, respecting human rights and counteracting corruption. As regards performance indicators related to social, employment, environmental issues, and respecting human rights, all analysed companies have them. An exception is the performance indicator related to counteracting corruption that TAURONPE does not have.

Summary

Based on the conducted analysis, the following conclusions can be drawn:

Implementation of legal regulations in the scope of reporting non-financial information (Directive 2014/95/EU) has had a significant impact on the increase in the scope of non-financial information disclosed by public companies. Information reporting is definitely better standardised, substance-focused and transparent, which makes it more reader-friendly.

Despite the fact that the analysed companies were covered by WIG20, WIG30 and mWIG40 indices and operated in the same sectors, they varied significantly in terms of capitalisation, from nearly PLN 37 million in the case of PKNORLEN to nearly PLN 3 million in the case of TAURON, which could have a significant effect on the substantive nature of the non-financial data (e.g. TAURON, as the only analysed company, did not have performance indicators regarding counteracting corruption).

All companies disclosed information on their business model, policies in relation to social issues, policies in relation to employment issues, policies in relation to the natural environment, policies in relation to respecting human rights and policies in relation to counteracting corruption. As regards performance indicators related to social, employment, environmental issues, as well as respecting human rights, all analysed companies have them.

In their non-financial reporting, all public companies operating in the energy, fuel and gas sector disclosed information in the scope of the building of employees' awareness of issues related to the natural environment, limitation and monitoring of the impact on the natural environment, use of environmentally-friendly technologies, use of natural resources and fuels, taking actions related to reclamation.

The most transparent and reader-friendly reports containing non-financial data, i.e. best reporting practice, were presented by the following companies (in random order): PGNIG, LOTOS, PKNORLEN, PGE, i.e. companies with the highest capitalisation.

The least transparent and reader-friendly non-financial report was prepared by the company with the lowest capitalisation – TAURON.

Reference

Act of 15.12.2016 on Amendment of the Accounting Act, Journal of Laws of 2017, item 61.

Aluchna, M., Kytsyuk, I., Roszkowska-Menkes, M., 2018, Raportowanie społecznej odpowiedzialności biznesu. Przypadek spółek z WIG20, Studia i Prace Kolegium Zarządzania i Finansów / Szkoła Główna Handlowa, 170, 9-27.

Directive 2014/95/EU of the European Parliament and of the Council of 22 October 2014 amending Directive 2013/34/EU as regards disclosure of non-financial and diversity information by certain large undertakings and groups, L 330/1.

ENEA, 2019, https://raport2019.csr.enea.pl/pl/wplyw-na-srodowisko/ochrona-srodowiska-w-strategii-grupy-enea/, [15.09.2021].

EY 2016, The Road to Reliable Nonfinancial Reporting, https://www.ey.com/Publication/ vwLUAssets/EY-ccass-road-to-reliable-nonfinancial-reporting/$FILE/EY-ccass-road-to-reliable-nonfinancial-reporting.pdf, [15.09.2021].

GPW, 2021, https://www.gpw.pl/, [15.09.2021].

Hahn R., Kühnen M., 2013, Determinants of Sustainability Reporting: A Review of Results, Trends, Theory, and Opportunities in an Expanding Field of Research, "Journal of Cleaner Production", 59, 5-21.

Krzysztofek A., 2016, Dyrektywa 2014/95/UE oraz wynikające z niej zmiany, „Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu", 450, 334-346.

Lotos, 2019, https://standardy.org.pl/wppsndrd/wp-content/uploads/2020/05/ LOTOS_2019_O_SJ.pdf, [15.09.2021].

Ministerstwo Rozwoju, Wydanie II poprawione, 2017, Raportowanie niefinansowe. Poradnik dla raportujących, pr. zbior. p. red. L. Anam, J. Kacprzak.

Monciardini, D., 2016, The 'Coalition of the Unlikely' Driving the EU Regulatory Process of NonFinancial Reporting, "Social and Environmental Accountability Journal", 36, 1, 76-89.

PGE, 2019, https://standardy.org.pl/wppsndrd/wp-content/uploads/2020/05/PGE _2019_S_SJ.pdf, [15.09.2021].

PGNIG, 2019, https://standardy.org.pl/wppsndrd/wp-content/uploads/2020/ PGNIG_2019_S_SJ.pdf, [15.09.2021].

PKNORLEN, 2019, https://standardy.org.pl/wppsndrd/wp-content/uploads/2020/ 05/PKNORLEN_2019_S_SJ.pdf, [15.09.2021].

Pomykalska B., Pomykalski P., 2017. Analiza finansowa przedsiębiorstwa Wskaźniki i decyzje w zarządzaniu, PWN, Warsaw, p. 131.

Regulation of the Minister of Finance of 25.05.2016 Amending the Regulation on Current and Periodical Information Disclosed by Issuers of Securities and Terms of

Considering Information Required under the Laws of a Non-EU Member State Equivalent, Journal of Laws of 2016, item 860.

CSR, Społeczna Odpowiedzialność Biznesu (CSR) w czasach IV Rewolucji Przemysłowej, kontynuacja, etap X, 2020, Ewolucja raportowania niefinansowego w Polsce. Analiza raportów niefinansowych za 2019 rok spółek notowanych na Giełdzie Papierów Wartościowych w Warszawie, „Kolegium Zarządzania i Finansów, Katedra Teorii Zarządzania, Centrum Badań nad Odpowiedzialnym Biznesem SGH", dr hab., prof. SGH Rafał Mrówka.

TAURONPE, 2019, https://standardy.org.pl/wppsndrd/wp-content/uploads/2020/06/TAURONPE_2019_S_SJ.pdf, [15.09.2021].

Tschopp D., Huefner R., 2015, Comparing the Evolution of CSR Reporting to that of Financial Reporting, "Journal of Business Ethics", 127, 565-577.

SUMMARIES
IN POLISH

Izabela DZIADUCH

OCENA STOPNIA WDROŻENIA ZASAD ZRÓWNOWAŻONEGO ROZWOJU W TRANSPORCIE NA PODSTAWIE EKONOMICZNEJ ANALIZY CYKLU ŻYCIA AUTOBUSÓW SZYNOWYCH

STRESZCZENIE: W artykule przedstawiono ekonomiczną analizę cyklu życia autobusów szynowych. W ramach tej analizy ocenie poddano koszty ponoszone przez użytkownika w fazie eksploatacji autobusu szynowego. Do oszacowania kosztów wykorzystano autorską metodę prognozowania kosztów eksploatacji obiektu technicznego (np. środka transportu, urządzenia, maszyny), która uwzględnia zmienność ponoszonych kosztów w czasie. W artykule przeprowadzono także implementację tej metody weryfikującej możliwość jej zastosowania w praktyce przy szacowaniu kosztów eksploatacji obiektów technicznych. Weryfikacja doświadczalna, która oceni przydatność metody prognozowania kosztów jest celem niniejszego artykułu.

Weryfikację przeprowadzono dla ośmiu jednoczłonowych autobusów szynowych typu X wyprodukowanych przez tego samego producenta. Weryfikacja doświadczalna metody szacowania kosztów eksploatacji w cyklu życia obiektów polegała na:

1. Przeprowadzeniu badań niezawodności obiektów eksploatacji w celu uzyskania danych o charakterze techniczno-ekonomicznym,
2. Wstawieniu danych do metody i obliczeniu prognoz kosztów;
3. Ocenie poprawności wyników.

Stopień trafności prognozy kosztów eksploatacji zmierzono za pomocą względnego błędu prognozy ex post. Analiza zgodności prognozowanych wartości kosztów z rzeczywistymi, wykazała dużą ich zgodność, o czym świadczy poziom oszacowanych błędów względnych (średni błąd wyniósł 4,9%). Uznać zatem można, że wartość prognostyczna metody jest stosunkowo wysoka.

Zaprezentowana w artykule ekonomiczna analiza cyklu życia obiektów technicznych jest jednym z narzędzi do oceny stopnia wdrożenia zasad zrównoważonego rozwoju w transporcie. Ocena stosowania filozofii zrównoważonego rozwoju w praktyce opiera się jednak nie tylko na wiedzy, jakiej dostarcza ekonomiczna analiza cyklu życia, ale także na wiedzy z zakresu środowiskowej i społecznej oceny cyklu życia obiektu. Dlatego też, analiza cyklu życia autobusów szynowych biorąca pod uwagę aspekty środowiskowe i społeczne stanowi kolejny etap pracy badawczej autorki artykułu.

SŁOWA KLUCZOWE: analiza kosztu cyklu życia (LCCA), koszt eksploatacji, autobusy szynowe, zrównoważony transport

Małgorzata BURCHARD-DZIUBIŃSKA

ROLA OGRODNICTWA MIEJSKIEGO W BUDOWANIU ODPORNOŚCI MIASTA NA ZMIANY KLIMATU

STRESZCZENIE: Artykuł ma dwa cele. Pierwszym z nich jest pokazanie roli, jaką miejskie ogrodnictwo może odegrać w budowaniu odporności miasta na różne negatywne skutki wynikające ze zmian w sferze ekonomicznej i społecznej oraz w związku z globalnym ociepleniem. Drugim celem jest zbadanie, czy polskie miasta wykorzystują ogrodnictwo miejskie do wzmacniania odporności systemów społeczno--gospodarczych na zmiany klimatyczne. Na podstawie studiów literaturowych przedstawiono doświad-czenia i współczesne trendy w ogrodnictwie miejskim w różnych krajach jako kluczowy czynnik poprawy odporności miast. Inicjatywy i projekty zostały opisane na podstawie dedykowanych im stron interneto-wych. Aby sformułować rekomendacje dla polskich miast, krytycznej analizie poddano wyniki projektu „Wczujmy się w klimat", w ramach którego opracowano 44 miejskie plany adaptacyjne. Na całym świecie coraz powszechniejsze staje się wykorzystywanie ogrodnictwa miejskiego w celu wzmocnienia odporno-ści miast na zmiany klimatyczne. Polskie miasta jeszcze nie dołączyły do tego pozytywnego trendu.

SŁOWA KLUCZOWE: ogrodnictwo miejskie, odporność miast, adaptacja do zmiany klimatu

Monika PARADOWSKA

STUDIOWANIE ZDALNE I DEKONSUMPCJA – ZRÓWNOWAŻONA MOBILNOŚĆ VERSUS (NIE)ZBĘDNE PODRÓŻOWANIE NA UCZELNIĘ

STRESZCZENIE: Jednym ze skutków pandemii był przymus zdalnego studiowania. Skutkował on obli-gatoryjną dekonsumpcją podróżowania na uczelnię, która, wraz z nauką zdalną, mogą być traktowane jako narzędzia polityki zrównoważonej mobilności. Na tym tle głównym celem artykułu jest określenie percepcji studentów co do korzyści i niekorzyści związanych z codziennym podróżowaniem na uniwersy-tet przed rozpoczęciem nauki online, ze szczególną uwagą poświęconą satysfakcji wynikającej z podró-żowania poszczególnymi środkami transportu. W tym kontekście określono skłonność zarówno do bardziej zrównoważonej mobilności, jak też do potencjalnej, teoretycznej, dalszej dekonsumpcji proce-sów transportowych. Autorka przeprowadziła wstępne badania ankietowe online pośród studentów dwóch uczelni publicznych w Polsce. Uzyskane wyniki wykazały, że studenci w większym stopniu koja-rzyli podróżowanie na uczelnię z korzyściami aniżeli niekorzyściami. Opinie różniły się jednak w zależno-ści od najczęściej stosowanego środka transportu. Użytkownicy samochodu w niewielkim stopniu postrzegali korzyści z dojazdów i byli najmniej skłonni do rezygnacji z motoryzacji indywidualnej. Piesi i rowerzyści dostrzegali najwięcej korzyści i byli najbardziej zadowoleni. Ogólnie rzecz biorąc, po zakoń-czeniu pandemii respondenci kontynuowaliby podróżowanie na uczelnię swoim poprzednim środkiem transportu. Niemniej jednak, kiedy zapytano studentów o wymarzony sposób dotarcia na uczelnię, uwzględniając możliwość dekonsumpcji procesu transportowego w formie taniej, ogólnodostępnej tele-

portacji , samochód okazał się lepszą opcją niż teleportacja wśród studentów dojeżdżających samochodem oraz miejskim transportem zbiorowym. W takiej hipotetycznej sytuacji, jedynie użytkownicy samochodu i studenci preferujący aktywną mobilność nie zmieniliby swojego zachowania transportowego. Wyniki badań stanowią podstawę do rekomendacji dla polityki zrównoważonej mobilności. Kluczową kwestię stanowi zrozumienie powiązań pomiędzy znaczeniem oraz satysfakcją z podróżowania na uczelnię różnymi środkami transportu, prospołecznymi i prośrodowiskowymi postawami transportowymi, a także elastycznością popytu na podróżowanie samochodem. Dlatego też niniejsze badanie dostarcza nowych spostrzeżeń dla rozwoju teorii dotyczącej zrównoważonych zachowań transportowych młodych osób.

SŁOWA KLUCZOWE: nauka zdalna, dekonsumpcja, zrównoważona mobilność, podróżowanie na uczelnię, pandemia COVID-19

Igor PETRUŠKA, Jana CHOVANCOVÁ, Eva LITAVCOVÁ

ZALEŻNOŚĆ EMISJI CO_2 OD ZUŻYCIA ENERGII I WZROSTU GOSPODARCZEGO W UNII EUROPEJSKIEJ: MODEL PROGOWY

STRESZCZENIE: Niniejsza praca ma na celu analizę zależności emisji dwutlenku węgla (CO_2) od zużycia energii pierwotnej przy różnych poziomach produktu krajowego brutto (PKB) w 28 krajach europejskich. Do opracowania modeli wykorzystano dane z lat 1995-2019. W analizie danych panelowych zastosowano efekty losowe, efekty stałe, nieliniowy model progu panelu i model ciągłego załamania. Praca pokazuje, że zależność emisji CO_2 od zużycia energii jest różna na różnych poziomach PKB. Najbardziej odpowiedni okazuje się model z dwiema wartościami progowymi, które określają trzy sposoby zachowania. Wraz ze wzrostem poziomu PKB maleje współczynnik regresji zależności emisji CO_2 od zużycia energii. Zrozumienie związku między tymi zmiennymi ma zasadnicze znaczenie dla świadomego i opartego na dowodach podejmowania decyzji oraz przyjmowania nowych lub rewizji istniejących polityk i strategii w zakresie energii i klimatu na szczeblu UE i krajowym.

SŁOWA KLUCZOWE: zużycie energii, wzrost gospodarczy, emisja CO_2, model progowy

Jakub BARTAK, Dariusz FIRSZT, Marek JABŁOŃSKI, Łukasz JABŁOŃSKI

JAKOŚĆ WYBRANYCH USŁUG PUBLICZNYCH W DOBIE EPIDEMII COVID-19 W OPINII STUDENTÓW KRAKOWSKICH UCZELNI

STRESZCZENIE: Celem artykułu jest prezentacja wyników badania opinii studentów na temat jakości usług publicznych świadczonych w Krakowie przed oraz w trakcie epidemii Covid-19. Zakres analizowanych usług publicznych obejmuje dostawę wody pitnej, odbiór ścieków, ogrzewanie oraz komunikację publiczną. Percepcja jakości tych usług została oceniona z wykorzystaniem badania ankietowego, przeprowadzonego w dwóch turach – w roku 2019 oraz w roku 2021, na reprezentatywnej próbie studentów największych uczelni krakowskich. Analiza wykazała, że pomimo wyzwań związanych z epidemią Covid-19, zasadnicza ocena usług publicznych nie pogorszyła się.

SŁOWA KLUCZOWE: jakość usług komunalnych, Covid-19, percepcja usług publicznych

Roman NOVOTNY, Martin ROVNAK, Lenka STOFEJOVA, Peter ADAMISIN, Matus BAKON

UJĘCIE ANALITYCZNE POSTRZEGANIA WYBRANYCH PROBLEMÓW ŚRODOWISKOWYCH WE WSCHODNIEJ SŁOWACJI: PERSPEKTYWA POKOLENIOWA

STRESZCZENIE: Celem artykułu była ocena i porównanie poglądów respondentów ze wschodniej Słowacji na wybrane zagadnienia środowiskowe z perspektywy pokoleniowej. W badaniu wykorzystano ankietę internetową do zebrania danych. Zgodnie z wynikami, każde pokolenie inaczej postrzega powagę problemów środowiskowych, przy czym pokolenie Y stawia im najwyższy priorytet, a Baby Boomers najniższy. Na podstawie przeprowadzonych badań statystycznych możemy potwierdzić statystycznie istotną różnicę między poszczególnymi pokoleniami respondentów w kwestii pozytywnego wpływu pandemii Covid-19 na środowisko, ale brak statystycznie istotnej różnicy między poszczególnymi pokoleniami respondentów w kwestii oceny tego, czy sortowanie odpadów i recykling zmniejsza ilość odpadów deponowanych na składowiskach czy też zwiększa ilość odpadów deponowanych na składowiskach.

SŁOWA KLUCZOWE: percepcja środowiskowa, postawy ekologiczne, problemy środowiskowe, perspektywa pokoleniowa, wschodnia Słowacja

Katarzyna DEMBOWSKA

RAPORTOWANIE NIEFINANSOWE DOTYCZĄCE ŚRODOWISKA NATURALNEGO W SPÓŁKACH GIEŁDOWYCH Z SEKTORA ENERGII ORAZ PALIW I GAZÓW W ROKU 2019

STRESZCZENIE: Celem artykułu jest przedstawienie praktyki dotyczącej raportowania niefinansowego w zakresie zagadnień dotyczących środowiska naturalnego w spółkach giełdowych na przykładzie sektora energii oraz paliw i gazów. Badaniem zostały objęte spółki z indeksów WIG20, WIG30 i mWIG40 na Giełdzie Papierów Wartościowych w Warszawie w 2019 roku. W artykule przeprowadzono badanie metodą *case study*. W pierwszej części artykułu zostanie zaprezentowana część teoretyczna dotycząca raportowania niefinansowego. Druga część artykułu przedstawia raportowanie niefinansowe ze szczególnym uwzględnieniem środowiska naturalnego na przykładzie spółek giełdowych z sektora energii oraz paliw i gazów.

SŁOWA KLUCZOWE: Raportowanie niefinansowe, społeczna odpowiedzialność biznesu, środowisko naturalne, dyrektywa 2014/95/UE, spółki giełdowe

Types of Publications

1. Scientific Papers

Authors are invited to submit original research manuscripts on theoretical and empirical aspects of Sustainable Deve¬lopment and Environmental Management and Environmental Economics and Natural Resources.

A model form can be found in TEMPLATE. Submissions should have up to 25.000 characters, excluding abstract and reference list, with a clearly defined structure (Introduction, Chapters, Sub- -chapters, Ending/Conclusions). Please strictly observe the number of characters. Each additional 1.000 characters of the text are charged (25 PLN or 6 EUR net).

Papers should be submitted on the website http://ekonomiaisrodowisko.pl to Peer Review process. Submission of a manuscript implies that the work described has not been published previously and is not considered for publication elsewhere.

After considering our reviewers ' comments, the article is treated as the final text. Authors can only make possible corrections resulting from the editorial composition on pdf files sent for our approval. Any modifications should concern only the errors resulting from the work on the text during the composition.

Please proofread the paper before sending them to us, as only the papers without any grammatical and spelling errors will be accepted.

Please use the correct scientific English. The Editorial Office may publish abridged versions of papers or change titles.

Author's Fees: PLN 1500, or 350 EUR.

The fee is charged after accepting the paper for publication.

2. Book Review

We invite you to submit reviews of books that are related to the field of economics and the environment.

Authors of a submitted manuscript must sign the CONTRACT, confirm that the paper has not been published previously and transfer the propriety copyrights concerning the Publisher's work.

3. Information on Academic Conferences, Symposia or Seminars

Editorial Office Contact Details:

FUNDACJA EKONOMISTÓW ŚRODOWISKA I ZASOBÓW NATURALNYCH
Journal "Ekonomia i Środowisko-Ekonomics and Environment"

Correspondence address:

FUNDACJA EKONOMISTOW SRODOWISKA I ZASOBOW NATURALNYCH
Sienkiewicza 22, 15-092 Białystok,
POLAND e-mail: czasopismo@fe.org.pl

Bazyli Poskrobko (1941-2021)

W dniu 28 października 2021 roku zmarł Profesor dr hab. inż. Bazyli Poskrobko – Fundator Fundacji Ekonomistów Środowiska i Zasobów Naturalnych oraz wieloletni redaktor naczelny Czasopisma „Ekonomia i Środowisko".

Redakcja Czasopisma załącza artykuł pro memoria poświęcony Profesorowi, autorstwa T. Borysa, S. Czai i B. Fiedora.

Nie umiera ten, kto trwa w sercach i naszej pamięci.

Elżbieta Broniewicz
redaktor naczelna
Czasopisma „Ekonomia i Środowisko"

Tadeusz BORYS
Stanisław CZAJA
Bogusław FIEDOR

Profesor Bazyli Poskrobko
uczony i nauczyciel akademicki przyjaciel, człowiek

Profesor Bazyli Poskrobko trwającą ponad czterdzieści lat niezwykle aktywną i owocną pracą naukową, działalnością dydaktyczną, kształceniem młodych kadr naukowych, organizacją badań i popularyzacją nauki zasłużył sobie na miano jednego z niekwestionowanych liderów polskiej nauki w takich obszarach, czy subdyscyplinach nauki, jak ekonomika ochrony środowiska, ekonomia środowiska i zasobów naturalnych, polityka ekologiczna, i ekonomia zrównoważonego rozwoju oraz organizacja i zarządzanie w ochronie środowiska. W każdym z wyżej wskazanych obszarów aktywności miał bardzo bogaty, wręcz imponujący pod względem ilościowym i jakościowym dorobek. Dorobek, który w pełni uzasadnia określenie go mianem wybitnego uczonego i nauczyciela akademickiego, osoby o której możemy powiedzieć, że uosabiała humboldtowski ideał uniwersytetu jako instytucji dążącej do doskonałości nauki i nauczania i zarazem twórczego przenikania się tych dwóch sfer. Zarazem jednak, będąc zawsze głęboko zanurzonym w życie społeczno-gospodarcze, a w ekologiczny czy przyrodniczy wymiar procesów rozwojowych w szczególności, znakomicie rozumiał Profesor Bazyli Poskrobko, na czym polega tzw. trzecia misja współczesnego uniwersytetu, czyli potrzeba jego aktywnego oddziaływania na procesy rozwojowe i szeroko rozumiana społeczna odpowiedzialność z tym związana.

Już w okresie po uzyskaniu stopnia naukowego doktora nauk ekonomicznych (1978), a przed kolejnym awansem naukowym, czyli habilitacją w zakresie nauk ekonomicznych (1994), Profesor Bazyli Poskrobko stał się powszechnie znanym i uznanym w kraju autorytetem w zakresie ekonomiki ochrony środowiska, ekonomii środowiskowej oraz organizacji zarządzania w sferze ochrony środowiska i gospodarowania jego zasobami. Z Jego pomysłów i idei będą jeszcze długo korzystać przyszłe pokolenia badaczy. Obszerność dorobku nie pozwala na jego bardziej szczegółową prezentację w tym pośmiertnym wspomnieniu. Przytoczmy zatem tylko kilka ważnych faktów:

- autorstwo (współautorstwo) wielu dziesiątek publikacji naukowych, w tym książek wydanych m.in. przez Państwowe Wydawnictwo Naukowe (obecnie Wydawnictwo Naukowe PWE S.A.) oraz Wydawnictwo „Ekonomia i Środowisko";
- przygotowanie (samodzielnie, jako kierownik zespołu bądź wykonawca) kilkudziesięciu raportów, ekspertyz itp. dla instytucji krajowych i zagranicznych: Ministerstwa Ochrony Środowiska, Zasobów Naturalnych i Leśnictwa, Polskiego Towarzystwa Ekonomicznego, Narodowego Funduszu Ochrony Środowiska i Gospodarki Wodnej, University of Minnesota, Europejskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych i innych;
- członkostwo w Radzie Ekologicznej przy Prezydencie Rzeczpospolitej Polskiej;
- członek-założyciel Oddziału Polskiego Europejskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych i jego wieloletni wiceprezes, współinicjator powołania i redaktor naczelny czołowego polskiego czasopisma w obszarze ekonomii środowiska i ekonomii ekologicznej „Ekonomia i Środowisko";
- rozprawa habilitacyjna pod tytułem: „Sterowanie procesami ochrony środowiska", będąca twórczym wkładem Profesora Bazylego Poskrobko w obszarze badań empirycznych i dociekań teoretycznych nad efektywnością ekonomiczną i skutecznością ekologiczną prawno-administracyjnych i ekonomicznych instrumentów sterowania jakością środowiska w warunkach transformacji systemu gospodarczego Polsce.

Dynamika i jakość dokonań naukowo-dydaktycznych czy organizacyjno-popularyzatorskich w kolejnym okresie Jego pracy, której zwieńczeniem było uzyskanie w roku 2000 tytułu profesora nauk ekonomicznych, były nadal godne najwyższego uznania. Przytoczmy tylko kilka najważniejszych faktów to ilustrujących:

- autorstwo (współautorstwo) siedmiu monografii, rozpraw i studiów;
- autorstwo około trzydziestu referatów opublikowanych w materiałach konferencji międzynarodowych i krajowych;
- współautorstwo czterech podręczników i skryptów;
- wykonanie trzydziestu czterech opracowań w ramach grantów, prac zleconych i ekspertyz (piętnaście samodzielnych i dziewiętnaście współautorskich) oraz kierowanie jedenastoma projektami badawczymi. Zleceniodawcami tych projektów byli: Komitet Badań Naukowych (KBN), Ministerstwo Ochrony Środowiska, Zasobów Naturalnych i Leśnictwa (MOŚZNiL), Instytut Ochrony Środowiska (IOŚ), samorządy terytorialne i przedsiębiorstwa;
- recenzje wydawnicze dwunastu publikacji książkowych i około czterdziestu artykułów naukowych;
- Członkostwo w Komitecie Człowiek i Środowisko przy Prezydium Polskiej Akademii Nauk oraz tytuł Honorowego Akademika Białoruskiej Akademii Nauk Inżynierskich (1997).

Już w okresie przed uzyskaniem tytułu naukowego (2000) Profesor Bazyli Poskrobko w sposób niezwykle znaczący i powszechnie dostrzegany w kręgu ekonomistów środowiska i zasobów naturalnych, specjalistów w zakresie zarządzania środowiskiem, a także wśród przedstawicieli nauk przyrodniczych i technicznych

podejmujących problemy ochrony środowiska, powiększył swój dorobek od strony jakościowej. Należy tu zwłaszcza podkreślić jego publikacje, badania i dorobek wdrożeniowy dotyczący takich dziedzin jak:

a) koszty ochrony środowiska, w tym – nie identyfikowane przez statystykę państwową – bieżące nakłady na ochronę środowiska w przedsiębiorstwach;

b) rachunek ekonomiczny ochrony środowiska;

c) zasady projektowania oraz oceny efektywności funkcjonowania ekonomicznych instrumentów ochrony środowiska, w tym zaprojektowanie nowego system opłat za emisję zanieczyszczeń powietrza (1998 r.). Związana z tym nurtem monografia, „Zarządzanie środowiskiem", zawierała m.in. własny, ogólny model systemu zarządzania środowiskiem, określała jego prawne i polityczne uwarunkowania (zarówno krajowe jak i międzynarodowe – prawo i polityka ekologiczna Unii Europejskiej), dokonywała systematyzacji narzędzi zarządzania środowiskiem oraz proekologicznych systemów zarządzania w przedsiębiorstwie, z uwzględnieniem uwarunkowań wynikających z ogólnej koncepcji jak i polityki zrównoważonego rozwoju (ekorozwoju);

d) wniesienie twórczego wkładu w określenie teoretycznych podstaw i praktycznych rozwiązań w zakresie modelowania systemu zarządzania środowiskiem w skali państwa, regionu i samorządu terytorialnego oraz kosztów i efektów zarządzania środowiskowego w przedsiębiorstwie;

e) analiza teoretycznych i praktycznych aspektów trwałego i zrównoważonego rozwoju (ekorozwoju);

Z pełnym przekonaniem można powiedzieć, że ten dorobek złożył się na stworzenie Białostockiej Szkoły Naukowej szeroko rozumianej ekonomii i ekonomiki środowiska, obejmującej wszystkie wyżej wskazane nurty refleksji teoretycznej i badań empirycznych. Szkoły, która w kolejnych latach osiągała z jednej strony znaczenie i uznanie dzięki dorobkowi Profesora i Jego uczniów, zyskujących kolejne stopnie naukowe (doktora i doktora habilitowanego), z drugiej zaś dzięki twórczej i aktywnej współpracy z innymi ośrodkami naukowymi zajmującymi się ekonomią i ekonomią środowiska, ekonomią ekologiczną i ekonomią zrównoważonego rozwoju: Wrocław i Jelenia Góra, Warszawa, Łódź, Poznań, Szczecin, Katowice czy Kraków. W kolejnych latach niezwykle owocną platformą tej współpracy stały się zwłaszcza zapoczątkowane dzięki inicjatywie Profesora Bazylego Poskrobko, z czasem międzynarodowe, interdyscyplinarne konferencje poświęcone różnym aspektom i obszarom zrównoważonego rozwoju jako współczesnemu imperatywowi i modelowi zarazem rozwoju społeczno-gospodarczego.

W drugiej dekadzie XXI stulecia zainteresowania badawcze Profesora Bazylego Poskrobko objęły zagadnienia wiedzy, jej kształtowania i rozumienia, co było naturalnym wykorzystaniem Jego niezwykle obszernego oraz głębokiego zasobu doświadczeń badawczych. Zaowocowało to wieloma znakomitymi opracowaniami Profesora, które mogą stanowić bogate źródło inspiracji, ale przede wszystkim wiedzy z tego zakresu, o bardzo uporządkowanym i holistycznym charakterze. Warto przywołać w tym momencie dwie monografie. Pierwsza z nich – „Nauka o kreowaniu wiedzy" –

ukazała się w 2017 roku, będąc jedną z pierwszych tego typu prac w polskiej literaturze. Realizując ją Profesor Bazyli Poskrobko rozszerzył wyzwania z zakresu zrównoważonego rozwoju na przestrzeń kolejnej rewolucji cywilizacyjnej – społeczeństwa informacyjnego i gospodarki opartej na wiedzy, czy jak szczególnie lubił – gospodarki opartej na mądrości. Praca Profesora Bazylego Poskrobko pokazała, jak zmienia się charakter współczesnej nauki i metod jej kreowania i jakie generuje to wyzwania dla współczesnego człowieka. Ogromną jej zaletą, a jednocześnie dowodem niezwykłej erudycji Profesora Bazylego Poskrobko jest konsekwentny holizm poznawczy.

Druga praca – „Warsztat naukowy ekonomisty" – opublikowana w 2020 roku, stała się, czego nie można było przypuszczać podejmując to wyzwanie, swoistym „testamentem naukowym" Profesora Bazylego Poskrobko, który pozostawił wszystkim młodszym i bardziej dojrzałym badaczom. Bardzo chciał opublikować tę obszerną, ale i ważną merytorycznie pracę, co Mu się udało i co podkreślał w ostatnich miesiącach swojego życia. Mieliśmy okazję wspólnie z Profesorem współtworzyć, z Jego inicjatywy i pod Jego redakcją naukową, „Warsztat naukowy ekonomisty". To Profesor Bazyli Poskrobko nadał tej pracy unikatowy charakter narracji, opartej także na osobistych doświadczeniach autorów książki i zakładającej – co Profesor wyraźnie podkreśla w Przedmowie, że *„Warsztat naukowy to wiedza i umiejętności wychodząca poza ramy uprawianej dyscypliny. Wzbogaca on wiedzę czysto ekonomiczną o te aspekty, które w dużym stopniu powodują, że dane opracowanie ma walor naukowy i wysoką jakość, a zatem rzeczywiście, a nie pozornie wzbogaca naukę ekonomii".*

W ostatnich latach wydawało się, że wyhamowuje swoją aktywność naukową ale to były tylko pozory. Co pewien czas publikował inspirujące dzieła coraz bardziej wkraczające na obszary innych dziedzin i dyscyplin naukowych. Zawsze podkreślał, że to rozszerzanie perspektywy badawczej było dla niego „starannie pielęgnowanym marzeniem". Obrazowało się coraz odważniejszym wkraczaniu w niezwykle złożone problemy socjologii i psychologii wiedzy, procesów myślenia czy twórczości.

Profesora Bazylego Poskrobko postrzegać należy jako godny rekomendacji i naśladowania wzór uosabiający humboldtowski model uniwersytetu: profesora jako uczonego i profesora jako nauczyciela akademickiego i wychowawcę, czy intelektualnego i duchowego przewodnika młodych adeptów nauki. Wspomnijmy tylko, że pod Jego naukowym kierunkiem kolejne osoby uzyskały stopień doktora nauk ekonomicznych, zaś inne, dzięki Jego pomocy i wsparciu pomyślnie przeprowadziły swoje przewody habilitacyjne. Jedna z Jego naukowych wychowanków uzyskała już tytuł profesora nauk ekonomicznych. Profesor Bazyli Poskrobko był recenzentem w wielu postępowaniach o nadanie stopnia doktora, doktora habilitowanego i o nadanie tytułu naukowego profesora.

Dorobek dydaktyczny Profesora Bazylego Poskrobko jest znany i uznany w całym kręgu ekonomistów środowiska i zasobów naturalnych w Polsce, a dzięki kontaktom międzynarodowym Oddziału Polskiego ESEŚiZN (obecnie Polskiego Stowarzyszenia Ekonomistów Środowiska i Zasobów Naturalnych) oraz osobistej współpracy Profesora z niektórymi uczelniami zagranicznymi (m.in. University of Minnesota w USA

oras Ecole des Hautes Etudes en Sciences Sociales) także za granicą. Propozycje i programy dydaktyczne opracowane osobiście przez Profesora Bazylego Poskrobko lub przez zespoły, którymi kierował, były często wykorzystywane w innych uczelniach polskich, zwłaszcza w ośrodkach współpracujących (Uniwersytety Ekonomiczne we Wrocławiu, Krakowie i Katowicach, Uniwersytet Warszawski, Akademia Górniczo-Hutnicza w Krakowie i inne) z Jego macierzystymi uczelniami. Profesor Bazyli Poskrobko pracował na Politechnice Białostockiej, Uniwersytecie w Białymstoku, czy Wyższej Szkole Ekonomicznej w Białymstoku

Spośród zainicjowanych bądź rozwiniętych (opracowanych) przez Profesora Bazylego Poskrobko przedsięwzięć dydaktycznych do najważniejszych zaliczyć należy:

1. Przygotowanie programów nowych, kierunków studiów i specjalności. Był współautorem planu studiów magisterskich na kierunku *ochrona środowiska*, w tym autorem planu studiów na specjalności *zarządzanie ochroną środowiska*. Pod kierunkiem Profesora Bazylego Poskrobko został opracowany plan studiów magisterskich na kierunku *zarządzanie i marketing*, i plan studiów na kierunku *turystyka i rekreacja*, specjalność *turystyka na obszarach przyrodniczo cennych*. Służył również cennymi uwagami osobom, które starały się wprowadzać nowe kierunki, specjalności i przedmioty środowiskowe na własnych uczelniach.

2. Autorskie plany i programy studiów podyplomowych: „Ochrona środowiska dla nauczycieli", „Zarządzanie ochroną środowiska", „Sterowanie ekorozwojem" i „Zarządzanie".

3. Autorskie programy oraz prowadzenie wykładów z takich przedmiotów, jak: (a) ekonomika ochrony środowiska, (b) ekonomiczne, prawne i społeczne podstawy ochrony środowiska, (c) kształtowanie ekorozwoju, (d) zarządzanie środowiskiem.

4. Prekursorski wkład w stworzenie podstaw ekonomii zrównoważonego rozwoju, szybko rozwijającej się subdyscypliny teorii ekonomii i teorii rozwoju społeczno-gospodarczego.

Będąc uczonym i nauczycielem akademickim wpisującym się w klasyczną, humboldtowską wizję uniwersytetu, Profesor Bazyli Poskrobko był w pełni świadomy, że w poczuciu społecznej odpowiedzialności współczesny uniwersytet, a więc i poszczególni profesorowie, powinni angażować się także w działania służące wspieraniu rozwoju lokalnego, regionalnego, rozwoju kraju, a nawet podejmować wyzwania o charakterze globalnym, z którymi tak często przecież mamy do czynienia choćby w przypadku transformacji od tradycyjnego modelu wzrostu do rozwoju zrównoważonego i trwałego. W tym właśnie kontekście należy postrzegać tak liczne opracowania o charakterze eksperckim i doradczym, jak również inne aktywności Profesora, a w tym zwłaszcza:

1. działalność w stowarzyszeniach naukowych, w tym zwłaszcza Europejskim Stowarzyszeniu Ekonomistów Środowiska i Zasobów Naturalnych – Oddział Polski (m.in. funkcja wiceprezesa), przekształconym następnie w Polskie Stowarzyszenie Ekonomistów Środowiska i Zasobów Naturalnych;

2. współpraca z centralnymi organami administracji państwowej, w tym zwłaszcza Ministerstwem Środowiska, oraz organami samorządu terytorialnego;

3. działania na rzecz podnoszenia poziomu edukacji ekologicznej społeczeństwa przez organizacje różnych form edukacji ekologicznej, w tym zwłaszcza organizację Regionalnego Centrum Edukacji Ekologicznej w Białymstoku i autorstwo bądź współautorstwo wielu cennych publikacji w tym zakresie;
4. bezpośrednie działania organizacyjne związane z urzeczywistnianiem idei trwałego i ekologicznie zrównoważonego rozwoju, zwłaszcza w ramach Programu „Zielone Płuca Polski";
5. organizacja konferencji i seminariów naukowych, w tym w szczególności największej w Polsce interdyscyplinarnej, cyklicznej konferencji „Uwarunkowania i mechanizmy ekorozwoju";
6. działalność wydawnicza, a zwłaszcza utworzenie i prowadzenie przez niemal 20 lat jako redaktor naczelny periodyku „Ekonomia i Środowiska", przez długi czas jedynego tego rodzaju pisma naukowego w krajach Europy Środkowo-Wschodniej. Ponadto, z inicjatywy Profesora Bazylego Poskrobko powstało bardzo zasłużone dla rozwoju ekonomii środowiska i ekonomii ekologicznej w Polsce Wydawnictwo „Ekonomia i Środowisko".

Przedsięwzięcia, które Profesor Bazyli Poskrobko inicjował i realizował odegrały i nadal odgrywają wiodącą rolę w stworzeniu oraz konsolidacji polskiego środowiska badaczy, a także praktyków zajmujących się środowiskiem przyrodniczym i jego relacjami z człowiekiem, społeczeństwem czy gospodarką. Dzięki pomysłom i wieloletniej pracy Profesora możemy dzisiaj cieszyć się istnieniem takiej wspólnoty, podejmującej liczne badania, opracowującej publikacje, popularyzującej wiedzę oraz wprowadzającej zagadnienia ekonomiczno-ekologiczne do życia akademickiego, społecznego i gospodarczego, wspólnoty przyjaznych sobie ludzi.

Wspominając dzieło Profesora Bazylego Poskrobko jako uczonego i nauczyciela akademickiego, jako osoby, która wniosła ogromny wkład do polskiej nauki ekonomii w zakresie takich subdyscyplin jak ekonomia i ekonomika środowiska, ekonomia ekologiczna, ekonomia zrównoważonego rozwoju oraz zarządzanie ochroną środowiska (zarządzanie ekologiczne), nie sposób choćby krótko nie powiedzieć o Nim jako o Człowieku. dla nas bowiem (piszących to wspomnienie) w tym właśnie personalnym wymiarze Jego odejście jest stratą największą i najbardziej bolesną. Tracimy wraz z Jego odejściem serdecznego i niezawodnego Przyjaciela, osobę, której bardzo dużo zawdzięczamy w wymiarze zawodowym, Kolegę z którym współpraca była zawsze i inspirująca i zobowiązująca, z którym przeżyliśmy także wiele miłych i radosnych chwil w życiu prywatnym – na przykład kiedy nam pokazywał wspaniałości podlaskiej przyrody i kultury – który zawsze miał dla nas czas, z którym rozmowa, czy to bezpośrednia czy telefoniczna, rozpoczynała się zawsze szczerym i serdecznym, krótkim zdaniem: witam cię mój przyjacielu.

Wielu z nas odwiedzało prywatnie Profesora Bazylego Poskrobko i jego najbliższych w domu, ciepłym i serdecznym, jak Oni sami. Były niekończące się rozmowy, mądre opowieści Profesora i radość bycia ze sobą. Poruszaliśmy wówczas nie tylko problemy naukowe. Profesor Bazyli Poskrobko miał, o czym nie wszyscy wiedzieli,

duszę artysty. Potrafił zachwycać się pięknem przyrody, estetyką dzieł sztuki, fascynacją płynącą z lektury książek. Sam również wspaniale opowiadał i pisał utwory literackie, niezwykłe i bardzo osobiste. Miał w tym zakresie ciekawe pomysły i rozpoczął ich realizację; zaskakująca śmierć nie pozwoliła ich dokończyć.

Przy pożegnaniu Profesora byliśmy świadkami wielu bardzo osobistych i pełnych wzruszenia czy smutku wspomnień oraz refleksji związanych z Osobą Bazylego Poskrobko, a tym, co je łączyło było uczucie głębokiej wdzięczności za nieustanne tworzenie przez Niego niepowtarzalnej atmosfery życzliwości, serdeczności, gościnności i gotowości do pomocy. Ale jednocześnie Profesor Bazyli Poskrobko unikał deklaracji – zawsze Jego pomoc była bardzo konkretna i dobrze adresowana. I było w tym coś niesłychanie wzruszającego – Profesor Bazyli Poskrobko zawsze uważał, że to tylko On powinien nam dziękować i przepraszać, że może nie dość pomógł. Był to przejaw wielkiej POKORY w stosunku do tego co robił dla innych i wielkiej SKROMNOŚCI, gdy ciągle umniejszał własne zasługi i podkreślał, nawet przerysowując, zasługi innych. A przecież to właśnie Profesor Bazyli Poskrobko stworzył, zwłaszcza przez organizowanie w Białymstoku, Supraślu czy Białowieży cyklu konferencji „Mechanizmy ekorozwoju", swoiste laboratorium integrowania, nie tylko krajowego środowiska, ekologów, ekonomistów, inżynierów, Mottem tego integrowania była zawsze przypominana przez Profesora – przyjaźń w uprawianiu nauki. To laboratorium nieustannie było wzbogacane fantastycznymi wyprawami i zwiedzaniem Podlasia, a niemal w każdym miejscu tego regionu był przez „tutejszych" rozpoznawany i serdecznie witany. To były niezapomniane chwile, w których poznawaliśmy i odczuwaliśmy Wielkie Serce Jego samego, a także Jego Rodziny i Jego Współpracowników. Była to gościnność i serdeczność tak charakterystyczna dla ludzi Podlasia.

Profesor Bazyli Poskrobko nigdy nie administrował ludźmi. Potrafił z nimi nawiązać takie kontakty, które zawsze zachęcały do samorozwoju, do podejmowania nowych wyzwań, niekiedy tylko pozornie – jak przekonywał – przekraczających ich możliwości. Swoją niezwykłą osobowością przyciągał do siebie ludzi, którzy w Jego towarzystwie czuli się potrzebni, zwyczajnie dobrze. Tak było przy wielu inicjatywach Profesora Bazylego Poskrobko. Ich ilość trudno wymienić, ale zawsze cechowała je unikatowość pomysłu, otwarcie na wymianę poglądów oraz niesamowita konsekwencja we wprowadzaniu ich w życie.

Mamy świadomość, że wraz ze śmiercią Profesora Bazylego Poskrobko coś bezpowrotnie straciliśmy. Odszedł od nas Człowiek, który był tak rzadkim przykładem prawości, rzetelności, pracowitości, otwartości na ludzi i ich problemy. Codziennie będzie nam brakować Kolegi, Przyjaciela i Profesora, mądrego Doradcy.

Drogi Bazyli, żegnaj nasz Przyjacielu!