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The selective treatment of municipal waste – a challenge for the architect

Beata Komar

beata.komar@polsl.pl | http://orcid.org/0000-0002-8276-704X

Beata Kucharczyk-Brus

beata.kucharczyk-brus@polsl.pl | http://orcid.org/0000-0002-3943-9227

Faculty of Architecture, Silesian University of Technology

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Abstract

Contemporary civilisation has an obsession for consuming more and more goods. This, combined with the packaging habbits of suppliers, results in the emergence of increasingly large amounts of waste in Poland. The collection, selection and utilisation of this waste are becoming more and more significant, expensive and logistically complicated problems. In Poland, municipal utilities enterprises are responsible for solving these problems. However, as the space occupied by the collection, storage and disposal of waste is becoming larger, architects and urban planners should also consider being involved in providing solutions. This article presents figures and legal regulations related to the subject of municipal waste management in Poland. They are correlated with the methods of selective waste collection in Polish housing estates. Scientific research that was performed in housing estates is also presented; this research was aimed at checking the quality of existing urban and architectural solutions for municipal waste collection points. The article moves on to present good practices – examples of beneficial solutions for selective waste collection in selected European countries, such as Sweden and Italy. In order to carry out preliminary analyses of how to solve the functional and aesthetic issues related to housing waste collection points as part of the didactic classes at the Faculty of Architecture, of SUT, research exercises were conducted on the subject of developing a concept for new containers in a housing estate. Based on the received work (65 drawings) elements can be noticed that students most often paid attention to. Based on the conducted research and analysis, conclusions were reached regarding the methods of aestheticisation of district selective waste collection points and fundamental problems related to their design.

Keywords: municipal waste, housing estates, smart city

1. Introduction

The effects of the social pursuit for modernity and the irresistible need to have new things, as well as the policy of various industries – mainly food – with regard to disposable packaging, are the generation of increasing amounts of waste, the selection and disposal of which are becoming one of the most important tasks of the municipal economy.

The purpose of the article is to present Polish figures and legal regulations related to the selection and utilization of municipal waste in order to familiarise the reader with good practices in this area and address the issue of aesthetics. The article is based on literature research, the observations of the authors, scientific research (including the research method developed by one of the co-authors), local visions and didactic classes with students.

2. Legal regulations

After a period of political transformation in Poland, Ustawa z dnia 13 września 1996 r. o utrzymaniu czystości i porządku w gminach was introduced to regulate municipal waste management (Dz.U. Nr 132, poz. 621 i 622). Under the act, the municipality's tasks were: the creation of conditions for maintaining cleanliness by creating appropriate organisational units responsible for performing these works; the construction of waste dumps; the prevention of littering on streets, squares and open areas; the organization of hazardous waste management; "[...] creating conditions for the selective collection, segregation and disposal of waste suitable for use"[1]. In accordance with the act large, colourful containers for selected types of discarded packaging (bottles, cans, cartons, plastics) appeared in various places within Polish cities. Residents filled these containers voluntarily, at various intervals, which was completely unrelated to the regular collection of household waste, which was performed on the basis of mixed waste collection.

The first step towards making the segregation of waste obligatory in Poland was the so-called Rubbish Reform introduced in July 2013 (Dz.U. Nr 152, poz. 897) . On January 1, 2012, Ustawa o zmianie ustawy o utrzymaniu czystości i porządku w gminach oraz niektórych innych ustaw came into force. From that day on, municipalities had 18 months to introduce changes and implement new municipal waste management systems in their area. Under the new ordinance, municipal waste management occurs only on a regional basis Waste should be processed or neutralised as close as possible to the place of its production, in accordance with the principle of proximity, which is one of the principles of the idea of sustainable development. In addition, the responsibilities of municipalities include, inter alia:

- the development and implementation of a municipal waste management system in the commune, including the establishment of collection rules and costs for the collection of mixed and separated waste;
- achieving appropriate levels of recycling, preparation for re-use and recovery by other methods, and the reduction of biodegradable municipal waste sent for storage;
- providing the construction, maintenance and operation of either their own regional waste treatment installations or the sharing of such facilities with other municipalities.

The new regulations gave municipalities a free hand in their strategies with regard to conducting the separate collection of different kinds of waste, so the segregation of waste at the housing estate level looked different in different places. Some immediately introduced a system of separating garbage into: paper, glass, bio-waste, metal / plastic and other, non-segregated.

[1] Art. 3, p. 6 of the Ustawa z dnia 13 września 1996 r. o utrzymaniu czystości i porządku w gminach.

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Some municipalities – to facilitate segregation for residents – divided waste into only two fractions: dry and wet.

In mid-2017, a regulation detailing the manner of collecting municipal waste came into force, which obliges local authorities to selectively collect paper, glass, metals, plastics and biodegradable waste, with a particular emphasis on bio-waste. This method of collecting waste from all households is to be compulsory from mid-2021[2] (Dz.U. 2017 poz. 19).

3. Statistics

The purpose of selective waste collection is to introduce and facilitate the recycling process In this way, nearly the whole amount of the selectively collected metals (99.9%), glass (99.6%) and paper and cardboard (94.3%) is recovered. It is also a major way of managing plastics (88.8%) and clothing and textiles (77.5%). About 10% of selectively collected plastic waste and 20% of separately collected clothing and textile wastes is thermally neutralised. (Domańska, 2018: 145–149).

The mass of collected waste in Poland (including municipal waste) increases year by year. Thus, the average mass of waste per capita increases, although it is still one of the lowest rates among European countries. The average amount of municipal waste generated per capita in the European Union in 2016 amounted to 483 kg. In Poland, in 2017, it was about 320 kg. The highest amounts of waste were generated by countries with high prosperity: Denmark – 777, Germany – 627, Luxembourg – 614 and countries with a high share of tourists, such as Cyprus – 640 and Malta – 621. Additionally, countries outside the European Union generated large amounts of municipal waste: Norway – 724, Switzerland – 720, Iceland – 656 kg per capita (Domańska, 2018: 145–149).

In Poland, a total of 140 million tonnes of waste was generated in **2016**, of which 8% constituted municipal waste (11.6 million tonnes). There was an increase in the amount of municipal waste generated by 7% compared to the previous year. The largest amount of used equipment was collected in the group consisting of large-scale household appliances (50% of the total weight of collected equipment), ICT and telecommunications equipment (14%) and consumer equipment and photovoltaic panels (9%). Around 3.2 million tons of municipal waste collected was recycled (1.8 million tons in 2010, 2.8 million tons in 2015); there was 2.3 million tons of thermal waste disposal in incineration plants (2010 – 39 thousand tonnes, in 2015 – 1.4 million tonnes); biological processing amounted to 0.8 million tonnes (in 2010 – 0.2 million tonnes, in 2015 – 0.6 million tonnes) (Rozkrut, 2018).

In **2017**, 11.9 million tonnes of municipal waste was collected in Poland (more than in 2010 by 19.2%, more than in 2015 by 10.2% and more than in 2016 by 2.7%), including 3.2 million tons for recycling, 0.8 million tons for composting or fermentation, and 2.9 million tons for thermal transformation. On average, 312 kg of municipal waste was collected per one inhabitant of Poland. Compared to 2016, the amount of municipal waste generated per capita increased by 9 kg. Municipal waste collected in 2017 from households (9.9 million tonnes) constituted the majority (83.3%) of municipal waste generated (Rozkrut, 2019).

In **2018,** 12.5 million tonnes of municipal waste was collected (an increase of 4.3% compared to 2017). On average, there was 325 kg of municipal waste collected per capita, which means an increase of 13 kg compared to the previous year. 10.4 million tons of waste was collected from households, which constituted 83.7% of all municipal waste generated.

[2] P. 3 and p. 6 of the Rozporządzenie Ministra Środowiska z dnia 29 grudnia 2016 r. w sprawie szczegółowego sposobu selektywnego zbierania wybranych frakcji odpadów.

The municipal waste collected in 2018 was subjected to the following processes (Bochenek, 2018):

- recovery – 7.1 million tonnes (56.9%), including: recycling – 3.2 million tonnes,
  - biological processing (composting or fermentation) – 1.0 million tonnes,
  - thermal transformation with energy recovery – 2.8 million tonnes;
- disposal – 5.4 million tonnes (43.1%), including:
- thermal transformation without energy recovery – 1.9 million tonnes,
- storage – 5.1 million tonnes.

As the statistics show (Fig. 1), the share of separately collected municipal waste in Poland is increasing every year, which is caused by the introduction of legal regulations, increasingly organised waste collection and processing systems, as well as growing public awareness of the need to separate he produced garbage.

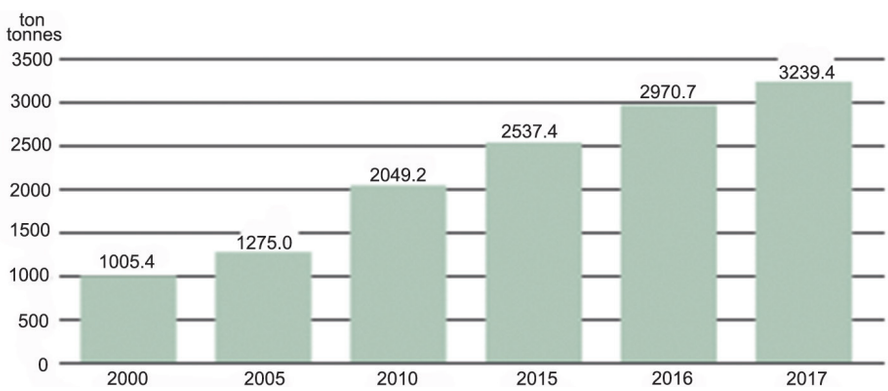

Fig. 1. Segregated municpal waste collected'n Poland (Domańska, 2018: 149)

Table 1. Municipal waste generated
(B. Kucharczyk-Brus study, based on Central Statistical Office data)

	2012	2013	2014	2015	2016	2017	2018
In thousand tonnes							
In total	9,580.8	9,473.7	10,486.1	10,863.5	11,682.8	11,968.7	12,485.4
Collected selectively	1,005.4	1,275.0	2,204.9	2,537.4	2,970.7	3,239.4	3,608.0
Mixed	8,575.4	8,198.7	8,281.2	8,326.1	8,712.1	8,729.3	8,877.5

Despite increasingly better organised methods for the separate collection and utilisation of municipal waste, much remains to be done in this field, especially if we compare European countries where refuse has been segregated in great detail for a long time, also dividing glass into dark and light, separating some biological fractions and separating plastics and metals into different types. Such segregation is possible not only thanks to social educational and promotional activities in which the media should engage but also properly organised selective collection points, especially in housing estates. This is a field of activity for planners, architects and estate administrators. Estate refuse bins should be organised in a way that facilitates the segregation of household waste, as well as the collection of clothing, electrical and electronic equipment, household appliances and furniture. These points should be easily accessible, simple to use and present an appropriate level of aesthetics, harmoniously integrated into the space in which they are located.

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4. Waste segregation in housing estates in the light of scientific research

The problem of such a large amount of waste lies primarily in the consumption and excessive production of packaging. In the times of the Polish People's Republic, the problem of waste was much less significant due to there being less packaging used, with many products not having any packaging at all At that time, the trash was not segregated. However, there were no plastic bottles or food bags. Glass bottles were sold to bottles collection centres, paper was recycled and rubbish chutes operated in blocks of flats. It seems thatthese practices should be viewed in a positive way in retrospect. This is therefore a petition to producers of food and packaging – if the modern world wants to handle waste, it is necessary to first of all reduce the production of packaging.

The second half of the 1980s conditioned the quality requirements with a triad of sustainable ecology-economy-society development, it was thus adopted as a determinant of contemporary quality of life in housing estates. In 2014, one of the co-authors of this article published a monograph (Komar, 2014) entitled *Modern quality of the space of cooperative housing estate in the view of Sustainable Development principles – case study*, where she published her own research method (urban audit), the aim of which was to analyse the quality of housing estates in the light of the principles of sustainable development.

The method included the following research factors:

- Ecology:
  - communication with subcriteria:
    - transport accessibility of the housing estate in relation to: A. the housing estate itself, B. estate – city center, C. housing estate – agglomeration;
- Economy:
  - energy efficiency;
- Society and culture:
  - urban composition of the housing estate with subcriteria:
    - composition of housing interiors with subcriteria: territoriality, privacy, the spatial layout of the housing estate according to Kevin Lynch's theory;
  - car parks;
  - greenery with subcriteria:
    - green screens against external noise,
    - isolation green by trashcans,
    - arranged recreational green space,
    - unarranged recreational green space, delimiting the territory;
  - playgrounds for children and recreation areas for adults;
  - housing estate infrastructure;
  - security – friendly and unfriendly places in the housing estate;
  - universal design – structural and unstructured barriers;
  - aesthetic and usable quality of housing estate.

Waste segregation – the subject of interest in this article – is included in the section on ecology. The following general assessment scale was adopted for the research criteria thus established:

1 – failure to meet standards without the possibility of improvement;
2 – failure to meet standards with the possibility of improvement;
3 – basic compliance with standards according to current regulations;
4 – above-standard compliance with standards;
5 – above-standard compliance with standards and adaptation to modern requirements.

In some casesa 3-point rating scale was proposed. These cases include car parks, the readability of the housing estate composition according to the principles of Kevin Lynch's theory, safety, universal design and waste segregation (Komar, 2016: 13–19).

Table 2. Waste segregation 2013 – Assessment criteria (Komar, 2014) (B. Komar study)

Scores	Assessment criteria adopted
1	lack of waste segregation
2	partial waste segregation (no repeated sequence of blue-green-yellow containers in each quarter of the housing estate)
3	basic segregation of waste at the housing estate (a repetitive sequence of blue--green-yellow containers and additionally gray / black for waste mixed in each quarter of the estate, which can be replaced by other properly described containers)

This method was used in three housing estaes in Katowice and one German estate in Leipzig in 2013. The research results were published in 2014 (Komar, 2014). The following results were obtained:

- **Tysiąclecia Housing Estate in Katowice** (62 refuse collection points were tested) – waste segregation is carried out in an organised and correct manner; mixed waste containers and free-standing coloured waste containers are located next to each block of flats;
- **J.J. Paderewskiego Housing Estate in Katowice** (17 refuse collection points were tested) – there is a basic segregation of waste; mixed waste containers are located behind special closed fences;
- **A. Zgrzebnioka Housing Estate in Katowice** (20 refuse collection points were tested) – basic waste segregation occurs; mixed waste containers are located behind closed special fences; some of the fences are covered with green insulating;
- **Grünau Housing Estate in Leipzig** (52 refuse collection points were tested) **–** there is advanced waste segregation; German society has been familiar with pro-ecological activities for many years; there is advanced glass segregation (divided into coloured and white) as well as paper and cardboard segregation.

In the assessment of waste segregation, all housing estates received a rating of **3 points.**

Based on the conclusions of research conducted in 2013 and the monitoring of modern waste segregation options available today, the author of the method proposes to enrich it with another research criterion: above-standard waste segregation, modern waste systems and containers, additional waste containers (in order to better separate differenttypes of refuse), a separate place for the storage of bulky waste – these measures would result in a rating of 4 points.

Table 3. Waste segregation 2019 – Assessment criteria (B. Komar study)

Scores	Assessment criteria adopted
1	lack of waste segregation
2	partial waste segregation (no repeated sequence of blue-green-yellow containers in each quarter of the housing estate)
3	basic segregation of waste in the housing estate (a repetitive sequence of blue-green--yellow containers and additionally grey / black for waste mixed in each quarter of the estate, which can be replaced by other properly described containers)
4	above-standard waste segregation, modern waste containers and systems, additional waste containers, a separate place for bulky waste storage

The method prepared in this way was used again in the previously tested housing estates in Katowice. Here is what was observed: **Tysiąclecia Housing Estate in Katowice** (62 refuse collection points in the old housing estate and 2 in the new part of the estate were examined) – designated and fenced places for containers for segregated and mixed waste were introducedSpacious, roofed and lockable places for containers for mixed waste were built near the blocks of flats of the Nowe Tysiąclecie Housing Estate (2017); bulky waste is also stored

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there. In the case of this housing estate, only its new part meets the stringent segregation requirements,

- **J.J. Paderewskiego Housing Estate in Katowice** (17 refuse collection points were tested as of 2014),
- **A. Zgrzebnioka Housing Estate in Katowice** (20 refuse collection points were tested as of 2014).

All housing estates received a rating of **3 points.**

Summing up these studies, it should be stated that at the examined housing estates in Katowice still lack rational waste segregation systems that would not only be technologically advanced but would also have a positive impact on the aesthetics of space.

a) b)

Fig. 2. Tysiąclecia Housing Estate in Katowice – places for dump containers: (**a**) The old part of the housing estate; (**b**) The new part of the housing estate (photos by B. Komar)

5. Waste segregation in Polish towns and cities

Solving the issue of selective waste collection is a task combining the fields of logistics, aesthetics, urban planning, architecture, environmental psychology and sociology. Since waste is beginning to occupy an increasingly large part of public space, it is not enough to just discuss the need to segregate it and collect itn colourful bags. The cooperation of society is needed, as well as the efforts of designers, to make the waste collection and disposal system attractive, easy and legible for residents and available to the city cleaning company. The actions of planners and architects are needed to isolate fragments of urban areas intended for interestingly designed selective waste collection stations. So far, this task in Polish cities remains in a very early phase.

Table 4. Current methods of selective municipal waste collection in Poland (B. Kucharczyk-Brus study)

Single-family housing estates	
	The collection of glass (only glass packaging used for food products), paper, plastic mixed with metals, and garden bio-waste is carried out with the use of bags intended for individual fractions: ▸ Blue – paper and cardboard, ▸ Green – glass, ▸ Yellow – plastics, metals, tetrapacks, ▸ Brown – gardening waste (leaves, grass, branches). Putting biowaste from the kitchen (food leftovers) or animal droppings into the brown container or the brown bags is not allowed. Kitchen waste is to be composted on the plot. Animal excrement should be thrown into the container for mixed waste, which are not subject to segregation.
	Collection of bulky waste and debris is carried out upon individual order of a container or the purchase of a "big bag", by a resident, after filling collection should be performed by a company dealing with municipal waste collection. Bulky waste can be taken away by the resident, free of charge to the selective municipal waste collection point (PSZOK).

	The collection of bulky waste from single-family housing estates is organised in such a way that on designated days, such waste can be put outside the property and it will be collected on trucks. Collections of clothing and other textiles are organised in a similar manner.
Multi-family housing estate – housing communities	
 	Selected waste is collected from colourful containers for appropriate fractions. Black containers are intended for mixed waste. The collection of bulky waste from multi-family housing estates constituting housing communities takes place in the same way as the collection from the single-family housing estates presented above – upon individual requests for container or big bag collection. Often, due to the lack of space on the plot of a housing community and the need for accessibility and ease of use, the containers are placed at random places, next to pavements and other pedestrian routes, cluttering the surroundings.
Multi-family housing estate – housing cooperatives	
	In cooperative and communal multi-family housing estates, waste is collected in a designated area, usually enclosed by a lightweight, roofed construction preventing unauthorised access. Selected waste is collected from colourful containers for appropriate fractions. A large, black container is intended for mixed waste. Containers for clothes, footwear and textiles were placed next to the enclosed dustbin. This container is also intended for use by people who are not residents of the housing estate.
	The collection of bulky waste is organised by the housing estate administration. Therefore, residents deposit them at the refuse container due to the lack of a special place designated for this purpose. This approach to the collection of objects of large dimensions spoils the aesthetics of the environment. The lack of roofing means that in bad weather, equipment that would be suitable for reuse (chairs, mattresses, cabinets) or for artistic and creative activities (Kucharczyk-Brus, 2018: 63–69) are completely destroyed.
	In some multi-family housing estates there are containers for small items of electrical and electronic equipment intended for use by all residents, as well as containers for textiles. The problem is that there are too few designated places in cities to store larger electrical equipment, and often residents leave them near such a container or a rubbish dump.

The examples presented above illustrate the main and common problems that occur with selective waste collection. It should be organised in an effective and aesthetic way, without disfiguring or littering the closest surroundings. Another problem is that refuse collected in housing estates is not always well segregated, bags are torn apart by people looking for second-hand materials, clothing is sometimes scattered around containers, electro-waste that is too big to fit the container, is placed next to it, etc.

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Effective segregation takes place at the municipal or city level under the applicable law (Dz.U. 2017 poz. 19), so-called PSZOKs are organised; these are points for the segregated collection of municipal waste, where each resident can give away selected waste without paying additional fees. These points were created in connection with the obligation of municipalities to properly dispose of municipal waste.

Residents may dispose of green, construction and bulky waste, used tyres, chemicals, used batteries and accumulators and electro-waste at these points and this is included in the general fee for collecting garbage. Transport must be organised by the residents themselves and the refuse must fulfill several conditions:

- it must come from a residential property,
- it must be delivered with a vehicle with a maximum permissible weight not exceeding 3.5 tonnes,
- it must be included in one of the following groups:
  - green waste,
  - worn tires,
  - construction and demolition waste from minor refurbishment of residential buildings (e.g. debris, roofing felt, mineral wool, polystyrene, foil) excluding asbestos and eternity,
  - bulky waste,
  - chemicals (e.g. acids, alkalis, photographic reagents, solvents, plant protection products, fluorescent lamps and other waste containing mercury, oils and fats, paints, inks, adhesives, detergents, packaging containing hazardous substances, oil filters, wiping cloths, such as rags or cloths),
  - used batteries and accumulators,

waste electrical and electronic equipment (including devices containing freons, as well as video cassettes and DVDs).

In the event of failure to comply with the above rules, waste may not be accepted. In particular, an employee of PSZOK may refuse to accept waste if it is not sorted or if its type or quantity suggests that it does not come from the household.

The organisation of PSZOKs is very effective especially since they are arranged in a way that allows easy use, access by car, and easier placement of waste in suitably large containers. Unfortunately, they are usually located on the outskirts of towns, and not everyone has the opportunity to transport furniture, debris or household appliances; therefore, such items remain likely objects of fly-tipping.

a) b)

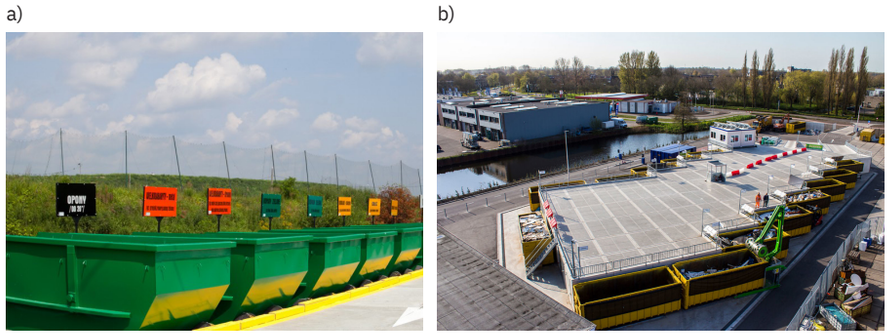

Fig. 3. Types of PSZOK: **(a)** Containers for segregated waste (source: https://skladowiskogliwice.pl/dla-mieszkancow/); **(b)** Modular PSZOK (source: http://gmgroup.biz/produkty/elementy-modulowe-pszok/)

6. Good practices

When attempting to identify suitable strategies for waste segregation infrastructure in Poland urban space, it is worth paying attention to good practices. These include the waste segregation system operated at the Hammarby Sjöstad housing estates in Stockholm and Italy, where the tourism industry is an important factor in the overproduction of waste. The description of the system is based on the local vision of the co-authors of this article and on literature research.

6.1. The waste segregation system at the Hammarby Sjöstad estate in Stockholm

Sweden has been running an economy based on sustainable development for years. Hammarby Sjöstad is one of the ultra-ecological building complexes in Stockholm; it was established in 1995–2017. In its functioning, every resident of the district should be part of an eco-cycle, covering energy, waste, sewage and water management for apartments and offices. An example of this cycle is the production of electricity and heat from waste incineration, the next is the recovery of heat from consumed hot water in a local heating system (Sachanowicz, 2013). This established and implemented system is illustrated in the diagram below.

Swedish law prohibits the removal of organic waste to landfills (Sachanowicz, 2013). Accordingly, the largest proportion of them should be recycled. To this end, two systems were designed on the estate: a stationary, pneumatic, underground garbage collection system and a mobile system.

Stationary pneumatic refuse collection (https://www.envacgroup.com/content/uploads/2017/08/Envac-Hammarby-Sjostad-folder.pdf) is a system by which refuse is transported long distances underground in pipes to a collection station, where it is compacted in closed containers. A stationary pneumatic refuse collection system uses air to transport the waste. The air flow is generated by exhausters creating negative pressure in the pipe system. The air enters the pipes at atmospheric pressure, entraps the solid waste and conveys it to the collection station.

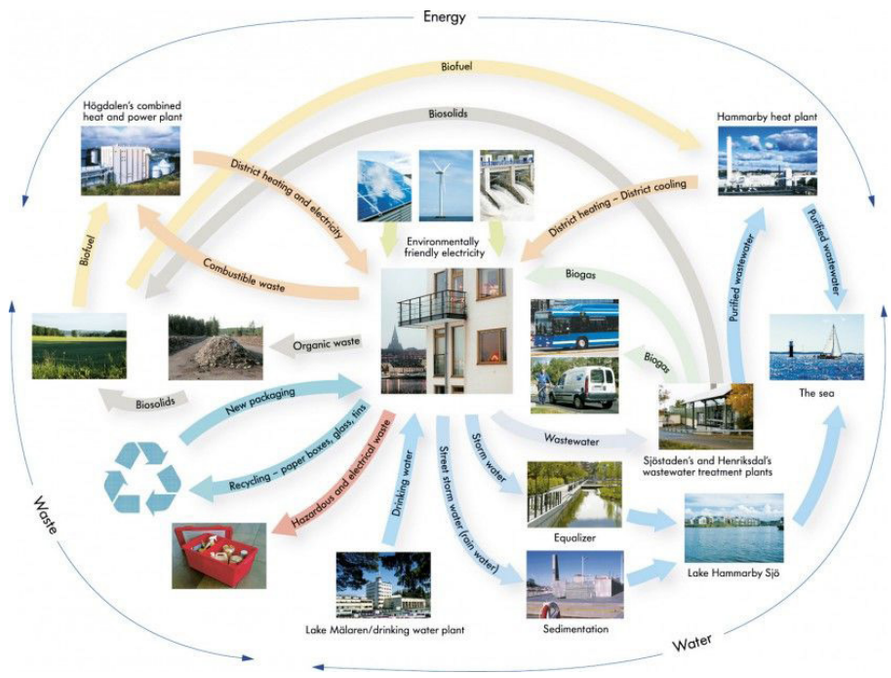

Fig. 4. Hammarby model of Waste-Water--Energy (source: www.hammarbysjostad.se)

The system can handle multiple types of waste simultaneously. One refuse chute is used for each separate waste stream. Typically, two to four separate waste streams are handled in a pneumatic refuse system using the same transport pipe network. In the collection station, each waste stream is directed to a designated container. By collecting each type of waste separately, the system ensures that waste and recyclables are not mixed in the system. As a result of this system:

- garbage does not have to be collected by trucks,
- unpleasant odors from garbage are eliminated,
- residents do not have to have contact with traditional waste containers,
- the problem of access to housing waste by unauthorised persons is eliminated,
- residents contribute to the production of heat and energy from waste,
- the aesthetics of waste containers has been greatly improved.

A mobile waste collection system uses underground tanks that are emptied by suction vehicles. For the people who live or work in the area, the mobile system functions in precisely the same way as a stationary system. Waste bags are placed in inlets located indoors or outdoors. The waste is stored in an enclosed tank below ground. The storage tanks are linked together by docking points via an underground network of pipes. The docking points are strategically located so that collection vehicles do not need to drive into constricted areas, such as backyards and narrow lanes.

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Fig. 5. Stationary garbage collection system, Hammarby Sjöstad, Stockholm (source: www.hammarbysjostad.se)

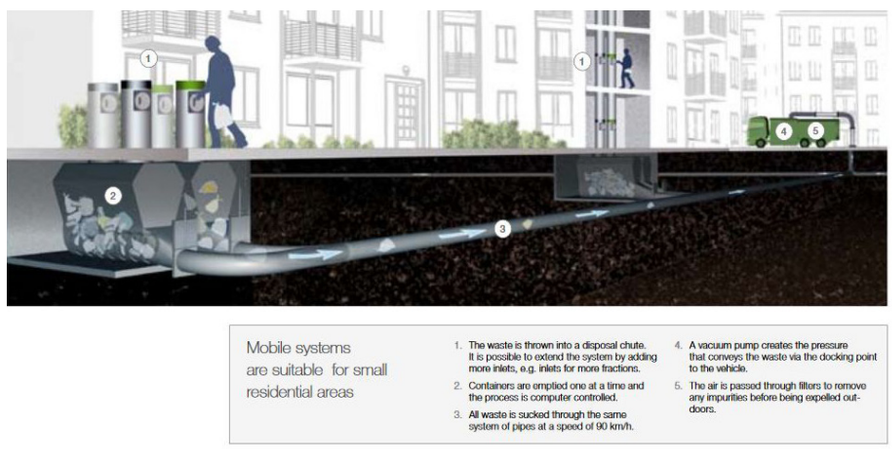

Fig. 6. Mobile garbage collection system, Hammarby Sjöstad, Stockholm (source: www.hammarbysjostad.se)

6.2. Italy – selective waste collection points in Florence

Another case of solutions for the selective collection of municipal waste are centres where there is a significant number of tourists, with only a small number of permanent residents. A comparative policy review of national waste management strategies and targets in the European Union (EU) showed that there is no separate field of policies and instruments for waste generated by tourism either on a European level or on a national level of EU member states. Historic attractive tourist destinations, spa or otherwise, must develop their own treatment policies that comply with the principles of sustainable development (http://www.urban-waste.eu/wp-content/uploads/2017/02/URBANWASTE--Compendium-of-waste-management-practices.pdf).

Within an area of around 100 km², Florence has approx. 380,000 inhabitants. In 2015, Florence was visited by 9 million tourists of which 76% were foreigners. The period of greatest influx of tourists is from April to October, but there are also many tourists in other months. There are different types of tourists who visit the city of Florence: family, individual or organised tour. The duration of visits also

Fig. 7. Florence – municipal waste selective collection points (photos by B. Kucharczyk--Brus)

varies: there are weekend tourists, transit tourists and visitors staying one week or more. The duration is on average 2.5 days. In order to prevent pollution of the city while collecting already segregated waste, selective waste collection points have appeared in many city squares. They can be used by residents, individual tourists, nearby shops and food outlets. Small, colourful containers and open litter bins have been replaced by systems of large, enclosed containers either above ground or underground, which regularly emptied with the help of special vehicles equipped with a crane. These systems take up much more urban space than standard refuse bins.

6.3. Polish example – PRESKO containers

The Polish company Hewea has designed a new waste collection system in the form of Presko containers. The system consists of underground, semi--underground and free-standing containers as well as special vehicles for emptying them. One container of the new type has a capacity of 3,750.0 l and replaces three traditional 1,110.0-liter containers. Unlike traditional containers, they are minimally exposed to the risk of fire, and their design does not allow rats and insects to access waste. They can be opened with the use of a magnetic card or chip. Thus, they are inaccessible to unauthorised persons They are also characterised by a very fast and simple emptying system, for which only one man is needed – the driver of an automated vehicle equipped with a manipulator. The emptying time for one container is 90 seconds.

The new container type is also distinguished by its modern design and it fits much better in the space of housing estates. Wrocław is the first city where the pilot project of the Presko container system is to be implemented.

Fig. 8. PRESKO container system

These few examples show how different systems can be employed for waste management in the city. The most advanced and at the same time the most aesthetic is the Stockholm system, in which most waste disposal operations take place underground. The Polish patent also affects the comfort and aesthetics of places related to waste. It also minimises human work. This seems to be the beginning of good practices in this area.

7. Waste segregation in the aspect of housing esthetics – student design concepts

The problem of waste segregation in a housing estate is associated not only with legal and technological issues but also with aesthetics. By monitoring selected housing estates in the Upper Silesia region since 2013, it can be stated that from then until now, the only thing that has been done in this area is the enclosure of waste segregation containers with fences or walls, some places have also been roofed. In connection with the above, the authors of the article, as part of their own didactic classes conducted at the Faculty of Architecture of the SUT, asked the students to think over the concept of new containers at the housing estate. Based on the received work (65 pieces), it can be stated that the factors to which students most often paid attention were as follows:

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- easy access to containers for both residents and municipal services;
- introducing the possibility of opening containers with the help of card readers, issued by the estate administrator to each resident, which would be used to eliminate unauthorized access to them;
- the possibility of opening containers with the help of pneumatic systems;
- installing roofing over containers;
- placing greenery on the rooftop or in the vicinity of the containers to emphasize the awareness of the need to care for the natural environment;
- providing space for leaving clothing, furniture, household appliances and other bulky items – it is desirable that the collection of these items is organized in such a way as to allow authorised access and reuse unauthorised access in line with the idea "share, do not destroy";
- the elimination of unpleasant odors by using sensory garden roofs on waste segregation facilities;
- placing containers in the ground to enable emptying by vehicles specially designed for this purpose;
- improving the aesthetics of containers by introducing new shapes and dimensions as well as pictograms and inscriptions.

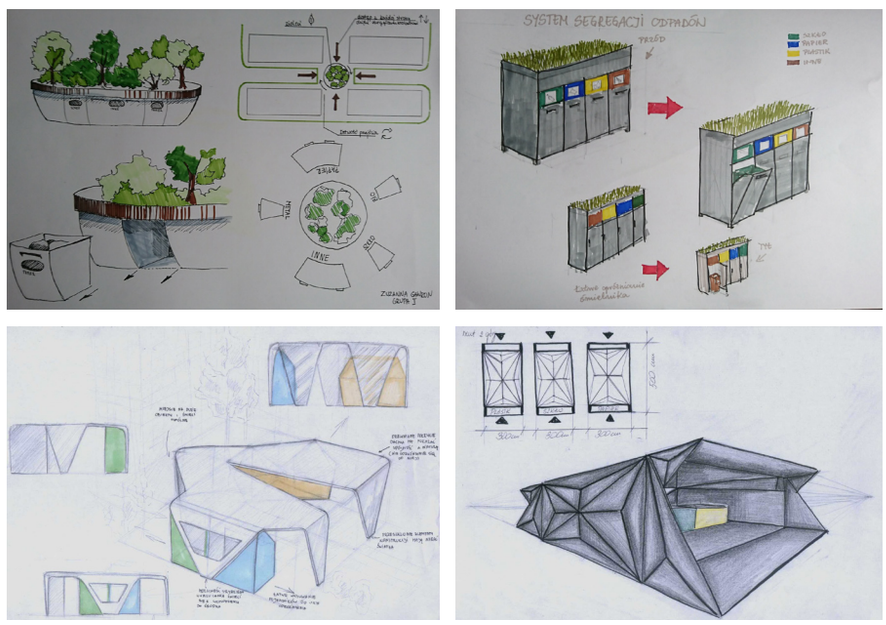

Fig. 9. Examples of students' concepts for a housing estate waste segregation point (source: Archive of Faculty of Architecture, Silesian University of Technology, Gliwice)

In 2020, at the Faculty of Architecture, in cooperation with institutions responsible for cleaning up the city, research and design works related to the development of waste segregation visual information systems will be performed as well as the concept of municipal and neighbourhood selective waste collection points for the city of Gliwice. The works will be a kind of continuation of the topic addressed in this paper.

8. Conclusions

Summing up, the issues presented in this paper can be stated as follows:

- Aestheticisation of PSZOK – in Polish multi-family housing estates, waste collection points occur and are organized in the form of a lockable "gazebo", which regulates the availability of selective and mixed collections of containers. However, neither the architectural form of these pavilions, nor the materials used for their construction match essentially with residential buildings on the housing estate. Also the way

in which this place is organized is ill-conceived – there is lack of space for bulky waste, containers for clothing do not fulfill their function, as the textiles placed there are destroyed when they are displayed next to the container. Observations show that clothing containers are often penetrated by outsiders, so clothing is often thrown out of the container.
- PSZOK design problems – there is the need to arrange a larger section of the plot for a waste collection point to fit used furniture and household appliances. A certain difficulty lies in the fact that this place should be located in such a way that it is not only easily accessible and user-friendly for residents, but also easily accessible for heavy road transport – for vehicles regularly emptying individual containers.
- The Stockholm system can be a very good solution for waste disposal. It seems that piloting it in a selected newly emerging Polish housing estate then observing its work for a set time may contribute to the development of modern standards in this field; once introduced, good practices may affect other Polish housing estates and cities.
- The solutions proposed by students can contribute to the increase of the aesthetics of waste segregation containers for their better inclusion in the identity of housing estates and urban spaces.

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