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Innovative Ecological Transformations in the Management of Municipal Real Estate

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Abstract: Innovative ecological transformations are implemented in order to improve the quality and comfort of people's lives, especially in urban spaces. The ecological awareness of the society has increased in recent years, which resulted in the emergence of a growing number of social initiatives in the field of ecological activities. The main purpose of the article was to conduct a survey in order to examine the environmental awareness of the inhabitants and the need to implement pro-ecological solutions in their area of residence. We analysed the results of research carried out among the residents of ZGM TBS Sp. z o.o. in Częstochowa. The authors' own research presented in the article was conducted in the first and second quarter of 2021 among the inhabitants of a medium-sized city in the Śląskie Voivodeship. Research was conducted in Częstochowa, which is a specialized Silesian region, is one of the most polluted pollutants in Poland, and is a reserved research stand. The survey was conducted with the use of a questionnaire administered to 400 respondents, the number of whom was considered sufficient to express the opinion of a part of the population on the topic under study. The obtained results of the research prove the respondents' awareness of the implementation of modern ecological solutions, allowing for a reduction in maintenance costs and unfavourable actions for the natural environment. The results of the study clearly indicate the need to adapt urban spaces to the requirements of its community and the respondents' willingness to implement ecological solutions. Ecological changes in the management of municipal real estate should be implemented and modernized in accordance with the standards set by modern society.

Keywords: innovation; ecological activities; municipal real estate; renewable energy sources

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1. Introduction

Ecological activities implemented in all aspects of social and economic life contribute to the improvement of the functioning conditions of the population. More and more often, we can observe innovative pro-ecological activities, which are necessary, especially in urban spaces. The possibilities of using modern technologies significantly support the involvement of building managers and local governments. The increasing frequency of extreme weather conditions (heavy rains, high temperatures, long-term droughts, and strong winds) and the progressing intense urbanization of rural areas, forces the use of a new approach to the development of urban areas. Without the active involvement of local governments and city residents, counteracting climate change is impossible [1]. It is primarily local authorities that should feel responsible for the implementation of sustainable energy development and climate protection. Innovation in the field of ecological activities allows for adaptations to the city space to be made to fit the natural environment. Organizing public space in the city so as to solve environmental issues involves proper planning and urban design that take into account the natural resources and aesthetic (preferences) of the inhabitants. Current greening systems for buildings include not only areas covered with vegetation but also green roofs and green walls as an aesthetic element

on buildings. It is a specific way of revitalizing cities and modernizing buildings. The research conducted over the last few years proves that green elements in the city contribute to the enhancement and improvement of the efficiency of the buildings themselves, and most importantly, their inhabitants. There is ample evidence that the proximity of green spaces in cities has a positive effect on the physical and mental health of inhabitants [2].

The subject of this work is the analysis of the perception of innovative pro-ecological solutions and the need for their implementation and dissemination in other parts of the city by the housing estate residents. The main goal set by the authors of the article was to conduct research on the environmental awareness of the inhabitants. Respondents were asked questions related to the need to implement pro-ecological solutions in their area of residence.

2. Characteristics of Innovative Ecological Solutions Implemented in Housing

The necessity and importance of implementing ecological solutions is related to the broadly understood care for the natural environment. The environment is defined as "the total of natural elements, including those transformed as a result of human activity, in particular the surface of the earth, minerals, water, air, animals and plants, landscape and climate" [3]. The natural environment and its resources are the basic elements of economic development. Increasing the social awareness of the quality of life affects human values, one's opinions, and the impact on one's place of existence, i.e., the environment in which he/she lives, refer to the broadly understood ecological awareness of societies [4,5]. This awareness is the subject of many studies and analyses [6]. Environmental awareness is changing because people find that preventing environmental degradation is simpler and cheaper than repairing damaged nature later [7,8]. Counteracting pollution, restoring natural elements to their proper condition, and managing environmental resources and their rational shaping in accordance with the principle of sustainable development are the components on which activities related to the protection of the natural environment are based [9,10]. In the document "Polska 2025, a long-term strategy of sustainable development" prepared by the Ministry of Climate and Environment in Poland, it is indicated that ensuring the welfare of society, both in material and environmental terms, is the overarching goal. The main activities in the field of environmental protection should be [11,12]:

- Ensuring the ecological safety of the country;
- Preserving biodiversity;
- Ensuring the improvement of the condition of the environment;
- Eliminating threats posed by urbanization, automotive, waste production, and energy consumption processes;
- All industrial plants with environmental protection requirements complying to the above activities.

Environmental management should equally cover three basic dimensions: economic, social, and ecological activities [13,14]. An example of these activities is the use of eco-innovative recycled materials and construction technologies that favour environmental activities in cities [15]. Ecological building materials that are made of renewable resources, biopolymers, innovative reinforcing fibres, and hybrid organic and inorganic composites reduce costs, i.e., the economic dimension of ecological activities [16].

For many years, research has been conducted all over the world on the impact of the natural environment on human life. An example is the study on the influence of greenery on the reactions of the human brain carried out in England, Spain, Sweden, the United States, and Japan. The results of these studies showed that the sight of a wall of greenery outside the window "soothes neurons" and produces endorphins associated with positive emotional states. People have a better frame of mind and learn and work better if they are surrounded by nature [17]. In the UK, proposals to build several new eco-cities were part of a larger government programme to reduce carbon emissions [18]. Until recently, an increased trend of moving beyond urban areas was observed, which was to bring about a constant improvement in well-being and quality of life. It has been shown

that all other changes, such as acquiring a better job or success, bring only temporary improvement [19]. Currently, one should strive to improve life in urban conditions by introducing more vegetation, for example, by planning underground parking lots and minimizing car traffic in the estate, which provides space for a green zone and arranging space for relaxation [20–22]. It is important to create favourable living conditions for birds and insects, which are very much needed by the natural environment. Urban green action projects in most countries of the world are supported by national programmes and grants [23–26]. Already, a few years ago, the Canadian provinces of Ontario and Quebec banned the use of the so-called cosmetic pesticides that were used to protect lawns from weeds. In some cities, plant-friendly parks are created, which are rich in pollen to attract insects, birds, and bats. Creating blooming spaces in cities that play an educational role brings many benefits for society [27–30]. Indicating standards and clearly defining the concept of eco-cities would allow for the creation of indicators needed to assess the progress of green projects in cities [31]. However, when defining eco-cities the subject should be broadly understood in order to maintain a certain degree of flexibility in various contexts of describing urban projects [31–34].

3. Innovative Solutions in City Logistics

The latest energy solutions include installations based on renewable energy sources, i.e., solar collectors for heat production, photovoltaic panels that provide electricity to consumers with the possibility of its transfer to the grid (prosumer energy: on-grid installation), and heat pumps as devices for heat production. More and more often, there are solutions based on the combination of these still innovative solutions supported by energy storage, which can be used in periods of high cloudiness [35,36]. In order to mount collectors or photovoltaic panels that have to occupy the places exposed to solar radiation for a long time, roofs of residential buildings are used, provided that their load-bearing capacity allows it. Placing solar radiation energy processing devices on roofs does not change the aesthetic value of the surroundings. Roofs can also be used for another purpose. Since the 1960s, there has been a growing interest in green roofs. It was caused by the increasing ecological awareness of the inhabitants [37–39]. If the use of renewable energy lowers CO_2 emissions to the atmosphere, green roof plants support this effect and additionally reduce rainwater runoff, providing additional thermal protection for roofs. Due to the transpiration phenomenon, the microclimate in the immediate vicinity of green roofs is significantly improved by reducing dust and oxygen production [40,41]. Green roofs counteract the formation of urban "heat islands" and, in combination with living walls or so-called vertical gardens minimise the noise level up to 46 dB and prevent the formation of so-called electro smog [42,43]. Green roofs and walls are biologically active surfaces, the proper design of which allows for the better use of urban areas and their development as gardens. Another way to revitalize the surroundings are projects based on the blue network, which in combination with green infrastructure is called the blue-green network. Solutions supporting the blue-green network include: construction of sidewalks and roads, pitches raised above the adjacent ground level, which prevent soil erosion and leaching, so-called buffer vegetation strips, increasing water infiltration and limiting the spread of noise, the use of permeable surfaces to prevent flooding and floods, and construction of retention basins in the form of a patio inside housing estate yards [44]. The blue infrastructure also includes ponds, ditches, and roadside and other supporting elements. Such places also undoubtedly affect the development of interpersonal contacts as well as unwinding and relaxation. These places allow for the creation of habitats for the life and development of various types of living organisms and plants, which supports the process of biodiversity, which is so important at the present time. Each method of building a concrete area in the city is also a way to eliminate unpleasant odours from, among others, exhaust fumes. As it results from the above, creating an environment that is friendly to both humans and the natural environment is based on an appropriate composition of various forms of greenery. Appropriate shaping of green facilities and modification of existing facilities may

not only improve the condition of the surrounding natural environment, which is very important, but may also enhance the aesthetic values of urban spaces and emphasize their environmental values, as well as mitigate the negative effects of the grey zone (for example, minimizing the effect of urban "heat islands") [45]. One of the innovative transformations implementing the assumptions of sustainable development is the construction of green infrastructure [46,47]. Elements of green infrastructure are natural areas, natural habitats, green routes, hydrological systems, forests and afforestation, allotment and home gardens, and green roofs and living walls with the accompanying necessary supporting devices.

The design and construction of green zones ensures the implementation of various functions. The most important of them is structure-creating and environmental-creating activity, allowing for the "ventilation" of the city or district and improving the accessibility of urban ecosystems to the residents. Undeniably, green zones in the city have a positive effect on the physical and mental health of the inhabitants [48,49]. Numerous plant species secrete phytoncides, antibiotic substances with bactericidal and fungicidal properties. Green infrastructure enables sports and recreation and can also have an educational function: botanical, dendrological, and zoological gardens, as well as culture-forming functions [50]. Joint work during the construction of green areas and the maintenance of green areas are conducive to establishing interpersonal contacts and the residents themselves better perceive the place they live in, which translates into their level of satisfaction and an improvement in their quality of life. It should be emphasized that the real estate adjacent to green areas is highly attractive and the value of such properties increases as the distance between the real estate and green areas decreases. In this way, the green network fulfils its economic functions. Green infrastructure allows for reductions in financial outlays related to environmental protection as well as expenses incurred for the construction and maintenance of various types of installations related to grey infrastructure (residential buildings, roads, pavements, parking lots, city squares, and hardened or degraded soil) [51–54].

4. Characteristics of Sociodemographic Data

In the context of the assumed purpose of this work, which was to examine the social awareness of implementing ecologically innovative pro-environmental measures and to analyse the level of awareness of the necessary changes, research was carried out among the citizens. The research presented in the article was conducted in the first and second quarter of 2021 among the residents, including employees of the municipal housing manager, in Częstochowa, the Department of Housing Management—Social Housing Association in Częstochowa LLC (ZGM TBS Sp. z o.o.) [3]. The research was carried out using the survey method. The measuring instrument was a paper questionnaire prepared in advance. The questionnaire included closed, single, and multiple-choice questions. The study was conducted on the basis of a simplified research model presented below (Figure 1):

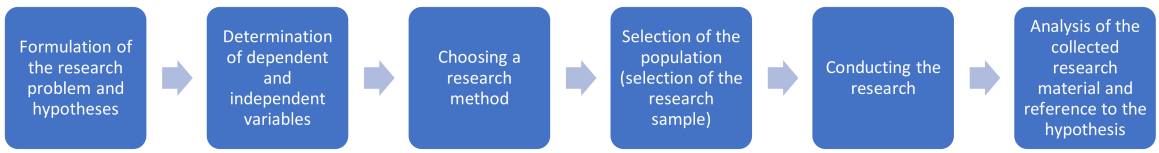


Figure 1. A simplified research model. Source: Own research.

The participants of the study were residents. A total of 400 completed questionnaires were received, of which 90.5% (i.e., 362 questionnaires) had been correctly completed. The location of the research was established in Częstochowa, which is located in Poland, Central Europe. Częstochowa is a city in the Silesian Voivodeship, considered to be one of the most polluted voivodeships in Poland. In the Barcelona Institute for Global Health ranking, Częstochowa was ranked 46th for cities with smog problems in Europe [55]. There are many factors, such as having a developed industry and a small amount of ecological activities, which negatively affect the quality and comfort of life in the city. Therefore, the authors of the article wanted to conduct environmental awareness research in this location.

The research results and information about the study participants are presented below. The survey was aimed at residents and employees as they are also largely residents of ZGM TBS. The opinion of all residents was crucial for the authors of the study in the implementation of the article and in order to prove the hypotheses.

The questionnaire was divided into a main part and a specification containing the following information: gender, age, education, and basic sources of income. The research results and information about the study participants are presented below. In total, 173 women and 189 men participated in the study, which constituted 47.8% and 52.2% of the respondents, respectively.

Table 1 presents all of the collected information on the respondents, which was processed and counted in the next stage in accordance with the assumptions of this article. All respondents were divided according to gender and then the percentages of the responses for individual criteria were calculated. As can be read above, more men than women took part in the study. The largest number of respondents were people aged 36–45, among whom women constituted the majority of 54% to 46% of men. The smallest group were people under the age of 18, consisting of only 2 women and 2 men. In total, 154 respondents had higher education, amounting to 55.2% women and 44.8% men. At least 21% were people with primary education, amounting to 42.8% women and 57.1% men. The most frequently indicated primary source of income was full-time employment, constituting 55.5% of all of the answers provided. Women constituted 51.2% of answers and men 48.7%. Full-time employment was indicated by 98 men and 103 women participating in the study.

Table 1. Characteristics of the research sample.

Parameters	Total	Coefficient %	Women	Coefficient %	Men	Coefficient %
Age						
less than 18	4	1	2	50	2	50
18–25	19	5.2	14	73.7	5	26.3
26–35	52	14.3	31	60	21	40
36–45	100	28	54	54	46	46
46–55	98	27	42	42.8	56	57.1
56–65	66	18.2	23	35	43	65
above 65	23	6.3	7	30.4	16	69.6
Education						
1-primary	21	6	9	42.8	12	57.1
2-vocational	51	14	16	31.4	35	68.6
3-secondary	136	37.5	63	46.3	73	53.7
4-higher	154	42.5	85	55.2	69	44.8
Primary source of income						
1-employment (full-time or part-time)	201	55.5	103	51.2	98	48.7
2-living off agriculture	3	0.8	2	66.7	1	33.3
3-student/pupil	12	3.3	7	58	5	42
4-own company	48	13.2	17	35.4	31	64.6
5-contract work	30	8.3	15	50	15	50
6-retired/disability pensioner	33	9.1	13	39.4	20	60.6
7-periodic job	17	4.7	7	41.2	10	58.8
8-unemployed	9	2.5	5	55.5	4	44.4
9-other	9	2.5	4	44.4	5	55.5

Source: Own research and calculations.

In relation to the above data, the average age and standard deviation were also calculated according to the following formula:

Standard deviation for the tested sample (Equation (1)):

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{x})^2}{N-1}} \quad (1)$$

where:

s—Standard deviation;
$\overline{x}$—Mean;
x—Another observation in the sample;
N—Number of people in the sample.

The mean and standard deviation of the surveyed population presented in Table 2 refer to the age of the respondents participating in the research. According to the presented data, the average age of the respondents is in the fourth group, which is people aged 36–45.

Table 2. The coefficient of the mean measure and standard deviation of the study sample.

Parameters	Total
Age	
Less than 18	4
18–25	19
26–35	52
36–45	100
46–55	98
56–65	66
Above 65	23
Mean	45.4
Standard deviation	1.31

Source: Own research and calculations, n = 362.

The education of the respondents is presented below (Figure 2):

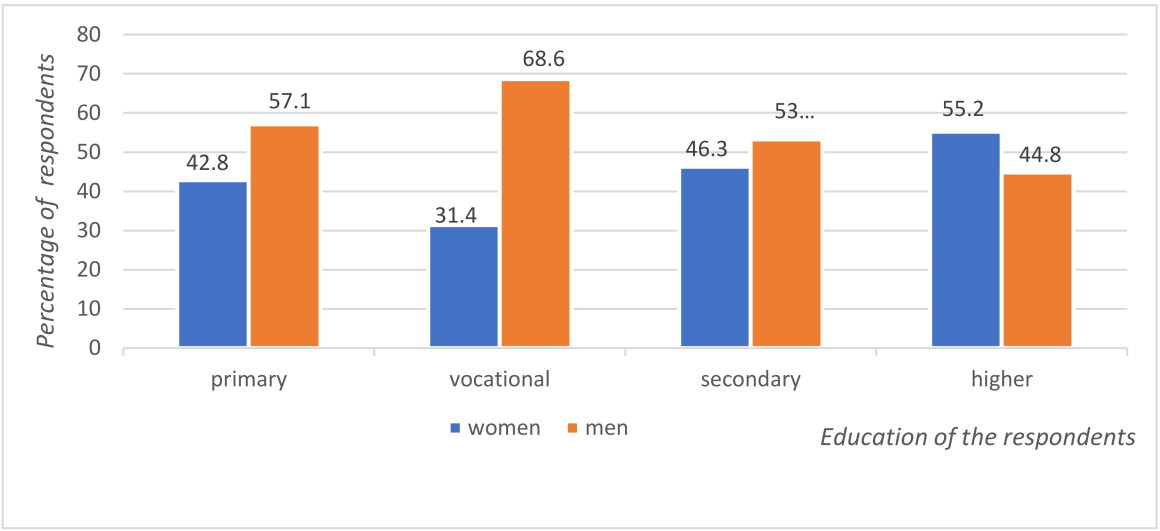


Figure 2. The structure of the study sample according to the education of the respondents (%). Source: Own research and calculations, n = 362.

Figure 2 presents the education of the respondents among women and men. Most of the respondents are women with higher education 55.2%, followed by secondary education (46.3%), primary 42.8%), and vocational 31.4%). On the other hand, most of the surveyed men have vocational education (68.6%), followed by primary (57.1%), secondary (53.2%), and higher education (44.8%).

The next stage of the research process was the authors' reference to the awareness of implementing pro-ecological measures among the residents and employees of the municipal housing manager, who were the respondents to the conducted questionnaire.

5. Presentation of Research Results from the Study Material and Comparing It with the Possessed Theoretical Knowledge

The conducted research was aimed at providing knowledge about innovative pro-ecological solutions in municipal real estate management. The subject of the survey was pro-ecological social responsibility aimed at improving the conditions of social functioning, taking into account ecological aspects. This study was undertaken in order to characterise the needs of introducing innovative ecological solutions to the residential space. An attempt was made to answer the question of whether the inhabitants of the studied areas notice the need to use pro-ecological solutions.

The presented survey shows how the inhabitants of the studied areas assess the importance of implementing pro-ecological activities in relation to the implemented social responsibility strategy of the property manager. This strategy encourages managers to implement socially innovative activities in specific areas. One of them is pro-ecological responsibility, which was examined in the survey in terms of the importance of social activities and reducing the cost of housing fees.

The main task of the research subjects was to respond to each of the given answer possibilities, according to the degree to which they agreed with it. The intensity of the respondent's attitude was measured using a bipolar ordinal scale, most often with five points, described verbally and numerically. Therefore, the Likert scale was used in the presented study. The answers were given numerical values (e.g., from 1 to 5), keeping the principle that the assigned values should increase according to the nature and direction of the defined feature. In order to measure significance with the statements, a five-point scale was used and the values were described verbally and numerically: 5—definitely significant; 4—significant; 3—insignificant; 2—definitely insignificant; 1—I have no opinion.

The following pro-ecological activities were mentioned among the respondents (see the Figure 3):

- Placing bird feeders, nesting boxes, and houses for insects in the property space;
- Creation of flower meadows, ponds, rain gardens, gardens with ecological education, green walls, green roofs, and green dumpster shelters;
- Planting new trees and shrubs;
- Creating recreational routes;
- Installation of rainwater tanks, photovoltaic panels on the roofs, heat pumps for buildings, anti-smog ventilators, and LED lighting;
- Development and construction of white roofs.

Among the above-mentioned activities, a division was made according to two criteria, the first one being the creation of objects influencing contact with nature and the second being the ecological activities that affect savings. The first criteria group is presented in Tables 3 and 4.

The data presented in Table 3 show that, for the vast majority of respondents, the introduction of pro-ecological measures is important and it is necessary to implement innovative solutions in the urban space. The presented activities were determined on the basis of the adopted criteria: the speed of introducing changes, low financial outlays needed for their implementation, availability of methods, and products to be created.

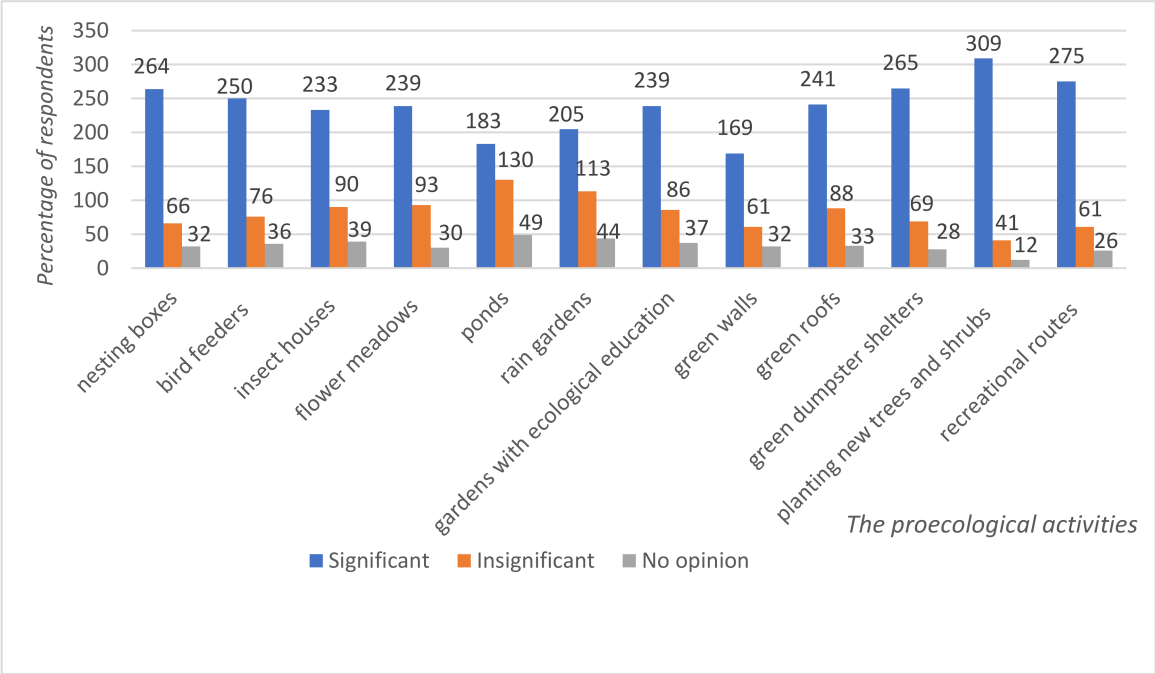


Figure 3. The structure of the sample according to the indication of the significance of pro-ecological activities. Source: Own research and calculations, n = 362.

Table 3. The structure of the sample according to the responses concerning the creation of objects influencing one's contact with nature.

The First Group of Pro-Ecological Activities	Definitely Significant	Significant	Insignificant	Definitely Insignificant	No Opinion
nesting boxes	67	197	61	5	32
bird feeders	62	188	69	7	36
insect houses	60	173	77	13	39
flower meadows	73	166	83	10	30
ponds	52	131	114	16	49
rain gardens	54	151	101	12	44
gardens with ecological education	60	179	74	12	37
green walls	71	98	51	10	32
green roofs	70	171	76	12	33
green dumpster shelters	83	182	51	18	28
planting new trees and shrubs	121	188	31	10	12
recreational routes	81	194	49	12	26
TOTAL	854	2018	837	137	398

Source: Own research and calculations, n = 362.

The conducted research results show that the structure of responses indicate a very high level of respondents' awareness. In the context of implementing innovative pro-ecological solutions, it can be noticed in the study results that activities deemed definitely important are indicated by the vast majority of respondents. The results of the conducted research were divided into two criteria. In the first one, i.e., the data presented in Tables 3 and 4, the most important activities should consist in planting new trees and shrubs (this answer was given 121 times), creating green garbage cans (according to 83 answers), and creating recreational routes (according to 81 answers). Resulting from the

structure of the responses, activities conducive to direct contact with nature are the most expected and, according to the respondents, the most socially beneficial. On the other hand, when analysing the second group of activities significantly influencing energy saving, we mention LED lighting and the installation of photovoltaic panels and heat pumps. Such activities were most often indicated in the survey as the most important and the most influencing of the natural environment. The example of activities implemented in the city of Częstochowa shows that even small cities care for the natural environment. The possible energy crisis will force implementations in the indicated areas and will naturally have a lower environmental impact. Local awareness of pro-ecological activities will contribute to a global improvement to the environment. The conducted and analysed studies prove the necessity to disseminate ecological activities all over the world.

Table 4. Structure of responses of pro-ecological activities.

Pro-Ecological Activities	Significant	Coefficient %	Insignificant	Coefficient %
nesting boxes	264	73	66	18
bird feeders	250	69	76	21
insect houses	233	64	90	25
flower meadows	239	66	93	26
ponds	183	50	130	36
rain gardens	205	57	113	31
gardens with ecological education	239	66	86	24
green walls	169	47	61	17
green roofs	241	66	88	24
green dumpster shelters	265	73	69	19
planting new trees and shrubs	309	85	41	11
recreational routes	275	76	61	17

Source: Own research and calculations, n = 362.

The above data indicate the willingness to create appropriate natural conditions in the residential space of the respondents. The adopted criteria made it possible to indicate those activities that the inhabitants can implement without incurring very high costs. An additional advantage of selected activities is the possibility of implementing them together with children, which is of educational value for future generations. The creation of nesting boxes in municipal multi-family buildings is indicated as significant by 264 research subjects, as well as creating bird feeders by 250 subjects, insect houses by 233, flower meadows by 239, ponds by 183, and rain gardens by 205 respondents. What is also important for the research subjects are activities that allow a combination of ecology with education by creating gardens with ecological education, which 239 respondents considered an important form of pro-ecological responsibility. The survey allows for a consideration of the importance of visual aspects in the residential space, which are combined with the anti-smog effect by creating green walls, the importance of which is seen by 169 respondents, as well as green roofs by 241, and green dumpster shelters by 265 respondents. As many as 309 respondents indicate the need to plant new trees and shrubs and 275 respondents indicate the need to create recreational routes. Recreational and sports routes in the vicinity of the place of residence have a positive effect on the possibility of practicing sports, including Nordic walking, cross-country skiing, cycling, and walking, which have a positive effect on the well-being and health of residents. Being surrounded by nature increases the competitiveness and attractiveness of places to live, which is very important in the current market situation.

The second group of innovative activities are investments mainly related to the use of renewable energy sources, such as sun and earth energy, i.e., the installation of photovoltaic panels (particularly important for 101 respondents) and heat pumps (definitely important for 87 respondents) (see Table 5). Respondents are aware that the use of renewable heat sources would reduce the costs of electricity and heat in buildings. To ensure safety in terms

of the health and safety of grey water demand, the so-called rainwater is very important for 70 and 100 respondents, respectively. When analysing the answers to all of the questions related to pro-ecological activities from the second group, it is important that all of the proposals listed in Table 5 are significant and constitute a significance coefficient above 69% (Table 6).

Table 5. Structure of the sample according to the answers provided.

The Second Group of Pro-Ecological Activities	Definitely Significant	Significant	Insignificant	Definitely Insignificant	No Opinion
rainwater tanks	70	194	55	10	33
photovoltaic panels on the roofs	101	170	50	13	28
heat pumps for buildings	87	185	50	12	28
anti-smog vents	100	177	44	11	30
LED lighting	116	189	30	11	16
white roofs	92	159	54	13	44
TOTAL	566	1074	283	70	179

Table 6. Structure of the responses.

Pro-Ecological Activities	Significant	Coefficient %	Insignificant	Coefficient %
rainwater tanks	264	73	65	18
photovoltaic panels on the roofs	271	75	63	17
heat pumps for buildings	272	75	62	17
anti-smog vents	277	76	55	15
LED lighting	305	84	41	11
white roofs	251	69	67	18

Source: Own research and calculations, n = 362.

Using the Likert scale, the percentage distribution of significant and insignificant pro-ecological activities indicated by the respondents was determined. Table 6 shows a diagram of how the response structures are distributed (Figure 4).

The data presented in the figure show that among the pro-ecological activities indicated in the survey, the vast majority of respondents indicate the importance of their introduction. Installing rainwater tanks allows for significant water conservation, for example, for watering lawns. This initiative is supported by 72.9% of the respondents. Another investment that would save the residents' financial resources are photovoltaic panels on the roofs of buildings and LED lighting. The investment of installing photovoltaic panels requires certain financial outlays but its profitability associated with obtaining cheap electricity is scientifically proven. The positive significance of this project is indicated by 75%, and LED lighting by 84% of the respondents. Installing heat pumps, which would reduce heating bills, was also indicated by 75% of research subjects. The large majority of residents, constituting 76% of the respondents, noticed the need to install anti-smog ventilators, which would provide them with cleaner air in their apartments. A total of 69% of respondents referred to the last initiative indicated in the study, i.e., white roofs, which do not heat up in summer and cause lower temperatures in the rooms.

Management of the implementation of pro-ecological investments, which were included in this part of the study, must be carried out under the supervision of experienced management board employees. Incurring high investment costs must quickly bring benefits to residents and owners. Therefore, the indicated pro-ecological activities in Częstochowa can be an example for other cities.

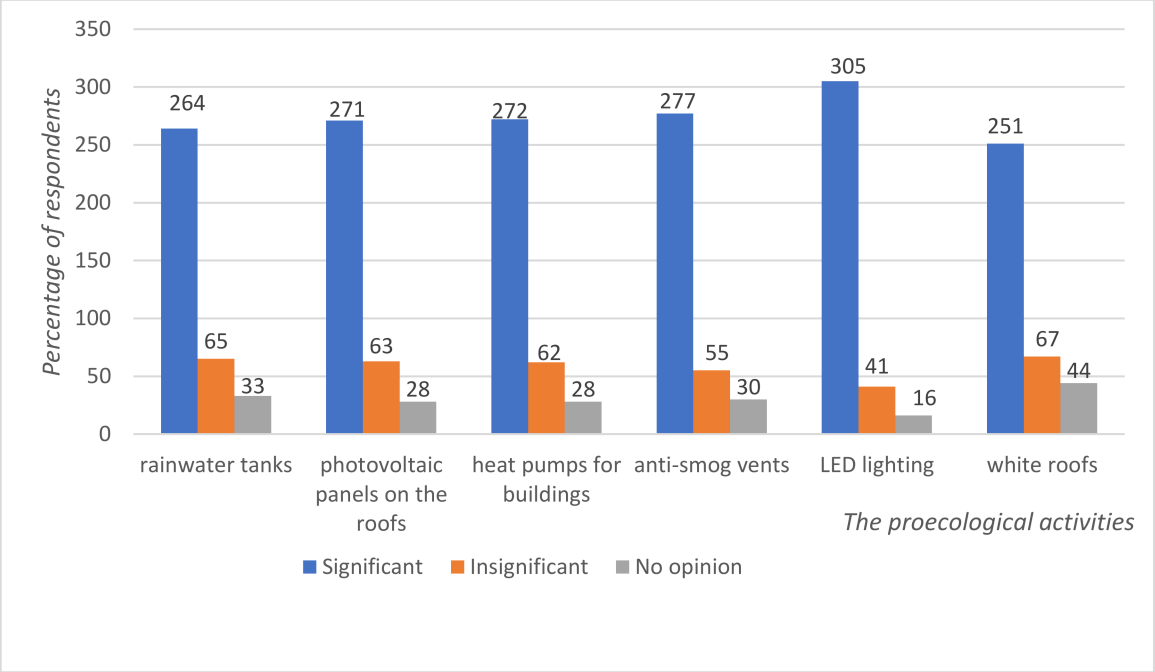


Figure 4. Structure of the sample of pro-ecological activities influencing the financial aspect in relation to its significance. Source: Own research and calculations, n = 362.

6. Discussion

As can be seen from the above research and analyses, regardless of factors, such as age, education, and sex, pro-ecological solutions are of significant importance for improving the quality of life of the inhabitants of the analysed city. The data presented in the study show that, for the vast majority of respondents, the introduction of pro-ecological measures is important and they see the need to implement them in the urban space. The implementation of pro-ecological investments in the examined city, which is considered very polluted, is needed for better comfort and health of the inhabitants of Częstochowa.

The most important solution is to install LED lighting and, successively, anti-smog vents, heat pumps, and photovoltaic panels, using renewable energy sources for the production of heat and electricity. Solutions using rainwater and white roofs are of great importance. Creating social initiatives, such as nesting boxes, bird feeders, insect houses, flower meadows, ponds, rain gardens, etc., on the territory of municipal real estate are necessary for communing with nature. Activities that allow residents to combine ecology with education by creating gardens with environmental education are also important to the respondents. All of the proposals for innovative pro-ecological solutions that are presented in the research and applied to the urban space of the studied city should strengthen contact with nature for all residents and make the profitability of the investment reduce the costs of using municipal premises in Częstochowa.

The ecological situation in Poland as a European country requires the implementation of more activities and innovative solutions to support the process of reducing the harmful impact of socioeconomic life on the natural environment. The number of pro-ecological initiatives in Poland is too small to protect the natural environment. Therefore, in order to achieve global improvement, local initiatives should be appreciated and implemented. The article presents the opinions of the residential community in Częstochowa in relation to pro-ecological activities concerning the area of their residence. These activities are positively received by the inhabitants of ZGM TBS and therefore such behaviour should be promoted in other European countries.

The future direction of research aimed at the same research group will be the analysis of the positive effects on the physical and mental health of green roofs and walls as well

as blue zones in the context of the development of grey areas in the city. An interesting observation will be the comparison of the behaviour of residents in Polish cities in the context of other European cities, where the above solutions are already a natural way to revitalize urban spaces, contributing to the improvement of the natural environment and improving the aesthetic value of the surroundings.

7. Conclusions

Numerous examples and questionnaires prepared for the purposes of this study indicate that the development of urban space by creating ecosystems is approved by the community. This method creates new places for rest or recreation by arranging green spaces in the grey areas of the city. Pro-ecological solutions contribute to improving the lives of inhabitants and promoting ecological behaviour. The subject matter under study is topical in many European Union countries that are considering the use of financial resources in pro-ecological activities in various areas. Particularly unconventional ecological activities in Polish cities prove that ecological social responsibility is noticeable and well-accepted by the society in various EU countries. The presented research results may be useful for analysing the issue before making the final decision on where and what ecological solutions should be implemented in urban spaces. According to the respondents, the pro-ecological solutions implemented and analysed in the article contribute to improving the lives of residents and promoting ecological behaviour. The possibility of using modern technologies to enable the introduction of modern and ecological solutions allows for money savings, which is very important today in all EU countries. Cities that generate increasing costs of living are currently facing many challenges that encourage governments to save in many ways. Many savings opportunities in EU cities are presented in the study. On the other hand, the implementation of pro-ecological solutions related to the reduction of the harmful impact of urban life on the natural environment should be applied in all countries. It is particularly important in the most polluted cities, an example of which is the examined city of Częstochowa.

Summarizing the above research results, it can be stated that initiatives to implement pro-ecological solutions have been the subject of discussion for many years. These measures should be used as often as possible to ensure that the costs of economic and social life are reduced, while increasing environmental awareness. The implementation of this type of solution is very socially and ecologically important due to the improvement of the quality of life, especially in urban areas. The possibility of using modern technologies to enable the introduction of modern and ecological solutions allows for financial resource savings and the creation of a friendly urban space that is close to nature.

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