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Joanna Bril[1]***, Edward Rydygier***[2]
[1] The Blessed Father Findysz Sub-Carpathian High School in Jasło
[2] Municipal Office of the Capital City of Warsaw

Implementation of return logistics rules in waste management by municipalities

Wdrożenie zasad logistyki zwrotnej w gospodarce odpadami przez gminy

Abstract. The article presents the need to implement the principles of return logistics in municipal waste management, which in Poland is implemented by municipalities as local government bodies. Municipalities have had a statutory obligation since 2012 to develop waste management systems. According to specialists in logistics, municipal waste management systems should meet the requirements of logistics systems. For example, in terms of logistics, the waste management system in Warsaw was evaluated.

Key words: municipal waste, waste management, logistics systems, circular economy

Synopsis. W artykule przedstawiono potrzebę wdrożenia zasad logistyki zwrotu w gospodarce odpadami komunalnymi, która w Polsce realizowana jest przez gminy jako organy samorządu terytorialnego. Gminy mają od 2012 roku ustawowy obowiązek opracowania systemów gospodarowania odpadami. Według ocen specjalistów z zakresu logistyki gminne systemy gospodarowania odpadami powinny spełniać wymagania systemów logistycznych. Przykładowo, w aspekcie logistycznym został oceniony system gospodarki odpadami w Warszawie.

Słowa kluczowe: odpady komunalne, gospodarka odpadami, systemy logistyczne, gospodarka o obiegu zamkniętym

Introduction

According to the amended regulations on waste management, the municipal authorities in Poland are obliged to manage the waste because the municipalities became their owners [Ustawa z dnia 1 lipca 2011 r…]. New waste management policy required by the European Union directives was introduced by the Waste Act in late 2012, which began to apply in 2013 [Ustawa z dnia 14 grudnia 2012 r…]. Waste management regulations speci-

fied in the law are aimed at protect human life and health and protect the environment in accordance with the principles of sustainable development. In detail, the regulations include sections such as prevention of waste generation, reduction of waste production, elimination of negative impact of landfills and processing plants on the environment, and preparation of waste for reuse or utilization.

According to the latest European Union directives related to functioning of the whole economy in close circulation, Poland must achieve 50% of waste recovery by 2020. In addition, the European Union rules stipulate that waste should be processed on its area, so e.g. composting should be done in waste collection areas. Taking into account currently required the priority of recycling, municipalities should accomplish two goals: organizing a well-functioning waste reception system and ensuring an adequate level of waste recovery [Buclet 2010, OECD 2015].

New tasks as results of European Union regulations are the challenge for these municipalities that invested in waste incineration plants [Bril and Rydygier 2016].

According to logistics specialists waste management, in order to achieve efficiency and effectiveness, should be supported by logistical solutions [Żygadło 1999, Szoltysik 2009]. New ways to manage waste can be found in the new branch of logistics called return or reverse logistics. In the literature of the subject, the return logistics is also known by the name waste logistics, recycling logistics, recovery logistics as well as eco-logistics [Szoltysik 2009]. The purpose of waste logistics is to find the most convenient organizational and cost solutions for transport, storage, processing and waste disposal. Waste logistics supports all waste management processes (including full and damaged products recognized by their disposers as a waste) and information related to waste flows from places of origin (appearance in the logistics system) to the place of destination where the waste is treated for reuse, recovery (repair or recycling) or proper disposal and long-term storage [Żygadło 1999, Christian et al. 2003, Pichtel 2014].

The Waste Act, amended in 2012, requires every municipality, which in Poland is the local self-government administration authority, to develop a waste management system [Ustawa z dnia 14 grudnia 2012 r…]. Authors of this article decided to investigate whether municipal waste management systems are logistics systems. Therefore, the purpose of this work is to examine waste management systems developed by municipalities in terms of compliance with the principles of logistics systems. As an example, the waste management system developed by the city of Warsaw was examined.

Methodology of research

As the research material, authors of this article took a waste management system in force in Warsaw, the capital city of Poland. The operation of the system was examined, including the implementation of planned activities and the founded construction of new investments. The analysis of the established waste managing system is carried out on the basis of the expert knowledge of the authors of the article and their experience of working in local governments. The study consisted of comparison the existing plan with the waste logistics system promoted in the literature. Then the implementation of an approved waste management system is examined. The examination of the implementation covered

the period from 2012 to 2020. The implementation of planned activities and investments was followed. It has been shown that many of the significant intended activities have not been carried out in the assumed time, and important investments in waste utilization plants have not been implemented to this day.

Logistics waste management systems

The logistics waste management system should take into account functional areas including waste generation, transport to processing facilities where waste is stored, recycled or neutralized, as well as current general and local regulations [Żygadło 1999, Bril and Rydygier 2017].

External conditions constituting restrictions on the functioning of the logistic waste management system include:

- quantity, composition, and location of waste,
- degree of regularity and dynamics of waste generation,
- principles of environmental protection,
- spatial and urban factors such as the structure and configuration of the settlement network of the region, the location of processing facilities, transport routes, spatial structure of economic activity,
- general standards, as well as local and regional requirements for acceptable environmental pollutants.

Internal conditions are closely related to the technological aspect of transport, storage and processing of waste and include:

- way of collecting waste,
- location and size of objects,
- waste transport routes and appropriate means of transport.

In a static model, the description of the system operation concerns a specific time point and a dynamic model takes into account changes in input parameters over time. Therefore, the dynamic model should take into account:

- frequency of waste generation,
- possibility of stepwise localization of objects,
- restrictions on the capacity of objects,
- possibility of launching new waste recycling processes,
- location of places available to build new objects.

The developed logistics waste management system should contain guidelines for future development as well as planned emergency procedures.

Warsaw waste management system

Warsaw, the Capital City, is the largest city of Poland, located in the central-eastern part of the country, on the Vistula River. Warsaw is a municipality with province rights. Warsaw municipal waste management system was established in a document entitled "Waste Management Plan for the Capital City Warsaw for the years 2008−2011, taking into account the years 2012−2015" [Fajfer et al. 2008]. Due to the dates, it looks like

the waste management system was created before the statutory obligation to develop it and was extended to 2012−2015. The plan includes basic data on the morphology of the waste, the number of inhabitants and the nature of the buildings. Morphological analysis presented in the examined document showed that municipal waste mainly includes organic components (vegetable, kitchen remnants, and animals), paper and cardboard, plastics, glass, metals, minerals, ash fraction, hazardous waste. In the stream of municipal waste there are also components requiring separate treatment, i.e. large-scale waste and waste from the renovation of houses and flats. Warsaw occupies a total area of 617 km^2, inhabited by 1.7 million people. There are also 500,000 people not registered in Warsaw. In the structure of Warsaw residential areas (habitable, industrial and other built-up areas, also undeveloped and recreational areas) are predominant. A significant part of the city area also occupies farmland, over 15,000 hectares, but their surface is decreasing. The remaining part includes grassland (over 3000 hectares). Warsaw is divided into 18 districts (from 2002) having the status of auxiliary self-government units (Figure 1). The largest district constituting 15.4% of the city's total area is Wawer District, then Białołęka (14.1%), Ursynów (8.5%), Wilanów (7.1%), Mokotów (6.9%), Bielany (6.3%), Włochy (5.5%), Bemowo (4.8%), Targówek (4.7%), Wesoła (4.4%), Praga Południe (4.3%), Wola (3.7%), Rembertów (3.7%), Śródmieście, i.e. Central District (3.0%), Praga Północ (2.2%), Ochota (1.9%), Ursus (1.8%) and Żoliborz (1.6%).

To realize waste management in Warsaw the following types of activities are listed:

1. Organization the system of selective waste collection through:
   - collection by the way 'at source' and 'containers set in the neighborhood',
   - district points of voluntary waste collection,
   - mobile points of waste collection.
2. Investments:
   - material recovery facilities for selective waste collection:
     - construction of eight district points of voluntary waste collection,
     - construction of two systems for the sorting of selective waste materials with a capacity of 20,000 Mg/year with the possibility of expansion to 30,000 Mg/ /year; In addition, there will be existing sorts of raw material waste belonging to private entrepreneurs,
     - construction of green waste composting plant with a capacity of 20,000 Mg/ /year,
     - construction of an anaerobic plant for biodegradable waste (a capacity 10,000 Mg/year),
     - construction of an installation for the dismantling of large-scale waste, including partially used electrical equipment with a target capacity of about 10,000 Mg/year,
     - construction of a plant to process the waste generated in home renovations with a capacity of 8,000 Mg/year;
   - installations for the disposal of waste mixed with the recovery of heat and electricity:
     - modernization and extension of the existing municipal waste utilization and incineration plant for operation of the right bank of Warsaw (Municipal Solid

Waste Disposal Plant) and the agglomeration with the target capacity of 312,000 Mg/year,

- undertaking activities aimed at the construction of a second waste disposal facility for operation of the left bank of Warsaw and the agglomeration of 390,000 Mg/year (taking into account the forecasts of the amount of generated waste by 2025 and the possibility of servicing the surrounding municipalities);

– storage facilities:

- construction of a non-hazardous and inert waste landfill with a capacity of 400,000 Mg in 2009, 300,000 Mg in 2011 and then around 190,000 Mg in 2013. The amount of landfill waste will be reduced due to the requirement to reduce the amount of biodegradable waste directed to the landfill and from 8 January 2013 to meet the criteria for the acceptance of waste for disposal at the landfill of that type.

3. Education: different means and forms of teaching the inhabitants how to handle waste properly.

The Warsaw waste management system can be presented on the Figure 1.

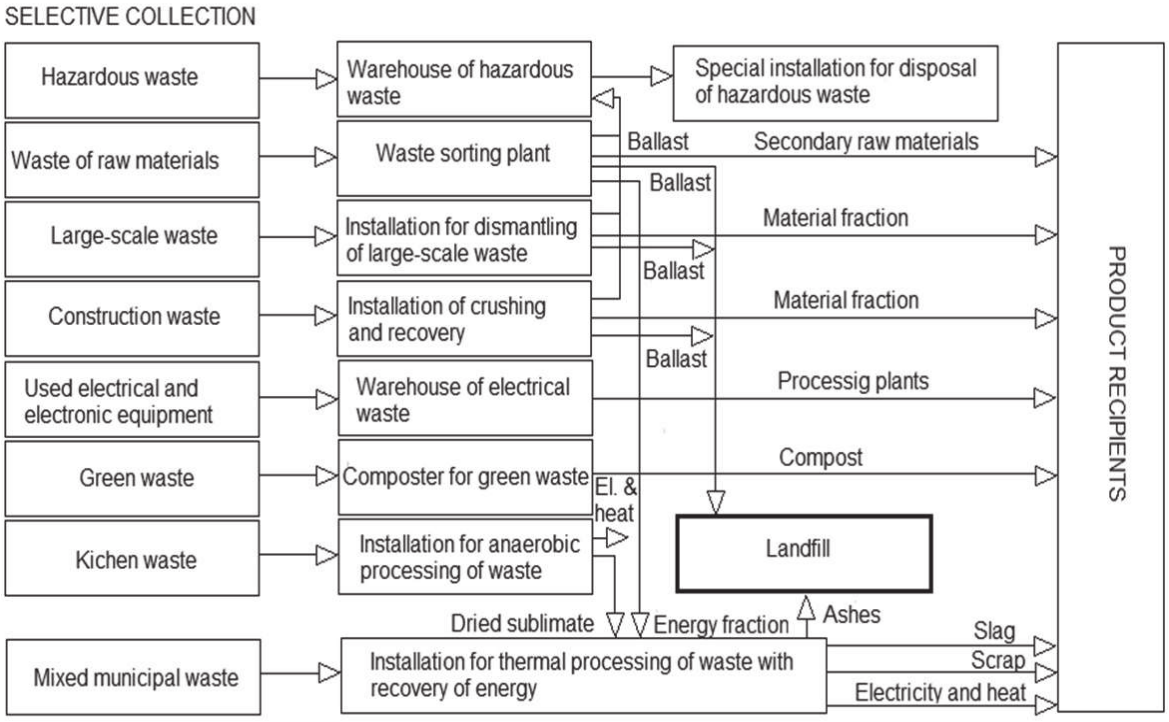

Figure 1. Scheme of waste management system in Warsaw

Rysunek 1. Schemat systemu gospodarowania odpadami w Warszawie

Source: own material on the basis of the [Fajfer et al. 2008].

Functioning of the system:

1. The mixed municipal waste will be directed to the thermal treatment of waste with the recovery of heat and electricity.
2. The system of selective collection and recovery of waste will be expanded:

- selective collection will cover the following types of waste: packaging waste, paper and cardboard waste, plastics waste, metals, hazardous waste, large-scale waste, construction waste, green waste, biodegradable kitchen waste (restaurants, hotels, canteens) and waste electrical and electronic equipment;
- selected raw material waste will be collected 'at source' from single family housing, and from multi-family housing by means of 'neighboring containers' and in district points of voluntary waste collection and then directed to the waste sorting plant,
- household waste and other biodegradable waste will be collected selectively 'at source' in single family and low multi-family housing;
- green waste from green areas will be selectively collected 'a source' and through district points of voluntary waste collection;
- selectively collected biodegradable waste will be composted in green waste composters and fermented in methanization plants;
- hazardous waste will be collected at district points of selective waste collection and in specially designated areas (e.g. pharmacies, schools, shopping centers, etc.); in addition, companies authorized to receive municipal waste, according to the regulations are obliged to receive, among others. Selectively collected hazardous waste by landlords;
- hazardous waste will be disposed of in specialized facilities dealing with the disposal of hazardous waste outside the capital city of Warsaw;
- large-scale waste will be collected as part of a temporary collection and in selective waste collection districts; in addition, companies authorized to receive municipal waste pursuant to the regulations are obliged to collect selectively collected large-scale waste by landlords;
- large-scale waste will be recycled in special dismantling installations;
- waste from repairs and demolition shall be taken in the district points of selective waste accumulation and recovered in the debris processing plant; in addition, companies authorized to receive municipal waste are obliged to collect waste from demolition;
- ballast waste from the sorting plant for packaging and raw material waste will be disposed in the waste thermal treatment plant and to the landfill depending on the type of waste.

Results

Waste Management Plan in Capital City of Warsaw was evaluated by the authors of this paper first in 2015 at the end of the period of validity [Bril et al. 2015]. No new document of the nature of the previous plan covering 2015 was developed. The city authorities planned to update the waste management system as part of the creation of the new "Environmental Protection Program for the Capital City of Warsaw for 2017–2020 with a view to 2023". In this purpose, a cycle of debates under the name EcoWarsaw was organized as meetings of inhabitants with experts and officials. However, as a result of these activities, no document updating the previous plan has been developed. It seems

that the reason for such behavior of the Warsaw authorities was the failure to implement the assumed investment plans. Useful information instructions for residents are published on the municipal portal includes up-to-date communications, legal documents specifying the system framework, form templates for making declarations, answers to frequently asked questions, useful tips, for example how to properly segregate waste, or how to set up a composter.

Regarding the planned system described in the Waste Management Plan in Warsaw, authors of this paper find that it contains logistic-oriented system features, as the specification of external determinants and internal conditions, the forecast of waste generation and required investments.

Evaluation of functioning system was made on the basis of ongoing implementation, comments of self-government activists, guidelines of the Ministry of Environmental Protection and opinions of residents as well as of the changes enforced by the new legislation in response to European Union Circular Economy Directives. Accurate studies of the course in the years 2012–2020 have shown that from the beginning the system was incorrectly implemented.

The main defects in the functioning of the system are:

1. Wild dumps.

Despite the obligation to export and segregate waste to municipalities, rubbish in the initial phase of the system‘s implementation was still being dumped in the forest and into illegal landfills. The reason for littering the surrounding woods was that many people successfully avoided fees, such as keeping the number of homeowners and not reporting their homes. Wild dumps were a scourge beyond control by administrative methods, because to be effective one had to catch the perpetrator on the spot. It wasn‘t until 2020 that the government, through amendments to regulations, supported municipal activities aimed at eliminating illegal garbage dumps and the shadow economy. From 1st January 2020, every waste disposal company registered in the Waste Database must keep electronic records of its operations.

2. Inadequate selective waste collection infrastructure.

The city has long failed to fulfill its obligation to create voluntary waste segregation points. Access to information on hazardous waste collection sites or large-scale disposals was difficult. Due to the permanent monitoring by the local press journalists, the Mayor Hall organized two points of selective waste collection in October 2015: one on the left bank of the Vistula River (Wilanów Districts) and second on the right bank (Białołęka District). In addition, mobile collection points were organized. It consists in the fact that from mid-October 2015 on Wednesdays and Saturdays special cars are on the streets of Warsaw and they stand after 1.5 hours in a designated place in each district. Compared to plans, the implementation of selective waste collection took too long.

3. Lack of economic aspect in educational campaigns.

Long preparing of the principles of waste segregation delayed the placement of properly labeled waste containers in the streets, which was only done in mid-2014. Waste were divided into three groups: dry waste (in red containers), glass (in green containers) and mixed waste (in black containers). After three years of application of the three-fraction segregation method, since 1 July 2017 Ministry of Environmental Protection has introduced a unified waste selection rules. Now, waste must be collected in four containers of

different colors: glass (green containers), paper, including cardboard (blue), biodegradable waste with special consideration of bio-waste such as kitchen waste (brown), metals and plastics (yellow). For mixed waste there are intended black containers. Despite the statutory provisions in Warsaw, containers for a new waste segregation have not been set up. This delayed the educational campaign explaining to inhabitants the new waste segregation. In January 2019, an educational campaign was launched with the use of large advertisements hung at public transport stops and on the walls of the metro station. Unfortunately, it was not possible to introduce new segregation rules in all districts, because the periods of acquiring waste collection companies were extended. The educational campaign had to be extended. In February 2020 posters appeared in the subway and at the stops, and in March 2020 even billboards. The idea of current action is different in 2019 because a specific type of waste is selected with information about where to throw it away. However, there is no action to mobilize residents to reduce waste production. The campaign to promote the reduction of garbage production is very desirable, but it must also have a financial incentive. Meanwhile, the flat-rate fee system is not such an incentive. The new segregation rules related to the circular economy have resulted in an increase in costs, which translated into an increase in fees for the waste disposal. Therefore, the residents received further waste segregation instructional actions as the authorities' expenses not for help but for restructuring.

4. Investment delays.

The construction of new waste treatment plants is necessary because existing plants use outdated technology requiring long storage of waste before they can be re-used. The municipal waste recovery and disposal system is based on the following main facilities Radiowo Composting Plant. Composting plant at 'Marywilska' Street at the Bialoleka District was not approved for waste treatment in 2006. Municipal Solid Waste Disposal Plant and Municipal Waste Landfill are located in Lubna locality in the municipality of the town of Gora Kalwaria. In total, the waste is exported to 19 landfills (public and private), up to 44 waste recovery plants and to the Municipal Waste Disposal Plant (incineration plant). Long-term waste discharges the odor nuisance for local residents. Before the elections in Warsaw in November 2014, the city authorities had promised to transfer the waste disposal plant from the Radiowo in Bielany District to the nearby town of Zielonka. After the election, the new authorities of Warsaw decided to expand the municipal waste treatment facility on the right side of the Vistula River on at the Targówek District. This plant handles around 40,000 tons of rubbish a year, and after the extension, it is expected to convert over 300,000 tons. The factory has been operating since 2000 as a waste incineration plant. This incinerator was obsolete at the time of launch, because the city government had opted for a cheaper old 80s technology. Today the plant uses about 10% of municipal waste, which is about 70 thousand tons per year. In December 2015, the Warsaw Council decided that the expansion of the incinerator, which would remove up to 320,000 tons of rubbish a year, would be financed by the town hall. Municipal City Cleaning Company (called MPO) is able to finance the investment financially as the European Investment Bank had already awarded over PLN 560 million. Commercial credit has been negotiated too. In addition, the MPO was seeking around PLN 600 million from European Union funds to refinance loans. In 2019 the tender for the construction of the incineration plant has been annulled because the MPO was misled by the Chinese tender winner. The new

tender will be settled in mid-2020. The expansion of the incineration plant will begin in 2021, and its completion is expected after 36 months, i.e. around 2024.

5. Inconvenience of landfills for local residents.

The landfill in Radiowo was liquidated in 2017 as a result of the decision of the Administrative Court in Warsaw after a six years battle of Association Czyste Radiowo, but it is still a source of odor, now as a result of green waste storage. Residents say that not only branches or cut grass are transported to the landfill, but also plastic or potato peelers, in plastic bags. Currently the residents have no clout, because the Warsaw authorities do not want to close the disposal of green waste. After that, residents will be exposed to nuisance for a long time because the liquidation of a closed landfill is at least a 30-year process, and it is still degassed all the time.

6. Large increase in fees for waste exports.

Pursuant to the resolution of the City Council of December 12 last year, from 1 March 2020 in Warsaw new rates of waste collection fees are charged. 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, two people – PLN 45, and three and more – 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, e.g. 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, two people –PLN 19, three – PLN 28, and four and more – 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 smallest difference will be felt by multi-person households. The fee for waste disposal in Warsaw has not changed since 2013, and labor, energy and fuel costs increased during this time. The method of calculating fees was changed before the vote, the payment was abandoned on the area of the apartment, and a system flat-rate was introduced for all apartments. Residents do not see the sense of waste segregation into five fractions. The waste collection fee is also influenced by the fact that the city does not invest in modern waste treatment plants and this is a serious drawback.

Conclusions

A thorough analysis of the elaborated plan of Warsaw waste management system has shown that the developed plan meets the requirements of the logistics systems. External determinants and internal conditions have been correctly listed. The functional areas including waste generation and transport to processing plants have been correct showed. The need for new investments was justified. It can be concluded that the developed system has the features of a dynamic model.

Unfortunately, there were undesirable delays and omissions in implementation. It should be emphasized that waste management operates on the basis of free market princi-

ples; therefore municipalities cannot predict many additional factors. A serious omission in the implementation of the assumed plan is the lack of a modern waste incineration plant. This drawback has a negative impact on many other aspects of waste management, and also increases the cost of maintaining the system: economic and social.

It should be pointed that a transformation the economy into a closed circuit is a major change for municipalities which requires a financial help from the state. Currently, two issues are burdensome for residents: waste segregation and waste collection fees. These are matters related to each other because they affect the differentiation of fees. According to the city authorities, the reasons for the increase in waste collection costs are the new five-fraction segregation system, energy price increases (by 67%), rising labor and minimum wage costs (by 25%), reduced rates for companies such as restaurants, shops and shopping centers; and the lack of financial responsibility on the part of producers of plastic packaging, e.g. plastic bottles. The city also includes the reasons for the increase in collection costs: withdrawal of companies from the recycling market, decrease in the prices of raw materials on the market, the cost of obtaining, sorting and cleaning them is several times higher than the purchase prices. Costs increased due to imports of raw material waste from abroad and a dramatic increase of 1100% environmental fee for gases or dust released into the air and placement of waste at the landfill. This rate until the end of 2017 was PLN 24.15, while in 2020 the rates increased up to PLN 270 per ton. No allowances are provided for those residents who reduce waste production. However, the local government is also responsible for the large increase in costs in waste collection. The choice of the method of billing was adopted by a resolution of the City Council for quickly without public consultation and comparison of the results of simulations of the operation of different options. In fact, the Warsaw City Council will now consider replacing the flat-rate scheme with linking charges to water consumption. The situation of mutual blaming local and central authorities for the rising costs of waste disposal is highly undesirable.

The conclusion summarizing this work is the statement that the development of a correct logistics system without systematic and planned implementation of the assumed activities leads to chaos in ad hoc decisions, which has a negative impact on the quality of life of residents.

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Correspondence addresses:

Joanna Bril, PhD
(https://orcid.org/0000-0001-7696-7646)
The Blessed Father Findysz Sub-Carpathian High School
Na Kotlinę St. 8, 38-200 Jasło, Poland
e-mail: joannabril@vp.pl

Edward Rydygier, PhD
(https://orcid.org/0000-0001-7696-7646)
Municipal Office of the Capital City of Warsaw
Kondratowicza St. 20, 00-983 Warsaw, Poland
e-mail: erydygier@gmail.com