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## SOCIAL PARTICIPATION IN THE BIOWASTE DISPOSAL SYSTEM BEFORE AND DURING THE COVID-19 PANDEMIC. A CASE STUDY FOR POZNAŃ

The degree of awareness and participation of the city inhabitants concerning biowaste segregation in Poznań has been examined. The assessment was based on a questionnaire survey of a local community, conducted in 2019 and 2020. Within the course of one year, a considerable increase was observed in the number of people involved in selective biowaste collection, at the simultaneous lower degree of acceptance for the operating system, which was evident particularly in the group of surveyed men. Among the respondents, the youngest group, represented by people aged 16–25 years, showed the lowest degree of knowledge and activity in the process of segregation. Regardless of the year of the study the greatest involvement in biowaste segregation was found among older people, individuals with university education, and those living in detached houses. A vast majority of respondents indicated the need to increase the number and scope of educational campaigns as one of the possibilities to improve the current, still unsatisfactory level of public participation. The effect of COVID-19 on social participation has not been directly confirmed; however, based on changes in the attitudes of Poznań inhabitants and growing amounts of biowaste such dependencies may be tentatively assumed.

### 1. INTRODUCTION

In 2020, the implementation of lockdowns in most countries worldwide due to the COVID-19 pandemic contributed to a variety of changes. As a result of enforced social isolation, home-office work, restrictions in tourism, transport, and industrial production, the level of air and surface water pollution decreased, similarly to the level of noise pollution, while biodiversity among plant and animal species improved and coastal beaches became cleaner [1]. Unfortunately, threats and hazards affecting human health and life accumulated, numerous socio-economic problems deepened, atmospheric ozo-

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ne concentration increased, while the volume of generated waste increased dramatically. Because of the unusual epidemic situation, we need to focus primarily on medical waste, generated at hospitals and composed of personal protective equipment such as disposable gloves and masks [2]. However, in addition to medical waste, the mass of biowaste is also significantly increasing. The successive gain in the amount of this waste has been observed for several years, as indicated by Makanjuola et al. [3], who in the years 2006–2020 recorded a 1.5-fold increase in the amount of biowaste, mainly food. The current pandemic situation has significantly contributed to the increment in the mass of biowaste. Sarkodie and Owusu [1] cited data estimating a 20% increase in the mass of biowaste since the beginning of the pandemic.

It needs to be remembered that increased biowaste from households balances the reduced volume of waste from closed businesses in the catering and hotel sectors [4]. One of the aspects of the recorded growing volume of biowaste is connected with the public fears of shortages or problems with purchasing daily necessities, leading to panic buying, as well as the stay-at-home campaigns and increased consumption [1, 4]. Cited authors indicated that a large proportion of the population accumulated excessive amounts of perishable food products, which were not used within the expiry dates, and being spoiled they constituted an additional mass of biowaste [3]. Jribi et al. [5] reported that this type of biowaste comprises mainly vegetables, fruit, and cereal products, which were either inappropriately stored or inadequately prepared and had to be disposed of. According to various sources [6, 7], biowaste accounts for 40–50% of the total mass of the generated waste. In Poland, it is estimated that the segregated mass of biowaste accounts for over 30% of the waste stream, with ca. 329 kg of municipal waste generated per capita in 2019 [8]. Boer [9] reported that biowaste constitutes ca. 116 kg per capita, including ca. 87.9% kitchen biowaste, with the other 12.1% being gardening and landscape waste. It may be assumed that these values will be higher in the nearest future since it is attempted to replace traditional plastic packaging with biodegradable materials [10]. This results, among other things, from implemented *Single Use Plastics Directive* [11] and guidelines limiting the spread of SARS-CoV-2. It is connected with the viability of SARS-CoV-2, which depending on the conditions may survive from 3 up to 28 days on plastics, while the more porous a given material, the shorter the period, dropping to as little as 1 day in the case of wood is [12].

Food waste, similarly to other biodegradable waste, is a heterogeneous mixture of carbohydrates, proteins, fats, and inorganic compounds, which readily undergo microbiological and biochemical changes, becoming noxious waste in the case of its inadequate management. For this reason, its appropriate segregation and disposal are of considerable environmental, economic, social, and health importance, which is particularly crucial in the current pandemic [2]. Despite the provisions of the Directive [13], segregation of the biowaste fraction from the entire waste stream is not a common practice in all European countries [14]. In Poland, such an obligation was imposed by the Resolution of the Minister of the Environment of 29 December 2016 [15].

The problem of the increasing mass of biowaste is inseparably connected with adequate segregation at the source, i.e., in households. The effectiveness and feasibility of such segregation depend first of all on the producers of this waste. For this reason, the degree of social participation and public education play an essential function in the entire process [16–19]. A crucial role of the local inhabitants is not only limited to the implementation of adequate segregation but it is also connected with a lower mass of generated waste thanks to the enhanced environmental awareness of the general public and less consumption-oriented attitudes. However, implementing selective waste collection at the source, public awareness, and acceptance of the imposed waste segregation system may vary depending on the individual attitudes of the local inhabitants. The varied perception of the waste management system and the creation of the resulting attitudes are determined by many social, demographic, cultural, and economic factors. At present, an additional element changing our social behavior and our perception of the world is connected with the COVID-19 pandemic. Given the above, this study focus on these dependencies, particularly:

- evaluation of the level of awareness among the Poznań inhabitants concerning waste segregation and their further disposal,
- level of participation among the local community in the process of biowaste segregation together with the perception of the current system.

## 2. MATERIALS AND METHODS

*Location of the study area and characteristics of the population.* Poznań, the capital of the Wielkopolskie province, is one of the oldest and largest cities in Poland. The city is located in the central part of the province, in the Wielkopolskie Lake District macroregion, on the Warta River in its middle course, at the confluence of its tributaries – the Bogdanka, Cybina, and Główna Rivers.

Table 1

Demographic characteristics and forecast for the city of Poznań [20].  
Total number of inhabitants (No.) in the years 2005–2050

Year	2005	2010	2015	2019	2050
No.	567900	551600	542300	534800	443800

The population of Poznań in 2019 was 534.8 thousand (Table 1) and it was by 6.2% lower than in 2005. In the opinion of Paradysz [20], the depopulation process may continue and by 2050 result in a reduction of the Poznań population by 19%, which will affect primarily the working age group at the simultaneously growing elderly population (Fig. 1).

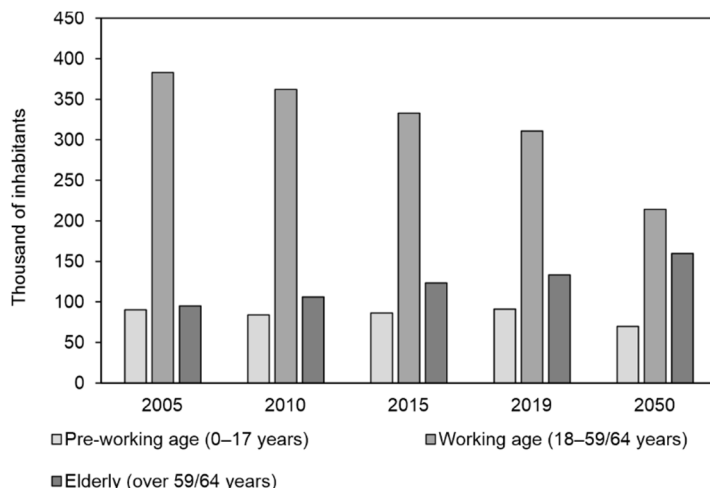


Fig. 1. Age structure and forecast for the city of Poznań [20]

*The scope and methods of the study.* The questionnaire survey was conducted in 2019 and 2020. In 2019, the survey of the Poznań inhabitants was conducted both in the form of direct questionnaires and online using the Google and Facebook platforms. In contrast, in 2020, due to the restrictions imposed concerning the COVID-19 pandemic, the questionnaire survey was limited to the Google and Facebook platforms. In both years a total of 300 questionnaires each were received. Respondents varied in terms of their sex, age, education, and type of housing. Based on these criteria, a detailed analysis of collected data was conducted. Each of the respondents filled in the same questionnaires composed of 6 questions presented in Table 2. Answering questions 3 and 5, the respondents could mark more than 1 response.

Table 2

Questions and suggested responses in the questionnaire

Question	Response
	Metrics
Sex	female male
Age	16-25 26-35 36-45 46-55 56-65 over 65
Type of housing	multifamily (block of flats) detached house

Table 2

Questions and suggested responses in the questionnaire

Education	vocational secondary higher
Questions	
1. Do you segregate municipal waste, including biowaste?	yes no
2. Do you consider the current biowaste segregation system to be appropriate?	yes no
3. What needs to be done to increase effectiveness of municipal waste segregation, including biowaste?	eliminate or reduce fees for segregated waste increase penalties for wrong segregated waste increase the number of educational campaigns encouraging waste segregation create a system for changing glass and plastic packaging
4. Do you know what is the further disposal of biowaste?	yes no
5. What should be further biowaste management?	composting disposal in landfill sites biogas plant combustion in municipal waste incinerators do not know
6. Do you have a compost heap?	yes no

### 3. RESULTS AND DISCUSSION

A total of 300 Poznań inhabitants participated in the survey, among which women were the more numerous group at 67.6% and 69.6% of the total number of respondents in 2019 and 2020, respectively. The dominant share of women in the total population of respondents has also been observed in other, similar studies [5, 16, 17, 21]. Cited authors also stressed the fact that the group of individuals aged 26–40 was the most numerous. Among women, regardless of the year of the study, individuals aged 16–25 and 26–35 were the most numerous groups of respondents (23–29.4%). In 2019, the least numerous group (8.6%) were women aged 56–65 years. In turn, in 2020 women aged 36–45 and 56–65 years were least numerous (11.5%) (Table 3). Similarly as among women, also for surveyed men in 2019, the dominant age group was from 16 to 25 and from 25 to 35 years old (23.5–24.7%). In 2020, a total of 23.7% and 21.1% surveyed men were over 65 and 16–25 years old, respectively (Table 3). In 2019, the lowest percentage of men (8.6%) were over 65 years of age. In turn, in 2020 men aged 46–65 years accounted for as little as 11.8 % of the total number of respondents. Regardless of the year of the study and their sex, the respondents predominantly had higher education (60.3–73.4% women and

57.9–72.8% men). The Poznań inhabitants participating in the questionnaire survey lived mostly in multifamily housing (60.5–83.3%) (Table 3).

Table 3

Sociodemographic characteristic of the respondents in Poznań [%]

Feature	Female		Male	
	2019	2020	2019	2020
Age				
16–25	23.0	25.8	23.5	21.1
26–35	29.4	24.2	24.7	18.4
36–45	17.2	11.5	18.5	13.2
46–55	11.5	12.0	12.3	11.8
56–65	8.6	11.5	12.4	11.8
over 65	10.3	15.0	8.6	23.7
Education				
Vocational	0	5.2	0	11.8
Secondary	26.6	34.5	27.3	30.3
Higher	73.4	60.3	72.8	57.9
Type of housing				
Multifamily	75.5	83.3	60.5	64.5
Detached house	24.5	16.7	39.5	35.5

As indicated in unpublished data collected from the local waste management enterprise, the mass of segregated and processed biowaste from Poznań in the years 2018–2020 increased significantly, i.e., 1.5-fold. This shows dynamic changes in the participation of the local community in the waste management process, particularly in the case of biowaste. The significance of the human factor in selective waste collection has been confirmed in studies by Jakubus and Tatuśko [16], Jakubus et al. [17], Kowalska et al. [18], and Kostecka et al. [19]. Questionnaire results presented in this paper also underline the involvement of the Poznań inhabitants in waste segregation, although it depends to a varying degree on sociodemographic factors. Data in Fig. 2 indicate that in 2020 compared to 2019 the number of people declaring active participation in the selective biowaste collection increased considerably from 54 to 86%. This trend was confirmed in the detailed analysis (Table 4). Regardless of factors investigated in this study, compared to 2019, in 2020 a higher percentage of respondents segregated waste, which was particularly evident among men. Irrespective of age, education, or type of housing during that year, the share of men declaring to segregate biowaste increased from 1.5 to 2.0-fold. Men aged 46–55 and over 65 years most actively participated in this process. Nevertheless, women were more involved in waste segregation in both years of the study, which was particularly evident among women aged 26–35, 36–45, and over 65 years (Table 4).

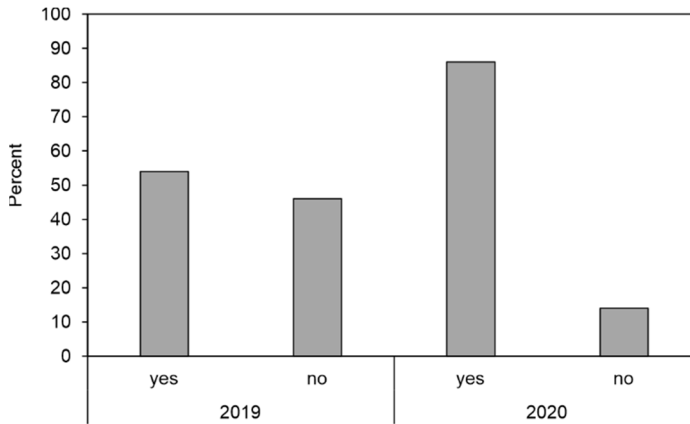


Fig. 2. Percentage shares of individuals segregating biowaste

Table 4

Shares of individuals segregating biowaste in dependence on sociodemographic characteristic of the respondents [%]

Feature	Female		Male	
	2019	2020	2019	2020
Age				
16–25	53.1	81.1	32.0	75.0
26–35	64.7	85.7	40.5	85.7
36–45	61.8	85.7	42.3	80.0
46–55	54.0	81.0	46.1	88.9
56–65	52.3	75.0	43.0	80.0
Over 65	68.2	96.2	58.6	94.4
Education				
Vocational	0	66.7	0	14.1
Secondary	43.7	80.0	28.3	31.3
Higher	55.9	92.4	39.6	54.7
Type of housing				
Multifamily	52.8	76.0	34.9	76.0
Detached house	58.5	85.3	56.5	100.0

Regardless of their sex, individuals with higher education and those living in detached houses participated more actively in the waste management program. Irrespective of their sex, the lowest involvement in waste segregation was observed among individuals aged 16–25 and 56–65 years (Table 4). The results of the authors' study are consistent with the findings presented in the literature on the subject [16, 17]. Cited authors also recorded limited participation of the youngest respondents at a simultaneous considerable involvement of the oldest respondents in waste segregation, including biowaste.

Because in Poznań social participation in waste segregation increases with age, while at the same time we are observing the process of population aging [20], one may assume an increase in social participation in the current waste management system. Moreover, it is stated that an effective waste segregation system is implemented by residents of detached houses. The primary causes for this trend include awareness of financial effects or a lack of waste collection service resulting from waste collection contracts. As it was reported by Triguero et al. [22], an additional aspect in the increased efficiency of selective waste storage is connected with the location of waste containers, according to the dependency that the closer the location of the waste container, the more willing the residents are to participate in selective waste collection.

Despite the considerable involvement of the Poznań inhabitants in biowaste segregation, this participation is still unsatisfactory. Thus a question arises how the local community evaluates the currently operating waste management system. Data in Fig. 3 indicate a relatively radical change in opinions in this respect since in 2019 the system was accepted by as many as 60% of respondents, while in 2020 it dropped to only 44%.

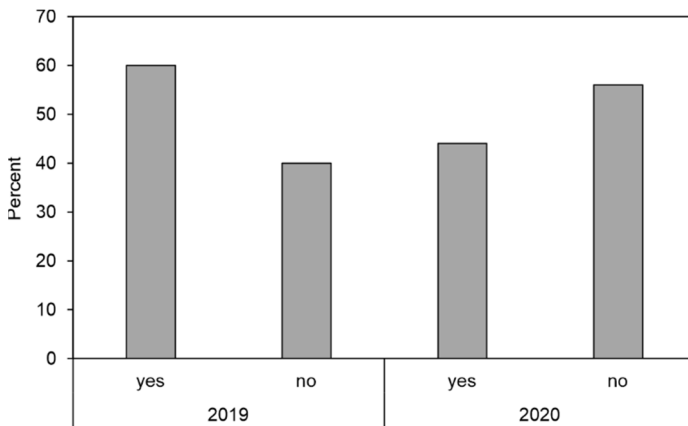


Fig. 3. Percentage shares of respondents accepting and not accepting the selective waste collection system

Irrespective of the year of the study, individuals aged over 65 and residents of detached houses have a more positive opinion on the operating biowaste collection (Table 5). It needs to be stressed that the lower the education level of respondents, the more satisfied they were with the present system of selective waste collection. Regardless of their sex, the least satisfaction with this system was declared by young respondents aged 16–25 (37.5–51.4%) and older respondents aged 56–65 years (50–50.7%). The current operating system was generally negatively evaluated by men (Table 5).

Because of the predominant dissatisfaction of the respondents with the current municipal waste management system, particularly biowaste, the inhabitants of Poznań were



asked what changes in this respect they consider justified (question 3). Out of the 4 suggested responses (Table 2) both in 2019 and 2020 they most frequently indicated the need to increase the number of educational campaigns (31–40%) and elimination or reduction of fees for waste collection (34%) (Fig. 4).

Table 5

Shares of respondents having a positive opinion on the operating waste management system [%]

Feature	Female		Male	
	2019	2020	2019	2020
Age				
16–25	51.4	50.3	40.5	37.5
26–35	55.1	53.3	50.6	57.1
36–45	60.8	52.4	55.8	60
46–55	62.0	61.9	55.9	44.4
56–65	50.7	50.0	50.0	50.0
Over 65	65.9	88.5	60.1	61.1
Education				
Vocational	0	77.8	0	55.6
Secondary	69.3	58.3	66.3	54.5
Higher	60.5	46.2	64.8	43.5
Type of housing				
Multifamily	66.2	54.5	52.7	42.0
Detached house	75.1	70.4	78.5	75.0

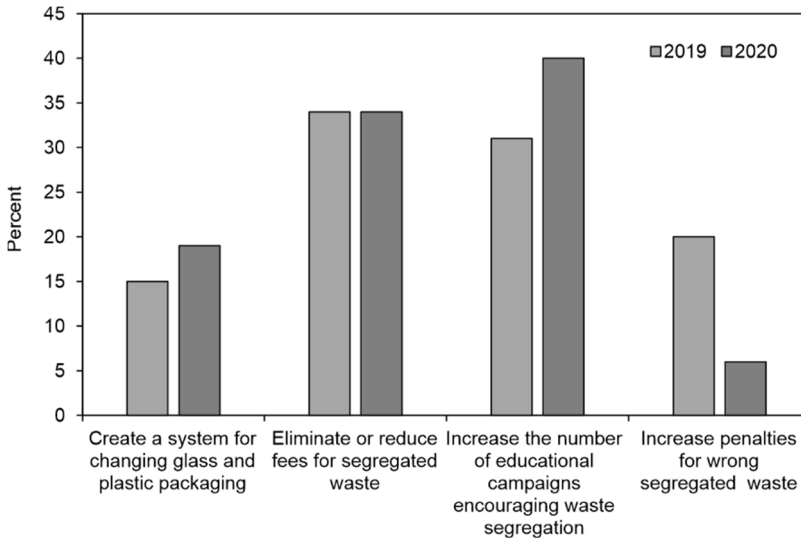


Fig. 4. Percentage shares of respondents proposing systemic solutions to increase the effectiveness of municipal waste collection

An interesting finding was related to the proposal suggesting an increase in penalty fees for inappropriate waste segregation, which was approved by 20% of Poznań inhabitants in 2019 and as few as 6.4% in 2020. The need to educate the public on the proper waste segregation, consumer attitudes, and the entire operation of the municipal waste management system was also indicated by the results of questionnaire surveys conducted by Jribi et al. [5], Jakubus and Tatuško [16], Jakubus et al. [17] and Oyedotun et al. [21]. In turn, Kowalska et al. [18] and Kostecka and Dunin-Mugler [19] stressed the considerable role of compulsory educational courses within the framework of kindergarten and school education. Such classes raising environmental awareness result in markedly greater knowledge of children and teenagers below 20 years of age compared to that of older people. This study (Table 4) does not fully confirm the opinion of the cited authors, since the group of individuals aged 16–25 was least involved in waste segregation, while at the same it was also least satisfied with its functioning. Nevertheless, the strong willingness of the general public to expand the educational offer concerning waste management suggests the need to broaden knowledge on this subject.

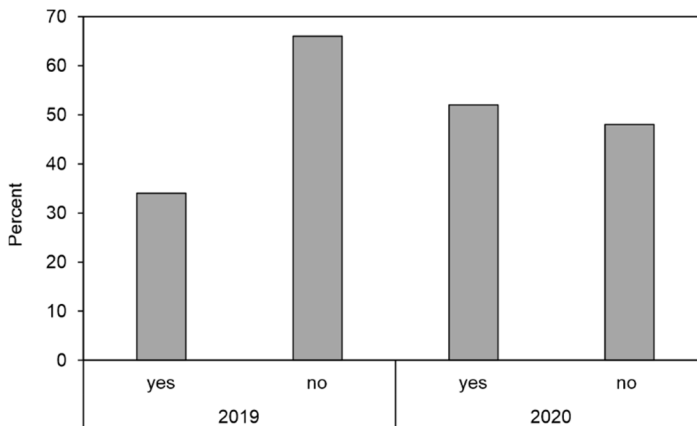


Fig. 5. Percentage shares of respondents knowing further biowaste management

The fully circular system of municipal waste management does not include only the segregation of individual fractions, but also their rational disposal. In Poland, similarly as in most European countries, biowaste is primarily subjected to biological processing based on composting [14]. The level of knowledge of the Poznań inhabitants on the subject is presented by data given in the figure (Fig. 5) and table form (Table 6). In 2019 knowledge on the further manner of biowaste disposal was declared by only 34% of respondents. A year later this number of 1.5-fold was greater. It needs to be stressed that the greatest increase in knowledge in this respect was recorded in individuals aged over 46 years regardless of their sex (Table 6). Both women (50–75%) and men (45–70%) aged over 56 declared knowledge on further biowaste disposal methods.

Table 6

Percentage shares of respondents having knowledge on further biowaste management

Feature	Female		Male	
	2019	2020	2019	2020
Age				
16–25	40.5	42.2	45.8	50.0
26–35	45.3	42.9	41.3	42.9
36–45	41.0	43.3	40.2	40.0
46–55	48.7	61.9	45.6	55.6
56–65	50.3	75.0	46.5	70.0
Over 65	50.0	65.4	45.0	68.8
Education				
Vocational	0	22.2	0	33.3
Secondary	40.3	43.3	38.3	39.1
Higher	41.8	47.8	40.8	42.2
Type of housing				
Multifamily	50.9	76.0	45.0	50.0
Detached house	50.7	85.3	54.2	59.3

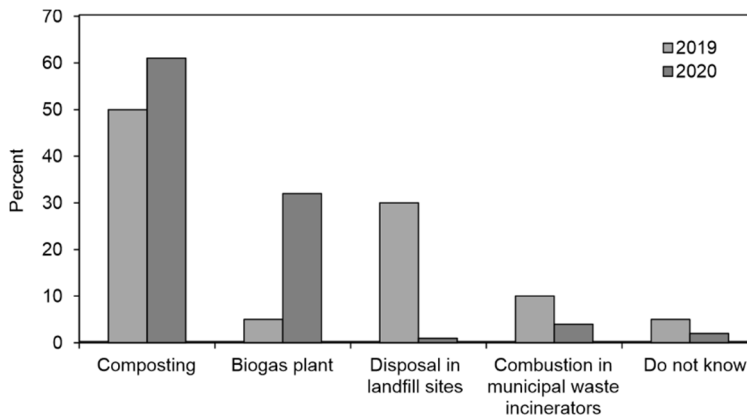


Fig. 6. Percentage shares of respondents expressing opinions on the manner of biowaste management

Irrespective of the year of the study, data in Table 6 indicate that the higher the level of education of the respondents, the greater their knowledge on biowaste management is. At the same time, residents of detached houses had greater knowledge of waste disposal processes (Table 6). Regardless of the year of the study, the youngest women aged up to 25 years (40.5–42.2%) and men aged 36–45 (40.0–40.2%) had the least knowledge on biowaste processing methods (Table 6). A majority of the Poznań inhabitants (50% in 2019 and 61% in 2020) consider composting to be an appropriate method of waste

management (Fig. 6). Selection of this method is fully in line with the promoted assumptions of circular economy, while at the same time it is confirmed by the knowledge and practice of the respondents since a vast majority of them declared to have compost heaps – it was 74% (2019) and 85% (2020), respectively (Fig. 7).

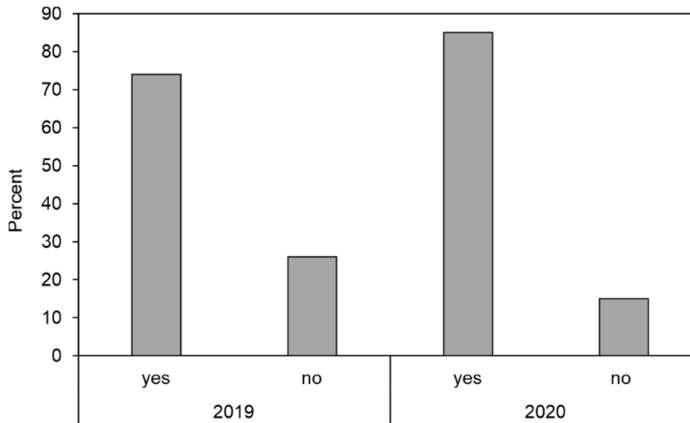


Fig. 7. Percentage shares of respondents having compost heaps

As was reported by Jakubus [23], biowaste composting is a rational and environmentally advisable method of its disposal. Through composting, a valuable organic fertilizer is produced, which may be used in agriculture, gardening, and land reclamation. Because of the chemical composition of biowaste, it is more advantageous to process it using natural methods rather than subject it to thermal treatment. Such an opinion is shared by the surveyed Poznań inhabitants, as only 4% (2020) and 10% (2019) respondents considered incineration as an appropriate method of biowaste disposal (Fig. 6).

The disturbing opinion presented by some of the respondents in 2019 that appropriate management of biowaste consists in its landfill disposal changed drastically, as a result in 2020 only 1% of respondents declared such an opinion. An interesting change was also observed for the opinion on biogas plants since in 2019 only 5% of respondents considered this method to be advantageous, while a year later already 33% inhabitants expressed this opinion (Fig. 6). Results from surveys conducted by Jribi et al. [5] and Oyedotun et al. [21] concerning the manner of household waste management, particularly food waste, also indicate that populations in other countries are also in favor of its rational recycling.

#### 4. CONCLUDING REMARKS

The current pandemic enforces several restrictions in many branches of the economy, also that related to municipal waste management. Based on data compiled by the

local institution responsible for waste management in Poznań, the mass of biowaste in 2020 considerably increased in comparison to 2019. On one hand, it needs to be interpreted as related to the imposed social isolation of the population due to lockdown, but also strengthening of civic attitudes of the Poznań inhabitants, who have become more involved in biowaste segregation. More intensive participation of the local population was a consequence of several changes, which took place in waste management. Following the implementation of the obligation to segregate the biowaste fraction educational campaigns have been intensified, while at the same time penalties were declared for the failure to adapt to the currently functioning system. The latter element may have been a stimulating factor, particularly for residents of detached houses, which may be easier to control and verify than it is the case for residents of multifamily housing. Moreover, for owners of detached houses biowaste segregation seems a more natural operation resulting from the selective accumulation of waste from the home garden and landscaping operations. This group of respondents probably additionally had compost heaps and were equipped with knowledge on the composting process as an effective method of biowaste management. When referring to composting we need to remember the group of oldest pensioners, who were characterized by the greatest involvement in the biowaste segregation system. Senior citizens very actively participate in such initiatives for several reasons. They are most frequently owners of allotment gardens and they are very well acquainted with composting. The group of senior citizens most often are relatively poorer, thus potential financial penalties for failure to segregate waste would be very painful for them. The psychological foundation of this attitude of senior citizens needs to be acknowledged, as by following the waste segregation guidelines they feel active, useful, and valuable members of the society.

When considering the potential effect of COVID-19 on the participation of the Poznań inhabitants in the biowaste management system it would be difficult to prove its direct, negative influence. Still, the involvement of the local community in the waste management system is not very high but progress may be seen within the last year, despite the imposed restrictions. Possibly lockdown in a way activated the society to take action. Imposed restrictions preventing social gatherings, closed shopping malls and restaurants promoted alternative activities. More frequent segregation of the municipal waste fraction and its deposition in appropriate disposal sites could be a good occasion to leave the house at least for a short time and experience a substitute of social contact. Moreover, the respondents themselves indicated that the key to appropriate waste management is to provide more extensive education, which they require so that we may become a community more aware of its actions and real impact on the environment. In this context, the obligatory environmental education included in the curricula at the elementary education level is justified to promote appropriate behavior. Data collected in this study indicate that the youngest respondents show the lowest level of participation in biowaste segregation, and while being least active in this process, they were

also most dissatisfied with it. This emphasizes the information gap and the need to immediately incorporate this group in waste segregation operations so that in the nearest future no problems are faced as a result of the introduction and spread of negative patterns.

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