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A GREEN ECONOMY IN MAJOR REGIONAL CITIES OF POLAND – THE STATUS OF ITS IMPLEMENTATION AND TRANSFORMATIONS IN THE PUBLIC SECTOR

ZIELONA GOSPODARKA W MIASTACH WOJEWÓDZKICH POLSKI – STAN WDRAŻANIA ORAZ PRZEKSZTAŁCENIA W SEKTORZE PUBLICZNYM

Summary: The aim of the article is to compare the status of implementing a green economy in selected aspects of management (transport, municipal engineering and environmental protection) in the system of Poland's regional cities, as well as the assessment of cities' similarity in the studied area and the dynamics of the process of adaptation to the requirements of a green economy The study has included Poland's 18 regional cities, i.e. Białystok, Bydgoszcz, Gdańsk, Gorzów Wielkopolski, Katowice, Kielce, Kraków, Lublin, Łódź, Olsztyn, Opole, Poznań, Rzeszów, Szczecin, Toruń, Warszawa, Wrocław and Zielona Góra. Its time scope covered the period 2012-2017. The collected data were used to develop 58 quantitative indicators regarding two aspects: transport and municipal engineering, as well as environment protection in cities, which were later used to analyse the similarity (grouping) of the studied cities with agglomerative methods.

Keywords: green economy, comparative analysis of cities, Poland's regional cities.

Streszczenie: Celem artykułu jest porównanie stanu wdrażania zielonej gospodarki w wybranych aspektach gospodarowania (transport, gospodarka komunalna i ochrona środowiska) w układzie miast wojewódzkich Polski, a także ocena podobieństwa miast w badanym obszarze oraz dynamiki procesu adaptacji do wymagań zielonej gospodarki. Badaniem objętych zostało 18 miast wojewódzkich Polski, tj. Białystok, Bydgoszcz, Gdańsk, Gorzów Wielkopolski, Katowice, Kielce, Kraków, Lublin, Łódź, Olsztyn, Opole, Poznań, Rzeszów, Szczecin, Toruń, Warszawa, Wrocław, Zielona Góra. Jego zakres czasowy obejmował lata 2012-2017. Zebrane dane zostały wykorzystane do opracowania 58 wskaźników ilościowych dotyczących dwóch aspektów: transportu oraz gospodarki komunalnej i ochrony środowiska w miastach, które następnie posłużyły do analizy podobieństwa (grupowania) badanych miast metodami aglomeracyjnymi.

Słowa kluczowe: zielona gospodarka, analiza porównawcza miast, miasta wojewódzkie Polski.

1. Introduction

The concept of a green economy is related to several various economic theories, ideas, practical approaches and assessment tools [Loiseau et al. 2016]. In the primary scientific discourse [Pearce et al. 1989] a green economy as a concept constituted an answer to the non-appreciation of environmental and social costs in a market economy system. Currently, the UNEP defines a green economy as a low-carbon, resource-efficient and inclusive economy, where an increase in income and employment is driven by public and private sectors' investment. This investment should lead to decreasing carbon dioxide emissions and level of pollution, increasing energy effectiveness and the effective management of resources, as well as it should conduce preservation of biological diversity and development of ecosystem services [UNEP 2011, s. 16]. Initially, the term "green growth" referred solely to the ecological development of industry; currently it is used with regard to economic growth. Moving to a green economy can be perceived as eliminating contemporary environmental, economic and social issues in a balanced manner. Nevertheless, knowledge of the topic of the practical implementation of a green economy is still scarce [Gibbs, O'Neill 2015]. The pillar of switching to ecological, green economy is to be provided by policies and programmes (e.g. in the scope of green energy), and the assumptions thereof are expressed in the most important priorities of the European Union's policies [Herrerias et al. 2013].

The interest in a green economy in cities results from the willingness to improve accommodation conditions due to decreasing the environmental burden of urbanised systems and, as a consequence, an improvement of regional and local competitive-ness [Chapple, Hutson 2009; Hahnel 2010]. This competitiveness is manifested with rivalry in the annual competition entitled Global Earth Hour Capital – in 2016 the title was awarded to Paris as an example in the range of the submitted vision of the pro-ecological development and engagement of various stakeholders' groups therein [www1]. Developing a green economy in the case of cities concerns [Rode 2013; Ryszawska 2013]: transport, construction, optimisation of energy consumption and using renewable energy sources, the introduction, protection and preservation of green areas, water, waste, production and food consumption management, the use of modern technological solutions in order to improve city management, including establishing an intelligent infrastructure.

Popularising new technological and infrastructural solutions enables reorienting policies implemented by local government authorities in Poland [Drobniak et al. 2017]. Authorities of Polish cities have been implementing pro-ecological technological and organisational solutions aimed at decreasing the negative impact on the environment. The activities of administrative units in this scope can concern, among others, the functioning of balanced transport systems (including, public transport), municipal construction, waste management and recycling, water and

waste water management and issues related to protecting natural environment. The aim of the article is to compare the status of implementing a green economy in selected aspects of management (transport, municipal engineering and environmental protection) in the system of Poland's regional cities, as well as the assessment of cities' transformations and similarities in the scope of their adaptation to a green economy's requirements. The regional cities were selected as a consequence of a study on the scale of the support for a green economy in Polish cities within the Infrastructure and Environment Operational Programme and Innovative Economy Operational Programme from 2007-2013, where among the ten cities embracing the largest number and value of projects in the scope of a green economy, the capital cities of nine regions of the country were included [Plac 2016]. These issues constitute a continuation of studies concerning the economic transformation in Polish cities during 2005-2012 [Plac 2015]. Quantitative indicators were used in the analysis, on the grounds of which studied centres were grouped with the use of agglomerative methods.

2. Material and research methods

The study covered 18 Poland's regional cities, i.e. Białystok, Bydgoszcz, Gdańsk, Gorzów Wielkopolski, Katowice, Kielce, Kraków, Lublin, Łódź, Olsztyn, Opole, Poznań, Rzeszów, Szczecin, Toruń, Warszawa, Wrocław, Zielona Góra. The time scale of the study covered the period 2012-2017, with the possibility of modification in various sections depending on the availability of data. Analyses are mainly based on data published in the Local Data Bank of the Central Statistical Office (BDL GUS) available on 15 June 2018, which has been supplemented with information from budgetary implementation statements of the studied cities (expenditures in chapter 60004 – Local public transport) and data posted on the websites of cycle systems' operators. The collected data were used to develop 58 quantitative indicators regarding two aspects: transport and the municipal economy, as well as environmental protection in cities. From among them, 30 indicators were used to analyse the similarity (grouping) of the studied cities with the use of agglomerative methods: average linkage and complete linkage. In order to ensure comparativeness of results, the analysis used quantitative information – statistical indicators and dynamics indexes. In the case of data characterised by high volatility in the studied period, the average values from several years were used.

In the complete linkage method the distance between the two groups of objects is defined as a distance between two furthest objects belonging to various groups of objects, whereas in the average linkage method this distance is defined as the arithmetic average of the distances between all pairs of objects belonging to various groups [Panek, Zwierzchowski 2013]. Using the aforementioned method implied the necessity of the prior provision of comparability of data at consecutive steps

[Suchecki 2010] determining the character of variables (Xs – stimulants, Xd – destimulants), transforming destimulants into stimulants (a postulate of uniform preference of variables), standardisation of variables for meeting the additivity postulate (with the Z-transformation method), creating a distance matrix with the use of Euclidean distance measures.

Half of the measures characterised the transport system (markings: T1-T15), and the second half – cities' activities related to municipal engineering and environmental protection (GK1-GK15). Grouping was performed for three sets of variables: T1-T15, GK1-GK15, T1-T15 and GK1-GK15. The symbols of variables stand for: T1 – the length of bus-lanes per 1 ha of developed and urbanised area in 2016 [m], T2 – the number of car parks in the Park & Ride system per 100K citizens of working age in 2016, T3 – the number of city cycle stations as on 01.07.2018 per 100K of residents[1], T4 – cycle lanes per 10K km^2 in 2016 [km], T5 – the length of cycle lanes (road for cycles) – dynamics in 2016 (2013=100), T6 – cycle lanes per 10K of residents in 2016 [km], T7 – road accidents per 100K of residents in 2016 (Xd), T8 – road accidents per 100K of residents – average dynamics in 2015-2016 (average from 2012-2013=100) (Xd), T9 – casualties in road accidents per 100K of residents in 2016 (Xd), T10 – casualties in road accidents per 100K of residents – average dynamics for 2015-2016 (average from 2012-2013=100) (Xd), T11 – the number of passenger cars per 1,000K residents of working age in 2016 (Xd), T12 – the percentage of passenger cars aged 5 years and newer in 2016 [%], T13 – the number of registered buses aged 3 years and newer per 10K of residents in 2016, T14 – the percentage of buses aged 3 years and newer in 2016 [%], T15 – the percentage of buses using fuel other than diesel and petrol in 2016, GK1 – expenditures in chapter 900 – Municipal engineering and environmental protection per 1 resident in 2016, GK2 – property and investment expenditures in chapter 900 – Municipal engineering and environmental protection per 1 resident in 2016, GK3 – property and investment expenditures in chapter 900 – Municipal engineering and environmental protection – average dynamics of changes from 2015-2016 (average from 2012-2013=100), GK4 – expenditures in chapter 90005 – Protection of ambient air and climate per 1 resident (average value from 2012-2016), GK5 – expenditures in chapter 90001 – Waste water management and protection of water per 1 resident (average value from 2012-2016), GK6 – expenditures in chapter 90002 – Waste management per 1 resident (average value from 2012-2016), GK7 – industrial and municipal waste water requiring treatment discharged to the water or ground per 1 resident in 2016 [m3] (Xd), GK8 – industrial and municipal waste water requiring treatment discharged to the water or ground per 1 resident – dynamics in 2016 (2013=100) (Xd), GK9 – biodegradability of municipal waste water BOD/COD ratio in 2016, GK10 – share of waste water discharged directly to the water or ground in industrial waste water discharged in 2016 (Xd), GK11 – the length of sewerage

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[1] For Kraków an estimate value was given.

network (discharging waste water and rain water) released in 2012-2016 per 1 ha of developed and urbanised area [m/ha], GK12 – waste generated per 1 resident in 2017 [tons] (Xd), GK13 – generated waste – dynamics in 2016 (2013=100) (Xd), GK14 – mixed waste collected per 1 resident in 2016 [kg] (Xd), GK15 – mixed waste collected from households – dynamics in 2016 (2013=100) (Xd).

3. Results

With regard to transport the analysis covered the following aspects: expenditures on the organisation and service of local public transport, the infrastructure of public transport and alternative means of transport, road safety and the average number of registered passenger vehicles, the parameters of such vehicles, as well as the type of fuel used by public transport vehicles. The country's regional cities are characterised by a significant diversification of average annual expenditures in chapter 60004 (local public transport) per 1 resident, as well as significant differences concerning the transport infrastructure. In the period 2015-2017 the largest amounts of money for this purpose were allocated in Warszawa (approx. 1.7K PLN/resident/year), whereas the smallest in Zielona Góra (PLN 127.70) and Opole (PLN 207.48). Furthermore, significant expenditures are noted in Poznań (PLN 911.37), Szczecin (PLN 903.57) and Gdańsk (PLN 739.08). In 2013-2016, a system of bus lanes was developed at the fastest rate in: Rzeszów, Szczecin, Bydgoszcz and Łódź; however, in 2016 the longest lanes were located in: Warszawa (48.5 km), Kraków (26.8 km), Wrocław (25.3 km) and Łódź (25 km). The capital city was also the leader in terms of the number of P&R car parks, the number of city cycle stations and the length of cycle lanes. In 2016, 14 P&R car parks were functioning in Warszawa. The system of this type of car parks was also developed in Gdańsk (8), Wrocław (7), Toruń (3), Kraków (2) and Szczecin (1). In the middle of 2018, the system of renting a city cycle was functioning in the majority of Polish regional cities with the exception of: Gdańsk, Gorzów Wielkopolski, Kielce, Olsztyn and Zielona Góra. Work aimed at activating this type of system was pending in Gdańsk, Olsztyn and Zielona Góra. Apart from Warszawa, the most developed networks of cycle lanes are located in Wroclaw (242.5 km), Kraków (185.3 km), Gdańsk (173.5 km), Rzeszów (144 km) and Lublin (138.9 km). Cities with the least developed networks included Gorzów Wielkopolski (43.9 km) and Kielce (49 km), however after 2013, these cities experienced a dynamic development of cycle lanes networks. The density of cycle lanes networks was the highest in Rzeszów and Białystok. With regard to safety (i.e. the number of accidents per 10K residents) the following cities scored the highest: Toruń (33 cases/100K citizens), Bydgoszcz and Gorzów Wielkopolski (51), Warszawa (52) and Białystok (53). The highest frequency of road accidents was noted in Łódź (246 cases/100K residents), and next in Rzeszów (218) and Olsztyn (171). Moreover, in recent years, the number of road accidents has increased in those cities. In particular, more dangerous road accidents causing casualties in 2016 were

noted in Opole (7.6 persons/100K of residents), then Gorzów Wielkopolski (6.5), Katowice (6), Toruń (5.9) and Rzeszów (5.4). Among these cities, Opole and Toruń were characterised by a significant increase in the number of casualties in accidents in comparison with the period between 2012 and 2013.

Green cities' development is aimed at changing the patterns of local residents' behaviour towards using balanced transport. In the case of Polish regional cities in 2016, significant differences were observed in the number of registered passenger cars with regard to the population in those cities. In Warszawa, Wrocław, Katowice, Opole and Poznań, a higher number of vehicles is registered than the number of citizens of working age, whereas there are only 655 vehicles per 1K persons of working age in Białystok. In Warszawa, Katowice and Poznań the age of over a quarter of passenger cars does not exceed 5 years, whereas in Białystok, Bydgoszcz, Gorzów Wielkopolski and Łódź such cars make up only 11-14% of the total number of registered vehicles. Both, the average number of vehicles per 1 resident and the age of vehicles registered in a given city show significant positive correlation with regard to the GDP level per capita of the region where they are located; the Pearson correlation coefficient amounts to 0.77 and 0.73, respectively. In Opole over 20% of registered buses comprise vehicles aged 3 years and newer. With regard to this aspect, among regional cities also the following score highly: Katowice, Kraków, Rzeszów, Olsztyn, Poznań and Warszawa, where the share of such vehicles exceeds 15%. The smallest share of new vehicles is observed in Zielona Góra, Gdańsk, Toruń, Szczecin and Wrocław – in these cities the share of vehicles aged 3 years and newer does not exceed 7%. In 2016, Wrocław was the leader in using buses operating on fuel other than diesel and petrol (30% of vehicles). A significantly higher percentage than in other cities was also noted in Rzeszów (13%). In other regional cities of the country the use of renewable fuels in public transport is of marginal significance.

High expenditures per 1 resident in chapter 900 – Municipal engineering and environmental protection in 2016 were characteristic for: Wrocław (PLN 686), Kraków (PLN 672) and Opole (PLN 521), expenditures lower by more than a half in comparison with Kraków or Wrocław were noted in Poznań (PLN 233), Białystok and Toruń (PLN 256), and Lublin (PLN 290). The highest investment expenditures in this scope, measured with the amount of property investment expenditures per 1 resident in 2016 were noted in Kraków (PLN 197) and Gorzów Wielkopolski (PLN 168). In chapter 90001 – Waste water management and water protection, a large difference in the amount of expenditure per 1 resident was noted[2]. The highest expenditures were noted in Gorzów Wielkopolski, Wrocław and Rzeszów (PLN 57-60/citizen). At the same time, expenditures for this purpose in Bydgoszcz and Toruń did not exceed PLN 4/citizen.

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[2] The significant differentiation of the amount of expenditure in chapters 90001, 90002 resulted in adopting an average value from the period 2012-2016 for the purposes of analyses.
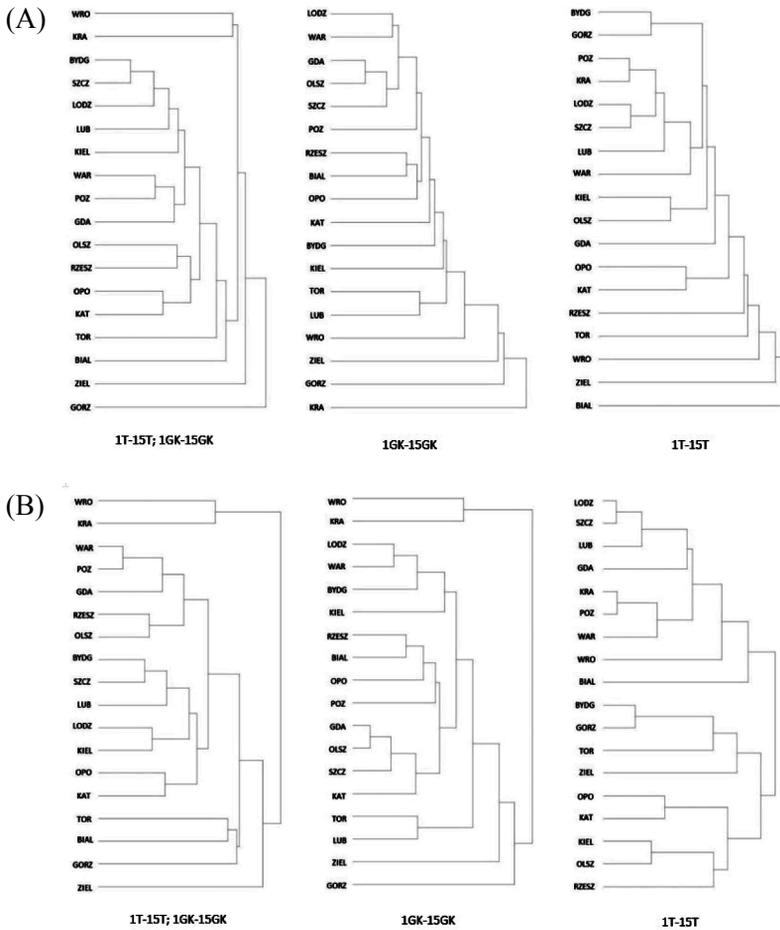
Fig. 1. Grouping regional cities – dendrograms obtained with (A) the average linkage method; (B) the complete linkage method

Source: self-study based on Local Data Bank, Statistics Poland.

In the scope of the effects of tangible investment in environmental protection and water management, it is worth noting the high amount of municipal and industrial waste water discharged directly to the water or ground in 2016 in Katowice (97.4 m³/ resident), in this city only 81.1% of the total amount of this type of waste water was treated. Furthermore, in Kraków, where this indicator was characterised with a tendency to increase in 2013-2016, and in 2016 it amounted to 66.3 m³/resident. Regarding waste management, the largest number of waste per citizen in 2017 was produced in Katowice (3.73 tons) and Opole (3.47), whereas in Katowice in 2013-2016[3] there was

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[3] Dynamics in 2013-2016 due to the change in Opole's administrative borders in 2017.

a significant decrease in the amount of produced waste of 47%, whereas in Opole there was an increase of 62%. The cities where in 2017 the smallest amount of waste was produced included: Toruń (0.16 tons/resident) and Lublin (0.28 tons/resident). Approximately 52% of waste in Kraków in 2017 was recycled, in Wrocław – 27%, in Katowice – 19%, in Toruń – 17%, in Gdańsk – 15%, whereas in other cities this percentage did not exceed 10%. The cities where in 2016 the highest number of mixed waste was produced per 1 resident included: Olsztyn (372 kg), Wrocław (359 kg), Warszawa (343 kg) and Poznań (328 kg), Katowice (327 kg), Kraków (326 kg). The significant increase in the amount of waste produced by households in 2013-2016, in Kraków (by 67%) and in Warszawa (by 53%), should be underlined.

Using the complete linkage method (Figure 1B) allows to indicate five groups of cities similar with regard to "the level of green economy implementation" in terms of municipal engineering, environmental protection and transport: Wrocław and Kraków (1); Warszawa, Poznań, Gdańsk, Rzeszów, Olsztyn (2); Bydgoszcz, Szczecin, Lublin, Łódź, Kielce, Opole, Katowice (3); Toruń, Białystok, Gorzów Wielkopolski (4); Zielona Góra (5). The results obtained from applying the average linkage method (Figure 1A) allow to indicate the stronger similarities of the following centres: Wrocław and Kraków (1); Bydgoszcz, Szczecin, Łódź, Lublin and Kielce (2); Warszawa, Poznań, Gdańsk (3); Olsztyn, Rzeszów (4); Opole and Katowice (5). The application of this method underlines the distinction between Kraków and Wrocław and the other cities: Toruń, Białystok, Zielona Góra and Gorzów Wielkopolski.

In the scope of transport systems, in the case of the results obtained with the average linkage method, especially strong differences are noticeable between Bydgoszcz and Gorzów Wielkopolski compared to Białystok, Zielona Góra, Wrocław, Toruń and Rzeszów. The complete linkage method underlines similarities between: Łódź, Lublin and Szczecin (1), Kraków, Poznań and Warszawa (2), Bydgoszcz and Gorzów Wielkopolski, (3) Opole and Katowice (4) and Kielce, Olsztyn and Rzeszów (5). The application of the average linkage method in order to group cities due to the features of municipal engineering and environmental protection locates the following cities at opposite ends: Łódź, Warsaw, Gdańsk, Olsztyn and Szczecin (1) and Kraków, Gorzów Wielkopolski, Zielona Góra and Wrocław. The centres with the most similar features (based on the results obtained with the complete linkage method) include: Wrocław and Kraków (1), Łódź, Warszawa, Bydgoszcz, Kielce (2), Rzeszów, Białystok, Opole, Poznań (3), Gdańsk, Olsztyn, Szczecin, Katowice (4), Toruń and Lublin (5). Zielona Góra and Gorzów Wielkopolski were not included.

4. Conclusions

The conducted analysis based on the data concerning transport, municipal engineering and environmental protection in cities allows for drawing conclusions regarding the potential of a green infrastructure and the achieved tangible effects of

the investment made, as well as allowing to attempt to indicate units similar with regard to the level of their green economy implementation in the public sector.

With regard to the status of the implementation of green economy solutions in transport systems, Warszawa, as well as Kraków and Wrocław, are leaders in the analysed group in terms of changes. The analysis allows to state that in those cities the subject solutions are applied to the greatest extent. Cities where the obtained results are especially or mostly unfavourable include Gorzów Wielkopolski, Zielona Góra, Kielce and Olsztyn. It is more difficult to indicate definite leaders in the scope of municipal engineering and environmental protection, however it can be stated that in Gorzów Wielkopolski, Toruń, Białystok and Katowice, positive trends in this respect are observed more frequently than in the others. In this case the position of Katowice is ambiguous – on the one hand the city can serve as an example, and on the other, it can be included in the group of cities that are more often than others characterised by explicitly unfavourable indicators (together with Warszawa, Kraków, Opole and Łódź).

All of the country's regional cities are characterised by the small share of new vehicles in terms of their public transport (20% or less). Moreover, using renewable fuels in public transport is of marginal significance, the only exception in this case being Wrocław, where the share of this type of vehicles amounts to almost a third. Furthermore, it is worth underlining that the behaviour of the local residents of the studied cities greatly depends on their level of wealth, which is proven by the significant positive correlation between the number of vehicles registered in the cities and the GDP per capita in a given region. This can mean that while taking decisions on purchasing a new vehicle, residents of Polish regional cities consider pro-ecological factors only to a small degree, and this type of decisions depends more on their purchasing power. As a consequence of the described dependency, cities in the eastern part of the country are more often characterised by a low number of vehicles per 1K of residents, as well as older vehicles.

The conducted grouping of regional centres with the use of agglomerative methods (average linkage) shows an extreme dissimilarity in their analysed scope, namely Kraków and Wrocław, as well as Zielona Góra and Gorzów Wielkopolski. As a result of using the complete linkage method, two groups of relatively similar cities can be indicated, i.e. (1) Warszawa, Poznań, Gdańsk, Rzeszów, Olsztyn and (2) Bydgoszcz, Szczecin, Lublin, Łódź, Kielce, Opole, Katowice. The strongest similarities are shown by the following pairs of cities: Wrocław and Kraków, Warszawa and Poznań, Rzeszów and Olsztyn, Bydgoszcz and Szczecin, Łódź and Kielce, and finally Opole and Katowice.

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