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Waste management in Poland versus the circular economy

Gospodarowanie odpadami w Polsce w warunkach gospodarki w obiegu zamkniętym

Abstract. The authors of the article examined the municipal waste management system in Poland in terms of the impact of European Union directives introducing a circular economy in the European Union countries. When assessing the functioning of the system, the social factor was taken into account, as municipal waste management has a significant impact on social life. For example, increasing costs of waste management, resulting in high increases in fees for garbage collection, cause opposition from residents. Lack of funds for the implementation of waste management tasks by municipalities may result in failure to comply with the obligatory recycling levels, which may result in imposing fines on the municipalities. In addition, recycling rates may not be met due to the coronavirus epidemy. It should be emphasized that, just as the introduction of municipal responsibility for waste management in 2012 was equated to a revolution called commonly the "junk revolution", the conversion of the entire economy to a closed loop is an extremely difficult challenge for municipalities, as neglect of waste management may result in an ecological disaster.

Key words: municipal waste, waste management, circular economy

Synopsis. Autorzy artykułu zbadali system gospodarowania odpadami komunalnymi w Polsce pod kątem wpływu dyrektyw unijnych wprowadzających w krajach Unii Europejskiej gospodarkę w obiegu zamkniętym. Przy ocenie funkcjonowania systemu wzięto pod uwagę czynnik społeczny, gdyż gospodarka odpadami komunalnymi ma znaczący wpływ na życie społeczne. Przykładowo, wzrastające koszty gospodarowania odpadami skutkujące wysokimi podwyżkami opłat za wywóz śmieci powodują sprzeciw mieszkańców. Brak funduszy na realizację przez gminy zadań w zakresie gospodarowania odpadami może skutkować niezachowaniem obowiązkowych poziomów recyklingu, co grozi nałożeniem kar pieniężnych na gminy. Ponadto, poziomy recyklingu mogą zostać niezachowane z powodu epidemii koronawirusa. Należy podkreślić, że tak jak wprowadzenie odpowiedzialności gmin za gospodarowanie odpadami w 2012 roku było przyrównywane do rewolu-

cji, nazwanej powszechnie „rewolucją śmieciową", to przestawienie całości gospodarki na obieg zamknięty stanowi wyjątkowo trudne wyzwanie dla gmin, gdyż zaniedbania w zakresie gospodarki odpadami grożą katastrofą ekologiczną.

Słowa kluczowe: odpady komunalne, gospodarowanie odpadami, gospodarka w obiegu zamkniętym

Introduction

The recent transition of the European Union economy to a closed circuit model has resulted in significant changes in waste management. In the new conditions a waste recycling has become the priority, while other ways of waste utilization like storage and incineration have been reduced. According to the European Union directives, Poland should achieve 50% of waste recovery by 2020. In Poland, since 2012, municipalities are obliged to manage waste [Ustawa z dnia 14 grudnia 2012 r…]. Municipalities represent the local government territorial authority at the lowest level. In large cities, the municipality also includes second-level local government, i.e. district authority. In new conditions in the field of waste management defined by European Union directives, municipalities should pursue two objectives: implement a well-functioning waste collection system and ensure an appropriate level of recycling [Pichtel 2014, OECD 2015]. Taking into account changes in waste management resulting from the transition of the economy to a closed circuit creates a real challenge for municipalities, especially for those that have invested in waste incineration plants. Municipal waste management is the current research area of the authors of this article. The research is being conducted in cooperation with various academic research centers such as the University of Technology and Humanities in Radom, or the Kielce University of Technology. The results of this cooperation were presented at international scientific conferences on logistics, transport systems and transport safety organized by the Transport Committee of the Polish Academy of Sciences in Szczyrk, Poland [Bril et al. 2017] and at national scientific conferences like for example Symposium on Science –Technology – Management organized by the Saint Cross University of Technology in Kielce, Poland [Bril and Rydygier 2016]. The research concerned the use of return logistics rules in the development of municipal waste management systems [Bril and Rydygier 2017]. The research presented in this article fits in the lines of research conducted in Polish research centers in the field of economics on various aspects of municipal waste management, such as, for example, research on the impact of the principles of sustainable development [Maśloch 2014], opinions of residents [Lorek 2015]. On the other hand, the impact of the circular economy is investigated in a technical aspect [Smol et al. 2019], and the authors of this article also took into account the social perception of changes in municipal waste management.

Method of research

The presented article is an analysis of the functioning of the national waste management system based on the expert knowledge of the authors. The authors of this article undertook to assess the situation of waste management in Poland using their knowledge

in the field of return logistics as well as experience in activities in government administration and authorities. Municipal waste management is a specific waste management issue which is closely linked to the social aspect and has a direct impact on the lives of residents. The authors of the article thoroughly examined all legal acts and documents concerning the functioning of the municipal waste management system in Poland: parliament acts, government regulations, announcements of high state offices or acts of local law. The opinions of local government activists, non-governmental organizations, press studies and the position of the inhabitants were also taken into account. As the conducted analysis concerns the aspect of functioning of the municipal waste management system in the conditions of the circular economy, the period 2017–2020 was taken into account. In 2017, the regulation of the Minister of the Environment from 29 December 2016, on the detailed method of selective collection of selected waste fractions came into force [Rozporządzenie Ministra…].

Influence of European Union circular economy on a waste management

European Union directives on the development of circular economy (also called a closed-loop economy) according to which recycling is to be a promise in waste utilization and storage and incineration have been significantly reduced. Waste incineration with heat and electricity production is allowed. These directives order by 2025, at least 55% municipal waste is to be recycled, in 2030 − up to 60%, and in 2035 already 65%. By 2030, only 10% municipal waste will be able to end up in landfills. Earlier, various methods of waste utilization, such as storage, incineration and recycling, were permitted by law [Ustawa z dnia 1 lipca 2011 r…]. In connection with the promotion of sustainable development of the economy in the world, recycling was recommended to recover secondary raw materials [Zygadlo 1999, Christian at al. 2003, Buclet 2010]. The transfer of economy in European Union countries to a closed cycle also changes the functioning of the packaging industry. The limited liability of packaging manufacturers has been promoted up to now, and now the government is introducing the producer's total responsibility for packaging.

In case of a closed economy cycle in urban agglomerations are only allowed the waste incinerations with energy recovery. These activities are part of the search for ways to replace conventional sources with others. Energetically, 1 ton of coal corresponds to 2––3 tons of municipal waste. At the same time, in a sense, waste that is once processed into energy disappears because the energy obtained is used to produce many other products from which energy can also be produced.

In 1 July 2017, in connection with new European Union directives, the Ministry of the Environment has introduced a unified waste selection rule [Rozporządzenie Ministra…]. Waste must to be collected in four containers of different colors: glass packaging (green), paper including cardboard (blue), biodegradable waste with special consideration of biowaste such as kitchen waste (brown) and metals together with plastic (yellow). The mixed waste is collected in black containers. Earlier the waste was segregated, but each commune could use its own segregation system. In Warsaw the segregation covered three groups of waste: dry waste (red containers), glass (green containers) and mixed waste (black containers).

It should be noted that the new waste segregation rules corresponding to the European Union directives preferring recycling depend on the good will of the residents. However, if the residents persistently fail to comply with the segregation rules, they will be punished with a doubling of the waste collection fee. Much in this regard depends on the public's awareness of environmental protection. Listed below are directions for changes in waste management due to a closed-loop economy.

Recycling of hazardous waste

Interest in the recycling of hazardous waste is growing, as it is the way to implement the circular economy. Hazardous waste requires the application of very strict rules, regulated by law, regarding their storage, transport, utilization or recycling. Hazardous waste includes fuels, glycols, paints, glues, industrial ashes, catalysts, solvents, pickling acids and alkalis, or used oils. They are usually disposed of and could be recovered [LaGreda et al. 2010]. For example, the product resulting from the processing of solvents can be used in the paint industry and for the production of plastics. The same is true for glycols used in refrigeration, which can be distilled and reused. Some substances contained in hazardous waste mean that they cannot be recycled. However, their number is gradually decreasing. A good example is the use of metals contained in hazardous waste in catalysts from the food and chemical industries, or in galvanic sludges and in lithium-ion batteries.

Circulation of packagings

In view of the growing amount of municipal waste, actions to reduce their production are important. Because packaging accounts for almost half of municipal waste, municipalities are demanding that producers of packaged goods also invest in the waste management system. As a result, this will reduce drastically rising prices for collecting waste from residents. Manufacturers set the condition: if they were to take over responsibility for bottles, containers, bags or boxes in which they pack their goods, then they would also like to take full responsibility for the collection and management of this waste financed from product fees. There would also be deposits for returnable packaging. However, local government officials believe that they will then have trouble achieving adequate levels of recycling imposed by the European Union. The producer's responsibility for the collection and management of waste is called extended producer responsibility. The implemented concept of extended producer responsibility should lead to a reduction in the amount of packaging waste produced from plastics that cannot be recycled today. It is also possible that some of today's known packaging will be withdrawn from the market, because the burden of being unable to meet recycling obligations will be so high that they will force companies to look for alternative solutions. Another element is the standardization of returnable packaging specified by standards under pain of penalties for marketing non-standard packaging. Municipalities believe that the implementation of extended producer responsibility must involve a product fee paid by the producers. It would ultimately cover the costs associated with the operation and development of the recovery and recycling organization and the selective collection of packaging waste.

The Ministry of Climate, former Ministry of Environment, is working on the new regulations on the extended producer responsibility. The designed system is essentially based on two mechanisms – fees and deposit.

The fees mechanism includes two types of fees by the manufacturer:

- a first fee paid only for marketed packaged products intended for households, which will then be paid to marshal offices,
- a second charge that will apply in practice to all other packaging products that will be marketed and which will be paid to the organization of extended producer responsibility.

The deposit mechanism will apply to selected types of packaging.

In practice, it will be the creation of a completely new system that will be aimed at starting the functioning of a new, green order in the field of environmental protection. Unfortunately, the new regulations were not implemented either in the summer or in the fall. In October 2020, the Ministry of Climate announced that the new provisions on extended producer responsibility will not enter into force until 1 January 2022. From that date, packaging producers will participate in the costs of waste management. The new act will implement the European Union directive on waste, packaging and packaging waste into Polish law. According to the new law, producers of e.g. products in packaging are to finance the collection and management of packaging waste at a much higher level than is currently the case. The fees charged to packaging manufacturers will be determined by the regulator's office. According to the assumptions of the Ministry of Climate, this office is to be established at the Institute of Environmental Protection, which is responsible, inter alia, for maintaining a waste database. The fees are to be collected per ton of packaging placed on the market and will depend, among others, on what they consist of (plastic, metal, paper or glass) and whether they are easier to manage (the fees will be lower, the more environmentally friendly a given product is, i.e. the more recyclable). The production of PET bottles with heat-shrinkable foil will certainly not be profitable. It will also be more expensive to pay for tetrapacks, which consist of several materials and are more difficult to recycle. However, with regard to the deposit system, which includes, for example, purchase points for packaging from buyers, the Ministry of Climate still develops rules in talks with entrepreneurs. Funds obtained from the application of extended producer responsibility will be able to flow to local governments to co-finance waste collection and treatment systems.

Environmental awareness of society

Educational campaigns carried out by municipalities focus on explaining the principles of waste segregation, while there is no explanation as to why waste should be segregated, there is also no teaching on how to produce less garbage, i.e., there are no elements of raising awareness. To explain how to operate in a circular economy, a broad social educational campaign is needed at government level, also for cost reasons. In addition, to the transfer of knowledge, it is necessary to create a fashion for eco-products, the message should focus on the fact that the product from recovery is trendy, at the top and cheaper than a similar one made from raw material not yet processed. To be effective, a campaign to raise environmental awareness must include television, and messages should take advertising time.

Municipalities obliged to run educational campaigns are limited our education actions only to propagating waste segregation instructions. Large cities have more opportunities here than small municipalities. And so, in Warsaw, from February 2020, the second educational campaign is already underway. The first outpaced the real placement of appropriate containers due to protracted tenders for waste collection companies. In addition, it was criticized for the excessive artistic expression of the posters at the expense of their content. Now the educational campaign has to be extended. Posters have not only appeared in the subway and at the bus and tram stops, but also billboards have been used. Leaflets informing about how to properly segregate waste were propagated through post boxes and were also placed in garbage cans and arbors (Figure 1). The current action is completely different from the one carried out in 2019. The idea is that a specific type of waste is selected with information about where to throw it away (Figure 2). The educational campaign only concerns instructions on how to segregate waste, and it does not explain why segregation is necessary. Also it does not promote the principles of closed-circuit economy and does not promote the reduction of waste production by household.

Figure 1. Information leaflets on waste segregation
Rysunek 1. Ulotki informacyjne o segregacji odpadów
Source: private material, photo by E. Rydygier.

Figure 2. Poster at a bus stop
Rysunek 2. Plakat na przystanku
Source: private material, photo by E. Rydygier.

In big cities various pro-ecological actions are also organized by non-governmental organizations with the help of local commune authorities consisting in rewarding people who select waste. One of these actions is the setup the recycling machines in several places in Warsaw (Figure 3).

The recycling machine is similar to a parcel machine, but instead of issuing parcels, it accepts PET bottles, glass bottles and cans. First, the user must download the Eco Wallet application, create an account in it, and after receiving the QR code, scan it in the recycling machine. Points are awarded for each raw material thrown into the recycling machine, which can later be converted into discounts for coffee or tickets to the cinema 'Multikino' and to two Warsaw theaters.

Together 'Coca-Cola' and the 'Our Earth' Foundation are responsible for the project. By funding recyclers, 'Coca-Cola' as a great carbonated beverage producer that generates tons of garbage, wants to encourage people to recycle them. However, this does not replace the producer's responsibility for the production of waste wrapped from bottles used by customers. Customers would prefer to receive money for bottles thrown in to recycling machines.

Figure 3. Recycling machine near the Warsaw City Hall
Rysunek 3. Butelkomat niedaleko warszawskiego ratusza
Source: private material, photo by E. Rydygier.

It is commendable to the attitude of artists who have engaged in promoting recycling by designing furniture or clothing from recycled materials and even by creating works of art from waste. For example, the workers of the scrap metal warehouse in Pruszków, the city near Warsaw, are created steel-cast sculptures showing various vehicles and characters from science-fiction films. The local municipal authorities opened the special pavilion for these sculptures as the Gallery of Steel Figures. Schools are organized trips to this museum for pupils. The Gallery also organizes exhibitions in various Polish cities (Figure 4).

Figure 4. Exhibition of steel figures at the Palace of Culture and Science in Warsaw
Rysunek 4. Wystawa figur stalowych w Pałacu Kultury i Nauki w Warszawie
Source: advertising materials of the Gallery of Steel Figures.

Fees for waste disposal

The transition of the economies of the European Union countries has a closed cycle, resulting in an increase in fees for garbage collection. Pursuant to the act on maintaining cleanliness and order in municipalities, municipal authorities set the amount of fees for waste disposal. Inefficient waste management in Poland causes that waste collection fees are constantly increasing. An increase of garbage disposal fees is inevitable as waste treatment costs are currently underestimated. So far, relatively low rates for garbage did not take into account the real costs of their export and disposal. Meanwhile, the amount of waste produced is constantly increasing. Non-segregating people will usually pay twice as much as segregating ones. The current increase in fees for garbage collection results not only from earlier underestimation of costs, but also, among others from rising fuel and electricity prices. More expensive electricity means higher costs of transport as well as storage or combustion of waste. In 2019, electricity prices did not rise, although they should have been because they were frozen by a special government bill. In 2020, due to the increase in the costs of waste management (as a result of new rules of waste segregation and due to new obligations imposed on waste processing installations, such as: video surveillance, financial security of claims, regulation of legal titles to real estate, fire safety requirements), municipalities introduced high increases in fees for waste disposal. In accordance with the provisions of the Act on maintain of cleanliness and order in municipalities [Ustawa z dnia 1 lipca 2011 r…], self-government authorities cannot set arbitrarily high fees for waste collection. To determine the maximum rates of fees for municipal waste management, the average monthly disposable income per capita in the previous year is of key importance. It is announced by the president of the Central Statistical Office. On 31 March 2020, an average monthly disposable income of 1 person in total for the previous year in the amount of PLN 1819 was announced [Obwieszczenie

Prezesa...]. The maximum rate for waste can be 2% of disposable income. This means that currently residents cannot pay more than PLN 36.38 for collecting segregated waste. In the absence of segregation, the highest rate is PLN 145.52. If the method of calculating the amount of water consumed is used, the maximum rate is PLN 12.7 per cubic meter, whereas when the fee is calculated on the basis of the premises, a resident may pay a maximum of PLN 1.46 per square meter. The highest fee possible when charging it from the household is PLN 101.86. For example in Warsaw, from 1 March 2020, new rules for calculating fees have been adopted by the City Council. On 12 December 2019, the Council of the Capital City of Warsaw has decided to introduce new rates for municipal waste management in Warsaw [Uchwała nr XXIV/676/2019…]. It was agreed that the fees for waste collection will be calculated on a flat-rate basis both for family housing and for multi-family housing. A fixed monthly amount for the collection of segregated waste from a single-family house is PLN 94, and from an apartment in a block of flats or a tenement house − PLN 65. In the event of unsorted waste, the fees will double. These are large increases, which are criticized by residents. Until now, a mixed method was used, depending on the class of households: one person residing in a single-family house paid PLN 30 per month for collecting segregated waste, for two persons − PLN 45, for three and more persons − PLN 60. In the case of a flat in a single-family house, the fees were PLN 15, 23 and 30 respectively. Similarly, in multi-flat real estate, in apartment blocks and tenement houses, the lowest rate was paid by one-person households. The rate for one person to collect segregated garbage is PLN 10, for two persons − PLN 19, for three persons − PLN 28, for four and more persons − PLN 37. In the event of unsorted waste, 20% added the amount indicated. Currently, changes in rates are the most severe for those living on their own premises. Their fees will increase by up to 600%. The fee for waste disposal in Warsaw has not changed since 2013, and labor, energy and fuel costs increased during this time. The Warsaw authorities blame the government for the need for increases, but they could nevertheless be better prepared to introduce them. The method of calculating fees was changed before the vote, the payment was abandoned on the area of the apartment, and a flat rate was introduced for all apartments. Residents do not see the sense of waste segregation, and since waste has to be divided into five fractions, segregation has declined. The waste collection fee is also influenced by the fact that the city does not invest in modern waste treatment plants. Real estate used for non-residential purposes is to be excluded: shopping malls, hotels, etc. Other rates will be developed for them. In December 2019, the town hall wanted to link the fees for garbage collection with the area of apartments. It would also mean increases, especially for lonely and elderly people who occupy large flats from which children moved out. At the last minute before voting, majority club councilors pushed the fee with a flat rate for flats (PLN 65) and single-family houses (PLN 94). Currently, companies using real estate for non-residential purposes pay abnormally low rates for municipal waste management, because this is blocked by law. In view of the residents' permanent objection to the flat-rate fee, during the session on 15 October 2020 Council of the Capital City Warsaw adopted a resolution on new rules for calculating fees for waste management, which will apply from 1 December 2020. The Council of the Capital City of Warsaw decided to introduce a solution other than the flat-rate one, which is provided for in the regulations, i.e. the calculation of the fee depends on the amount of water used. The monthly fee for single-family houses,

multi-family flats and for mixed properties will be calculated according to the formula: PLN 12.73 per cubic meter. The fee will be calculated on the basis of the average water consumption for the next six months of the last year. If the property does not have a water meter or it is not connected to the water supply system or there is no data on water consumption for the period of six consecutive months, we will calculate the fee according to the formula: inhabited property: number of inhabitants × 4 per cubic meter of water × × PLN 12.73, while mixed, uninhabited property (e.g. a delicatessen in a tenement house, a beauty salon in a multi-family block): water consumption standards according to the annex to the resolution of the Council of Warsaw of 12 December 2019 on the method of calculating the fee for waste management and multiplied by PLN 12.73. Both in the case of multi-family and single-family properties, residents will not pay for irretrievably used water, i.e. water used for watering the garden. It will be deducted and will not affect the amount of the waste fees. The fee for summer houses or other recreational and holiday properties will be PLN 181.90 per year. The resolution adopted by the Warsaw Council is criticized by councilors from the opposition club, according to them, the rate per cubic meter should be at least four times lower. They believe that the Warsaw authorities want to save the waste budget by increasing the fees, and so far they have done little on waste management, for example, the extension of the waste incineration plant in the Targówek district has not been completed. Residents perceive the new regulation in fees as a drastic increase, especially severe for families, because on average one person a month would pay approx. PLN 50, two − PLN 100, but a family of four − PLN 200.

Impact of coronavirus epidemic on the waste management

Because of the coronavirus epidemic, there is a fear of a "junk crisis". Today, the municipal industry is the third, after health and uniformed services, front line in the war with corona virus. Many sorting plants, especially the less modern ones, which depend on employees and not machines separating waste into individual fractions, may cease operations. Employees of waste companies may be forced to quarantine, and may refuse to work for fear of exposure to the virus. On the other hand, residents in panic before infection may not stick to waste segregation. Negligence in waste segregation and recycling may result in municipalities failing to comply with the levels of recycling required by regulations (50% this year), which entails millions of penalties. Added to this is the increase in waste collection fees. With ever-increasing costs, waste industry companies may give up contracts or fail because there will be no jobs that would guarantee profitability. The fewer companies, the more difficult it is to manage litter, which in turn translates into increased fees. To avoid such a black scenario, on April 7, 2020 the Minister of Climate and the Chief Sanitary Inspector developed guidelines on the management of waste generated during the occurrence of SARS-CoV-2 coronavirus infection and incidence of COVID-19 disease caused by it. These guidelines are intended for municipalities, people in isolation, healthy persons in quarantine, entities dealing with waste collection and management, and for persons using preventive measures such as gloves or masks at work or during shopping.

According to the guidelines, waste generated by healthy people, e.g. masks and gloves used to minimize the risk of coronavirus infection and spread, including in the workplace, and public transport, or during shopping, should be thrown into a container or mixed waste bag. Waste generated, among others caution is required in places of insulation. Municipalities should provide bags in a specific color or marked with a symbol (e.g. the inscription C) in order to uniquely identify waste, ensure collection at no less than every seven days of marked bags, organize appropriate transport directly to the municipal waste disposal installation of marked bags or designated by the municipality places for the collection of municipal waste from insulated households and to ensure disinfection of reusable containers and means of transporting waste transporting waste from households or persons from groups C.

Waste collection and recycling companies should store selectively collected waste for nine days before sending it for processing. Waste in specially marked bags taken from persons in isolation or quarantine should not be processed with the participation of sorting persons. In the absence of technical processing capabilities only on fully automated lines without human intervention, this waste should be sent directly for disposal (thermal transformation or direct storage is recommended preferably in landfills with an active degassing installation). The guidelines recommend that employees use personal protective equipment, i.e. glasses or visors, masks, gloves and work clothes.

Conclusions

Municipalities in Poland need state support. When passing the waste management to municipalities, the legislator did not expect such deep changes in the functioning of the economy in the European Union. The transfer of the European Union economy to a closed cycle changes the paradigm of dealing with pollution and caring for environmental protection. This matter will not be dealt with by ministerial ordinances. There is a need to change the environmental awareness of the society, but also specific state actions supporting the industry related to waste recycling, which requires special funds. Without this state aid, the municipalities do not carry out the waste management tasks imposed on them. The conflict between municipal and central authorities is already visible today, for example in the area of waste collection charges. A comprehensive reform of all aspects of the system is needed, especially in terms of financial support of investments in recycling, reduction of fees for waste collection, introduction of total producer responsibility for packaging as well as more effective public education, including regarding waste segregation.

References

Bril J., Lukasik Z., Rydygier E., 2017: Gminne systemy gospodarowania odpadami komunalnymi w ujęciu logistycznym [Municipal logistics waste management systems], Autobusy 18, 6, 1327–1334 (CD) [in Polish].

Bril J., Rydygier E., 2016: Efektywne gospodarowanie odpadami jako wyzwanie dla gmin, Monografia Politechniki Świętokrzyskiej M78 [Effective waste management as a challenge for communes], Wydawnictwo Politechniki Świętokrzyskiej, Kielce [in Polish].

Bril J., Rydygier E., 2017: Municipal waste management systems in the terms of logistics, IJEART 3, 8, 16–25.

Buclet N., 2010: Municipal waste management in Europe: European policy between harmonization and subsidiarity, Springer-Verlag, New York.

Christian L., Hellweg S., Stucki S., 2003: Municipal Solid Waste Management, Springer, Berlin.

LaGreda M.P., Buclaingham P.L., Evans J.C., 2010: Hazardous Waste Management, Long Grove, Waveland Press, Illinois.

Lorek A., 2015: Assessment of household waste management system in Silesian voivodeship in consumer opinion, Economic Studies, Scientific Journal of the University of Economics in Katowice 232, 113–123.

Maśloch G., 2014: Gospodarowanie odpadami komunalnymi w aspekcie wyzwań wynikających z realizacji koncepcji zrównoważonego rozwoju (wybrane problemy) [Municipal waste management with regard to sustainable development challenges. Selected aspects], Studia i Prace Kolegium Zarządzania i Finansów 138, 23–38 [in Polish].

Obwieszczenie Prezesa Głównego Urzędu Statystycznego z dnia 31 marca 2020 r. w sprawie przeciętnego miesięcznego dochodu rozporządzalnego na 1 osobę ogółem w 2019 r. [Announcement of the President of the Central Statistical Office of March 31, 2020 on the average monthly total disposable income per person in 2019], M.P. 2020 poz. 330 [in Polish].

OECD, 2015: Environment at a Glance, OECD Publishing, Paris, France.

Pichtel J., 2014: Waste management practices: Municipal, Hazardous, and Industrial, CRC Press, Boca Raton.

Rozporządzenie Ministra Środowiska z dnia 29 grudnia 2016 r. w sprawie szczegółowego sposobu selektywnego zbierania wybranych frakcji odpadów [Regulation of the Minister of the Environment of 29 December 2016 on the detailed method of selective collection of selected waste fractions, as amended], Dz.U. 2017 poz. 19 z późn. zm. [in Polish].

Smol M., Kulczycka J., Czaplicka-Kotas A., Włoka D., 2019: Zarządzanie i monitorowanie gospodarki odpadami komunalnymi w Polsce w kontekście realizacji gospodarki o obiegu zamkniętym (GOZ) [Mamagement and monitoring of municipal waste in Poland in the contect of circulareconomy (CE) implementation], Zeszyty Naukowe Instytutu Gospodarki Surowcami Mineralnymi i Energią PAN 108, 165–184 [in Polish].

Uchwała nr XXIV/676/2019 Rady Miasta Stołecznego Warszawy z dnia 12 grudnia 2019 r. w sprawie ustalenia sposobu obliczania opłaty za gospodarowanie odpadami komunalnymi w przypadku nieruchomości, która w części stanowi nieruchomość, na której zamieszkują mieszkańcy, a w części nieruchomość, na której nie zamieszkują mieszkańcy, a powstają odpady komunalne [Resolution No. XXIV/676/2019 of the Council of the Capital City of Warsaw of December 12, 2019 on the determination of the method of calculating the fee for municipal waste management in the case of which it is partly real estate inhabited by residents, and partly real estate on which no residents live, and municipal waste is generated], Dz. Urz. Woj. 2019.15293 [in Polish].

Ustawa z dnia 1 lipca 2011 r. o zmianie ustawy o utrzymaniu czystości i porządku w gminach oraz niektórych innych ustaw [The Act of 1 July 2011 amending the Act on maintaining cleanliness and order in municipalities and certain other acts, as amended], Dz.U. 2011 nr 152 poz. 897 z późn. zm. [in Polish].

Ustawa z dnia 14 grudnia 2012 r. o odpadach [Act of 14 December 2012 on waste, as amended], Dz.U. 2013 poz. 21 z późn. zm. [in Polish].

Żygadło M., 1999: Gospodarka odpadami komunalnymi [Municipal Waste Management], Wydawnictwo Politechniki Świętokrzyskiej, Kielce [in Polish].

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