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ENVIRONMENTAL POLICY AND MANAGEMENT

STUDIES AND MATERIALS

GENERAL ENVIRONMENTAL AND SOCIAL PROBLEMS

ENVIRONMENTAL POLICY AND MANAGEMENT

POLITYKA EKOLOGICZNA I ZARZĄDZANIE ŚRODOWISKIEM

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QUALITATIVE FACTORS OF DEVELOPMENT IN PROBLEM AREAS

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ABSTRACT: The aim of the article is to analyze the qualitative factors in terms of creating development potential that will enable the construction or reconstruction of local communities and economies, especially in problem areas. The analysis of qualitative factors was based on the conducted individual in-depth interviews. This made it possible to formulate recommendations for decision-makers in the field of creating development potential in problem areas. The conducted research allows for the formulation of the following conclusions: problem areas are still stuck in the old development paradigm, in which development is seen in hard factors, and this in turn translates into decisions made and directions of spending funds; little importance in the development of soft factors such as: leadership, cooperation, social participation, quality of education; the level of financing and co-financing of innovative programs is low and basically comes down to the purchase of modern equipment by individual farmers and the expansion of the scope of crops; despite the fact that rural communes in problem areas are leaders in obtaining external funds, this does not translate into the improvement of their economic situation.

KEYWORDS: problem area, development factors

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Introduction

Currently, the developed world is facing a new wave of changes, and the epidemic crisis requires the restructuring of enterprises, leads to the closure of large industrial facilities and the reduction of employment. These changes are often associated with a steady economic decline. Many cities and regions are looking for new development opportunities, new specializations, new forms of entrepreneurship, and strive for greater diversification. Such a situation justifies the need to conduct research in the field of creating development potential, which will enable the construction or reconstruction of local communities and economies, especially in problem areas[1].

The undertaken subject is also part of the issue of sustainable development, because the sustainable development postulate assumes an approach to planning and decision-making, which is aimed, among others, at achieving a real and lasting reduction of social and economic differences, at meeting the needs of the present without reducing the possibility of satisfying the needs of future generations and at the same time providing society with a long-term vision of development.

When addressing the issues of development factors, it is important that there is no one „miracle" factor that guarantees success. The economic growth and sustainable development of a given area is most often determined by the configuration of mutually influencing factors (Final Report, 2011, p. 72), and the actions taken do not always bring the intended results (Domański, 1997; Gawlikowska-Hueckel, 2003; Tondl, 2001). These difficulties mobilize regional economists and geographers to continue searching for new factors determining regional development.

Based on the literature about this subject, the thesis about the primacy of endogenous factors in local development over exogenous factors can be considered legitimate. Hence, the aim of the article is an attempt to investigate what development factors the problem areas have at their disposal on the example of the West Pomeranian Voivodeship (Poland).

In order to achieve the goal, the contemporary factors of development present in the literature on the subject, the issue of delineating problem areas and stimulating their development, were first discussed synthetically, and then they were compared to the identified qualitative factors of the

[1] Defining the problem area is a difficult task. The literature review shows that these definitions may vary depending on the country or region affected by structural problems. The article assumes that the problem area is characterized by an unfavorable socio-economic situation, which is reflected in indicators such as low GDP per capita, employment, low prices, low disposable income of households, outdated sectoral structure, aging of the society and depopulation, low level of public and private services.

underdeveloped areas in the West Pomeranian Voivodeship. The analysis of qualitative factors was carried out on the basis of individual in-depth interviews. It is one of the basic methods of qualitative research, consisting in a detailed, insightful conversation with the respondent. The interviews were conducted based on a standardized scenario. This made it possible to formulate recommendations for decision-makers in the field of creating development potential in problem areas.

Factors in the development of problem areas

Actions leading to the development of problem areas should take into account the contemporary development paradigm.

However paradoxical this statement may seem, there is a close link between globalization and local development. It is noticed that the gradual spread of the processes of internationalization of markets, where the horizontal system of rules of competitiveness prevails and the gradual unification of cultures, valorises differences, disabilities, inhibitions „in an opposite way", bringing to the fore the local communities responsible for this development and stimulates the emergence of new, dynamic patterns of development that supersede traditional formulas of public intervention. The globalization of markets is accompanied, on the one hand, by the ineffectiveness of the production system, and, on the other hand, by the not very modern character of national countries. Undeniably, the post-industrial era privileges non-material forms of power, collected in the form of information packets and intellectual capital (Rifkin, 2000). A production brand, which in the industrial society was only a distinctive sign of manufactured goods, is now a good in itself, an intangible asset, often of higher value than all other components of the company and functioning regardless of the scope of the enterprise itself (Klein, 2001).

The effectiveness of state policy depends largely on the positive rivalry that takes place not only between individual states, but also between local self-governments and territorial authorities and central administration (Rotelli, 2000). Indeed, in the global market, competition involves not so much total domestic production as individual productions developed in a given territory thanks to favorable natural, cultural, social, organizational and institutional conditions (Becattini, 2002).

P. Krugman, referring to the observations of A. Marshall (Marshall, 1927), draws attention to the importance of regional processes of concentration and industrial specialization. The basic factors of local specialization are:

1. The occurrence of high demand and, at the same time, supply of qualified personnel, in areas related to the region's specialization.
2. Concentration of specialized suppliers who are looking for locations close to the sales market.
3. Technological spillover effects, thanks to the intensive exchange of information.

It should be noted that the author mentions technology diffusion only in third place among the three basic factors of industrial location, considering that this effect applies to technologically advanced industries. Krugman places emphasis above all on economies of scale and low costs of goods distribution, and therefore low transport costs (Krugman, 1991).

J. Scott, M. Storper and R. Walker (Storper et al., 1989) argue that the benefits of concentration do not only consist in increasing the efficiency of management thanks to the economies of scale and low transport costs, but in the benefits of easy communication. Knowledge and competences are no longer examined at the level of an individual company. They become a regional location factor and an element of regional competitive advantage. At this point, it is clearly visible that the location theory, while looking for determinants of establishing companies in a given territory, at the same time describes the factors of the region's investment attractiveness, and thus its competitiveness. Storper emphasizes the importance of the so-called untraded interdependencies, i.e. dependencies that are not tradable – they cannot be purchased or transferred (Storper, 1997). It is about the connections between regional entities that are built on the basis of institutions specific for the territory, i.e. patterns of behavior (conventions, customs), norms and rules of conduct (Vatne, Taylor, 2000).

This new approach emphasizes the role of local and regional institutions in facilitating the adaptation of the regional economy, drawing on the latest work of economists such as D. C. North (North, 1995) and D. Rodrik (Rodrick et al., 2004). While there are many uncertainties about the detailed impact of the „matter of institutions", there is general agreement that stable and enduring institutions are critical to economic development and that they can alter relations between regions, communities in a national or transnational context, while A. Sen – emphasizes the importance of democratic institutions in formulating development priorities.

According to G. Gorzelak (Gorzelak, 2010, p. 71-81), the modern economy is shaped by three interrelated processes: globalization, competition and innovation. Permanent competitive advantage is enjoyed by those countries, regions and cities where enterprises capable of creating innovations are concentrated. Quantitative factors of location (availability of natural resources, human resources, mass transport, infrastructure, etc.) have been

replaced by qualitative factors (qualifications, reliable, modern and fast technical infrastructure, research and development facilities, friendly and efficient public authorities, business support infrastructure, business conditions, the living conditions, and values of the environment).

According to J. T. Hryniewicz (Hryniewicz, 2000, p. 53-54), the most important factors of economic development are: social mobilization, education and cultural import, which have a greater impact on economic development than infrastructure, entrepreneurship and type of ownership (by individual members of the society).

Similarly, B. Domański (Domański, 2001, p. 127-134) assigns a key role in development to soft factors (learning ability, culture, qualifications, innovation, social ties, climate of trust).

The World Bank's Monitoring Environmental Progress Report (World Bank, 1995) presents an attempt to estimate the sources of global wealth in the context of three types of capital (natural, economic and human – the latter includes social and human capital in the sense of the "Four Capital Model"). According to this source, 20% of the world's wealth is attributed to Natural Capital, 16% to Produced Assets, and the rest, 64%, to Human Resources. As can be seen from the example above, people and their abilities are the most important resource and the basis for the functioning of the economy.

Based on the above classifications, it is not difficult to notice that the common feature of the above-mentioned development factors is one thing: searching for the sources of development in qualitative factors and requiring, never before on such a scale, unseen factors of cooperation (Kozak, 2014, p. 71-80). Research on local development in Poland made it possible to identify the most important endogenous factors of local development, which help to cope with the mechanisms of the modern global, competitive economy based on innovation, and these are (Gorzelak, 2000, p. 99-120):

1. a local leader, able to formulate a long-term vision of the development of a given local system and having the ability to gather the local elite around him, which could consistently implement these visions;
2. local elite, grouping the most active actors – local government activists, managers of the most important local institutions, local entrepreneurs, as well as informal leaders – residents with high authority. It is important that this elite should be able to opt for a pro-development strategy, not a recovery strategy or one focused on short-term benefits (collective or even private);
3. local institutions that stabilize the actions of the local leader and the local elite, maintaining the achieved dynamics and structure of local development even after their departure or after profound changes in the composition of the local elite.

4. an integrated community of local entrepreneurs willing to cooperate with local government authorities and willing to contribute to the city / commune (borough);
5. active local community, joining projects initiated by local authorities and local institutions and showing initiative for the common good. The condition of social activity is the lack of fundamental political and territorial divisions, allowing for the achievement of significant mutual trust within the local community (it is also a condition for the emergence of an efficient local elite);
6. tendency to cooperate between communes, especially with neighbors, allowing for solving problems and undertaking projects beyond the capacity of only one commune (borough).

These factors take the form of general conditions of local development, independent (or little dependent) on the specificity of a given system (its location, economic and social structure, resources, previous management, etc.). However, practice shows that each of these factors is important in local development and the non-existence of the most important of them – e.g. the lack of a local leader, failure to institutionalize existing initiatives, the presence of strong, insurmountable divisions among residents and their elites, reluctance of local business to cooperate, conflicts with neighbors – drastically reduces the possibilities of achieving lasting success in local development (Gorzelak, 2000, pp. 99-120).

Increasing the development opportunities of problem areas requires overcoming the long-term lag in terms of human capital (Skubiak, Taraszkiewicz, 2018, p. 85-91). The trend in local and regional development is shifting towards more reliance on communities that take more and more responsibility for their own economic situation and their future. Successful communities in local development conclude that it is up to them in the long run. Local leadership and the ability to organize play a key role in developing the community's ability to address this challenge. Success in engaging initiatives to work towards a common goal depends on leaders working in partnership with all the community players (members). Numerous studies show how important it is to have a high level of involvement of people in achieving common goals. This presents enormous potential for successful local efforts to achieve economic development. Research by McKinsey (McKinsey, 1994) and Kelty (Kelty, 1993) on regional development trends and priorities has shown that:

- communities have great opportunities to help themselves;
- higher growth and better quality of life are achieved when local government, businesses, trade unions and community groups work together to pursue common interests;

- the quality of organization and leadership have a great influence on economic development.

Local communities must be guided, stimulated and motivated to act by a local leader. Leadership is essential to the implementation of the local economic development process, to mobilize local communities and the necessary financial resources. Leadership can be manifested in the form of a strong local government, a strong social group or the existence of a development organization in its territory.

Analysis of qualitative factors

The aim of the study using the technique of individual interviews was to reach precise information and broaden the knowledge related to this topic. During the interview, exploratory questions were asked to explain/understand the phenomena occurring within the analyzed issue. The adopted research methodology has predicted the implementation of in-depth interviews, with the use of targeted selection of representatives of communes with the highest and the lowest development potential (areas of growth and stagnation). Within each capital, 4 interviews were carried out (n = 3 in communes with the lowest development potential and n = 1 in communes with the highest development potential).

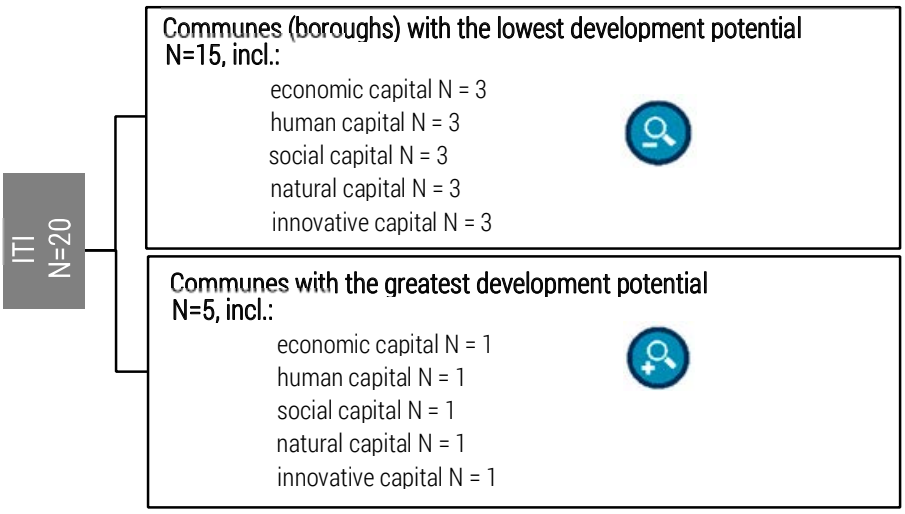

Figure 1. The structure of the realized sample in the ITI survey

Source: author's work.

The results of the quantitative study were presented for communes (boroughs) with the lowest development potential, broken down into individual capitals (economic, human, social, natural, innovative) and for all capitals jointly[2]. The potential of the communes was determined at the desk research stage. Taking into account the average response for all capitals, economic capital was rated the lowest (3.0), while natural capital was rated the highest (3.9).

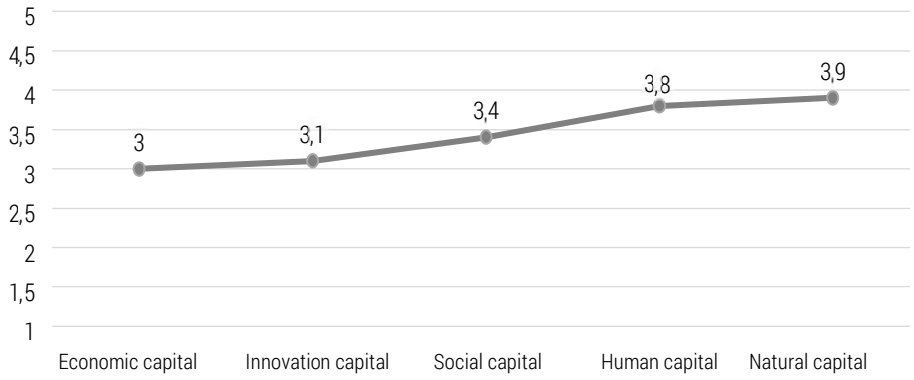

Figure 2. Average assessment of problem areas among representatives of communes with the lowest potential.

Source: author's work.

Representatives of communes (boroughs) were asked about the assessment of economic capital areas. As a result of the analysis, it turns out that among the communes with the lowest economic potential, the lowest is the presence of large enterprises and foreign investors (1.9), the lack of availability of business investment areas and commercial premises (2.5) and the lack of availability of environmental institutions for business (2.6), as well as the lack of availability of employees with the desired knowledge and qualifications (2.6). On the other hand, the highest scores were awarded to water and sewage infrastructure (3.9) and the availability of residents to trade and services (3.8).

Communes with a low economic development potential are usually located far from large urban centers. Moreover, their inhabitants emigrate to work to richer, neighboring communes. It is noted that in these communes there is a shortage of employees with appropriate qualifications and skills.

[2] Average assessment of responses regarding economic, social, human, natural and innovative capital for communes with the lowest development potential, identified at the desk research stage.

The future of economic development may lie in the photovoltaic industry, which is being gradually developed in some communes with low potential.

Table 1. Assessment of economic capital areas of representatives of communes with the lowest development potential

Type of commune	Name of commune	Competitiveness of the local economy	Availability of employees with the desired knowledge and qualifications	Water and sewage infrastructure	Road infrastructure	Occupational activity of residents	Presence of large enterprises and foreign investors	Availability of investment areas and commercial premises	Availability of bei (business environment institutions)	Accessibility of residents to trade and services	Average value
Rural commune	Białogard	3	1	4	3	4	2	2	4	4	3.0
	Brzeżno	4	3	4	3	3	2	3	3	4	3.2
	Krzęcin	4	4	5	3	4	3	1	2	4	3.3
	Radowo Małe	3	2	2	3	3	1	1	1	3	2.1
	Rąbino	2	3	4	1	4	1	1	2	3	2.3
	Sławoborze	3	2	4	5	3	2	4	3	3	3.2
	Szczecinek	2	2	4	4	3	2	4	4	4	3.2
	Świdwin	4	4	4	3	3	2	4	2	5	3.4
Average value		3.1	2.6	3.9	3.1	3.4	1.9	2.5	2.6	3.8	3.0

Note: Scale of answers: 1 – very bad; 2 – rather bad; 3 – neither good nor bad; 4 – rather good; 5 – very good
Source: author's work.

Most of the answers given by the representatives of communes with the lowest social capital were associated with an above-average rating (rather good and good). The respondents rated social participation as the lowest (3.6). In turn, the highest rating concerned the number of foundations, associations and social organizations operating in the commune (4.0).

Table 2. Assessment of social capital areas of representatives of communes with the lowest development potential

Type of commune	Name of commune	Social participation	Number of foundations, associations and social organizations	Sense of solidarity among residents	Average value
Rural commune	Białogard	3.0	4.0	5.0	4.0
	Darłowo	5.0	5.0	4.0	4.7
	Marianowo	3.0	4.0	4.0	3.7
	Sławno	4.0	4.0	3.0	3.7
	Stargard	4.0	4.0	4.0	4.0
	Szczecinek	2.0	4.0	2.0	2.7
	Świdwin	4.0	4.0	4.0	4.0
	Wałcz	4.0	3.0	4.0	3.7
Average value		3.6	4.0	3.8	3.8

Source: author's work.

According to the respondents participating in the in-depth interviews, the activity of the inhabitants of communes in making decisions that are directly related to the functioning of the community, is at a high level, especially if we compare it with the inhabitants of larger agglomerations. It has been noticed that the local community integrates and is willing to cooperate around common goals in the case of, for example, the closure of schools. In addition, it was emphasized that in the case of other important events and decisions affecting their lives, residents integrate too late, usually only after making binding decisions that they could have had a real influence on when developing the proposal. The respondents are not able to determine the degree of solidarity among residents in relation to residents of other municipalities. The author believes that solidarity manifests itself in special situations through, for example, various types of strikes and protests, which has been a rarity until now. There is also one voice of the commune representative that emphasizes the strong identification of the inhabitants with their place of residence, which to some extent, may indicate a sense of solidarity. In the municipalities with the lowest social potential, there are no organizations supporting the pro-development activities of the leader and the elite. On the other hand, there are active civil society organizations, such as senior clubs, organizations working for the benefit of people with disabilities, rural housewives' clubs, and associations dealing with the organization of free time and

pursuit of hobbies, e.g. running. It should be emphasized that communes are willing to subsidize this type of activity and are open to their development and dialogue.

At present, inter-municipal cooperation, which enables undertaking projects that exceed the capabilities of one local system, is implemented to a very small extent. Representatives of municipalities meet during various events or meetings, but this is not a permanent, nor official cooperation. The lack of this kind of cooperation is argued by the lack of perceived needs. The only formal form of inter-communal cooperation mentioned is the "Association of the Lower Oder" (an association in Poland in the region of the river Oder). It is worth noting that one of the representatives of the communes presented the idea of introducing a commune guard, which would require cooperation between several communes.

Human capital is another area which was rated above the average among the representatives of communes with the lowest potential. It is worth noting, however, that one of the areas – the assessment of lifelong learning differs from that of the other factors, and it is assessed as low compared to other factors (2.9). On the other hand, the highest scores were given to the entrepreneurship of the inhabitants (3.8) and the financial situation of households (3.7).

The representatives of municipalities participating in the qualitative interviews unanimously emphasize the improvement of the financial situation of households. One of the indicators (noticed by one of the respondents) is the lower number of applicants in social welfare centers. The situation is similar if we take into account the assessment of the level of education, which is also assessed at an appropriate level. The representatives of communes notice the development of certain areas that make up human capital. Inhabitants (mainly seniors) are characterized by involvement in training activities in the field of gaining computer skills and skills connected with new technologies (digital competences). The potential has also been noticed in terms of entrepreneurship. According to the respondents, its development is visible, which can be observed in tax returns – incl. in return of part of the taxes from the residents to the local government (by indicating in the tax statement 1% of their paid tax for the benefit of local institutions), or on the basis of the visible development of various economic activities.

Table 3. Assessment of social capital areas of representatives of communes with the lowest development potential

Type of commune	Name of commune	Financial situation of households	The level of education of the inhabitants	Digital competences of inhabitants	Health of residents	Lifelong learning	Entrepreneurship of residents	Average value
Rural commune	Banie	3	3	4	4	3	4	3.5
Rural-urban commune	Dobrzany	2	2	3	3	2	4	2.7
Rural commune	Dolice	4	3	3	3	3	3	3.2
Rural commune	Dygowo	4	3	2	3	3	4	3.2
Rural commune	Przybiernów	4	4	4	4	3	4	3.8
Rural-urban commune	Resko	4	3	3	4	3	3	3.3
Rural commune	Rymań	4	4	4	3	2	4	3.5
Rural commune	Siemyśl	4	4	4	3	3	4	3.7
Rural-urban commune	Stepnica	4	4	3	3	3	4	3.5
Rural-urban commune	Suchań	4	4	3	3	4	4	3.7
Average value		3.7	3.4	3.3	3.3	2.9	3.8	3.4

Source: author's work.

Natural capital was rated the highest by representatives of communes with the lowest potential identified at the desk research stage (3.9). Taking into account the individual areas of capital, it should be noted that environmental protection has the lowest rating (3.3), which in relation to the use of renewable energy sources (4.4) or the level of forest cover (4.4) is evaluated by the respondents as a "low".

Table 4. Assessment of natural capital areas of representatives of communes with the lowest development potential

Type of commune	Name of commune	Water quality	Air quality	Afforestation level	Availability of green areas infrastructure	Use of renewable energy sources	Enviromental protection	Protection of natural resources	Waste management	Average value
Rural commune	Darłowo	4.0	5.0	4.0	5.0	3.0	4.0	3.0	3.0	3.9
Rural commune	Kołbaskowo	4.0	4.0	4.0	4.0	3.0	4.0	4.0	3.0	3.8
Rural commune	Przelewice	4.0	4.0	3.0	4.0	1.0	3.0	3.0	4.0	3.3
Rural-urban commune	Pyrzyce	5.0	5.0	3.0	5.0	5.0	5.0	5.0	4.0	4.6
Rural commune	Sławno	4.0	5.0	5.0	5.0	4.0	4.0	3.0	4.0	4.3
Rural commune	Stargard	4.0	4.0	4.0	5.0	4.0	4.0	4.0	4.0	4.1
Rural commune	Świdwin	4.0	4.0	5.0	4.0	4.0	4.0	4.0	5.0	4.3
Rural commune	Warnice	3.0	4.0	2.0	3.0	2.0	4.0	4.0	4.0	3.3
Average value		4.0	4.0	4.4	3.8	4.4	3.3	4.0	3.8	3.9

Source: author's work.

The quality of water in communes is assessed rather good. Most are obtained from the underground sources. During the talks, it was emphasized that the obtained water is very good for humans, but due to the degree of hardness it becomes problematic for e.g. household appliances. In municipalities with a water quality problem, that problem was dealt through repairing the local water pipes system. It seems that air quality in communes with low natural potential is at a very good level. This is due to the lack of the presence of industrial plants, the education of the residents and the control the residents exhibit over this matter. The respondents notice an increase in inhabitants' awareness of selective waste segregation, which, in their opinion, is visible in the increased number of people using intelligent segregation of waste. This goal was achieved thanks to effective education and help from the commune authorities. Afforestation in these communes is smaller than in

other communes. The respondents believe that it is because of the good soil in the area, and that farmers prefer having agricultural fields rather than owning forests on their land. On the other hand, they see no contraindications in afforestation, which is also practiced during e.g. road construction. Despite the lack of forests, access to the infrastructure of green areas is at a satisfactory level. Parks and squares are places that are in abundance in these communes. The respondents emphasize the use of renewable energy sources, including wind turbines or photovoltaic installations, which are used both in private and public construction.

Innovation capital is one of the two lowest rated capitals (3.1). The research and development activity of enterprises was assessed below the average (2.8). On the other hand, innovations in the agricultural sector were rated the highest (3.6).

Table 5. Assessment of the areas of innovative capital of representatives of communes with the lowest development potential

Type of commune	Name of commune	Business innovation	Innovation in the agricultural sector	R&d activities of enterprises	Average value
Rural commune	Białogard	3.0	4.0	3.0	3.3
Rural commune	Bielice	3.0	4.0	3.0	3.3
Rural commune	Marianowo	2.0	4.0	3.0	3.0
Rural-urban commune	Mieszkowice	3.0	3.0	3.0	3.0
Rural-urban commune	Nowe Warpno	3.0	3.0	1.0	2.3
Rural-urban commune	Polanów	3.0	4.0	3.0	3.3
Rural commune	Postomino	3.0	3.0	2.0	2.7
Rural commune	Rymań	3.0	4.0	4.0	3.7
City with (county) poviat rights	Świnoujście	3.0	3.0	3.0	3.0
Rural-urban commune	Tuczno	3.0	4.0	3.0	3.3
Average Value		2.9	3.6	2.8	3.1

Source: author's work.

The level of financing and co-financing of programs and projects in communes with the lowest innovative capital in relation to financing in the areas of other communes is assessed positively by the respondents. These communes are leaders in obtaining external funds, also due to the high degree of qualification in competitions (government and UE contests for the improve-

ment of the local infrastructure). It is worth emphasizing that the most important barrier in obtaining funds is the obligation of their own contribution, which often cannot be afforded by some communes. Representatives of communes with the lowest innovative capital do not notice the innovations introduced among enterprises in the commune. They recognize that there is a potential in their commune that should be exploited, which in itself is innovation understood as development. The situation is similar in the case of research and development activities – due to the lack of large companies and the lack of needs, research and development activities practically do not exist in communes with low innovative potential. The situation is different when it comes to innovation in agriculture. According to the respondents, its level in this case is at a high standard. It has been noticed that farmers are investing in innovative equipment, reacting to the market situation and expanding the range of their crops. Moreover, in the municipalities with the lowest innovative potential, organic farming is spread wider and more and more often implemented.

Conclusions and recommendations

The conducted research allows for the following conclusions:

1. The problem areas are still stuck in the old paradigm of development, in which development is seen in hard factors, i.e. in the technical infrastructure (water supply, sewage, roads, shop areas, etc.), and this in turn translates into decisions made and directions of spending financial resources.
2. There is little importance in the development of soft factors such as: leadership, cooperation, social participation, quality of education.
3. The level of financing and co-financing of innovative programs is low and basically comes down to the purchase of modern equipment by individual farmers and the expansion of the scope of crops.
4. Despite the fact that there are leaders in communes in problem areas who obtain external funds, but this fact does not translate into an improvement in their economic situation. This is probably due to the privileged nature of these areas in acquiring funds, on the one hand; and spending directions, on the other hand. Acquiring financial resources becomes the goal of governing, not a tool to improve the socio-economic situation.

The variable that determines the success of the local government is the level of human capital. The higher this level, the higher the level of other indicators influencing the development: social capital, entrepreneurship development, use of EU funds, etc. Adequate education of young people, as well as

educating adults by organizing and facilitating access to courses and training, will help the society, especially in villages and small towns, adapt to rapidly changing socio-economic conditions, facilitate the use of technological achievements, and in the long-run, it may contribute to the development of entrepreneurship, leading to an increase in the standard of living of the inhabitants.

However, the level of human capital alone does not guarantee that all problems will be overcome. It must be ensured that people with appropriate competences, especially those who can manage the resources of local government well, and also those people with appropriate moral qualifications, will find themselves in local government authorities and administration. The experience of many communes suggests that the optimal situation is to have stable local authorities that have a vision of the commune's development and are able to implement it. The problem, however, is that the Polish society seems to limit its activity in good situations: when the commune develops, carries out its tasks, people stop getting involved in acting for the common good, they do not control the authorities, do not participate in elections; one could even say that their level of social capital is declining. They mobilize only when there is a crisis or a deterioration of the situation. For this reason, an important task is to involve the society in the daily operation of local government, co-responsibility for the common good, regardless of the circumstances.

In 2007, J. Buzek wrote: "... We must learn to cooperate again, talk and respect the partnership for Poland. If there is a lack of trust and good will between politicians, local government officials, scientists and entrepreneurs, we can squander the great potential of a modern decentralized state system (Buzek, 2007).

Since development is now determined by innovative, human and social capital, actions should be taken to support and develop the above-mentioned capitals. Taking this into account, several recommendations relating to the analyzed issue are formulated below:

1. Social and economic needs should be properly diagnosed at the local level because it will enable better targeting of public intervention based on the voivodeship strategy, which should increase its effectiveness and efficiency. The created strategic documents should be a tool for stimulating the development of entrepreneurship, innovation, social and human capital in problem areas. It is important that this occurs while stimulating capacity and activity at the individual and household level, in the public and private sectors and in the third sector.
2. Effective activation of local communities requires compliance with the following rules and principles:

- introducing new management methods that will allow for wider participation of social organizations in the decision-making processes;
- introducing changes to the organizational structure in the decision-making process (for governance to be productive, you cannot adjust the human factor to the existing structures or change people because they do not fit into the structures that already exist;
- the development of an incentive system that requires greater decentralization of power; it is easier to mobilize society to act if it operates in formalized groups;
- changes in culture in the governance process, characterized by a perspective attitude.

3. Solutions that develop trust in the process of social participation in management should be designed. Trust is an important factor contributing to solving problems in social, political and economic life. It becomes all the more important as the basis for the development of an active community is subjectivity, which needs stability and transparency, while the consistent implementation of the actions taken requires the elimination of all uncertainties.
4. A big problem of problem areas is the quality of human capital, which is confirmed by available national research and research conducted by the author in the analyzed area.

While socio-economic status is a predictor of school achievement and is influenced by genes, developing interventions that address the environmental impacts of poverty, reduced stimulation, overpopulation, and chaos; it is the best path to take if the goal is to genuinely equalize opportunities. Problems cannot be solved by acting on the level at which they manifest themselves. Thus, allocating additional funds to subsidize poverty only perpetuates incorrect patterns of behavior and beliefs in those areas, thereby perpetuating the phenomenon that is to be worked out and solved. The instrument of change is properly profiled education and properly designed educational programs – revitalization education. To this end, educational genetics should form a core part of all education programs for teachers and social welfare and policy practitioners, as well as physicians and those involved in perinatal care. Solving social problems with the help of financial and material help is "magical thinking", consolidating characteristic attitudes, beliefs and values that are counter-developmental.

There is a great need to educate specialists in the field of revitalization activities in the field of education and the development of intervention programs (using the conclusions from research in the field of neurosciences and epigenetics), the aim of which is to cause a permanent change in disadvantaged and socially excluded people/social groups. In the long-run, this will

prove beneficial both socially and economically for individuals and to the society as a whole.

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BARRIERS TO SUSTAINABLE COMPOSITE POLES ADOPTION IN INFRASTRUCTURE

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ABSTRACT: Fiber-reinforced polymer (FRP) poles are, next to wooden poles, a more environmentally friendly solution than traditional steel or concrete poles. In addition to having a lower negative impact on the environment, they are characterised by durability, resiliency, and corrosion resistance. But, unfortunately, the range of their use, both in Poland and around the world, is limited. In this paper, the authors try to identify the most important barriers to the wide use of FRP poles in infrastructure construction. They also propose some actions to change this unfavourable situation from the sustainable development point of view.

KEYWORDS: composite poles, sustainability, barriers

Introduction

Utility poles can be made of wood, steel, concrete or fibre-reinforced composite materials. Fibre-reinforced polymer (FRP) poles represent a modern engineering solution in which sustainability and ecology play a significant role. These poles consist of glass or carbon fibres arranged in various patterns enclosed in a resin, which generally consist of vinyl ester, polyester and other epoxy compounds. The most frequent method of manufacturing of composite poles is pultrusion, filament winding and vacuum infusion. Due to the main advantages of glass fibre-reinforced polymer (GFRP) poles, such as exceptional strength to weight ratios, resistance to corrosion and chemical attack, non-conductivity and long lifespans, the use of composite materials for poles is rapidly gaining acceptance throughout the utility industry.

Composite poles represent a new generation of poles that are becoming increasingly important in the lighting market. Concrete and metal poles still make up the vast majority of investments, but they are susceptible to the negative impact of environmental conditions. On the other hand, composite elements are characterised by greater durability. For this reason and potential economic benefits, significant interest from investors in composite poles has arisen.

According to research carried out by the Swedish Environmental Research Institute (Erlandsson, 2011), which evaluated the life cycle of lighting poles made of different materials, composite poles show one of the lowest environmental impacts, inferior only to wooden poles. In addition, they occupy first place in the category of human toxicity (they are the least toxic). The longest life cycle and high passive safety of the element are also important to avoid excessive damage to the vehicle during a collision.

Composite materials are versatile, durable and corrosion-resistant structural materials, relatively inexpensive, that can reduce the total outlays necessary compared to the cost of conventional structural materials. However, while introducing FRP composites into applications, barriers to the widespread use of these materials in infrastructure continue to exist. They occur at all levels, from regulation to fundamental material science (Sheridan et al., 2017). The paper aims to identify barriers to the broad introduction of fibreglass-reinforced composite poles to sustainable infrastructure and identify the environmental benefits and negative environmental impact of these poles.

Literature review concerning LCA of utility poles

Depending on the type of material the electricity poles are made, their negative impact on the environment throughout the entire life cycle is different. Thus, evaluating the environmental impact of product choices is increasingly important. Moreover, considering the substitution principle, which stipulates that, if possible, an environmentally harmful chemical or material shall be substituted with a less dangerous one, policy-makers or electric utilities faced up to the choice of the most sustainable pole material. By quantifying the environmental impacts of products, life cycle assessment (LCA) is a tool that can provide good insight to decision-makers (Nimpa et al., 2017). The existing literature on comparing the environmental impact of utility poles is not rich. Eight items are presented in which LCA has been applied directly – as a study by authors or indirectly – as a literature review. In general, all case studies concern four main materials from which utility poles are produced: wood, concrete, steel and composite materials.

In table 1, a summary of results from the literature on comparative LCAs of utility poles made from different materials is presented.

Table 1. Results from the literature on comparative LCAs of utility poles made from different materials

Name, year	Comparison	Methods of analysis	Factors	Ranking
Petersen and Solberg, 2005	Construction materials and poles: wood, steel, concrete	Literature review	energy, emissions to air, waste, global warming, acidification, eutrophication, human toxicity	1. wood 2. steel 3. concrete
Wood et al., 2008	Utility poles: wood, concrete, steel, high-density polyethylene (HDPE)	LCA	greenhouse gas (GHG) emissions, use of energy, toxic relases	1. high-density polyethylene (HDPE), wood 2. concrete 3. steel
Erlandsson, 2011	Utility poles: concrete, creosote impregnated wood, steel, composite – fibreglass	LCA	climate change, eutrophication, acidification, ground level ozone, ecological toxicity, human toxicity	1. creosote impregnated wood 2. concrete, composite – fibreglass 3. steel
AquAeTer Inc., 2012	Utility poles: wood, concrete, steel and fibre-reinforced composite	LCA	energy & resource use, anthropogenic greenhouse gas, total greenhouse gas, acid rain, Eco toxicity and eutrophication causing emissions	1. treated wood 2. fibre-reinforced composite 3. steel 4. concrete

Name, year	Comparison	Methods of analysis	Factors	Ranking
Maxineasa, Țăranu, 2013	Construction materials: concrete, steel, timber, fibre reinforced polymeric (FRP) composite materials	Describing	life span of a structure	1. FRP composite materials 2. others
Emeryville CA, 2013	Utility poles: wood, galvanised steel	LCA	energy resource depletion, water use, metals and minerals resource depletion, land use ecological impact, global climate change, acidification, ecotoxitcity, human health impact, risk from untreated hazardous waste	1. steel 2. wood
Nimpa et al., 2017	Utility poles: wood, steel, concrete, and fibre-reincorced composite	Literature review	global warming potential (GWP), acidification potential (AP), eutrophication potential (EP), ecological toxicity (ET), smog potential (SP)	1. wood 2. steel, FRC 3. concrete
Lu, Hanandeh, 2017	Veneer-based composite (VBC), concrete, steel	LCA, LCC	global warming, acidification, eutrophication, fossil depletion and human toxicity	1. VBC 2. steel 3. concrete

Source: author's work.

There is a large discrepancy in the results of the presented analyses. Wood appears most often as the material with the least environmental impact. However, many of the authors emphasise that impregnates used for wood cause significant environmental damage. The United States Environmental Protection Agency has labelled creosote a potential carcinogen and sharply limited its use. For this reason, the vast majority of new utility poles are treated with CCA. CCA has its problems, however, as arsenic is a heavy metal that can contaminate air and water with very low concentrations (Wood et al., 2008, p. 4).

Outside the USA, wooden poles were also popular in Australia. However, due to the growing demand for utility poles and the ban on native logging in Australia, it is necessary to find sustainable alternatives to round utility poles made of wood. Currently, steel and concrete are the most common alternatives (Lu and El Hanandeh, 2017), and these are also the most common poles in Europe.

According to LCA analyses, the first or second place in the ranking is often occupied by composite poles. In fact, if the wood is not taken into account,

composites are better material for building electric poles than steel or concrete.

A composite material is a combination of two or more materials: reinforcing elements (such as fibres) and binders (such as polymer resins), differing in form or composition. The combination of these materials can be designed to result in a material that maximises specific performance properties. The resin is primarily attributed to the following favourable FRP material properties (Liang and Hota, 2013):

- higher specific strength and stiffness than steel or wood;
- higher fatigue strength and impact energy absorption capacity;
- better resistance to corrosion, rust, fire, hurricane, ice storm, acids, water, intrusion, temperature changes, attacks from micro-organisms, insects and woodpeckers;
- longer service life (over 80 years);
- lower installation, operation and maintenance costs;
- non-conductivity;
- non-toxicity;
- reduced magnetic, acoustic and infrared interferences;
- design flexibility, including ease of modular construction;
- consistent batch-to-batch performance.

The environmental benefits of FRP composites can be discussed in terms of (Liang and Hota, 2013):

- better durability;
- lightweight;
- lower transportation costs;
- superior corrosion resistance and thus longer service life;
- ease of installation;
- free of maintenance.

Identification of the impact on the environment

The negative environmental impact can be expressed in commonly used indicators such as global warming, acidification, eutrophication, ozone layer depletion, toxicity and resource depletion. The key environmental concerns in composite structures can be categorised as follows: energy use in production (embodied energy), energy use in service (operational energy), transportation, use of raw materials and water, emission of harmful substances, recycling and reuse, waste treatment and land use, indoor environment.

The negative environmental impact of composite poles may occur throughout the entire life cycle:

- the extraction of raw materials,
- transportation from suppliers to composites manufacturers,
- manufacturing process,
- installation,
- operation and maintenance,
- transport to a disposal site,
- disposal process.

Kara and Manmek (Kara S., Manmek S., 2009) assessed the environmental impact of a 2.5 m long column cross made of composite fiber. They analysed the entire product life cycle (cradle-to-grave analysis). They compared the environmental impact of power-pole cross-arm made from fiber composite and the sawn hardwood. The life cycle analysis of these products consisted of four stages:

1) the materials stage is the total raw materials that are used in making the power-pole cross-arms;
2) the manufacturing process stage comprises the processes involved in making the power-pole cross-arms;
3) the use phase covers activities that follow after the manufacture of the power pole cross member, i.e. assembly and maintenance activities, up to the disposal of the product. In this case, the useful life was assumed to be 40 years;
4) the end-of-life stage is the disposal scenario which includes the transportation of the power-pole cross-arms to the disposal site and the disposal process.

Comparative life cycle analysis studies were conducted by using literature reviews and the libraries from the database of the LCA software, SimaPro 7.1.8. The research results are presented in three indicators: embodied energy consumption, greenhouse gas emissions and Eco-Indicator 99 H/A version 2.03 method[1]. The results of Eco-Indicator 99 are presented in figure 1.

The environmental impact of the power-pole cross-arm at the material life stage is 7 points per power-pole cross-arm for the hardwood and 2 points per power-pole cross-arm from the fibre composite. This 68% increase for the hardwood power-pole cross-arm is due to the fact that the hardwood was based on a forest transformation scenario and cutting wood from the forest. Therefore, it is associated with a high environmental impact in terms of land use and reducing biodiversity. In addition, a large amount of fuel is required to cut forests. Another advantage of the fibre composite power-pole cross-arm is the use phase, where the environmental impact is reduced by 99.7%

[1] This index is calculated as a single score, expressed in points. It is a comprehensive life cycle assessment analysis that considers human health, ecosystem quality and the impact of resource use.

during installation and replacement operations. This is due to the weight of the fibre composite power-pole cross-arm, which is lighter than the hardwood timber power-pole cross-arm. As a result, the truck will consume less fuel while transporting to the chosen destination.

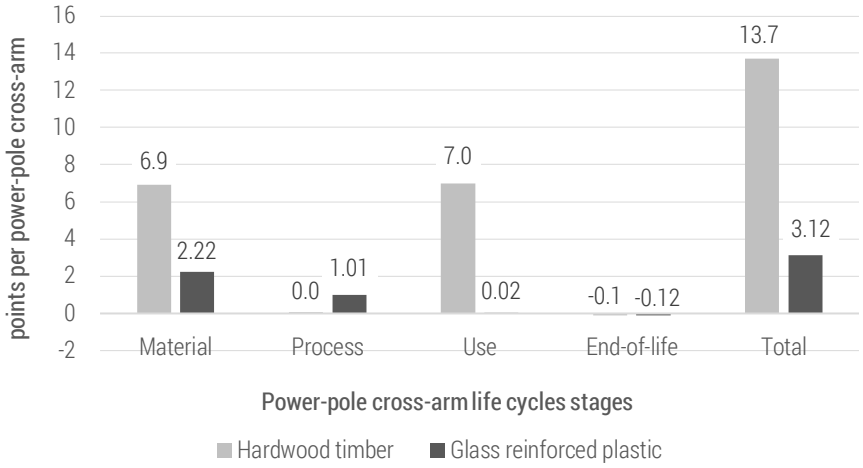

Figure 1. Comparison of environmental impact two kinds of power-pole cross-arm [in a unit of points]

Source: (Kara S., Manmek S., 2009, p. 163).

Moreover, due to the long service life of the composite material, there is no need to replace the power-pole cross-arm during use. This significantly reduces the amount of materials and energy compared to the power-pole cross-arm made of hardwood. However, a disadvantage of a fibre composite power-pole cross-arm is the manufacturing process, where its overall environmental impact is 99.97% higher than a hardwood timber power-pole cross-arm.

In general, the life cycle of composite items has much lower embodied energy than traditional products (steel, concrete, wood, aluminium) in a cradle-to-grave analysis. This is important because typical materials require a significant amount of energy during their extraction. During the production process, the majority of composite items have a higher embodied energy than traditional products. At the stage of use, composite products outperform traditional items significantly. This is mainly due to its small weight and resistance to corrosion. Maintenance tasks, for example, can save up to 35 percent on fuel consumption. Despite their many benefits, composite materials have a drawback at the end-of-life stage, when they are now 100%

garbage. In contrast, traditional products such as steel and aluminium are 65 to 70% recyclable. The composites sector may face a future challenge in improving the recyclability of composite products. This will help composite products improve not only their embodied energy efficiency but also their competitiveness.

In conclusion, composite products are anticipated to perform better than traditional products in terms of embodied energy incurred over their life cycle stages. They are the most effective in the material stage. Their superior material features, including strength and lightness, provide them with a distinct advantage over traditional materials.

Main barriers and their overcoming

Stand-alone FRP composite products, like utility poles, represent a small portion of the overall FRP composite infrastructure market and face specific barriers to increasing their market share. Owners, designers, and contractors are familiar with traditional materials and construction processes, so they are reluctant to use FRP composites even though they promise increased safety, lower life-cycle costs, and greater durability.

The main barriers for stand-alone FRP composite structures are identified as follows (Sheridan et al., 2017, p. 11):

1) predicting service life;
2) codes, specifications, and standards;
3) first-cost paradigm;
4) training and education.

Infrastructure structures typically have a service lifetime of 75 to 125 years. The major engineering assessed design properties are stiffness, failure strength, creep and creep rupture, damage tolerance, bearing strength, fatigue life, and environmental resistance because UV radiation, wetness/moisture, saltwater, cyclic and persistent loads (fatigue), and large temperature changes are all common service conditions of infrastructure structures. Composite materials' higher durability in severe settings is well acknowledged. The capacity to quantify the remaining life for asset management needs is the key difficulty. The rate of corrosion or fatigue-crack propagation in steel, for example, is well established and can be used to estimate the chance of a pipeline failing. However, there may be no apparent symptoms of degradation or propagating cracks in an FRP composite material that allow precise forecast of remaining service life.

Currently, FRP structures are designed conservatively for safety, which raises costs and inhibits structural innovation. Due to a lack of understanding

of FRP materials (particularly their long-term durability), a lack of approved design standards, and a lack of thorough property characterisation of the material, high safety factors are frequently applied. Because many original applications have not reached their projected lifetime, material property data acquired from realistic exposures is not readily available. Furthermore, no systematic attempt has been made to collect publicly available in-service data on material property changes resulting from exposure. Non-destructive monitoring approaches must be combined with statistical predictive modelling to make correct asset management decisions.

The short term amortisation of the purchase cost of composite columns does not accurately reflect the cost benefits of FRP composites. However, in the US, overall installation costs have been observed as FRP utility pole crossarms became widely used (Sheridan et al., 2017).

Customers believe that FRP composite materials require cumbersome training and safety equipment for installation and maintenance. For example, trained installers are needed to repair infrastructure in the event of a natural disaster, which further complicates the implementation of FRP composites outside of niche applications.

Extensive research and testing are required regarding the properties of composite materials. These would provide the necessary data for an accurate estimate of the remaining service life and would serve as a basis for changing the existing safety factors in the existing standards. This, in turn, would reduce costs. Modelling methods should be performed with solid scientific support. The development of existing standards for the use of FRP composites in infrastructure applications will help owners feel more comfortable with the specification of FRP composites. The standards will help engineers to use FRP composites in their designs properly, and also provide a more consistent approach to design using these materials. The development of standards related to the use of FRP composites in infrastructure provides the opportunity to address many of the identified barriers related to the adoption of FRP composites. However, it is a complex task that requires considerable time and commitment from various stakeholders (Sheridan et al., 2017).

To create and implement such standards to be successful, collaboration between industry, government, and academia is essential. A framework is needed that includes guidelines for manufacturing, quality control, and repair processes. Standards should include 1) certification, 2) design and manufacturing process, 3) quality control, maintenance methods to ensure durability.

It is suggested that a program be developed to set up testbeds, collect data, and generate models from accelerated testing to produce a set of dependable design tools. This empirical method should be supplemented by

an a priori program aimed at developing tools that can predict service life solely based on the particular structure and material combinations. The resulting models and data would be made broadly available to industry, end-users, engineers, architects, and designers through an online tool. Because industry participation is critical to ensuring that the research program is commercially relevant, a public-private partnership is desirable. This collaboration should focus on gathering data on composite durability and service life as a function of environmental and material characteristics (ultraviolet, moisture, mechanical fatigue/creep, salt spray, freeze/thaw cycle, temperature exposure, chemical structure). Case studies and laboratory testing could be used to validate the forecasts to be able to predict more than 100 years of service life. The Durability Testing program should include: identification of critical data and modelling needs, accelerated ageing methods for FRP composites, fundamental durability and lifetime models (Sheridan et al., 2017).

Design guides and trustworthy data tables for infrastructure applications should be collected, curated, and disseminated. In the short term, it would produce valuable data by categorising and storing existing data to make it broadly available for infrastructure applications and accessible to all.

The activities should aim at:

- facilitate end-user communication and education,
- widespread availability of guides and standards for FRP composites,
- ensure traceability and harmonisation of standards and norms.

Such activities should give the first steps in harmonising design rules and standards, allowing for a more comprehensive view of the design space and verification test techniques. This standardisation should be expanded to a worldwide endeavour to provide a broad and consistent market, allowing for widespread use of composites in infrastructure.

Durability testing and design data information must be transmitted to designers, practising engineers, and end-users so that it may be used in infrastructure applications.

As data and information created by these activities become public and recognised, curriculum development may include them. Once such programs are established and approved, they may be used to teach qualified technicians and designers, who can then instruct others to provide direct, decentralised, and individualised education.

Conclusions

Scientific research has repeatedly confirmed the sustainable nature of composite materials. Environmental impact analyses and life cycle analyses conducted by scientists confirm the lower negative environmental impact of structural elements made of fibre-reinforced polymer. The main advantages of composite materials are their strength, corrosion resistance and longevity. However, because composites are a relatively new material in civil engineering, they are not well understood. This is the main barrier to their wide application. Insufficient knowledge of the strength, construction techniques, a real lifetime of FRP composites is a barrier for designers. It is necessary to conduct extensive research on composites' properties and then establish standards for FRP composites. These should include the stages of design, production, maintenance, quality assurance and certification. Another problem is the lack of skilled labour for field installation. For many engineers and workers, the procedural knowledge of, e.g. fixing and anchoring FRP composites to existing structures is insufficient. Education in the correct technique of installing the structure is necessary.

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The contribution of the authors

Mirosław Broniewicz: conception – 60%, literature review – 10%, writing 30%
Elżbieta Broniewicz: conception – 40%, literature review – 60%, writing 30%
Karolina Dec: literature review – 10%, writing 20%
Szymon Lubas: literature review – 20%, writing 20%

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STUDIES AND MATERIALS

STUDIA I MATERIAŁY

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VALUE OF THE SEWAGE MANAGEMENT DEVICES IN RURAL AREAS IN THE OPINION OF LOCAL COMMUNITIES ON THE EXAMPLE OF THE WYSZKI COMMUNE

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ABSTRACT: The aim of the article is to present the public reception of the implementation of household-level sewage treatment plants in the Municipality of Wyszki. The CVM method of conditional valuation was used to learn the opinion of residents on the implementation of domestic sewage treatment plants, using the willingness test for payment (WTP). The method of conditional valuation was carried out based on a survey. The research trial was conducted using direct interviews among 100 inhabitants of the commune of Wyszki. The questionnaire contained, among other things, questions about the types of sewage collection and treatment system in the municipality. For the article, the answers of the commune residents who were not connected to the sewage system or had a holding tank were considered.

KEYWORDS: contingent valuation method, the social acceptability of the investment, WTP questions, home sewage treatment plants

Introduction

In rural areas, when designing investments to protect the environment, it is necessary to consider the sewage treatment plant and sewage system of a given region, including local conditions. The construction of a sewage treatment plant and the expansion of the sewage system should be connected with the financial possibilities of the municipality. The cost of building a sewage system supplying sewage to a sewage treatment plant is often several times higher than the cost of building the plant itself. In areas with dispersed development, which is characteristic of the village, holding tanks are used for technical and economic reasons. However, taking into account their leakage, which significantly contributes to the pollution of the environment, and especially the surface and underground waters, the inhabitants of the communes are proposed to build household-level sewage treatment plants.

The costs of sewage disposal and neutralization will continue to increase. It is due not only to legal restrictions in the environmental policy but also to pressure from organizations working for environmental protection.

It is also important for the municipal authorities to know the degree of social acceptability of sewage management projects in the municipality. In order to get to know the opinion of the residents on the implementation and operation of sewage treatment systems, a conditional valuation method (CVM) can be used, using the willingness to pay (WTP) test. The information obtained by this method will allow determining how much the local community is able to pay for using the sewage treatment system.

The aim of the article is to present the results of a survey of willingness to pay by the residents of the commune of Wyszki, located in the Podlaskie Voivodeship, for the improvement of the standard of wastewater treatment. The conditional valuation method (CVM) was used (using the willingness to pay (WTP) test) to get to know the opinion of the residents on the ways of wastewater treatment. The survey of the local community's opinion was based on a survey conducted in the municipality.

Selection criteria for wastewater collection and treatment systems

Sewerage systems and sewage treatment plants require large investment outlays; therefore choosing the right sewage system and sewage disposal system is of fundamental importance for rural residents as well as for the national economy. The choice of an appropriate sewage collection and treatment system consists primarily in finding the right length and configuration

of sewage networks, discharging sewage to a specific sewage treatment plant so that minimum investment outlays and operating costs can be achieved. In rural areas, the gravitational sewage system dominates, but it is a system characterized by high implementation and operating costs. Collective wastewater treatment plants, on the other hand, are characterized by higher efficiency of pollution removal and low unit costs of wastewater treatment.

The choice of an appropriate wastewater collection and treatment system should be based on four basic criteria:

1. The technical criterion, which takes into account land gradients, location of the sewage receiver, groundwater level, the nature of the buildings and existing underground infrastructure and roads.
2. The economic criterion presents the possibilities of financing investments by the municipality in the construction of an appropriate sewage system, collective sewage collection and treatment, or, if it is not possible, domestic sewage treatment plants and the costs of operating these facilities.
3. The environmental criterion, which contains information on protected areas in the municipality and groundwater pollution.
4. The social criterion, which provides all the arrangements between the authorities and the residents of the municipality for the implementation and operation of collective wastewater collection and treatment systems and domestic wastewater treatment plants.

When deciding to implement a collective sewage collection and treatment system or a domestic sewage treatment plant, the municipality is based on two criteria: technical and economic. The technical criterion determines the conditions that must be met for a particular type of sewage system, sewage treatment plant and domestic sewage treatment plant. Even though they ensure the fulfilment of ecological requirements, some solutions cannot be realized due to the second criterion, namely the economic criterion. Such a situation occurs mainly in conditions of dispersed development, where the construction of a sewage system and a collective sewage treatment plant requires large investment outlays and operating costs. Therefore, for economic reasons, holding tanks (septic tanks) or domestic sewage treatment plants are built.

However, when implementing public investments, the opinion of society is important. So far, the commune authorities did not have a tool that would enable them to get to know the inhabitants' opinions on the implementation of wastewater management investments. The assessment of this type of project's social acceptability is of great importance, especially in relation to the construction of the collective sewage collection and treatment system, as these are long-term investments and their lifetime is several dozen years.

Prior to the construction or expansion of collective wastewater collection and disposal systems and the construction of septic tanks or household-level wastewater treatment plants, municipalities should have developed a wastewater collection concept taking into account the solutions selected in accordance with the above criteria.

The commune needs to consider the inhabitants' opinion when implementing its policy of ensuring collective sewage disposal and treatment, as well as the construction of septic tanks or household sewage treatment plants. In this situation, the commune authorities may use a tool based on the conditional valuation method.

The developed procedure for testing the social acceptability of implementing a collective sewage disposal and treatment system is based on questions in the form of WTP.

The proposed method consists of the following stages:

1. The concept for selecting a wastewater treatment method:
   a. The concept for building a collective sewage treatment and the concept of the sewage system implementation
   b. The concept for building a household-level sewage treatment
2. Cost analysis of the proposed solutions
3. The determination of operating expenditures and operating cost
4. Setting price levels
5. The development of a survey questionnaire
6. Conducting surveys
7. Statistical analysis of the results obtained

The first step in this procedure is selecting and concept of the implementation and construction of an appropriate sewage collection and treatment system (municipal or domestic sewage treatment plant). In the case of a municipal sewage treatment plant, the amount of sewage that will be treated at the plant is taken into account, and the daily amount of sewage and annual costs of sewage treatment are calculated. The collective wastewater treatment and discharge system consists of a sewage system and the municipal wastewater treatment plant. Therefore, based on the analysis of local conditions, one of the sewage systems (gravitational, pressure, or vacuum) should be chosen. Then, depending on local conditions – technical criterion, the appropriate sewage collection and treatment system should be selected, and then the cost analysis of selected technological solutions – economic criterion. The next step is to determine the investment outlays and operating costs for the selected sewage system (it is necessary to determine the approximate length of the sewage system that will serve the planned number of residents) and the selected sewage treatment plant. It is also possible to determine the annual costs of the entire sewage treatment and discharge system

at this stage. The last stage of the procedure is the statistical elaboration of the results obtained based on surveys conducted among the local community – a social criterion. In the case of the proposed method of social acceptability of the implementation of the sewage treatment method, it is proposed to conduct the survey in the form of a direct interview. It is known that the results obtained by this method are burdened with systematic error, but an experienced interviewer is able to conduct the interview in a proper way. In the case of the problem the method concerns, it is important to be able to explain the purpose of the survey, what the investment concerns and what the particular price levels resulting from.

Contingent valuation method

The Contingent Valuation Method (CVM) can be used to examine residents' opinions on the implementation of wastewater management investments. This method is based on surveys conducted among respondents interested in a given good or service. The researcher may ask the respondents questions in the form of WTP (Willingness to Pay), i.e. if they are able to pay for access to a given good or service. Most often, these are closed questions in which information is obtained in an indirect way whether the respondent's WTP is above or below the amount specified in the question (Czajkowski, 2011; Graczyk, 2005). A significant problem related to closed-ended questions is the so-called confirmation effect, where some respondents tend to give positive answers to the asked questions, regardless of their content (Holmes et al., 2002).

Questions about WTP should be applied when the respondent is entitled to the current level of a given good. Then the question concerns his situation improvement and when the respondent is entitled to the current level of a given good. Then the question concerns the possibility of its deterioration. Surveys are usually conducted in several variants, differing in the amount of the sum, which allows for a more accurate estimation of the WTP distribution (Perman et al., 2003).

A closed question variant is a double closed question. Depending on the answer to the first question, another one is asked. The amount is reduced in case of a negative answer or increased in a positive answer (Bateman et al., 1996).

The beginnings of the method of conditional valuation date back to 1947. This method was used in 1958 for the valuation of recreational activities in the Delaware river basin (Mack et al., 1965). In 1963, Davis spread the use of this method (Davis, 1963) However; it was not until 1979 that the CVM in the

USA was officially accepted after the Water Resources Council had revised the rules and standards used to evaluate water projects (Hanemann, 1992; Navrud, 1992). In 1980, conditional valuation was accepted in the USA, along with other environmental assessment methods, as since then, government agencies have increasingly used this valuation technique (Carson, 1998; Turner et al., 1992; Carson, 2002).

In 1993, after the Exxon Valdez oil tanker disaster, environmental organizations used the results of the conditional valuation method used to estimate the value to American society of the destroyed ecosystems of Alaska. This case, which was originally intended to discredit the method, contributed to the recognition that conditional valuation could be used as a reliable means of measuring value, provided certain principles of the study were followed. These rules specify how to construct a survey scenario and then conduct a survey to limit the effects of WTP revaluation (Carson et al., 1992; Harrison et al., 1998).

The Contingent Valuation method has been used, e.g. for the valuation of rare and endangered species of plants and animals (Loomis, 1996), or for the valuation of measures aimed at reducing flood risk (Shabman et al., 1996; Liziński, 2007).

Surveys based on WTP questions were conducted in France, for example. They concerned with the willingness to pay for the improvement of water quality in rivers. The results of the surveys showed that both industry and agriculture do not bear the costs resulting from water pollution. Households had the largest share in the expenditure on water protection (Cost recovery analysis or economic water cycle, 2005).

The research using the contingent valuation method was also carried out in three municipalities on the island of Crete in Greece. The research was carried out in the Economic Department of the University of Crete in Rethymno in 2005. The research questionnaire was developed in such a way as to reveal the willingness of residents to pay for the implementation of municipal wastewater treatment plants in these municipalities (Genius, 2005).

Attempts have also been made to use the contingent valuation method in Poland. The best known is the study (it was called „Baltic"), which formulated the question of how much Polish citizens would be willing to pay to stop the eutrophication of the Baltic Sea. As a result of the undertaken actions, the minimization of the number of closed bathing sites and the renewal of life in the sea was presented (Markowska, Żylicz, 1996).

The contingent valuation method was also used to examine the readiness of residents of three communes in the Podlaskie Voivodeship, namely Miastkowo, Zbójna and Dubicze Cerkiewne, to pay for improving the standard of wastewater collection and treatment, within the framework of the Polish-

Greek project entitled: „Assessment of readiness to pay for wastewater treatment and closure of water circuits", carried out at the Bialystok University of Technology in 2008-2010.

Comparison of the results of the research conducted in Poland and Greece shows that in the surveyed municipalities, located on the island of Crete, almost all the surveyed residents (97.5%) expressed willingness to pay for the construction of municipal sewage treatment plants, while in the surveyed municipalities of Podlaskie Voivodeship such willingness was shown by only 47% of the residents. This difference can be explained by the fact that in the communes on the island of Crete, most of the population lives from tourism and attaches great importance to the sanitary level in their area (Report on the implementation of the Polish-Greek research project, 2008).

Assessing the social acceptability of the implementation of a wastewater treatment system in the municipality of Wyszki, located in the Podlaskie Voivodeship

The Commune of Wyszki is located in Podlaskie Voivodeship, in the north-eastern part of Bielsko County. It is a typically agricultural commune. The area of the commune is 206.5 km^2. The population of the commune is 4347 people (as of 20019). In Wyszki Commune, there are 59 settlements (http://www.wyszki.pl).

The condition of sewage management in the commune is unsatisfactory. The total length of the sewage system in the commune of Wyszki is 10.2 km. 172 people are connected to the network, which gives a total of 3.25% of the commune's sewage system. The vast majority of households do not have regulated wastewater management. The property has septic tanks, from which waste is periodically removed, individually by farm owners (475 septic tanks and 20 household sewage treatment plants). Municipal sewage from municipal buildings is transported to the sewage treatment plant in Bielsk Podlaski (https://bialystok.stat.gov.pl).

The research tool was a survey questionnaire, consisting of three parts. The first part included questions related to the issue of wastewater management in the analyzed community. There were also questions concerning the development of sewage management. The second part of the questionnaire consisted of questions concerning the preferred amounts for the use of the sewage management system by inhabitants. The third part of the questionnaire concerned the respondents' personal data and general socioeconomic characteristics, which consisted of questions concerning their age, gender, education, income, and place of residence.

The research trial was conducted by means of direct interview among 105 inhabitants of the commune of Wyszki of which 83% of the respondents are men, and 17% are women. The questionnaire contained, among other things, questions about the types of sewage collection and treatment system in the municipality. For the purposes of the article, the answers of the commune residents who were not connected to the sewage system or had a holding tank were taken into account.

The conducted research has shown that the inhabitants of the commune are aware of the fact that the expansion of the sewage system is a profitable investment only in urbanized areas. In contrast, an alternative to dispersed areas is home wastewater treatment plants. The residents are aware of the fact that they will not have a sewage system, which is why the survey showed support for building a household-level sewage treatment plant. Some of them claimed that everything is better than a holding tank, which threatens the environment. The survey also showed that the residents of the Municipality of Wyszki are aware of how sewage management is conducted in the municipality and was able to identify problems related to the discharge and treatment of wastewater in the municipality.

The respondents were also asked how much they would be willing to pay to construct a household-level sewage treatment plant (figure 1).

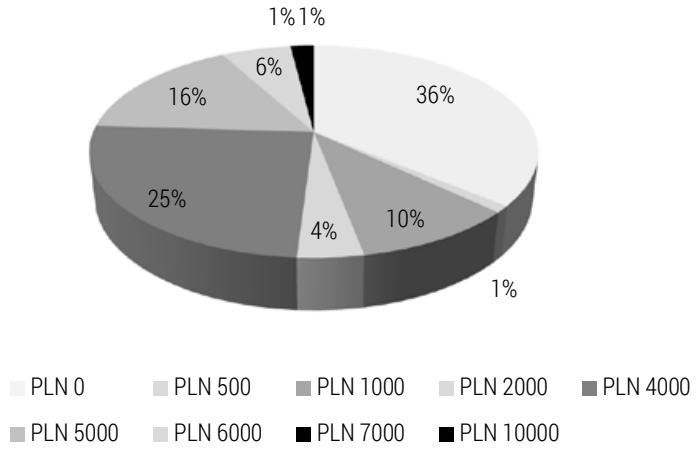

Figure 1. Amounts declared by the respondents for the construction of a household-level sewage treatment plant

Source: author's work.

The largest number of respondents – 25% – gave and 4000 PLN as the maximum amount they are able to pay for the liquidation of septic tanks for the benefit of a household-level sewage treatment plant. 16% of the respon-

dents stated that they were able to pay 5000 PLN. The highest amount that the respondents are willing to pay is 10000 PLN (1% of people). On the other hand, 36% of respondents are not ready to pay for building a household-level sewage treatment, due to the lack of money in the home budget for this type of investment.

Based on the conducted surveys, socioeconomic data of the residents of the commune of Juchnowiec Kościelny were also obtained. On their basis, it was possible to calculate the correlation coefficient between these characteristics. With the help of Microsoft Excel 2007, the relations between the obtained socioeconomic features were examined. The tool „Pearson's linear correlation coefficient" was used for this purpose. If the value of this coefficient is:

- positive – means that with the increase of the X characteristic, the Y characteristic increases,
- equal to 0 – it means no correlation (with the rise of the X characteristic, the Y characteristic increases or decreases),
- negative – it means that with the increase in X characteristic, the value of Y characteristic decreases.

In addition, you can also determine the strength of the correlation for the r coefficient depending on its value:

- no linear relationship when r <0.2;
- there is a weak relationship when r is within the range 0.2-0.4;
- there is a moderate dependence when r is in the range 0.4-0.7;
- there is quite a strong dependence when r is within the range of 0.7-0.9;
- there is a very strong relationship when r> 0.9 (http://www.statystyka-zadania.pl/wspolczynnik-korelacji-liniowej-pearsona/).

Based on the obtained figures concerning: age, income, the amount of waste disposal at one time, the declared amount that the respondents are able to bear for the construction of a household sewage treatment plant, correlation coefficients were determined.

The first two features taken into account in the case of respondents who wanted to liquidate a holding tank for the benefit of a household-level sewage treatment plant were the age of the surveyed person and the amount of money spent on sewage disposal time. The research has shown that the respondent's age increases while the amount spent on sewage disposal decreases, and there is no correlation between these characteristics (figure 2).

Then, the respondent's age and the declared amount he or she can pay to liquidate the septic tank for the benefit of the household sewage treatment plant were examined. The research have shown that as the age of the respondent increases, the declared amount increases. However, in this case, too, there was no correlation between the examined features (figure 3).

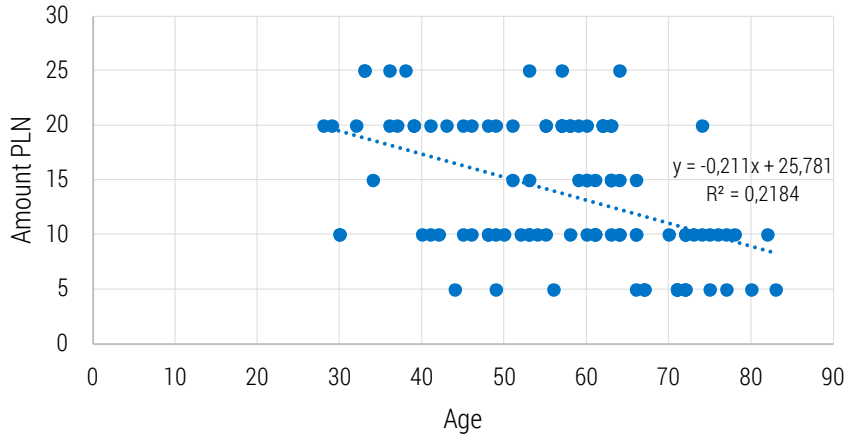

Figure 2. The correlation coefficient between the age of the respondents and the amount allocated for one-time waste disposal

Source: author's work.

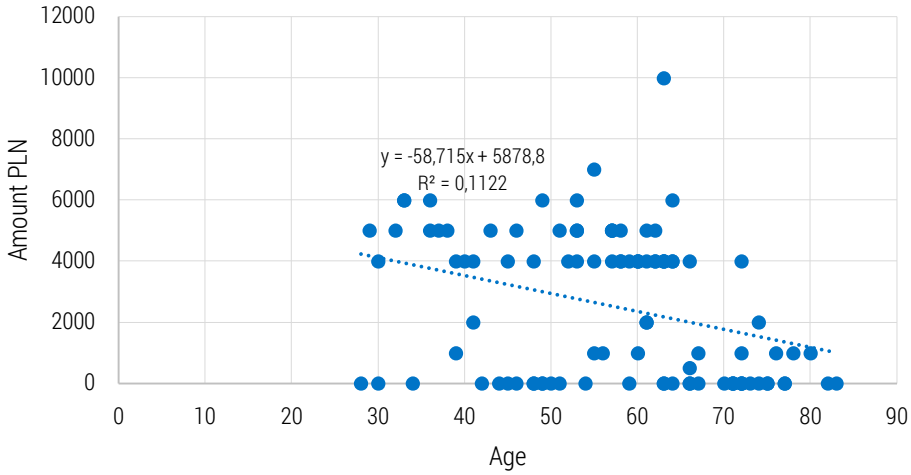

Figure 3. The correlation coefficient between the respondents' age and the amount declared by them for the construction of a domestic sewage treatment plant

Source: author's work.

The respondents' gross income is a factor influencing the cost of building a domestic sewage treatment plant. The research has shown that there is no strong correlation between the examined features (there is a moderate cor-

relation), which confirms that not all people are willing to allocate certain funds for the construction of a domestic sewage treatment plant (figure 4).

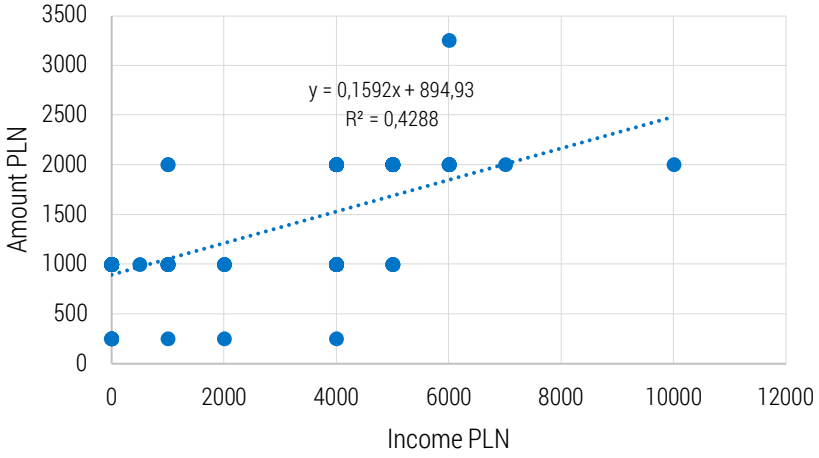

Figure 4. The correlation coefficient between the respondents' income and the amount declared by them for the construction of a domestic sewage treatment plant

Source: author's work.

Furthermore, people with gross income per 1 person 1500-2500 PLN declared that they are able to bear the cost of 5000PLN – 11% and 4000 PLN – 12%. On the other hand, persons whose gross income per 1 person was below 500 PLN declared 4000 PLN – 2% and persons whose income was between 501-1500PLN declared 4000 PLN – 13%. Persons whose income was between 2500-4000 PLN declared 10000 PLN – 1%. It follows that the declared amount strongly depends on the income, because the greater the income, the greater the declaration of the respondent (figure 5).

Also, the number of children owned by the respondents and the declared amount for the construction of a household-level sewage treatment plant were examined. The research have shown that as the number of children increased, the declared amount decreased and there is no correlation between the examined features.

In addition, socioeconomic research has shown that residents who are entrepreneurs have declared higher amounts, i.e. 10000 PLN – 1%, 6000 PLN – 1%. On the other hand farmers declared amounts: 4000PLN – 20%, 5000 PLN – 14% and 1000 PLN – 5% respectively. Only pensioners declared low amounts: 1000 PLN – 3% and 500 PLN – 1% respectively, while people employed in companies declared that they were ready to pay 4000 PLN – 3%.

One characteristic is dependent on the other because the better the status on the labor market, the more respondents were able to pay (figure 6).

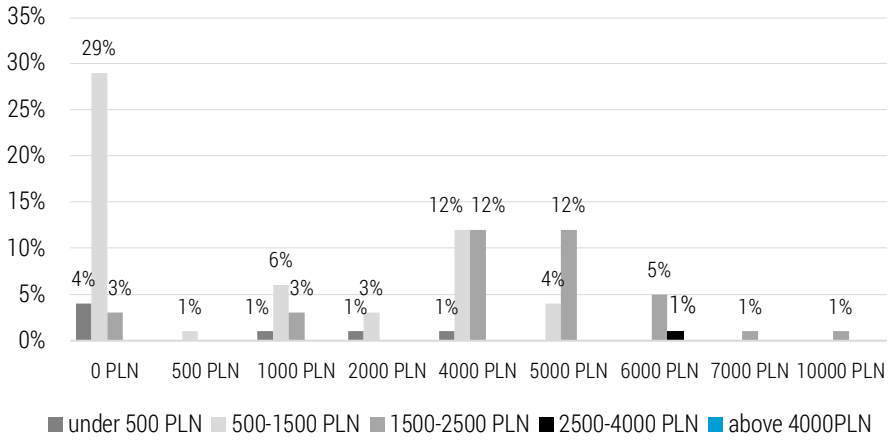

Figure 5. Declared amounts for the liquidation of a septic tank for a household sewage treatment plant according to gross income per capita

Source: author's work.

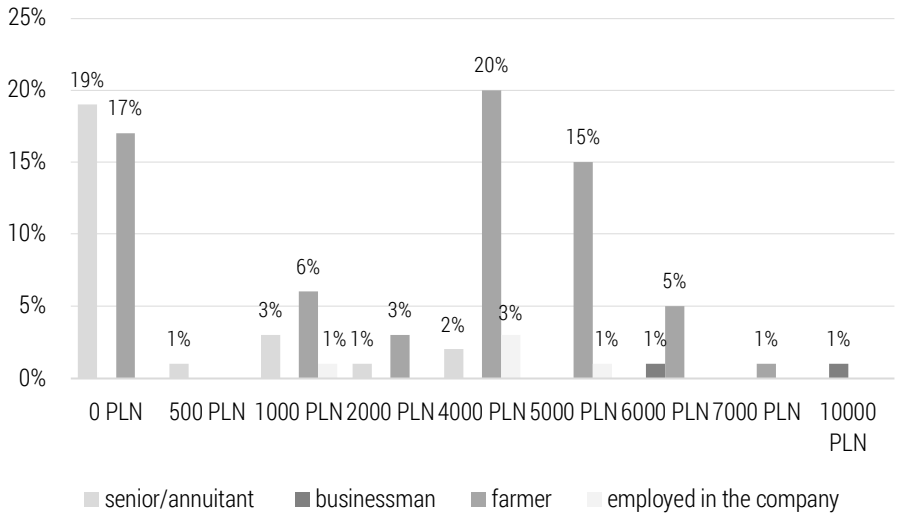

Figure. 6. The amounts declared by the respondents for the liquidation of a septic tank for the benefit of a household sewage treatment plant by labour market status

Source: author's work.

The research also showed that people with secondary education declared high amounts for constructing a household-level sewage treatment plant: 10,000 – 1%, 6000 PLN – 5%, 5,000 PLN – 14%, 4,000 PLN – 11%. People with higher education declared amounts 5000 PLN and 4,000 PLN – 1%. People with primary education declared amounts: 4000 PLN – 13%, 1000 PLN – 7% and 2,000 PLN – 4%. Based on this, it can be concluded that with the increase in education, the amount declared don't increases (figure 7).

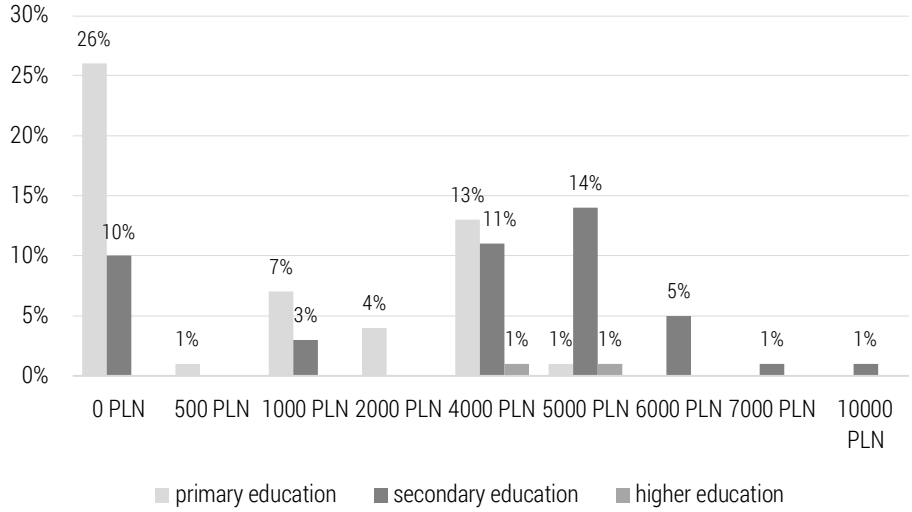

Figure. 7. The amounts declared by the respondents for the septic tank liquidation for the benefit of a household sewage treatment plant according to the education

Source: author's work.

Conclusions

Research carried out in the municipality of Wyszki has shown that most residents agree to the construction of a household-level sewage treatment plant. Furthermore, they are willing to finance its construction and operation, believing that this will improve surface and groundwater quality in the municipality and allow for the decommissioning of holding tanks and environmentally harmful transport of this sewage by slurry tankers.

In the case of questions about WTP, it was found that the respondents who wanted to eliminate the holding tank for the benefit of a household-level sewage treatment plant are 25% and are able to pay 4,000 PLN and 16% of people are able to pay 5,000 PLN for the construction of a household-level sewage treatment plant. The amount of 6,000 PLN was declared by 6% of

people each and 2,000 PLN – 4%. The smallest amounts that were declared were: 500 PLN – 1% of people and 1,000 PLN – 10% of people. The largest declared amounts are 10,000 PLN and 7,000 PLN (1% of people). On the other hand, 36% of respondents are not ready to pay for building a household-level sewage treatment due to the lack of money in the home budget for this type of investment.

Then, as a result of a general analysis of the respondents' answers, the relationship between their socioeconomic characteristics was considered, which was achieved by the so-called correlation coefficient. A correlation coefficient was found in the group of people who had a holding tank and wanted to have a domestic sewage treatment plant. As the age of the respondent increased, the amount for one-time sewage disposal increased. It was also noted that the status on the labour market was important for the declared amount for the construction of a household-level sewage treatment plant. The largest amounts were declared by entrepreneurs, while the lowest was by farmers. In this case, the declared amount was influenced by the education of the respondent. The respondents with higher education were willing to pay a higher amount than residents with lower education. The gross income per capita also influenced the declared amount. It was found that the higher the income, the higher the declared amount.

All the above-described declarations of the respondents on sewage management and their willingness to pay depends on many factors. The monthly costs of sewage disposal and willingness to pay for the construction of a household-level sewage treatment plant are influenced both by age, the number of children and gross income per capita. Older people, like farmers, are able to pay less for the construction of domestic sewage treatment plants than people of working age. This is due to the lower financial resources of this social group.

The Commune Office prepares documents related to investments aimed at the development of sewage management in the commune. For localities where it is not possible to expand the sewage system due to dispersed development, the commune has prepared a concept of planned areas for household-level sewage treatment plants, of which there are currently few in the commune (about 20).

To sum up, the impact of the environmental protection principles and activities of the European Union determines the development of technical infrastructure related to wastewater management in Poland. However, insufficient awareness of the inhabitants in the field of sewage management and a low level of economic development in the commune makes the deficiencies in this field still visible.

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Elżbieta GOŁĄBESKA

THE BENEFITS OF IMPROVING THE TECHNICAL CONDITION OF A BUILDING IN THE CONTEXT OF ENERGY EFFICIENCY

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ABSTRACT: This article deals with the impact of thermal upgrading measures on the energy efficiency of a building. The thesis is that improvement of the technical condition through: increasing the thermal insulation of walls, modernisation of ventilation system, regular inspections and repairs of central heating boilers, modernisation of hot water preparation systems, the introduction of alternative energy sources or using modern technologies in construction, affects the increase of energy efficiency of this building.

KEYWORDS: energy efficiency of the building, technical condition of the building, thermomodernization measures of buildings

Introduction

In light of the current legislation on environmental protection and energy conservation, the energy efficiency of buildings is a major challenge not only for private property owners, but also the managers of public buildings. The main reasons for the building's excessive consumption of thermal energy are inadequate insulation of the external envelope and low efficiency of the central heating system. Therefore, to improve the energy efficiency of the object, many improvements called thermomodernization are carried out.

This article aims to assess the impact of the technical condition of a selected public building on its energy efficiency. A school building was chosen for the analysis. Based on the energy audit, the technical condition of the object before thermomodernization was analysed, with particular emphasis on thermal energy consumption. Then seven variants of thermomodernization were indicated, and the scope of works for the optimal variant was specified. Detailed analysis and technical condition assessment of the building after thermomodernization allowed to compare the energy demand of the building for heating and domestic hot water preparation. It also allowed indicating the elements which significantly affect the reduction of this demand. The improvement of the energy efficiency of a building brings benefits on several levels. The most expected are the financial savings achieved by reducing the building's thermal energy demand, which concludes that the achieved energy effect translates into an economic effect. In addition, a building that uses less fuel has a positive impact on the environment. Therefore, an extended approach to energy and the related issue of energy efficiency is included in the Sustainable Energy Policy. This concept links energy use to all aspects of sustainability: social, economic and environmental. The purpose of sustainable energy policy is to improve the standard of living of society while maintaining a balance between energy security, meeting the needs of society, the competitiveness of services and environmental protection (Lis, 2009).

Related research

The energy efficiency of a building in the context of environmental protection

Topics related to the energy efficiency of buildings, resulting from the improvement of their technical condition, is taken up by many authors in various studies. In Poland, for many years, the analysis and assessment of the technical condition of buildings from the point of view of their importance in

the efficient energy management are dealt with, among others, by Górzyński, Nadolna, Lis, Sadowska, Stachniewicz, Kaliszuk-Wietecka, Węglarz, Krajewska, Drozd and many others.

Limited resources of fossil fuels and the resulting increase in their prices affects the increased emphasis on environmental protection and the emergence of more and more new legal regulations on thermal protection of buildings (Górzyński, 2012). Inevitably linked to this is the energy efficiency concept, which is explained as „the ratio of the achieved amount of the utility effect of a given object (...) to the amount of energy consumption by this object" (Law of May 20 2016 on Energy Efficiency). In other words, it is the relationship of the amount of energy used to heat a building before and after its modernisation or thermomodernization.

In order to determine the energy demand of a facility, it is necessary to analyse the energy performance of a building. According to the Energy Performance of Buildings Act of August 29 2014, this term is explained as the energy data and indices of a building that determine „the total energy demand required for their usage in accordance for their intended purpose". According to the model certificate of the energy performance of a building, which is an annexe to the Regulation of the Minister of Investment and Development of February 27 2015. (item 376), currently, there are three indices necessary to perform such characteristics: *Eu* – an indicator of annual demand for usable energy [kWh/(m^2-yr)], *Ek* – an indicator of annual demand for final energy [kWh/(m^2-yr)] and *Ep* – an indicator of annual demand for non-renewable primary energy [(kWh/m^2-yr)]. In addition, *E*CO_2, describing carbon dioxide emissions [t CO_2/(m^2-yr)], and % RES, or the share of renewable energy sources in the annual final energy demand.

In order to improve the energy efficiency of the building, thermomodernization of the building is carried out, which means certain actions aimed at reducing the expenses incurred for heating the building and preparing hot water. The thermomodernization brings a number of other benefits such as less fuel used to heat the building, reduction of pollutant emissions to the environment as well as improvement of the external appearance of the building. In order for the thermomodernization measures to have the intended effect of improving energy efficiency, it is necessary to carry out a full energy audit before starting the thermomodernization works (Nadolna, 2014).

The energy audit as „a study specifying the scope, technical and economic parameters of a thermomodernization project, indicating the optimum solution, in particular from the point of view of project implementation costs and energy savings". This document contains, among others: technical and construction inventory of the building together with the characteristics of instal-

lations and heating systems. If the energy audit shows that as a result of thermomodernization measures there the following will occur:

- reducing annual energy demand by 10% for buildings in which only the heating system is modernised or by 25% for other buildings, or
- reduction of annual energy losses by at least 25%, or
- reduce annual heat acquisition expenditures by at least 20% or
- switching to a renewable energy source.

The investor can apply for a „thermomodernization bonus", i.e. a bonus for repaying a part of the loan taken for thermomodernization (Act of November 21 2008 on supporting thermomodernization and renovation).

The concept of energy efficiency can be broadly understood as a set of different types of actions, behaviours and conditions that come down to minimising energy losses and the costs incurred for its generation (Lis, 2009). A large part here plays environmental protection and more and more new legal regulations, not only Polish but also European.

Factors affecting building energy efficiency

Factors determining energy efficiency can be divided into external, which is meant climatic conditions or urban conditions, and internal, which can include: the way the building is used or the types of installations in which the building is equipped (Sadowska, 2016).

The factors most often cited by experts are:

- the period during which a given building object is designed and then erected and used. The type of building materials, energy carriers or equipment and installation elements undoubtedly affect the energy consumption of the building (Górzyński, 2012);
- architectural solutions resulting from local spatial development plans should be taken into account at the design stage. The applied solutions should serve to minimise the negative impacts of wind and maximise the use of solar radiation (Kaliszuk-Wietecka, Węglarz, 2019);
- a solid, which in its most favourable shape should be simple and compact, e.g. a cube. It is connected with the building shape coefficient A/V, which is the ratio of the external partition surface to the heated volume of the building. An extended body of the building, containing recesses, bays or arcades, increases heat transfer which is associated with excessive energy consumption (Firląg, Warsaw 2019);
- thermal insulation of external and internal partitions, walls adjacent to expansion joints, walls of unheated underground storeys, roofs, flat roofs and ceilings under or over unheated rooms, floors on the ground, which in turn increases the tightness of the building and reduces the share of

infiltration losses. The proper technical condition of window and door woodwork is also important;
- the ventilation system used (Kaliszuk-Wietecka, Węglarz, 2019);
- type of central heating system (Kaliszuk-Wietecka, Węglarz, 2019);
- the hot water preparation system implemented in it;
- the lighting system used and furnishing it with household appliances and electronics (Firląg, 2014).

Types of thermal upgrading measures

Thermomodernisation consists of making changes to reduce heat loss and provide more economical and energy-efficient heating for the interior and domestic water. The main reason for the high consumption of heating energy is excessive heat loss from the building. As already mentioned, it penetrates outside the building through inadequately insulated external walls and windows, roof and floor on the ground. For that reason, thermomodernization is usually performed:
- insulation of external walls of the building;
- replacement of window and door woodwork;
- roof or flat roof insulation;
- insulating the ceiling above an unheated basement or insulating the floor on the ground.

Thermomodernization of the building also concerns its internal installations and consists, among others, in:
- modernisation or replacement of the heating system;
- start using RES (renewable energy sources) for heating purposes, e.g. by installing solar collectors or heat pumps;
- the use of mechanical ventilation with heat recovery (recuperation);
- insulation of exposed central heating and hot water pipes;
- improvement of the domestic hot water preparation system.

Research methodology

Methods of assessing the technical condition of buildings

There are several methods of assessing the technical condition of buildings. One of the most common is the visual method, which is carried out on the basis of visual inspection of the building, also taking into account the age of durability and operation of the building. It is characterised by quickness of execution and widespread acceptance of the results. Visual assessment of a building's technical condition can be augmented by either exploratory or laboratory testing for samples taken from the building (Drozd, 2017).

The visual assessment can be performed using the following formula (1) for the weighted-average method of building deterioration (Drozd, 2017):

$$Sz = \sum_i^n \frac{U_{ei} \cdot Sze_i}{100}, \quad (1)$$

where:
Sz – is the weighted average degree of technical wear and tear of an object expressed as a percentage;
U_{ei} – percentage share of the value of the i-th element in the cost of the entire building (...);
Sze_i – the degree of wear of the i-th element (...) expressed as a percentage;
n – number of integrated elements;
i – another element.

The value for U_{ei} is determined according to source materials, or as in the case of the value for Sze_i, it is determined by an appraiser. Thus, adequate knowledge and experience are required in this case (Drozd, 2017). In addition to the visual method, time-based methods are often used, which are used depending on the degree of care for a given object. A distinction is made (Drozd, 2017):

- linear method, the so-called proportionality method, which is adopted in the case of buildings in poor use, for which repairs were not carried out or were performed rarely:

$$Sz = \frac{t}{T} \cdot 100\%, \quad (2)$$

where:
Sz – is the degree of technical wear and tear;
t – determines the age of the building in years;
T – shows the expected life of the facility expressed in years.

- non-linear method, used for buildings for which renovations were performed regularly:

$$Sz = \frac{t(t+T)}{2 \cdot T^2} \cdot 100\%. \quad (3)$$

- the parabolic method, for buildings according to which the owner or manager expresses special care by performing repairs more often than usual:

$$Sz = \frac{t^2}{T^2} \cdot 100\%. \quad (4)$$

Other methods are also known for determining the technical wear and tear of a building, mostly used in the West. They are characterised by greater complexity of formulas, but they do not introduce new parameters except the already mentioned: age of the building t and durability of the building These are methods: „Graff, Gerarde, Hague, Tschellestnigg" (Drozd, 2017).

Case study

Study Subject. Characteristics of a public building

The subject of the analysis is a public building dating back to the 1920s that served as an elementary school and was intended for educational purposes. The analysed building is located in the area under preservationist protection – in „B" zone, which means strict preservationist protection of the historical urban layout. Modernisation of the building was allowed in order to adjust it to current standards or in case of a desire to increase its aesthetic value. However, any activity required a conservator's agreement. The investor carrying out the comprehensive thermomodernization obtained the necessary permission from the Voivodship Conservator of Monuments, with the emphasis on the obligation to make smooth plaster on the external walls.

Comprehensive thermomodernization of the analysed building was aimed at lowering the operating costs of heating the building and preparing hot water and meeting the requirements of thermal protection of the building.

Analysis of the technical condition of the building before thermomodernization

The analysed building is a rectangular-plan object with a building shape factor of 0.50 [1/m]. It was built in traditional brick technology, two-story, with a partial basement and an attic.

The building consists of two parts: the main building with two balconies, cornices and lisens on the top floor and the second part of the building – slightly lower, serving as an administration building. The building has a gable roof, on a wooden rafter framing with rafter and purlin structure, covered with flat metal sheets. Window frames – tripartite or bipartite PVC windows – in good technical condition and not in need of replacement. The building is adapted to the needs of the disabled – there are two ramps, two parking spaces and an elevator.

Basic data regarding the area, cubic capacity and building dimensions are presented in table 1.

Table 1. Basic technical parameters of the analysed building

No.	Parameter	Value	Unit
1.	length	41.46	m
2.	width	12.09	m
3.	height	11.40	m
4.	build-up area	about 550.00	m^2
5.	usable area	937,10	m^2
6.	communication area	265.17	m^2
7.	cubage	about 4000.00	m^3
8.	cubic capacity of the heated part	3095.00	m^3

Source: Sarosiek et al., 2015.

The external walls of the building are made of 54 cm thick solid brick and plaster on both sides. The ceiling under the unheated attic is a dense rib ceiling. These partitions are characterised by insufficient thermal insulation. The values of heat transfer coefficient U [W/(m²·K)] for external partitions are as follows:

- external basement walls: U = 1.151 for above ground basement walls and U = 0.661 for walls in the ground;
- external walls of above-ground: U = 1.151;
- ceiling under unheated attic: U = 0.973;
- exterior entrance doors: U = 2.00 (for above-ground section doors) and U = 5.10 (for basement doors).

These values were too high in relation to the requirements included in technical conditions that buildings and their location should meet. In order to reduce them and thus limit heat losses, it was necessary to insulate the building envelope and the floor under the unheated attic with a thermal insulation material e.g. foamed polystyrene. It was also advisable to replace the old door frames with modern doors of low heat transfer coefficient U.

The central heating system of the building consisted of an eco-pea coal boiler room from 2010 with central regulation, traditional and previously unmodernised two-pipe system with bottom distribution and sectional cast iron radiators without thermostatic valves. The technical condition of radiator valves did not allow for their regulation due to the possibility of leakage.

Table 2. Efficiency coefficients of central heating installation before thermomodernization of the building

Components of the efficiency index	Value	Additional information
ηg	0.70	determined on the basis of an on-site visit of an energy audit
ηd	0.80	ducts without insulation in the unheated part
ηe	0.77	central adjustment, no local adjustment
ηs	1.00	no buffer tank

Source: Sarosiek et al., 2015.

Characterisation of the central heating system can be done by the efficiency coefficients (table 2) shown in the above table. The total efficiency of the heating system o was calculated using the following formula (5):

$$\eta_o = \eta_g \cdot \eta_d \cdot \eta_e \cdot \eta_s, \tag{5}$$

where:
η_g – is the efficiency of heat generation;
η_d – heat transfer efficiency;
η_e – efficiency of regulation and use of the heating system;
η_s – represents the efficiency of accumulation.

Based on the energy audit of the education building in question, the total efficiency of the heating system is:

$$\eta_o = 0.70 \cdot 0.80 \cdot 0.77 \cdot 1.00 = 0.4312.$$

In addition, this document presents the energy characteristics of the building, the calculations of which were performed using the computer program Audytor OZC 4.8 Pro, for meteorological data from the station Bialystok. Peak heating power (demand for thermal power) is 95.58 kW. Seasonal demand for heat in standard heating season is 1,209.32 GJ/year, and taking into account the efficiency of the central heating system, this value increases to 2,804.55 GJ/year. In order to improve the efficiency of the heating system, it was necessary to perform a completely new central heating installation together with the replacement of radiators with thermostatic valves on each one.

Analysing the technical condition of the building before modernisation, one should also pay attention to the method of preparation of usable hot water at the designed temperature of 60°C. During the heating season, the hot water was prepared in the existing boiler room for eco-pea coal.

During the summer season, hot water was supplied by electricity through the use of electric water heaters. The hot water supply pipes are galvanised steel pipes, and the entire installation is routed alongside the cold water and sewage pipes. According to the design data, the average annual hot water consumption was 274 m^3.

Air exchange is mainly through gravity ventilation. In addition, there is also micro-ventilation of windows. Due to the old door carpentry, there could be periodically an excessive influx of cold air during the winter season, thus affecting the heat consumption needed to heat the ventilation air.

According to the energy audit of the building in question, the ventilation airflow, calculated in accordance with the requirements of in PN-83/B-03430/Az3:2000 „Wentylacja w budynkach mieszkalnych zamieszkania zbiorowego i użyteczności publicznej" („Ventilation in residential buildings of collective residence and public utility buildings"), was 2,358 m^3/h.

Summarising the technical condition of the various components of the educational building, it was necessary to introduce several thermomodernization improvements in order to reduce the consumption of thermal energy, reduce the costs associated with its production and adapt the building to current guidelines for thermal protection. For implementing these works, the investor received funding from the European Regional Development Fund under the Regional Operational Program of the Province for 2014-2020, action 5.3 Energy efficiency in the housing sector and public utility buildings.

Determination of optimal variant of thermomodernization undertaking

The energy audit of the building in question presents seven different variants of thermomodernization undertakings. The differences between them consist, among others of: the scope of proposed works, planned costs of execution of these works, annual savings of energy costs, as well as percentage savings of energy demand, taking into account the total efficiency.

- The first variant assumed: replacement of the entrance door to the overground part of the building, insulation of the external walls of the basement, replacement of the entrance door to the basement part of the building, insulation of the external walls of the overground part of the building, replacement of the hot water system, insulation of the ceiling under the unheated attic and replacement of the central heating system. The planned total cost was 366,662.00 PLN. Annual savings of energy costs could reach almost 64 thousand PLN. Percentage saving of energy demand was predicted within 70.50%;
- The scope of works of the second variant was very similar to the first one, but the replacement of the entrance door to the overground part of the building was omitted. The planned cost of works was calculated for the

amount of 345,522.00 PLN. The annual saving in energy costs would reach just over 63 thousand PLN, so in comparison to the first variant, it is almost a thousand PLN lower. Percentage saving of energy demand amounted to 69.49%;

- The third variant was reduced by insulation works on external basement walls. Total costs decreased to 325,469.00 PLN, and annual energy cost savings to just over 62 thousand PLN. Percentage saving of energy demand decreased to 68.30%;
- The works planned in the fourth variant included insulation of external walls of the building above ground and the ceiling under the unheated attic, as well as replacement of central heating and hot water installations. Planned costs were calculated at 322,529.00 PLN, and an annual saving of energy costs decreased relatively little, compared to the third variant, to the amount of 61,859.00 PLN. The percentage saving in energy demand, in comparison with the third variant, decreased by 0.18%;
- The fifth variant was limited only to the thermal insulation of the ceiling under the unheated attic and replacement of the hot water and central heating systems. The costs of such works oscillated around 229,673.00 PLN. As a consequence, compared to previous variants, the annual saving of energy costs decreased to 52,370.00 PLN and the percentage saving of energy demand to 57.28%;
- The scope of work in the sixth variant, in comparison to the fifth, has been reduced by the replacement of the hot water installation. The cost of their implementation was set at just over 209 thousand PLN and energy cost savings of over 51,000 PLN per annum. Savings in energy demand was calculated at 57.01%;
- The seventh variant – was limited only to the replacement of the central heating installation for the amount of 138,823.00 PLN. Energy cost savings were calculated at 22,745 PLN per year. Also, the saving of energy demand, in comparison to the sixth variant, could decrease more than twice – 25.99%.

The optimal variant, which meets all the requirements in the light of the Act of November 21, 2008, on supporting thermomodernization and renovations, is variant no. 1.

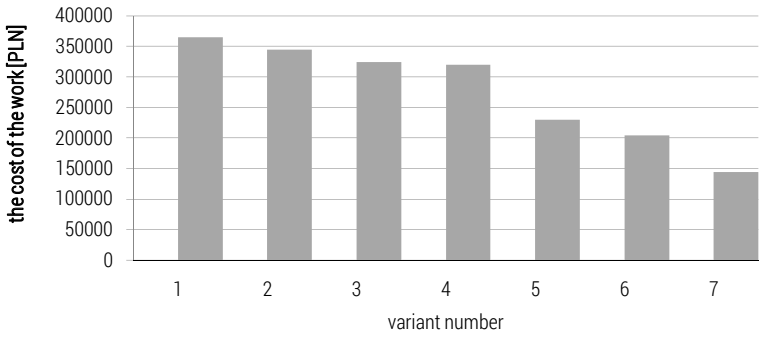

Figure 1. Planned total costs of thermomodernization works for seven variants
Source: author's work based on energy audit (Sarosiek et al., 2015).

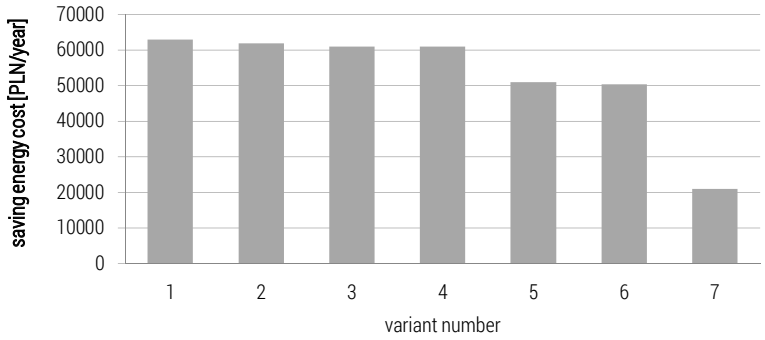

Figure 2. Annual energy cost savings for seven variants
Source: author's work based on energy audit (Sarosiek et al., 2015).

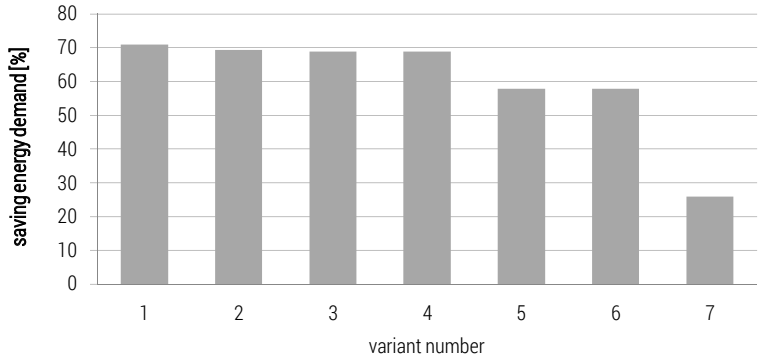

Figure 3. Percentage Energy Demand Savings with Total Efficiency
Source: author's work based on energy audit (Sarosiek et al., 2015).

Within the scope of works, it was necessary to insulate external walls of the building basements in such a way that thermal resistance of the insulation layer amounted to R = 4.25 (m²·K)/W. For example, a part of the basement above ground level should be insulated with polystyrene with a thickness of 17 cm and thermal conductivity coefficient λ = 0.04 W/(m·K). The part located below the ground level had to be insulated with extruded styrofoam. The surface of basement walls which had to be insulated, amounted to 91.70 m². The cost of this work was estimated at 218.68 PLN per 1 m², which gives a total amount of 20,053 PLN. The external walls of the above-ground part of the building had to be insulated similarly to the above-ground part of the basement – with a 17 cm thick layer of insulation (styrofoam) with λ = 0.04 W/(m·K). The cost of insulating 636.00 m² was estimated at 92,856 PLN. The next thermomodernization work was the insulation of the ceiling over the last storey of the building with a 23 cm thick layer of mineral wool with λ = 0.04 W/(m·K), at the cost of 70,528 PLN. The works also included replacement of old entrance doors to the basements, at the cost of 2,940 PLN, and entrance doors to the overground part, at the cost of 21,140 PLN, with heat transfer coefficient U = 1.30 W/(m²·K) each.

In order to improve the preparation of usable hot water, the installation of a solar installation has been proposed to support the existing heat sources – eco-pea coal boiler in the winter season and electric heaters outside the heating season. The total planned cost of this investment was estimated at over 20 thousand PLN. One of the most costly works was to perform a completely new central heating installation, including radiators and thermostatic valves on each. The calculated cost of the last proposed thermomodernization improvement is almost 129 thousand PLN. Heat demand, according to the optimal variant, would be 134,028 kWh/year.

In conclusion, it can be said that the scope of work included in the optimal variant of this project will reduce the energy consumption needed to heat the building and to prepare domestic hot water. This is part of the government's efforts to improve energy efficiency in the public sector. In addition, the purpose of this work is also to increase the aesthetic value of the building. The condition is to keep the same form and colour of the facade, which will preserve the historic value of the building.

Analysis of the technical condition of the school building after thermomodernization

The scope of thermomodernization works was not limited only to improvements proposed in the optimal variant. There were also performed many additional works improving both technical and visual condition of the building. In order to assess the technical condition of the school building

after thermomodernization, technical documentation of the project and visual method based on inspection were used.

One of the key works which was carried out as part of complex thermomodernization was the insulation of external walls of the building. For this purpose, a number of necessary works were carried out. Initially, downpipes, exterior window sills, balcony railings, lighting, etc. were removed. Then, external walls were prepared for thermal insulation by washing with water, repairing plasters, filling cavities in walls and priming with deep penetrating primer. Then, according to the recommendations contained in the optimal variant of the energy audit, the walls were insulated with 17 cm thick polystyrene foam, using the light-wet method, which involves attaching the thermal insulation material to the wall, then covering it with a reinforcing layer, such as glass fabric, and finishing with a thin-coat plaster (Bajno, Grzybowska, 2017). This method is characterised by good sealing of the wall surface, durability and allows maintaining the traditional appearance of the building façade. The facade coating was made of silicate plaster. Also, the architectural details were insulated while maintaining their original proportions: cordon cornice, crowning cornices, lisens and decorative elements over the windows. The façade was painted with light sand colour, and architectural details were highlighted with white paint. According to the energy audit of the analysed building, after insulating the above-ground walls, the heat transfer coefficient will decrease from U = 1.151 W/(m^2·K) to U = 0.195 W/(m^2·K). Two balconies have also been insulated with 5 cm thick foamed polystyrene together with the execution of water insulation. On their surface, stoneware tiles were laid. The renovation of external walls also included the replacement of entrance doors to the ground floor with doors with the heat transfer coefficient of U = 1.30 W/(m^2·K). In addition, the balustrades were cleaned.

The balcony and staircase railings have been cleaned and painted, and new external window sills made of galvanised steel have been installed. Spikes were installed at the level of the cornice to protect the elevation against birds without posing any danger to them.

The basement and foundation walls were also insulated. Before starting the works, existing green areas were protected against possible damage. After dismantling the sidewalk surface and the band around the building, the building was dug out to the level of footings. Initially, a layer of waterproofing was made with dispersion mass. Next, the base and walls of the building were insulated to a depth of 160 cm using 17 cm thick Styrodur.

Below the ground level, a bucket foil was also placed, which additionally insulates the underground parts of the building. The plinths were finished with mosaic plaster in dark brown colour. In addition, the cellar window wells were renovated, the cellar door was replaced with a door with improved

insulation parameters, for which the heat transfer coefficient is U = 1.3 W/(m^2·K), and the cellar stairs were renovated by laying stoneware tiles.

As part of thermomodernization works, the roof covering was renovated together with Solar installation and installation of solar collectors. After disassembly of antennas, lightning protection system, guttering and former metal roofing, rafters were extended in order to make the eaves sticking out in front of the wall. Then completely new roofing was made of brick-red tile together with wind insulation. At the same time, a new lightning protection system was installed, chimneys were renovated, and flashings were made. The highest ceiling was also insulated by installing a vapour barrier, mineral wool mats with a total thickness of 23 cm and a pressure layer made of light concrete with a thickness of 4 cm. The roof hatch over the staircase was also replaced.

The scope of thermomodernization works also included the execution of the solar installation supporting the preparation of usable hot water. For this purpose, solar collectors were mounted on the roof of the connecting passage between the analysed building and the second school building not included in the analysis and thermomodernization. Three Vitosol 200-F flat-plate collectors with a total surface area of 7.26 m^2 were selected. The connecting element between the solar thermal system and the existing DHW system is a 400-litre vertical bivalent water heater.

It serves as the primary hot water storage tank. When the amount of sunlight is not sufficient for the solar system to heat water to the required temperature, hot water is prepared through the top coil connected to the existing DHW cylinder.

When the amount of solar radiation is not sufficient for the solar system to heat water to the proper temperature, hot water is prepared through the upper coil connected to the existing central heating boiler. Radiators have also been replaced throughout the building.

The radiators were chosen according to the geometry and thermal power requirements of the room. Each radiator is equipped with a thermostatic valve.

Measures to improve the efficiency parameters of the heating system included: execution of a new central heating system with its insulation, made of steel pipes and installation of new radiators, which were selected according to the geometry and thermal power requirements of the room. Each radiator was equipped with a thermostatic valve with a head. For example, in a room (vestibule) with an area of 2.83 m^2 and a volume of 7.924 m^3, a radiator 0.6 m high, 0.4 m long and 0.06 m deep was installed. Its actual heating power is 292 W.

The main purpose of improving the technical condition of the building in question was to increase its energy efficiency. Significant influence on energy consumption in the analysed object had external partitions. The uninsulated walls, the leaky entrance door and the rusted roof, due to their insufficient insulation, caused heat losses by penetration. Also, the ceiling under the unheated attic had insufficient thermal insulation. The traditional central heating system, due to its low efficiency, was also qualified for modernisation. In addition to thermomodernization improvements, renewable energy sources were also used. Solar collectors were installed in order to heat up domestic hot water, thus reducing the consumption of electricity needed for its production. Another aim of thermomodernization of the discussed object was to adjust it to the requirements of thermal protection of the building, which will be obligatory in Poland since January 1, 2021. A positive aspect of this undertaking was the cost of investment execution, which was fully financed from European funds. This made it possible to carry out individual works at the same time.

Energy saving in heating and hot water preparation will reduce the costs of public institutions functioning. In addition, the improvement of technical conditions positively influenced the aesthetics of the building while preserving its historic values.

Results of the project

The influence of a building's technical condition on its energy efficiency

The main method to determine and indicate the impact of the technical condition of the selected building on its energy efficiency is the presented case study. One of the most important issues to be compared is the heat demand for heating the building and preparing domestic hot water.

The analysis shows that the works carried out in the optimal variant of thermomodernization allow saving more than 70% of energy demand. This energy saving value is influenced by several factors. The first of them is the limitation of energy losses by penetration through external partitions, which is the result of:

- insulation of external walls of overground and basements;
- thermal insulation of ceiling under the unheated attic;
- replacement of roofing with a new one;
- replacement of old door carpentry to the basement and;
- overground part of the building.

The lower values of the heat transfer coefficient *U* for the external partitions (table 3) indicate that they have become a better heat insulator. Insulating materials have been selected in such a way that the value of their *U*-value

meets the requirements for thermal protection of buildings effective from January 1, 2021 – according to current guidelines contained in the Regulation of the Minister of Infrastructure on technical conditions to be met by buildings and their location.

From the economic point of view, the optimal thickness of insulating material for the external walls of the above-ground building was 10 cm. However, due to the maximum value of the *U* coefficient indicated in the above mentioned Ordinance, which was 0.20 W/(m²·K) at room temperature $t_i \geq 16^oC$, It was decided that the insulation material would be 17 cm thick.

Table 3. Values of *U*-value for external walls of the building in question before and after thermomodernization

Outer partition		Factor value U (W/(m² · K))	
External basement walls*		Before thermomodernization	After thermomodernization
Above-ground external walls		0.83	0.183
Ceiling under an unheated attic		1.151	0.195
External basement walls*		0.973	0.148
Front door	to the basements	5.10	1.30
	to the overground part	2.00	1.30

* weighted average of basement wall area for coefficients: $\boldsymbol{U}$ = 1.151 W/(m² · K) for basement above-ground walls and $\boldsymbol{U}$ = 0.661 W/(m² · K) for walls in the ground

Source: author's work based on energy audit, Sarosiek et al., 2015, 2017.

The second element affecting energy savings in the building in question was replacing the central heating system with a new one, along with new radiators. This work improved the efficiency of the heating system. In particular, they changed:

- heat transfer efficiency (η_d), whose coefficient increased from 0.80 to 0.90, and
- the efficiency of regulation and use of the heating system (η_e), whose coefficient increased from 0.77 to 0.88.

Thermomodernization works reduced heat losses by penetration and ventilation (table 4) in the limit of 44.25%. Therefore, the annual heat demand for heating the building has also decreased (figure 4), keeping the thermal comfort of the building users at the same level. Before thermomodernization, the calculated energy consumption for heating the building (final energy for heating purposes) was 2,804.55 GJ/year. After the improvement, according to the data contained in the ex post audit, this value decreased

more than three times to 825.12 GJ/year. The heat saving, in this case, was 70.58%.

Table 4. Heat losses for the building before and after thermomodernization

		Before thermomodernisation	After thermomodernisation
heat loss (W)	by penetration	63,157	22,420
	by ventilation	32,426	30,872

Source: author's work based on energy audit, Sarosiek et al., 2015, 2017.

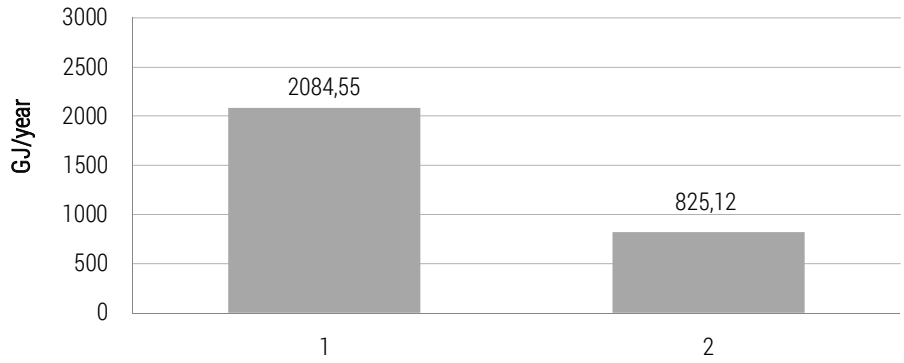

Figure 4. Change in the calculated energy consumption for heating the building
Source: Author's work.

Another element affecting the reduction of heat demand in this building are the solar collectors. They were installed in order to support the existing domestic hot water sources: an eco-pea coal boiler in the heating season and electric heaters outside the heating season.

Heat demand (final energy) for hot water purposes (figure 5), before thermomodernization, was respectively: 65.54 GJ/year coming from the boiler house and 13.58 GJ/year from electricity. The data included in the ex-post audit of the analysed building indicate that the solar installation will allow saving up to 40% of the heat used for DHW purposes. Because of this, the individual values were reduced to: 29.49 GJ/year (boiler house) and 6.11 GJ/year (electricity). Thus, the total energy saving for domestic hot water heating was 43.52 GJ/year.

Reduction of energy consumption for total building heating and hot water preparation was 2,022.95 GJ/year, which gives 561,930.56 kWh/year.

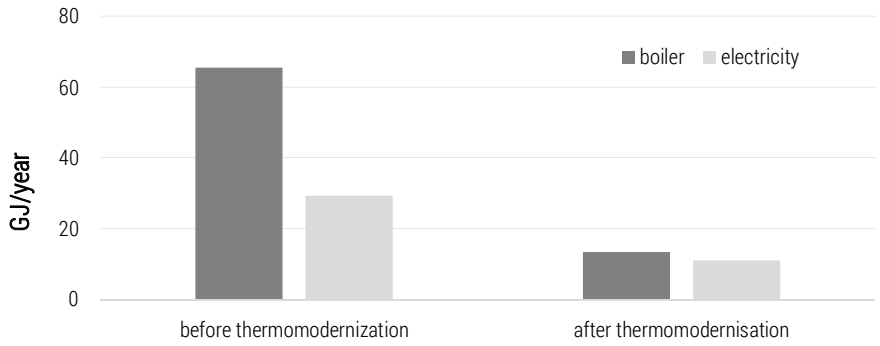

Figure 5. Change of heat demand for hot utility water before and after thermomodernization of the building

Source: author's work.

In order to present in a clear way the changes caused by thermomodernization works, it is necessary to compare the primary energy consumption before and after the improvements (table 5). In order to determine it, the values of the final energy for heating and hot water preparation and the values of the coefficient of the non-renewable primary energy input for the generation and delivery of the energy carrier or energy for the technical systems have been taken from the Regulation on the methodology of determining the energy performance of a building or parts of a building and energy performance certificates.

Table 5. Primary energy of the building in question before and after thermomodernization

Energy consumption target	Ek value (GJ/year)	Non-renewable primary energy input factor	Ep consumption (GJ/year)	Total Ep consumption (kWh/year)	Ep indicator (kWh/(m² · year))
before thermomodernisation					
heating	2 804.55	0.20	560.91	170,766.67	182.23
water heater	65.54	0.20	13.11		
	13.58	3.00	40.74		
after thermomodernisation					
heating	825.12	0.20	165.02	52,569.44	56.10
water heater	29.49	0.20	5.90		
	6.11	3.00	18.33		

Source: author's work.

Based on the data presented in the table below (table 5), the *Ep* factor [kWh/(m^2·year)] was calculated, showing the consumption of non-renewable primary energy. Determining *Ep* coefficient is the quotient of total demand for primary energy expressed in kWh/year before or after thermomodernization and the heated surface of the building, which for this building is 937.1 m^2. The indicator *Ep* before thermomodernization was 182.23 kWh/(m^2·year), and after finishing works *Ep* = 56.10 kWh/(m^2·year). So, the process of thermomodernization of the building allowed to reduce the value of *Ep* index more than three times.

As a result of the analysis, it was found that the works carried out within the optimal variant of thermomodernization allowed for a significant reduction of building's energy demand for heating and preparation of usable hot water without worsening the thermal comfort of its users.

The reduction of heat losses and the investment in renewable energy sources have enabled energy savings of 70%. This value and threefold reduction of *Ep* indicator confirm that the technical qualification made within the optimal variant of thermomodernization undertaking had a definite influence on the improvement of energy efficiency of this building.

Change in costs incurred for heating the building and for hot water preparation

Besides the improvement of energy efficiency of the building, the expected effect of thermomodernization works was the reduction of operating costs for heating and hot water preparation. According to the data included in the ex-post audit of the analysed building, thermomodernization improvements resulted in energy cost savings of 63,949.00 PLN per year. This value consists of both reductions of charges for heating and hot water preparation.

It was calculated that 1 GJ/year for heating and domestic hot water (prepared in the boiler house) costs 31.06 PLN. This fee also includes boiler room service charge, i.e. the cost of the stoker's salary. The price of 1 GJ/year of preparing domestic hot water in electric heaters was 180.56 PLN. These values are the same both before and after thermomodernization.

A detailed breakdown of heating and hot water expenditures is shown in the graph above (figure 6). The analysis shows that the total costs incurred for heating and usable hot water before thermomodernization amounted to 91,911 PLN per year. The amount of annual fee after thermomodernization works results from the application of: calculated thermal power, calculated internal temperatures in the building and standard heating season and equals 27,962 PLN. Comparing both values, the charges for heating and hot water decreased almost by 70%.

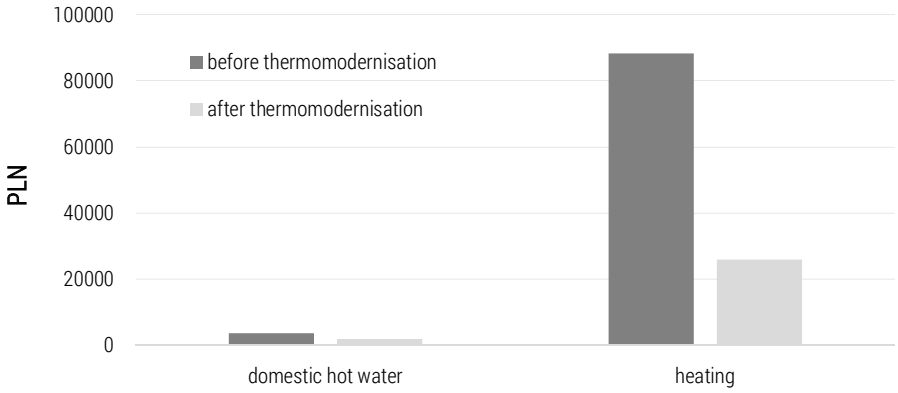

Figure 6. Change of costs borne for heating and domestic hot water in the analysed building

Source: author's work.

Energy and financial savings resulting from the thermomodernization of the discussed building shows the positive influence of the improvement of the technical condition of the object on its energy efficiency.

Costs of thermomodernization works and payback time

An inseparable element of each project, which is usually the starting point of the investor's work, is an analysis of the financial profitability of such an investment and examining the time needed to return the outlays incurred for its execution. In this case, the investor obtained co-financing from the European Regional Development Fund for the realisation of a wide range of thermomodernization works. The value of thermomodernization improvements of the optimal variant was valued at 366,662 PLN, and energy cost savings resulting from their implementation amount to 63,949 PLN.

To assess the profitability of the investment one of the simple methods was used, namely the Simple Pay Back Time (SPBT) method. This method determines the time in years needed to return the financial input incurred in the implementation of the investment. The SPBT value is determined by the following formula (6) (Stachniewicz, 2012):

$$SPBT = \frac{N_U}{\Delta O_{r\ c.o.}}, \tag{6}$$

where:

N_U – total cost of performing the given thermomodernization improvement [PLN]

$\Delta_{r\ c.o.}$ – energy cost savings resulting from its implementation expressed in PLN per year.

For the works carried out as part of thermomodernization, the time of return on investment was calculated (table 6) according to formula (6). The execution of a new central heating system required the highest financial costs, but at the same time has the shortest payback time of 5.66 years. The highest SPBT value was calculated for the improvement consisting of replacing the entrance door to the above-ground part, which amounted to 62.46 years.

Table 6. List of SPBT for individual thermal upgrading works according to increasing value

No.	Type of improvement	SPBT (years)	Cost of works (PLN)
1.	New central heating installation.	5.66	128,823
2.	Insulation of the ceiling under an unheated attic	11.89	70,528
3.	Solar installation	12.70	20,322
4.	Thermal insulation of above-ground external walls	13.30	92,856
5.	Replacement of entrance doors to basements	20.03	2,940
6.	Thermal insulation of external basement walls	32.25	20,053
7.	Replacement of entrance doors to the overground part	62.46	21,140

Source: author's work.

The payback time SPBT, calculated for the entire thermomodernization project according to formula (6) is:

$$SPBT = \frac{366{,}662}{63{,}949} = 5.73 \text{ years.}$$

Considering relatively short time of return of expenses incurred during thermomodernization works and using subsidies from the EU funds, it can be concluded that the investment in question was effective also from the economic point of view.

Conclusions

On the basis of the analysis of the building components efficiency and the energy consumption before and after thermomodernization, it was concluded that the improvement of the technical condition of the selected object and the investment in renewable energy sources contributed to a significant reduction in its energy demand. Thus, the thermomodernization improvements resulted in the improved energy efficiency of the building.

The energy efficiency improvement of the selected building also allowed to reduce the expenses for heating and hot water preparation. Energy cost savings oscillate around 63,949 PLN per year. Total payback time was calculated at 5.73 years. Taking into account the fact that the thermomodernization works were financed by the European Union, the high annual energy cost savings and the relatively short payback time, it was assessed that the investment was effective also from the economic point of view. The energy savings resulting from thermomodernization allow stating that the energy efficiency of the building depends on its technical condition.

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Ewa **OŁDAKOWSKA** • Jakub **OŁDAKOWSKI**

FINANCIAL ASPECT OF USING THE ASPHALT GRANULATE IN MIXTURES DESIGNED FOR ROAD SUBSTRUCTURES

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ABSTRACT: Asphalt granulate is a valuable building material suitable for the production of asphalt mixtures. Its use in modern road building is profitable not only for environmental reasons but also because of the economic aspect of saving natural aggregates and asphalt and saving road pavement construction costs. The purpose of the cost analyses was to determine the financial benefits resulting from using the asphalt granulate in asphalt mixtures. The cost calculations concerned the basic components of asphalt mixtures and the costs of constructing the pavement structure layer for which the mixtures had been intended. The analyses covered asphalt mixtures of asphalt concrete type AC 22P with different content of asphalt granulate purchased at different prices, intended for road pavement substructure layers loaded with traffic of KR3 and KR4 categories.

KEYWORDS: asphalt granulate, cost analysis, recycling, road substructure, sustainable development

Introduction

The recycling of asphalt pavements is highly desirable due to their ecological and economic aspects. The reuse of asphalt waste as an additive to asphalt mixtures began in the United States as early as 1915. However, it was only in the 1970s that there was a renewed interest in waste produced from milling the old pavements as a result of the oil crisis, which had resulted in a significant increase of prices of various materials, including bitumen (Application..., 2014, Epps, 1994, West, 2010). Not only the United States of America began the large-scale use the asphalt granulate to produce the asphalt mixtures, but also Western European countries. However, its content in the mixtures did not exceed 20% back then. Currently, the countries leading in the road construction sector are striving for maximum use of asphalt granulate to produce new mineral and asphalt mineral mixtures (Olard et al., 2008, Valdés et al., 2011, Aurangzeb et al., 2014). Its amount depends on the granulate dosing method during the production of mixtures. In Poland, according to the Appendix to Decree no. 54 of General Director of National Roads and Motorways from 8.11.2014 „Asphalt pavements on national roads" (WT-2 2014),the addition of up to 20% (addition of asphalt granulate to the paving plant mixer without preheating – „cold method") or 30% („hot method", meaning the addition of asphalt granulate to the paving plant mixer with preheating) is permitted. However, the condition of use is the homogeneity of the granulate corresponding to the requirements and the presence of aggregate in the granulate, which size D must not be greater than size D for the mineral mixture included in the mineral and asphalt mixture. Taking into consideration the intended use of the mixtures, it should be noted that in most countries, using the additive is permitted in the substructure layers and in the binding layer, whereas in the surface layer using the granulate is not permitted or its use depends on the traffic load (Alenowicz, 2019, Bressi et al., 2015, Copeland, 2011, Olard & Pouget, 2014). Despite the actions taken, Poland is a country where the use of asphalt waste to construct new or strengthening existing pavements is small and far from the standards of the leading countries in this respect (Bańkowski et al., 2016). This is confirmed by the annual EAPA (European AsphaltPavement Association) report (EAPA, 2012, EAPA, 2017), in which the last time it was found in 2012 with 4% use of granulate. The country of very significant material management is Finland. In 2017, out of 1,200,000 tonnes of asphalt waste obtained, 100% was reused (EAPA, 2017). Likewise, in Japan, 99% of all RAP (Reclaimed Asphalt Pavement) is reused in new pavement construction (West & Coupland 2015). Also, in countries such as the USA (EAPA, 2017, Willis & West, 2014), Slovakia, Hungary, and Belgium (EAPA, 2017), the problem of management of recycled

materials is addressed rationally. The barriers for promoting the recycling of materials already identified by PIARC Technical Committee (Review..., 2007) are legislation, economics, lack of knowledge of road managers (investors). Therefore, the expected increase in using the granulate is a result of administrative activities, stable and long-term policy, the development of research and educational activities (Alenowicz, 2019). In recent years in Poland, there have been no clear provisions in the regulations governing the use of asphalt granulate and some provisions in the technical specifications for road investments, sometimes even limiting using the asphalt granulate in asphalt mixtures (Wasilewska et al., 2015). However, an increasing number of newly built and renovated roads has contributed to the adjustment of regulations allowing for reuse of „waste material", which, as indicated by studies conducted in many research centres (Bańkowski et al., 2018, Edil, 2018, Ma et al., 2011, Mangiafico et al., 2013, Nokkaew, 2018, Plati & Cliatt, 2019, Reza Pouranian &Shishehbor, 2019, Sangiorgi et al., 2017, Tabaković et al., 2010, Xiao et al., 2018), may be a very valuable material for reuse.

Such reuse has many financial and environmental benefits (Horvath, 2003, Lee et al., 2010, Jamshidi & White 2020):

- reduction of dumps in landfills, and thus reduction of storage costs (for storage of asphalt waste in Poland an environmental fee is charged (Obwieszczenie ..., 2020), which in 2021is to 20.82 PLN/Mg; 1 PLN = 0.26 USD),
- reduction of road pavement construction costs due to lower demand for new material,
- reduction of transport costs if the material is reused on-site,
- reduction in environmental costs (Zarei et al., 2020) connected with recovery and preparation of primary material and production of asphalt mixtures in the world (production absorbs large amount of non-renewable natural resources and is responsible for tens of millions of tons of CO_2, which record concentration in the atmosphere, on the weekend of 12-13 May 2019, recorded and confirmed by the scientistsfrom the Observatory Mauna Loa in Hawaii, amounted to 415.26 ppm (TVNMETEO).

The use of asphalt granules in asphalt mixtures incorporated into the structure of new pavements is a direct saving of natural aggregates and bitumen (materials from non-renewable sources).It also means direct savings on the costs of road pavement construction, which depend on the prices and availability of the materials used.Furthermore, asphalt granulate in asphalt mixtures built into the structure of new pavements is also a response to the reduction of environmental pollution. The paper aims to determine the level of savings resulting from using the „valuable waste material" (which is an asphalt granulate) in the asphalt mixtures.

Subject and method of calculation

Subject of analysis

In order to determine the financial benefits resulting from using the asphalt granulate in asphalt mixtures, the cost analyses have been carried out, including the calculation of costs of basic components of asphalt mixtures and the valuation of costs of constructing the pavement layer for which the mixtures were intended. To assess the costs, the asphalt mixtures of asphalt concrete of type AC 22 P were used, intended for substructure layers of road pavement loaded with traffic of categories KR3 and KR4. The asphalt mixtures have been designed in accordance with (WT-2 2014). They were made from the mixture of aggregates (limestone dust, crushed and washed sand 0/2, broken sand 0/2, grit 2/8; grit 8/16; grit 11/16, grit 16/22) of constant granulometric composition and asphalt granulate in the amount of 0% (reference mixture), 10%, 15%, and 20%, meeting the requirements (WT-2 2014, PN-EN 13108-8:2016). Road bitumen 35/50 was used for the asphalt mixtures. The list of compositions, averaged over several designed asphalt mixtures, is presented in table 1.

Table 1. List of compositions (share in %) of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate

Type of material	Composition (share in %) of asphalt mixtures AC 22 P 35/50 KR 3-4 with use of granulate in the amount of			
	0%	10%	15%	20%
Bitumen	4.20	3.60	3.30	3.00
Aggregate	95.80	86.70	82.20	77.60
Granulate	-	9.70	14.50	19.40
Total	100.00	100.00	100.00	100.00

Source: author's work.

Calculation method

The assessment of costs of manufacturing the asphalt mixtures AC 22 P 35/50 KR 3-4 of different granulate content and the assessment of costs of manufacturing 1 m^2 of substructure layer were carried out based on a detailed calculation method (according to the commonly accepted cost calculation principles) and with use of prices and cost factors included in the monthly information (Informacja miesięczna..., 2021) and quarterly information (Informacja o stawkach..., 2021 and Informacja o cenach..., 2021) of "Seko-

cenbud" publishing house. The granulate price was determined based on sales offers (unit prices ranged from PLN 45 to 75 per Mg).

Analysed data

In order to determine the costs of manufacturing the asphalt mixtures of different granulate content, three formulations of mixtures in 4 price variants (differing in the unit price of granulate) have been considered: variant I – PLN 45 per Mg, variant II – PLN 55 per Mg, variant III – PLN 65 per Mg, variant IV – PLN 75 per Mg). Prices of 1 ton of waste material do not include the purchase costs and the external transport costs, which should be calculated individually according to the actual distance of deliveries and construction site organisation. The unit prices of other components of mixtures AC 22 P 35/50 KR 3-4 are listed in table 2.

Table 2. List of unit prices (PLN/t) of materials used for the production of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate

Material	Price [PLN/t]
Limestone dust	94.04
Crushed and washed sand 0/2	30.60
Broken sand 0/2	54.51
Grit 2/8	104.81
Grit 8/16	87.80
Grit 11/16	87.80
Grit 16/22	89.72
Bitumen 35/50	1 750.00

Source: author's work.

Table 3. List of unit prices of labour and work of construction equipment used for the realisation of substructure made from asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate

Specification	Price
Labour	21.10 [PLN/man-hour]
Self-propelled static roller 10 t	87.73 [PLN/machine-hour]
Self-propelled static roller 15 t	97.13 [PLN/machine-hour]
Bituminous mass spreader	204.23 [PLN/machine-hour]

Source: author's work.

In order to determine the costs to be incurred for the realisation of 1 m^2 of substructure layer made from mixtures with various granulate contents, the price assumptions for labour and work of construction equipment were

made in accordance with (Informacja o stawkach..., 2021 and Informacja o cenach…, 2021) and shown in table 3.

The cost estimate price for realisation of the substructure layers was determined using formula (1) (Kowalczyk and Zabielski, 2011):

$$C_k = \sum (L \times n \times c) + K_p + Z + P_v, \quad (1)$$

where:
C_k – costestimate value,
L – numberof take-off units,
n – unitexpenditures,
c – unitprices of production factors,
K_p – indirectcosts for the whole range of works,
Z – calculationprofit for the whole works,
P_v – value-added tax.

The unit expenditures were determined according to the Outlays In-kind Catalogue 2-31 (Katalog... KNR 2-31, 1997). The overhead indices for engineering works, which include construction works: road works (including access roads, parking lots, and garbage yards included in the construction equipment), track works, bridge works, works in the range of power networks and connections, telecommunication, water, sewage, gas, and heating networks, sewage treatment plant and water treatment plants works, as well as greenery, hydrotechnical, water and melioration, and well works, etc., have been based upon (Informacja miesięczna..., 2021).

Results and discussion

The costs of basic components needed to realiseasphalt mixtures of different granulate content are presented in tables 4, 5, 6, and 7. Table 4 (variant I) contains cost data estimated upon the basis of calculations, assuming that the granulate costs PLN 45 per Mg. The results of price calculations included in tables 5, 6, and 7 (variants II, III, and IV, respectively) are the values determined on the assumption that PLN 55, PLN 65, and PLN 75 will have to be paid for 1 ton of granulate.

The total amount, including the values of all components of the mineral and asphalt mixture AC 22 P 35/50 KR 3-4 without the addition of asphalt granulate, is PLN 149.88. The most expensive component in the analysed mixture is bitumen, for which, at its current prices, one must pay PLN 73.50, which accounts for 49.04% of the total cost. The cost of aggregate is the value of PLN 76.38, i.e. 50.96% of total outlays.

Table 4. List of costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate, assuming that the granulate costs PLN 45/ton

Type of material	Costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 with use of granulate in the amount of			
	0%	10%	15%	20%
Bitumen	73.50	63.00	57.75	52.50
Aggregate	76.38	70.49	67.53	64.49
Granulate	-	4.37	6.53	8.73
Total	149.88	137.86	131.81	125.72

Source: author's work.

Table 4, apart from the costs of components of the reference mixture AC 22 P 35/50 KR 3-4, also presents the costs of components of the mixtures with 10%, 15% and 20% of asphalt granulate content, which costs PLN 45 per ton. Expenditures on materials in case of a mineral and asphalt mixture with 10% addition of asphalt granulate equal to PLN 137.86, and at the same time, the value is lower by PLN 12.03 (8.02%) than the price of the reference mixture. The expenditures to be spent on materials necessary to make a mixture with 15% of granulate are PLN 131.81, which is the value lower by PLN 18.08 in relation to the standard mixture. In case of a mineral and asphalt mixture with 20% share of granulate, the price decreased by PLN 24.16 and amounted to PLN 125.72.

In order to determine the impact of the addition of asphalt granulate purchased at the price of PLN 55 per ton (table 5) on the costs of asphalt mixtures for the substructure layer, an analogous analysis was performed as in the case of a variant I, using the formulas of mixtures presented in table 1.

Table 5. List of costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate, assuming that the granulate costs PLN 55/ton

Type of material	Costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate of			
	0%	10%	15%	20%
Bitumen	73.50	63.00	57.75	52.50
Aggregate	76.38	70.49	67.53	64.49
Granulate	-	5.34	7.98	10.67
Total	149.88	138.83	133.26	127.66

Source: author's work.

The costs of components needed to make 1 ton of mineral and asphalt mixture AC 22 P with the addition of asphalt granulate (costing PLN 55 per Mg) in the amount of 10% are PLN 138.83. It is less by PLN 11.06 than the mixture without the addition of asphalt granulate. The higher amount of waste material in the composition of mixtures means lower total prices of those mixtures – respectively PLN 133.26 in case of 15% content of valuable waste material and PLN 127.66 in relation to 20% of its amount.

Table 6 presents a list of costs of analysed mixtures assuming that the granulate will be purchased at the price of PLN 65 per Mg. Each of the mixtures is characterised by a different price due to the different granulatecontent, which also affects the correction of the binder and aggregatequantity.

Table 6. List of costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate, assuming that the granulate costs PLN 65/ton

Type of material	Costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 with use of granulate in the amount of			
	0%	10%	15%	20%
Bitumen	73.50	63.00	57.75	52.50
Aggregate	76.38	70.49	67.53	64.49
Granulate	-	6.31	9.43	12.61
Total	149.88	139.80	134.71	129.60

Source: author's work.

A list of costs (table 6) of the basic components of asphalt mixtures with different contents of asphalt waste shows its clear impact on the total price of the mixture. One may notice that the more material created after milling old pavements in the mixture, the lower the price of the mixture and the smaller the amount of aggregate and asphalt. Thus, the addition of 10% of granulate made the total cost of all components lower by PLN 10.09compared to the cost of a mixture containing no asphalt granulate. The presence of 15% of the waste material caused the costs reduction to PLN 134.71, while the addition of 20% caused the price reduction to PLN 129.60.

The values of materials used to prepareasphalt mixtures AC 22 P 35/50 KR 3-4 with 10%, 15%, and 20% of the quantity of asphalt granulate purchased at the price of PLN 75 per ton are presented in table 7.

The last analysed variant is a variant in which the use of granulate purchased at the price of PLN 75 per ton was considered, which means that it will be cheaper only by 28% than the most expensive component of the aggregate mixture, and at the same time, it will be more expensive by more

than 60% compared to the price assumed in variant I ("the cheapest"). Similarly to the considered variants, No. I, II, and III, the asphalt granulate in the amount of 0% (standard mixture), 10%, 15%, and 20% were used.

Table 7. List of costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate, assuming that the granulate costs PLN 75/ton

Type of material	Costs [in PLN] of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 with use of granulate in the amount of			
	0%	10%	15%	20%
Bitumen	73.50	63.00	57.75	52.50
Aggregate	76.38	70.49	67.53	64.49
Granulate	-	7.28	10.88	14.55
Total	149.88	140.77	136.16	131.54

Source: author's work.

As a result of the analysis of costs of the components needed for production of asphalt mixtures without and with asphalt granulate it has been found that the cost of the mixture decreased with the increase in the quantity of asphalt granulate in the mineral and asphalt mixture and irrespective of its purchase price (in the range considered). The percentage differences in relation to the prices of the reference mixture are shown in table 8.

Table 8. List of percentage differences of costs of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate in relation to the reference mixture

Mixture with granulate in amount of	Granulate price			
	PLN 45	PLN 55	PLN 65	PLN 75
10%	12.03%	11.06%	10.09%	9.12%
15%	18.08%	16.63%	15.18%	13.73%
20%	24.16%	22.22%	20.28%	18.34%

Source: author's work.

The values presented in table 8 indicate that regardless of the amount of asphalt granulate additive and its purchase price (in the range considered), the use of the waste allows for significant savings. First of all, those are savings of natural aggregates and asphalt (granulate is a component "rich" in full value asphalt binder, it also reduces the amount of added aggregate), and

secondly, those are savings in the cost of the mixtures themselves. The presence of 10% of the waste material is the cost of materials lower by over 9÷12% (in relation to the amounts set for the reference mixture), 15% of the content of milled old pavement is lower by 13÷18%, while using the waste material in the amount of 20% is the cost reduced by 18÷24%.

In order to compare the level of costs to be incurred for the realisation of 1 $m^2$of the typical substructure an analysis has been performed based upon the presented formulas of asphalt mixtures with different content of asphalt granulate. The differences in financial outlay for the construction of a typical 10 cm layer of the substructure result only from differences in unit prices of materials, as in each analysed case, the costs of labour and equipment, indirect costs, profit, and VAT are the same. The summary of costs of construction of 1 m^2 of the substructure layer is presented in table 9. In contrast, table 10 shows the percentage differences in relation to the construction costs of the substructure layer using the reference mixture.

Table 9. List of costs of the basic components of asphalt mixtures AC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate purchased at different prices

Mixture with granulate in amount of	Granulate price			
	PLN 45	PLN 55	PLN 65	PLN 75
0%	58.52	58.52	58.52	58.52
10%	55.06	55.34	55.62	55.90
15%	53.32	53.74	54.16	54.57
20%	51.57	52.13	52.69	53.25

Source: author's work.

Table 10. List of percentage differences of costs of realisation of 1 m^2 of the substructure from the asphalt mixturesAC 22 P 35/50 KR 3-4 containing various amounts of asphalt granulate in relation to realisation costs with the use of the reference mixture

Mixture with granulate in amount of	Granulate price			
	PLN 45	PLN 55	PLN 65	PLN 75
10%	5.91%	5.43%	4.96%	4.48%
15%	8.89%	8.17%	7.45%	6.75%
20%	11.88%	10.92%	9.96%	9.01%

Source: author's work.

Analysing the data presented in table 10, one should say that using the granulate (costs of labour and equipment, indirect costs, and contractor's

profit do not change) causes reduction of realisation costs of 1 m^2 of the substructure. The realisation of the layer from the mixture AC 22 P 35/50 KR 3-4 without the addition of asphalt granulate was characterised by a cost equal to PLN 58.52. In case of using 10% of asphalt granulate, the price of 1 m^2 of substructure decreased to PLN 55.06, assuming that the granulate cost PLN 45 per ton, or to PLN 55.90 when PLN 75 was allocated for its purchase (1 ton). It makes a difference of 5.91% or 4.48%, respectively, compared to the realisation of 1 m^2 of the substructure from the reference mixture. The cost of constructing of the assumed substructure from a mixture in which the share of waste material amounted to 15%, decreased by 6.75% for the „most expensive" price variant of the waste material. In the case of a mineral and asphalt mixture with the addition of 20% of granulate, the price decreased by 11.88% (assuming that it will cost PLN 45 per Mg) and amounted to PLN 51.57.

The decrease of realisation price per 1 m^2 of road substructures may seem low, but considering the amounts connected with construction of many kilometres of roads, they may become very important in the total investment costs.

Conclusions

Using asphalt waste in the form of granulate in modern road construction is profitable not only for environmental reasons but also due to the economic aspect. The performed analysis clearly shows that with the increased amount of added asphalt granulate, the price of asphalt mixtures as well as the cost of their incorporation decrease. It results from lower demand for aggregate (desirable in the situation of increasingly limited access to high-quality rock raw material) and bitumen, the price of which is crucial for the production costs of mixtures. Another economic benefit associated with using the asphalt granulate for the production of new mixtures is the reduction in the number of waste dumps where the milled waste material is stored, for which fees must be paid. Using the asphalt granulate, apart from financial aspects, directly impacts environmental protection by solving the problem of granulate management and significantly reduces the use of natural non-renewable raw materials. The reuse of asphalt granulate as an additive to the asphalt mixtures gives measurable environmental and economic benefits without any negative impact on the final product, i.e. the mineral and asphalt mixture.

The cost analysis performed on the example of asphalt mixtures without asphalt granulate and with 10%, 15%, 20% of additive intended for road substructures, with presented assumptions, allowed to formulate the following conclusions:

- With the increasing content of asphalt granulate in the constitution of a mineral and asphalt mixture, the costs of its components decrease. The cost of components needed to make a mineral and asphalt mixture AC 22 P 50/70 KR3-KR4 without the addition of asphalt granulate is PLN 149.88. The addition of asphalt granulate purchased at the price of PLN 45 and in quantities of 10%, 15%, and 20% resulted in a decrease of price by PLN 12.03, PLN 18.08, and PLN 24.16, respectively, which in relation to the reference mixture constitutes respectively 8.02%, 12.06%, and 16.12%.
- The price of realisation of 1 m^2 of 10 cm thick substructure layer made from mineral and asphalt mixture AC 22 P 5/50 KR3-KR4 without the addition of asphalt granulate was estimated at PLN 58.52. On the other hand, a layer made from the mixture with 10% of granulate content purchased at the price of PLN 75 per ton was valued at PLN 55.90 (less by PLN 2.62); a 10 cm thick substructure layer with 15% of waste material (also purchased at the price of PLN 75 per Mg) is the cost of PLN 54.57 (less by PLN 3.95). The presence of 20% of asphalt granulate in the mixture means the price lower by PLN 5.27 in relation to the reference mixture.

The decrease of realisation price per 1 m^2 of road substructures may seem low. However,considering the amounts connected with construction of many kilometres of roads, they may become very important in the total investment costs.

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IMPACT OF RESIDENTIAL HEATING COSTS ON THEIR VALUE

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ABSTRACT: This article deals with the essence of the influence of factors related to various heat sources on property valuation. The study's main aim is to show that the applied heating system impacts the costs of maintaining and operating a building. A thesis was made that the type of heat source used to heat the property is a factor that significantly influences the value because its efficiency and general characteristics can significantly affect the amount of the building's operating costs. For this reason, the method of heating building objects should be an attribute taken into account during the valuation carried out by a property appraiser.

KEYWORDS: building real estate, real estate appraisal, real estate value, building heating costs

Introduction

In the era of the development of new technological solutions, contemporary housing construction is designed to provide the basic housing needs of the population and create the required comfort of use. Investors pay more and more attention, for example, to the heating systems used, taking into account not only the environmental protection aspects but, above all, the maintenance costs of the facility during its operation. There is no doubt that factors related to different heat sources in residential buildings impact their value and should be considered in the valuation process. Analyzing the literature on the subject and the legal basis for real estate valuation in the form of the Real Estate Management Act and the Regulation of the Council of Ministers on the valuation and preparation of the appraisal report, it is clear that there is a specific group of attributes taken into account in the valuation process. Unfortunately, none of the estimation methods takes into account the factors related to the heat sources used. However, there is no doubt that when buying real estate, the heating method that affects the cost of maintaining a building is an important element in the decision-making process. This article is to prove the validity of the thesis. The community of real estate appraisers could consider whether it would be worth considering the heating method as one of the attributes influencing the value in the valuation process.

Analysis of the installation costs of selected building heating systems

Buildings consume over 40% of the overall energy consumed globally and play a significant role in sustaining electric grid power balance; therefore, it is very important to choose the right heating system (Alimohammadisagvand et al., 2016). When choosing a building heating system, the investor decides what fuel to use to ensure optimal thermal comfort at a reasonable price during the heating period. Additionally, the choice of heat supply options in new residential areas depends on various factors, including available local energy resources, their market prices and the scale and density of heat demand in these areas (Truong, Gustavsson, 2019). In addition, it is important to analyze the investment costs associated with the purchase and installation of a heating system. Therefore, the overview of selected heating systems presented below depends on the price of heating power, device efficiency, brand and others.

The heat from combined heat and power plants

The use of energy from combined heat and power plants for the heating of buildings is the most common type of heating in Poland. This method is a convenient solution, especially in large cities, where the district heating network is well developed. Furthermore, the user of this system can enjoy the comfort of not purchasing and storing fuel, maintaining thermal devices, or, for example, removing ash.

Outside the city limits and large housing estates, access to heat network connections is significantly difficult. Construction of district heating mains in suburban areas, where single-family housing is dispersed, may turn out to be unprofitable. Initial expenses are the purchase of radiators and installation inside the building. The prices of radiators vary, but the cheapest of them cost about PLN 200 per piece (panel radiators). Another important issue affecting the profitability of the project is the offered tariff rate for the supplied energy. The table below shows the net prices for 1 running meter of the connection depending on the standard and the capacity of the main pipe – internal nominal diameter – Dn.

Table 1. Price list for the connection to the MPEC thermal network in Bialystok

No.	Types of fee rates depending on the diameter of the connection	Unit measures	Net price [in PLN]
1	Dn 25	PLN/m	215,57
2	Dn 32	PLN/m	216,21
3	Dn 40	PLN/m	229,75
4	Dn 50	PLN/m	249,73
5	Dn 65	PLN/m	264,81
6	Dn 80	PLN/m	303,25
7	Dn 100	PLN/m	341,42
8	Dn 125	PLN/m	448,56
9	Dn 150	PLN/m	510,59

Source: http://www.mpec.bialystok.pl/kategorie,86.html [27/06/2021].

Coal-fired boilers

Despite the extensive promotion of ecological energy sources and attempts to reduce the so-called low emission still, a very common method of heating real estate in Poland is coal-fired boilers. The significant advantage of

this solution is the relatively low installation cost. Due to the purchase price, hard coal boilers can be divided into three categories:

Low price group. There are charging boilers operated by hand, with the natural draft, with upper or lower flue gas discharge, coal-fired in the sort of cubes or nuts. The best devices in this group are characterized by a theoretical efficiency of up to 70%.

Average price group. There are charging boilers, operated manually, equipped with air blows. In the case of the bottom flue gas discharge, they are fed with lump coal (walnut or cube); in the case of the upper flue gas discharge, they are fired with pea coal or fine coal. The best devices in this group are characterized by a theoretical efficiency of up to 85%.

High price group. It includes automatic boilers equipped with an air blower, fired with pea or fine coal. The most effective devices in this group achieve theoretical efficiency of up to 90% (Zawistowski, Janiszewski, 2010).

Table 2. Costs of exemplary boilers fired with coal, fine coal, wood, eco-pea coal

Make, type	Type of coal	Heating power [in kW]	Boiler efficiency [in %]	Gross price [in PLN]
Tomiterm – PLESZEW BOILER	coal, fines, wood	11 – 27	82 – 88	from 5,000
MALKOT, MALINA PREMIUM	eko-pea coal	9 – 48	80 – 90	from 8,000
DEFRO, OPTIMA COMFORT	coal, fines, wood, chips	8 – 58	80 – 90	from 12,000

Source: own study based on current information from sellers of heating boilers [27/06/2021].

LPG-fired boilers

With modern condensing boilers, natural gas consumption in the central heating installation is relatively low because they can receive more heat from the flue gas than traditional boilers. Thus, they are characterized by greater efficiency (Kosieradzki, 2009). In the absence of access to the gas network, the cost of purchasing a gas-fired boiler and implementing a complete central heating installation. The purchasing costs or leasing costs of a container for storing this fuel should be added.

The purchase of an LPG gas tank is associated with a large expenditure of PLN 6,000 to PLN 10,000. Having your own tank involves the choice of a good supplier, the necessity to take care of the proper functioning and servicing of the device on your own, as well as refilling the gas level on your own. The advantage of this solution is independence from a single gas supplier.

A convenient way to provide gas for household needs without having to deal with technical service and constant ordering and refilling of fuel is the lease of such a tank.

Table 3. Costs of sample LPG-fired boilers

Make, type	Heating power [in kW]	Boiler efficiency [in %]	Gross price [in PLN]
ARISTON, CLAS B, 24BFFI	22	108	from 6,800
TERMET SILVER 1	35	109	from 3,800
ARISTON, GENUS PREMIUM 35FF	31	107.20	from 8,700

Source: own study based on current information from sellers of heating boilers [27/06/2021].

Biomass-fired boilers

Biomass fired boilers are currently the most advanced boilers in terms of design. They are equipped with mechanisms allowing for almost maintenance-free operation for a long period.

Table 4. Costs of exemplary biomass-fired boilers

Make, type	Type of biomass	Heating power [in kW]	Boiler efficiency [in %]	Gross price [in PLN]
STALKOT KWM-SGR	pellet	19	82.70	from 6,400
SAS AGRO-ECO	pellet	17 – 23	82	from 14,520
TROTEX 25	pellet, chips, wood	25	86-88	7,300

Source: own study based on current information from sellers of heating boilers [27/06/2021].

Heat pumps

Heat pumps are considered to be easy to operate and, at the same time, use the possibility of bringing low-temperature heat sources to a higher temperature. Therefore, they can be used to reduce the need for fossil fuels and greenhouse gas emissions. Their great advantage is the power supply for both heating and cooling and the possibility of working in a simultaneous mode. It means that virtually no heat is dissipated, making such systems truly efficient (Osterman, Stritih, 2021). The investment cost of installing a heat pump depends on many factors. The conditions for obtaining heat in a given area are an important issue here. It often happens that the costs of producing

a heat source and the costs of earthworks are comparable to the devices' price.

Table 5. Costs of making a heat source for a pump with a power of 10 kW

Type of heat source	Costs [in PLN]	Comments
Flat collector	5,000 – 10,000	No earthworks costs
Vertical probes	10,000 – 15,000	Total cost
Wells	15,000 – 20,000	Total cost
Air	2,000 – 5,000	Pump inside the building
Air	0	Pump outside the building

Source: (Oszczak, 2011, p. 44).

There is also the choice of the heat pump. The price difference between the most expensive pump and the cheapest one can be up to 100% (with the same heating power). More expensive pumps, as a rule, are more durable and more economical (Adamczewski, 2010).

Table 6. Costs of exemplary heat pumps

Make, type	Source of heat	Power range [kW]	COP	Gross price [in PLN]
NIBE SPLIT	air / water	3 – 16	4.4	29,000
EXOTHERM 30KW	brine / water	30	5.5	35,150
STIEBELELTRON WPL13/18/23E	air / water	7.7 – 17.1	3.3	up to 41,950

Source: own study based on current information from heat pump sellers [27/06/2021].

Solar panels

Installing solar collectors is an ecological and modern way of obtaining heat for heating residential buildings. These devices are now technologically well-developed and allow for savings in operation. Unfortunately, solar systems are still relatively expensive. The cost of the installation depends on the demand for domestic hot water. Standard solar collectors can provide about 60% of the annual demand for domestic hot water. The cost of installing this technology can pay off after 5-8 years (but only if the purchase is subsidized). The investment turns out to be completely unprofitable in economic terms if the user pays for the collectors himself. In addition, you should bear in mind

the expenses related to periodic inspections. The cost of inspections will be around PLN 150-300 / year (Solar collectors).

The minimum cost of installing solar collectors for a house used by a family of four is about PLN 10,000. This price includes installing and installing flat plate collectors from the lowest price range, e.g. Hewalex 2TLP-250C. More technically advanced devices with vacuum collectors and a selective absorber can cost about PLN 14,000. The prices of vacuum collectors with a heat pipe start from about PLN 18,000. Each extension of the functionality of the collectors or their integration with other heating systems will result in higher costs. The upper limit of financial expenditure on this type of equipment is difficult to define and depends on many factors (http://kb.pl/teksty/2017/01/25/kolektor-sloneczne-do-domu-jednorodzinnego/).

Table 7. Costs of sample solar collectors

Make, type	The composition of the kit	Efficiency [in%]	Optical efficiency	Gross price [in PLN]
Hewalex 2 TLP-250C	2 flat plate collectors, KS2000 TLP type with a total (active) aperture area of 3.6 m^2 and a 2-coil hot water heater with a capacity of 250 liters	64	0.802	7,780
Hewalex 3 KSR10-250	3 vacuum collectors type KSR10 with a total aperture area (active) 3.0 m^2 and a 2-coil water heater with a capacity of 250 liters	73	0.780	11,570

Source: own study based on current information of solar collector sellers [27/06/2021].

The solar set price does not include the cost of installing the collectors, which depends on the complexity and size of the installation, the degree of integration with another heating installation, the method of routing the solar pipes, and the type of roofing.

Depending on the above factors, the installation price ranges from PLN 1,500 to PLN 3,000 (http://www.instalacjebudowlane.pl/6770-23-55-jaki-jest-koszt-kolektorow-sloneczne.html).

In large installations, where collectors, for example, heat the water in the swimming pool, the economic sense of the investment is justified to a large extent. On the other hand, in small installations (e.g. in small single-family houses), where daily water consumption at 45°C is about 200-240 l, profitability depends on the price of supplied energy (the most expensive are electricity, fuel oil and LPG), growth fuel prices on the market, the amount of the subsidy. It is possible to use the subsidy from the National Fund for Environmental Protection and Water Management (NFOŚiGW), which offers a dona-

tion of 45% of the loan amount taken for the installation of collectors; however, income tax must be paid on this subsidy (http://www.budujemydom.pl/kolekty-sloneczne/13063-czy-oplaca-sie-instalowac-solary).

Summing up, it should be said that the prices of heating systems differ from each other depending on the brand, type of device, or the efficiency and heating power. Devices using renewable heat sources are a more expensive investment in comparison to boilers fired with solid fuels. However, with the development of the market sector offering unconventional energy, one should expect more and more competitive prices of modern devices generating the so-called clean energy.

Analysis of the operating costs of selected building heating systems

In order to determine the costs of heating a property with its own independent heat source, the following parameters should be analyzed: the current price of the energy carrier, the calorific value of the fuel, the efficiency of the heating system and the heat demand of the building.

Prices of energy carriers

The cost of fuel used to heat a residential building is a very important factor that is influenced by many factors. The price, in this case, depends on the offers and tariffs of local suppliers. However, a wide selection of energy resources and the emerging competition on the supplier market means that the prices of the offered fuels may sometimes turn out to be attractive. The table below shows the average prices of the fuels used.

Table 8. Costs of fuels offered in Poland

Fuel Type	Unit price
natural gas	2.35 PLN/m^3
LPG gas	2.40 PLN/l
LPG gas (tank lease)	4.50 PLN/l
heating oil	3.35 PLN/l
hard coal of the eco-pea type	1000 PLN/t
hard coal of fine type	650 PLN/t
pellet	950 PLN/t
electricity	0.74 PLN/kWh

Source: own study based on current information from fuel suppliers [27/06/2021].

Fuel calorific values

Fuel calorific value [MJ/unit] is the energy obtained from fuel combustion related to its quantity (mass), assuming that the combustion is complete and the water vapour released with the exhaust gas is not condensed.

Table 9. Calorific values of various fuels

Fuel Type	Calorific value
natural gas	37.6 MJ/m^3
LPG gas	43.5 MJ/l
heating oil	42.6 MJ/l
coal	30 MJ/kg
hard coal of fine type	32.7 MJ/kg
pellet	18 MJ/kg

Source: own study based on current information from fuel suppliers [27/06/2021].

The house's need for heat

On January 1, 2009, the Ministry of Infrastructure adopted a regulation according to which each building and apartment should have its energy certificate, covering the necessary scope of information for its users and possible records. The energy certificate contains an assessment of the estimated amount of energy needed for heating, lighting, ventilation, and air conditioning of the building and domestic hot water preparation. The basic measure in this system is the total energy demand of the property during the year, converted to 1 m^2 of its area [kWh/m^2/year]. A building is considered energy-efficient when the energy consumption is 70-100 kWh/m^2/year (Juliszewski, 2009).

According to the PN-EN ISO 13790: 2009 standard, the energy demand of real estate is the heat that should be supplied to maintain the intended thermal conditions.

Determining the heating costs of a residential building per year is a difficult task, requiring knowledge of many data. Information on this is provided in the building's energy performance certificate.

Annual expenses for heating a building real estate depend on the price of the energy carrier, its calorific value, the type and efficiency of the heating system and the building's heat demand. Therefore, choosing the most effec-

tive and optimal heating solution requires comparing and comparing the operating costs of various heat sources.

Table 10. Energy standards adopted for buildings in Poland

The period of building a house	Energy demand [kWh/m^2/ year]
Houses built until 1967	240 – 350
Houses from 1968 to 1985	240 – 290
Houses from 1986-1992	160 – 200
Houses from 1993-1997	120 – 160
Houses built since 1998.	90 – 120
Energy-efficient houses	max 70
Low-energy houses	max 45
Passive houses	max 15
Zero-energy houses	max 0

Source: Polish National Energy Conservation Agency.

The table 11 shows the annual heating costs of a building property with 150 m^2 with selected heat sources, taking into account the data provided and the division into different energy standards of the building.

Table 11. Annual heating costs of a building property with an area of 150 m^2 with the various heat source [PLN]

Type of heating device	Gas condensing boiler	Condensing boiler for LPG	Condensing boiler for LPG	Cauldron for heating oil	Cauldron for pellets	Cauldron for coal – eco-pea coal	Brine / water heat pump
Fuel Type	natural gas	LPG gas	LPG gas (leased installation)	heating oil	pellet	eco-pea coal	electricity
Annual heating cost (well insulated building)	2,911	3,237	5,958	4,940	2,347	2,075	1,460
Annual heating cost (poorly insulated building)	4,528	5,036	9,269	7,684	3,651	3,228	2,271

Source: own study based on current information from fuel suppliers [27/06/2021].

Selection of the most favourable heating method

This analysis presents selected thermal systems used to heat residential buildings along with their installation and operating prices. The most optimal heat source selection is associated with a thorough analysis of information about heating technologies and energy raw materials available on the market. It would be best if you also considered the type and characteristics of your property to match a heating system that is the most efficient, economical and safe to operate. In this case, the volume and structure of the property, its location (free-standing or compact building), the region and its climatic features, the presence of utilities such as municipal heating network or gas network installation in the vicinity are important. The factor determining the purchase of a specific heating system in practice is also the investor's financial capacity and expectations regarding the effectiveness and efficiency of the heat source.

In order to consider the selection of the most advantageous method of heating a residential building property, certain criteria should be adopted. Undoubtedly, operating costs are of great importance here. In the light of the analysis, the cheapest solutions during operation are a brine/water heat pump, a coal-fired boiler and a pellet-fired boiler.

The heat pump requires a high investment in the installation phase. Depending on many factors, the cost of purchasing and installing such a system can reach up to 60,000. PLN (www.tendeo.pl). Suppose the investor is able to cover these costs and decides to use a heat pump as a means of heating the property. In that case, he will be able to experience the many advantages of using this efficient heating system in the future.

The use of a coal-fired boiler is contrary to the idea of supporting ecology and the principles of environmental protection but still common. The operating costs resulting from heating with coal are not prohibitive compared to the operational costs of other thermal systems. It goes without saying, however, that the use of coal-fired boilers is definitely an outdated method.

Another solution that is characterized by low operating costs is a pellet-fired boiler. Pellet users appreciated its numerous advantages, which include: wide availability of the raw material on the market and competitiveness of its prices in relation to coal prices, high efficiency of pellet-fired boilers (usually above 90%) and their high automation and maintenance-free (granulate charging is often only necessary). Pellets are also clean and non-staining fuel, and the emission of harmful substances to the atmosphere during combustion is negligible (www.muratorplus.pl).

The use of modern and unconventional methods of heating real estate, such as heat pumps (based on the use of renewable, free energy from the so-called lower heat sources), requires relatively high financial outlays for

the purchase and installation of devices. Over time, however, low operating costs will translate into savings. In addition, such solutions are also characterized by great convenience and comfort of use. Undoubtedly, the attractiveness of using the so-called „Clean energy" in building heating has increased due to numerous government and EU programs supporting and subsidizing the use of unconventional heating methods that make a significant contribution to protecting the environment.

To sum up, the most advantageous methods of supplying heat for the needs of a building real estate, among those described in this paper and meeting the criterion of low operating costs, are two thermal systems: the use of a heat pump and a pellet-fired boiler. Both of these solutions are distinguished by modernity, ease of use, efficiency, high efficiency and care for the natural environment. Considering the above-mentioned characteristics of heating methods, they can be considered the most advantageous in selecting them as the optimal heating and building real estate method.

Influence of building heating method on real estate value

Many different factors influence the market value of a real estate building. Some of them determine the price of real estate more than others, so the impact is uneven. Such attributes include, among others: the location of the property, its area and cubature, the technical condition of the building, its surroundings and many others. One of the parameters significantly influencing the value of a residential building is the method of its heating. Therefore, when assessing the impact of heating conditions on the value of a building, one should focus on the specific object.

Currently, there are many ways to heat a property on the market. These systems are very different from each other on the following levels: general characteristics, type of fuels used, installation costs and everyday use. The advantages or disadvantages resulting from the specific use of the installed heating devices may encourage or scare a potential client considering purchasing a given property. Modern and effective technologies providing heat for the needs of residential buildings are, in this case, extremely desirable by buyers of single-family houses. The customer pays attention to the fact that the home heating installation generates future profits and savings and ensures comfort and convenience of use. The analysis indicates that, in addition to energy-efficiency measures regarding the building skin, a well-designed heating and ventilation system plays an important role in reducing financial costs and environmental impact over the lifespan of a dwelling (Debacker W. et al., 2013). For this reason, outdated, ineffective and requiring

constant control central heating systems based on, e.g. tiled stoves or coal-fired boilers, are not able to increase the value of a given property and usually lower it. In addition, a drop in the market price of a used building may be affected by the poor technical condition of the thermal installation and the need to replace or repair its individual components.

As already mentioned, the increase in the market price of real estate is positively influenced by the installation of modern and effective heating technologies, characterized by great convenience and ease of use. Furthermore, depending on the degree of availability of utilities (heat network, gas network), these can be heat systems powered by clean fuels, such as natural gas, LPG gas, heating oil, hot water from a combined heat and power plant, pellets and solar energy. Therefore, using any of the above-mentioned ecological heat sources contributes significantly to the increase in the value of the property and, at the same time, has a positive impact on the protection of the natural environment.

Conclusions

The article's main aim was to justify the hypothesis that the method of heating a building real estate has a significant impact on its market value. Considering the assumptions of the property valuation, the essence of the impact of the type of heating on the value of the building in question results from the analysis of energy raw materials and various heating systems available on the market. The sources of information on the current prices of heating devices and fuels were the data posted on the websites of energy suppliers or energy raw materials and internet offers of shops and distributors of heating devices.

This study attempts to indicate the most advantageous heating systems for residential buildings. One of the decisive criteria for the benefits of a specific heating system is low operating costs. Other factors contributing to the benefit of a given method of heating are efficiency and effectiveness of the heat source, ease of use, the comfort of use, environmental protection aspects and the financial profitability of the investment over the years. It was found to be modern and efficient heat sources are desired by potential property buyers and can significantly increase the value of a building. At the same time, obsolete heating methods, such as coal-fired boilers, for example, can lower.

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GENERAL ENVIRONMENTAL AND SOCIAL PROBLEMS

PROBLEMATYKA OGÓLNOEKOLOGICZNA I SPOŁECZNA

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THE SHARING ECONOMY IN THE OPINION OF POLISH CONSUMERS

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ABSTRACT: This article is devoted to the issue of the sharing economy. In Poland, the sharing economy is a relatively new area but with high development dynamics. Therefore, the paper aims to answer the question: „is Polish society ready to adopt the sharing economy concept?"

In Poland, there is a research gap in the context of the sharing economy. The phenomenon of collective consumption concerning Polish consumers is a relatively new area that requires careful research . For this purpose, a pilot study was used with the use of the diagnostic survey method using the questionnaire survey technique.

The presented research results show that 39.7% of the respondents have come across the sharing economy concept. However, ignorance of the concept does not mean that the respondents did not use services based on the assumptions of the sharing economy. 56.7% of respondents used at least one service provided by the sharing economy. There is a visible relationship between the respondents' age and education and their awareness of the sharing economy. The highest knowledge of the sharing economy was found in the age group under 36 and among respondents with higher education. Most of the respondents support the directions of activities presented by the sharing economy and use its services.

The conducted research is of a pilot nature. However, it allows drawing attention to an important issue in the acceptance of new solutions related to the application of the sharing economy by the older generation of Polish consumers. This is a field for further research on a much wider research sample.

KEYWORDS: sharing economy, sustainable consumption, sustainable development

... „sharing is the future of our world in which
we have strongly exaggerated with consumption"...
(*R. Botsman, R. Rogers, 2010*)

Introduction

The popularization of modern information and communication technologies and the development of society's knowledge influences consumers' attitudes and decisions. Interactions between market participants are changing, and thanks to the possibilities of the Internet and mobile technologies, they take the form of networks, often of global reach. They cover both the sphere of consumption, exchange and production, and more and more often also the common use of goods and services. The sharing economy is a new trend in consumer behaviour that is based on the exchange, lending and sharing of goods, and access to the product itself is seen as more important than owning it.

The sharing economy seems to be a very good trend, thanks to which it is possible to reduce the scale of the limitlessness of human needs in the face of limited resources. The sharing economy is indicated as an element that can be equated with the response to human needs, related to the increase in the quality of their lives and more efficient use of resources. It is also identified with the idea that has significantly contributed to the change in global consumption trends (Walsh, 2011). Furthermore, a positive change brought about by the sharing economy is the reduced impact on the environment.

The sharing economy and common consumption are issues that are more and more often discussed in contemporary media and scientific discourse. It is estimated that by 2025, global revenue generated by the sharing economy will reach $ 335 billion in activities such as transport, the hotel industry, financial services and tourism (PwC, 2016, p. 2).

So far, there is no single specific business model in the sharing economy. Therefore, the phenomenon of the sharing economy should be analyzed in many respects. The consumption based on access to goods reflects the mindset of a growing number of consumers who are committed to sustainable development. The sharing economy tools contribute to building social responsibility and shaping behaviours consistent with sustainable development.

Therefore, this article aims to answer the question to what extent Polish consumers are ready to accept and implement new forms of action brought about by the sharing economy. This question is mainly dedicated to Generation X and „baby boomers", the so-called post-war baby boom generation that grew up in the belief of traditional forms of management, defined by private

property. On the other hand, the digital generation (i.e. people born in the years 1988-1999 and later, the so-called Generation Y and Generation Z) raised in the era of popularization of modern technologies look at the world differently (Tapscott, 2009). They perfectly adapt to the new reality, show flexibility and value independence to a greater extent than their predecessors; they openly admit that you do not need to possess goods in order to consume them. The article also reviews foreign and domestic literature in the field of the sharing economy.

Literature review

Sharing economy is understood in an intuitive way as sharing produced goods or joint consumption of goods and services is not a new form of market organization (Puschman, Alt, 2016, pp. 93-99, Belk, 2014, pp. 1595-1600). The economic history of man shows that the sources of the sharing economy should be found at the beginning of the commodity economy, when „people began to exchange their products within local communities and also between them" (Rosati, 2017, p. 405). According to L. Rude, people share resources not only for economic reasons (to save money or „earn some extra money"), but also for social reasons (they want to meet new people, establish new relationships), for practical reasons (they want to save time) and for environmental reasons (high importance attributed to environmental protection) (Rude, 17-12-2020).

The sharing economy is identified with the social and economic phenomenon, which in its assumptions distinguishes the direct provision of mutual services. Participants in the sharing economy accept that the usage and enjoyment of goods and services is more important than their possession and ownership. What's more, co-creation, sharing, and all kinds of human activity are also becoming noticeable, ultimately increasing the efficiency of owned resources (Eckhardt, Bardhi, 2015).

Although the sharing economy – as a form of market organization – has been around for a decade and is in the phase of dynamic uncontrolled development, there is still no single definition of the sharing economy. Moreover, its terminology has not been systematized yet.

The European Commission defines the sharing economy as „connecting natural and legal persons via online platforms to enable them to provide services or share assets, time resources, skills or capital, often for a limited time and without transferring ownership rights" (PwCPolska, Report, 2016, p. 4). From the point of view of the economic literature on the subject, such a broad

approach is perfectly correct. In this perspective, the sharing economy comprises of three categories of participants:

1) Service providers sharing their goods, resources, time or skills – these may be natural persons offering services occasionally (peers) or service providers professionally involved in the provision of services (so-called: professional service providers);
2) Users of the above services;
3) Intermediaries connecting – via the Internet platform – suppliers with users and facilitating transactions between them (the so-called cooperation platforms) (European Commission, 2016, p. 184).

Analyzing the literature on the subject, it can be seen that there is no consensus among researchers regarding one commonly accepted definition of sharing economy. Görög conducted a literature review and provided 14 definitions that closely describe the sharing economy (Görög, 2018, pp. 175-189). The dominant approach in scientific studies is that the sharing economy is an alternative model of consumption that places access to given goods in the centre without the necessity to own them (Ozanne and Ballantine, 2010; Lamberton and Rose, 2012; Hamari, Sjoklint, and Ukkonen, 2015). It should be emphasized that the concept of sharing economy is not limited to material things because people's resources also include their skills and free time, which they can share with other people.

Recognized as a global authority in the field of cooperation and trust supported by modern technologies – Rachel Botsman[1] defines the „collaborative economy as a system that activates unused assets by launching models and markets within them that allow both access to these resources and increase their efficiency" (Botsman, 2015a). Botsman has classified various types of resource circulation based on digital platforms and social networks (Botsman, 2013). She distinguished the sharing economy among various systems such as collaborative economy, shared consumption, access economy, or peer economy. The analysis of the main features of the sharing economy allows it to be considered both narrowly and broadly. In a very narrow sense, Botsman defines the sharing economy as systems that facilitate the sharing of underused resources or services – for a fee or for free – directly between individuals or organizations (Botsman, 2015). According to the hierarchy proposed by Botsman (2013), the broadest concept is the so-called collaborative economy, defined as a community economy, which enables the use of previously unused resources by connecting those in need with those offering help without traditional intermediaries using Internet applications. Thanks to the cooperation enabled by technology, people can not only share but also among others, they can co-: -create, -finance, -design, -teach, -cure, -work, -lend, -help (Blanchard, 2015, p. 16; Zgiep, 2016, pp. 193-205).

Botsman lists many other terms that are often used interchangeably, although the meanings may vary considerably in certain cases. One of the terms used is called "collaborative consumption", meaning the revival of traditional market behaviours – renting, borrowing, exchanging, sharing, bargaining, giving, using modern technologies – the Internet or mobile applications. Admittedly, the idea of "collective consumption" appeared in literature almost 40 years ago, and it meant the sharing of goods between different consumers (Felson, Speath, 1978, pp. 614-624). In the economy, however, it was a period when ICT (information and communications technology) was actually in its infancy, which probably influenced the narrow application of the idea of sharing at that time. The current dynamic development of technology, the Internet and innovative communication (Rifkin, 2016, pp. 257-258; Kauf, 2018, pp. 141-151) have become factors increasing the dynamics of creating the sharing economy. Easy and quick access to the appropriate platform significantly shortens the stage of searching and influencing the amount of consumption (Feelländer, Ingram, Teigland, 2015, pp. 13-19). The main emphasis in the collaborative consumption model is on how goods or services are consumed rather than what is consumed (Botsman & Rogers, 2011; Allen & Berg, 2014).

The closest concept to the sharing economy is the access economy, which has emerged as an alternative to sharing in situations where sharing does not exist (Eckhard, Bardhi, 2015). It is supposed to indicate a slightly broader approach to this idea, and at the same time, take into account the greater role of more profit-oriented business entities.

Also, in Polish-language scientific publications and popular science press, for example, sharing economy has many connotations, such as co-sharing economy (ekonomia współdzielenia), shared economy and shared consumption (ekonomia dzielenia się i konsumpcja współdzielona) or collaborative economy (ekonomia kolaboratywna). The development of the conceptual apparatus of the Polish versions of the definitions proposed by R. Botsman has been discussed in detail with examples and presented, among others, by Grzegorz Sobiecki (Sobiecki, 2016, 27-38) [2]. Sobiecki distinguished a key feature for each of the concepts quoted above. It is a decentralized (networked) exchange for the collaborative economy without the mediation of traditional entities. In collaborative consumption, consumption occurs within the collaborative economy, while the co-sharing economy allows providers and consumers to freely share resources and services (Banaszek, 2016, pp. 51-59; Rudawska, 2016, p. 180). On this basis, it can be concluded that a synonymous understanding of these concepts is not a mistake. The main difference is their capacity.

In summary, the sharing economy complements mainstream economics by adding to it a business segment that changes the traditional concept of ownership by enriching it with aspects of social interaction. The sharing economy may contribute to the socially justified distribution of goods, which was pointed out by T. Piketty (2015, pp. 293-302), thus shaping behaviours consistent with the idea of sustainable development.

Research method

In quantitative research, the diagnostic survey method was used. A questionnaire was the tool of the research. The survey was conducted using an online form between January – March 2021 on a random sample of respondents, including 141 respondents. The author of the research wanted to reach the most diverse group of respondents in terms of age, including generation X, „baby boomers", generation Y and Generation Z. Therefore, bearing in mind that not everyone has access and knows how to use the Internet (e.g. elderly people), some of the surveys took the form of direct contact of the researcher with the respondents or by means of third parties, using a printout of the questionnaire form. Part of the online research in this age group was carried out thanks to the Senior Academy at the Faculty of Economics, Finance and Management at the University of Szczecin (Poland). In particular, online research was conducted among young people in this age group – mostly students – of both full-time and extramural studies.

In the questionnaire, closed questions were used, which largely contributed to the improvement of the research process and made it possible to standardize the answers. Closed questions allowed the selection of answers from a set of pre-prepared answers. In addition, filtering questions and the Likert scale were used (where 1 is the least important and 5 is the most important). The questionnaire was anonymous and consisted of 12 closed questions and 8 metric-related questions concerning data on the basic characteristics of the examined person, namely: gender, age, education, marital status, professional status, monthly net income and personal assessment of the financial situation.

Results and discussion

Characteristics of the surveyed respondents

One hundred forty-one respondents took part in the study, mostly city and town residents, who constituted 78.5% of the respondents, the remaining 21.5% of the respondents were rural residents. In addition, the majority

of the respondents were women, who constituted 66.7% of the surveyed group, while men constituted 33.3% of the respondents.

Concerning the age group, the most numerous respondents aged 18-26 constituted 42.1% of the respondents. The second age group were people aged 46-55 and above, constituting 40.1% of the respondents. People aged 36-45 accounted for 10.7% of the respondents, while those aged 27-35 constituted 7.1%.

Most of the respondents had higher education, constituting 50.7% of the respondents. The second largest group were people with secondary education, 47.2%. Finally, the least numerous group were respondents with basic vocational and primary education, constituting 2.1% of the surveyed group (table 1).

Table 1. Age and education of the surveyed respondents

Age of respondents	Participation in %	The numerical amount of sample size
18-26 and lower	42.1	59
27-35	7.1	10
36-45	10.7	15
46-55 and over	40.1	56
Altogether	100	141
Education	**Participation in %**	**Numerical amount of sample size**
Vocational education and lower	2.1	3
Secondary education	47.2	66
Higher education	50.7	72
Altogether	100	141

Source: own study based on the research carried out.

The research included both professionally active and professionally passive people. Over 38.8% of the respondents worked in public sector entities, almost 12% were self-employed or ran their own farm, and 37.4% studied. The group of students also included extramural studies, i.e. people in the age group between 27-35 years old, mostly employed. Among the respondents, there were 13% who had already retired. Due to the similar age of young respondents, in the research sample, 39.3% were singles (single men and women) and people who got married – 37.1% of the surveyed group. In the study, nearly 17.1% declared being in a free relationship, and 6.4% were widowers.

Among the respondents, 66 people assessed their financial situation as good and very good, which constitutes 46.8% of the respondents, 45.4% indicated their financial situation as average, and 11 respondents assessed their financial situation as bad or very bad, i.e. 7.8% of the respondents.

Respondents' awareness of the sharing economy

Only 39.7% of respondents have encountered the sharing economy concept for whom this concept is known and fully accepted. For more than half of the respondents, 51.1%, this concept is unknown, but they declare their willingness to accept it. The sharing economy concept is definitely unacceptable to 9.2% of the respondents (table 2).

Table 2. Distribution of answers to the question regarding the respondents' awareness of the sharing economy and acceptance of this concept

Have you come across the concept of the sharing economy, and is it acceptable to you?	Number of respondents	Participation in %
Yes, I have come across the concept of the sharing economy, and it is acceptable to me.	56	39.7
Yes, I have come across the concept of sharing economy, but it is not acceptable to me.	5	3.5
No, I have not come across the concept of sharing economy, but it is acceptable to me.	72	51.1
No, I have not come across the concept of sharing economy, and it is not acceptable to me.	8	5.7

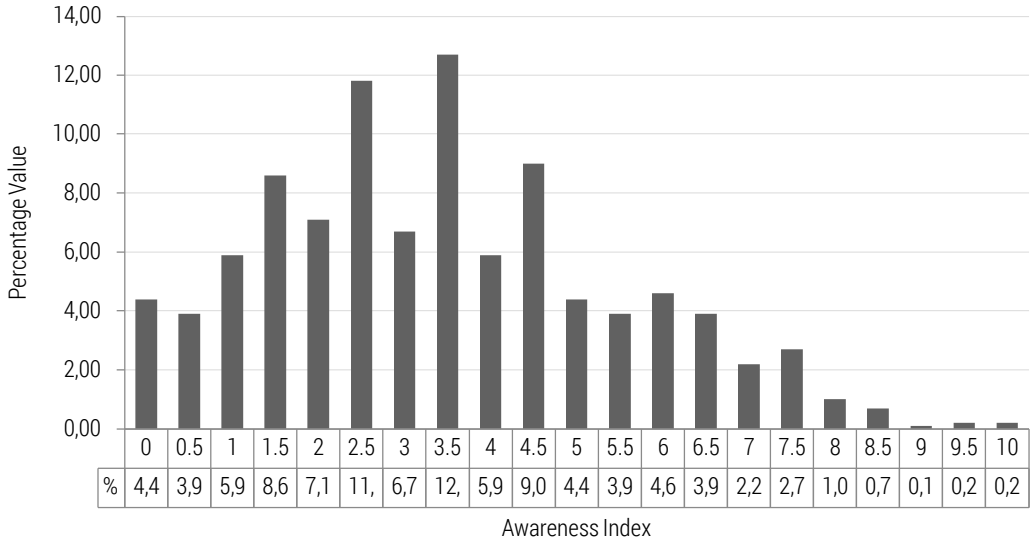
Source: own study based on the conducted research.

Women more often than men declared that they knew the concept of the sharing economy. It can also be observed that city dwellers more often than inhabitants of small towns and villages indicated that they had come across the sharing economy concept.

In Poland, unfamiliarity with the concept itself may be because the sharing economy comes under different nomenclature, such as access economics, economy on demand, common economy, or collaborative economy.

The survey shows that more than half of the respondents (56.7%) have actively used at least one sharing economy service. The most frequently mentioned service used by the respondents was: car sharing (61.3% of respondents), city bike-sharing 60.2% of respondents, sale of food products without intermediaries – directly from the manufacturer 55%, and a platform for reselling used goods 51.2%.

The awareness of the sharing economy is a combination of knowledge and practices related to the use of particular services based on the assumptions of the sharing economy. On this basis, a variable was created: The Sharing Economy Awareness (figure 1). This variable was created based on answers to two questions from the questionnaire – „Have you used or heard about particular services based on the assumptions of the sharing economy?". The distribution was obtained by summing up the affirmative answers according to the following scheme: answer yes: 0.5; each item from the question: „I heard about it and used it" – 1; „I heard about it, but I did not use it" – 0.5; „I did not hear about it, but I used it" – 0.5; „I have not heard about it, and I have not used it" – 0. This variable takes a value from 0 to 10, the higher the value of the variable, the higher the awareness. The analysis in figure 1. shows that the awareness of the majority of respondents in the sharing economy is low (the level of 3.5).



	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
%	4,4	3,9	5,9	8,6	7,1	11,	6,7	12,	5,9	9,0	4,4	3,9	4,6	3,9	2,2	2,7	1,0	0,7	0,1	0,2	0,2

Figure 1. Awareness of the sharing economy (the higher the value of the variable (0-10), the higher the awareness)

Source: own study based on the conducted research.

Further analysis of the empirical material identified the relationship between the level of education and sharing economy awareness among the respondents. The average value of the Sharing Economy Awareness Index for the entire sample was 3.5; and for the following groups of education: basic vocational and lower education – 2.8, high school education – 3.3, higher education – 3.7. Thus, the higher the respondent's education, the greater the awareness of the sharing economy.

Next, what is the relationship between age and the respondents' awareness of the sharing economy, which confirms that the correlation between these variables is statistically significant. In the age group below 36 years old, this indicator was the highest and amounted to 3.99, and in the age group of 46-55 years old and above the indicator amounted to 2.84.

The sharing economy and the problems of modern economies

The growing problems with environmental degradation, urban overcrowding, declining quality of life for their inhabitants, as well as communication problems and too much noise, are just some of the problems of modern economies. The use of sharing economy tools can solve contemporary problems of economies and thus build social responsibility and shape behaviors consistent with the idea of sustainable development.

Therefore, respondents were asked to assess the extent to which the sharing economy can contribute to solving the problems of modern economies. The analysis of the answers obtained shows that the sharing economy can mostly contribute to solving problems related to excessive consumption (90%). In the second place, the respondents indicated problems with environmental pollution in 81.6% of responses and problems with the excessive amount of waste for 80% of respondents. This was followed by global warming (77.1%) and traffic jams in 70.7% of the responses. In the opinion of the respondents, the sharing economy can contribute to the least extent in solving the problems related to irrational use of natural resources what was indicated by 16.7% of respondents (table 3).

Table 3. Distribution of answers to the question regarding the possibilities of solving problems of modern economies, in percentage value (%)

Problems of modern economies	Yes	No	Don't know
Problems related to overconsumption – waste problems	90	6.4	3.6
Traffic jams – solving traffic jam problems / CO_2 emissions	70.7	10.7	18.6
Environmental pollution problems – e.g. water, soil, forest pollution	81.6	10.6	7.8
Problems of excessive amount of waste – e.g. electro waste, packaging	80.3	12.9	6.8
Problems related to the lack of greenery (e.g. urban areas)	50.7	25.7	23.6
Global Warming problems	77.1	9.3	13.6
Problems of irrational use of resources	16.7	7.1	76.2

Source: own study based on the conducted research.

The potential of the sharing economy

The respondents were asked to respond to 7 statements that aimed to examine the attitudes favouring or inhibiting the development of the sharing economy (table 4). In general, the respondents had attitudes favouring the development of the sharing economy; nearly 75.4% of them believe that borrowing is cheaper than buying. Among many consumers, there is a belief that „access to something is more important to them today than owning a specific thing", as indicated by 62.1% of respondents. Instead of throwing things away, 88.4% of respondents prefer to give them away or resell them. Over 51.8% of respondents „can do without most of the things they have". Nearly 55.5% of the respondents use or intend to use the exchange service within the next year. It is worth adding that taking into account the people who marked the answer „I don't know" gives an additional 11.7% chance for an increase in the number of people using the sharing economy tools. In addition, nearly 90% of respondents believe that the current level of consumption is a threat to the environment.

Table 4. Distribution of answers to the question on consumption attitudes related to the sharing economy in percentage value (%)

Do you agree with the following statements:	Yes	No	Don't know
Access to things is more important than owning them	62.1	16.4	21.4
Borrowing is cheaper than buying	75.4	10.7	13.9
Limiting consumption is a threat to jobs	47.5	31.7	20.9
The current level of consumption endangers the environment (e.g. the amount of generated waste)	89.9	6.5	3.6
I can do without most of the things I own	51.8	32.1	16.1
Instead of throwing things away, I prefer to give them away or resell	88.4	8.0	3.6
I am using the exchange service or I plan to start using it in the next year	55.5	32.8	11.7

Source: own study based on the conducted research.

Summary and conclusions

When analyzing the presented research results, it should be stated that although only 39.7% of the respondents have come across the sharing economy concept, more than half of them – 56.7% have used at least one provided service. This means that ignorance of the concept does not exclude the use of

services based on the assumptions of the sharing economy. The most frequently used service, indicated by the respondents, was car and city bike-sharing (75 and 66.2%, respectively). According to the respondents, the least known services based on the assumptions of the sharing economy include: sharing a flat, co-financing projects and loans from private persons, transport services – parcel delivery.

The relationship between the age and education of the respondents and the awareness of the sharing economy is clearly visible. In the age group under 36, this indicator was the highest and amounted to 3.99; also, the higher the respondent's education, the greater the awareness of the sharing economy.

It is positive that for the majority of the respondents both facts are true: „access to things is more important than owning"(62.1%), and „borrowing is cheaper than buying" – this was indicated by 75.4% of the respondents. On the other hand, almost 90% of the respondents express their awareness of the excessive consumption dangers and the amount of waste associated with it. 88.4% of the respondents confirmed that „instead of throwing things away they prefer to give or sell their property". Moreover, 55.5% of the respondents declared that they „use the exchange service or intend to start using it". Although only slightly over 51.5% of the respondents declared that they "could do without most of the things they possess".

On the other hand, over 80% of the respondents believe that sharing economy tools can solve contemporary problems of market economies, such as the aforementioned excessive consumption and the amount of waste associated with it, environmental pollution, and the greenhouse effect or road congestion. The sharing economy changes society's approach to ownership – "you don't have to possess something to use it". It implies the sharing, exchange and lending of goods and services, which translates into the more sustainable use of available resources.

Summing up, the vast majority of the respondents not only support the direction of the sharing economy, but most of all, they use its services. Thus, it is ready to adopt the concept of the sharing economy.

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STUDENTS' PERCEPTIONS AND THEIR DERIVED SATISFACTION OF URBAN FORESTS IN THE MOST INDUSTRIALISED REGION OF POLAND

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ABSTRACT: In the face of growing urbanised areas, the presence of forests and their appropriate shaping is a key challenge for contemporary urban planning. The importance of forests is largely identified with natural, economic and social functions in non-urban areas; however, forests are of vital value in urbanised areas. This article explores young Polish urbanites' awareness of the role forests play, and submits diagnoses of the forests multidimensional benefits and their functions in Poland's urban areas. Moreover, the research is based on the premise that the management of urban forests must ultimately lead to the satisfying of social needs. Based on empirical research, the perceptions of the value of urban forests as assessed by young people (students) in the Śląskie Voivodeship are presented, leading to the authors' postulation that urban forests are underestimated resources. Furthermore, the study suggests that young Poles do not recognise the multi-beneficial aspects of urban forests; and the authors indicate feasible directions for local policy to achieve sustainable development. The final statements argue that in the face of serious threats to the functioning of Earth's ecosystem, a campaign for the presence of forests and green spaces in cities is necessary.

KEYWORDS: ecosystem services, local planning, Polish cities, urban forests

Introduction

The ongoing demographic and urbanisation pressures threaten ecosystems worldwide as these processes drive a large-scale conversion of rural to urban landscapes (Seto et al., 2011). Foreseen effects have a huge impact on climate change on a global scale (European Environment Agency, 2012). These changes require a complex sustainable development policy as their impact is multidimensional: on societies, the environment and the economy.

Sustainability in cities can be supported by the concept of ecosystem services, where environmental aspects are integrated and more directly embedded into urban decision planning (Andersson et al., 2015). Ecosystem services are not simply an outcome of ecological systems but rather are coproduced by human beings and nature. The ecosystem services approach also looks for more nature-based methods to climate change aims. This means refocusing environmental management from technological to more socio-ecological principles (European Commission, 2015; Kabisch et al., 2016). Nature-based solutions can be characterised as "... the use of nature in tackling challenges such as climate change, food security, water resources, or disaster risk management, encompassing a wider definition of how to conserve and use biodiversity in a sustainable manner" (Balian et al., 2014:5). Urban environments are also associated with many health and mental problems. Orientation geared towards nature and human well-being requires community-based governance models. An important task is to raise community awareness of the benefits of ecosystem services.

In many parts of the world we can observe a focus on the 're-naturing' of urban areas. The greening of cities comprises many forms of urban green spaces: squares, parks, urban forests. The latter option can be a real response to climate change resilience and environmental sustainability. While urbanisation transforms more and more of the world's surface, urban forests can harbour quite high biological richness. The multi-functional positive impacts of the development of urban forests are especially beneficial in post-industrial cities (Lawrence et al., 2013). The mixture of different green and blue spaces within urban areas is recognised for their capacity, not only in terms of direct biodiversity support but also in generating social and economic benefits (Haase et al., 2014). Urban forests balance the ecology of the entire city. Urban forests are rich in ecosystem services and increase the resilience of cities; in other words: the ability to adapt and thrive in changing and challenging circumstances.

Forests introduce natural wilderness and increase biodiversity into urban space (Kowarik, Körner, 2005). Nevertheless, there is research suggesting that residents of cities prefer green spaces that have more direct

signs of regular maintenance and care (Rupprecht, Byrne, 2014). This preference results in the shaping of urban green spaces limited mostly to so-called 'parkification' (Littke, 2015). Other studies demonstrate the discrepancy between green spaces developed by city administrations and those that adhere to citizens' preferences (Hartig et al. 2014; Luederitz et al., 2015). This suggests a need for more methods of local stakeholder engagement in the process of greening cities. The governance approach in urban forestry can provide a way to bridge the gaps between public authorities and citizens' knowledge, values and needs.

In view of rapid urbanisation, there is a growing interest to promote green spaces in cities. However, contrary to the wide variety of functions urban forests perform, poor attention is consistently paid to the management of green areas in cities or to so-called 'undeveloped greenery', most of which comprise forest areas. Many works have examined different contexts of urban forests, but the particular subject of city greening has not been thoroughly described in the literature.

The general aim of the research was to explore citizens' preferences, motivation and engagement in the usage and design of urban forests. In the study, we assess perceptions and valuations of urban forests by young people in Silesian cities in Poland, addressing different aspects of urban forests and incorporating multiple criteria that affect the sustainability of cities. A selection of ecological, social and economic questions examined in the research conducted among groups of students. The purpose of the research was to note whether there are statistically significant differences in the approach to urban forests between students of various fields of study. Our goal was also to observe whether there are significant statistical differences in the approach to urban forests between the male and female sex.

The importance of urban forests

Trees perform several ecosystem services for cities. The direct environmental benefits include air pollution removal, the cooling of air temperatures and carbon sequestration. The benefits that are of a social character account for better physical and mental well-being within a more aesthetically pleasing and green landscape. The economic benefits comprise, i.e. a higher level of attractiveness of the city and lower costs of health services. Wild urban ecosystems can provide various ecological, social and economic benefits, and these are always intertwined (Kowarik, 2011).

Forests affect air quality through the direct removal of different pollutants impacting citizens' health. In Poland, it is estimated that about 46.000

premature deaths are attributable to air pollution each year (European Environment Agency, 2017). Air quality benefits of urban forests assume the form of different pollutants' uptake and deposition. There is considerable research on carbon sequestration and storage (CSS) thanks to trees in the urban landscape. Nowak and Crane (2002) estimated carbon sequestration averaging 22,8 Mt C Yr-1 and carbon storage of around 700 Mt from urban parks and on streets in US cities. Based on studies mostly referencing American cities, annual carbon storage per tree range between 11 to 852 kg. Net annual air quality benefits including ozone, nitrogen dioxide, sulphur dioxide and PM10 per tree range from 0,003 to 1,81 kg (Song et al., 2018). Other studies show that pollution removal by urban trees in the United States has been estimated at 651.000 tonnes per year (Nowak et al., 2014).

Green spaces combat the urban heat island (UHI) effect and reduce the impact of climate change. An increased provision of urban green spaces to ameliorate high temperature in cities was also identified (Gill et al., 2007; Bowler et al., 2010).

Nature is a great contributor to human well-being. A substantial amount of research has documented that the existence of urban green areas improves mental and physical health (Lee, Maheswaran, 2011; Carrus et al., 2015). A number of studies have illustrated the positive health effects of living in close proximity to green spaces. What is more, they reinforce cultural identities, supporting a sense of belonging and place (Keniger et al., 2013; Hartig et al., 2014). People's contact with nature in cities increases prosocial and community building behaviour (Zhang et al., 2014). Studies demonstrate that the direct use of urban green spaces supports nature-friendly policies (Bragg et al., 2013). The 'GREEN SURGE' project in five European cities studied the perceptions and values of residents (3800 respondents) in relation to urban greening. Despite the fact that, in general, citizens value forests and other green spaces, their perception vary among cities, suggesting that regional and cultural contexts matter in terms of their relationships with nature (Fisher et al., 2016).

Economic benefits of urban forestry in monetary values can be considered individually or for the whole community. There are different aesthetic and amenity effects of forests on the real estate market, which in turn affect property sales' prices. Birch and Wachter (2008) recognise the economic incentives of urban forests in terms of less costly ways of reducing problems connected with climate change, air and water pollution, flooding and heat island impacts. From an economic perspective, urban forests also contribute to tourism development.

The economic values of forests vary among cities depending on local conditions. Complex studies conducted in American and Canadian cities called

attention to the economic benefits of urban forests. Based on the already cited studies by Song et al. (2018), the annual economic benefit per tree ranged between 7 to 165 USD. The studies also calculated the median annual costs and benefits per tree, including the following variables: biodiversity, aesthetic and amenity, shading, water regulation, carbon reduction, air quality, noise reduction, recreation and tourism, resource provision. The yearly complex benefit per tree was 44.34 USD and exceeded the costs, which amounted to 37.40 USD. Other studies by Nowak et al. (2014) show that air pollution removal by trees in the United States provided health benefits valued at 6.8 billion USD. Another research in 86 Canadian cities shows that the total amount of pollution removal was 16.500 tonnes, with human health value ranging between 38 to 292 million USD (Nowak et al., 2018). It is worth emphasising that these values are based on human health impacts. They would most likely increase if the impact on animals, crops, infrastructure, and buildings was considered.

The information given above point to the complex positive aspects of the development of urban green areas. Nevertheless, we should consider the existence of some negative aspects. In terms of the economic dimension and the real estate market, the installation of new green spaces or the restoration of existing green spaces may lead to increases in land prices and rent because of the increased attractiveness of the area. In turn, this can lead to a displacement process that is called the 'green paradox' (Wolch et al., 2014), eco-gentrification (Irvine et al., 2013; Haffner, 2015), ecological gentrification (Dooling, 2009), or environmental gentrification (Checker, 2011).

There were also identified so-called ecosystem disservices that can be defined as ecosystem functions rather negatively perceived by citizens. For example, they may relate to an increase in the numbers of insects, especially mosquitoes or an increase of allergic pollen in the air (Lyytimäki and Sipilä, 2009; von Döhren and Haase, 2015). Indirect costs of trees also include damage to buildings and pavements by tree roots or damage and disruption from falling branches (Vogt et al., 2015). It should be noted that ecosystem disservices only started to be recognised in the process of research being carried out.

Green areas have a generally positive effect on the holistic system of a city. Nevertheless, the power of an urban forest seems to be outstanding. In urban forests, nature is much less under the control of humans. It is more 'natural' with all its richness and density. The forest structure contributes to higher ecological resilience and variability than other green spaces in cities. Urban forests are therefore thought important for living sustainably alongside nature in cities.

Governance in the development of urban forests

The concept of ecosystem services was originally developed to explain human-nature relationships (MA, 2005). However, after years of research, a need towards an interdisciplinary model of services of biodiversity regarding governance was identified. The advocates of such an approach indicate the positive impact of stakeholder participation on the decision-making process and better recognition of human-nature links (Chan et al., 2012; Turnhout et al., 2013). In line with this statement, the European Union has indicated that ecosystem service mapping can be used for: "explaining the relevance of ecosystem services to the public in their territory" (European Union, 2015).

The last years have witnessed a growing interest of both the residents and administration of different levels in ecological life. This nature-oriented way of living can be incorporated into health-promoting strategies and the building of healthier cities (Hartig et al., 2014). We can also observe that urban greening is conducted more often under the formula of governance. Citizens' involvement in green spaces management can be perceived as a part of a wider reorientation towards stakeholder participation in urban planning. Numerous initiatives of greening cities by the residents and other local actors have emerged in Europe and other parts of the world over the last decades (Jansson, Lindgren, 2012; Buijs et al., 2017). Nevertheless, the number of governance strategies in urban ecosystem services has been limited (Luederitz et al., 2015). Ostoic and Konijnendijk Van den Bosch (2015) checked 519 articles from 1988 to 2014 in four leading journals on urban green spaces, and they stated: "Studies related to active participation of citizens and partnerships in urban forestry have been missing" (p.129).

An optimal strategy for the development of urban forests requires the engagement of many different actors. Local administration needs to cooperate with the community to have an ally during the development and maintenance process. It should be asserted here that it is often a challenge for city administrations to allocate local budget funds for implementing and maintaining green space projects in cities. When society fails to understand the complex and long-term benefits of ecosystem services, it will inevitably exert pressure to direct the available financial resources towards other needs.

The indicated socio-ecological approach to environmental management includes more collaborative orientation of the development of green areas in cities. Incorporating different aspects and different partners in the process of development of urban green areas can increase their attractiveness and the recognition of the scope of their potential. In the governance approach, the management of green spaces is more reflective of citizens' ideas and builds

stronger relationships with nature. Involving citizens can also lead to innovative approaches to land use planning. Nevertheless, stakeholder engagement in urban greening is a challenging task that requires complex coordination, good organisation and negotiations. Tensions may always arise.

In managing urban forests, there must be a public awareness strategy that leads to satisfying social needs (German-Chiari, Seeland, 2004). It is important to educate and engage residents in relation to urban ecosystem services. Arguably, at present, the decision-making process stands too much at a distance from local communities and their day-to-day practices. Governance towards designing and implementing urban forests requires more practical and more local context (McPhearson et al., 2015). The physical, social, cultural, economic and institutional diversity and a mixture of governance arrangements imply that there is no 'one-size fits all' strategy. For this reason, each community requires its own public participation approach in urban greening and consideration of what is best in its specific conditions.

The recognition of particular benefits of green areas becomes recognised through contact and direct practices. This illustrates how people value urban green areas and perceive them as a place. Place attachment is increased by the time spent there and visiting frequency and stakeholder participation in planning and maintenance of these places (Peters et al., 2010; Raymond et al., 2010; Chan et al., 2012; Turnhout et al., 2013). In addition, some studies show that a variety of local educational and practical activities hosted in urban green spaces increase engagement with these areas (Danforda et al., 2018). People can therefore feel the spirit of collective work, and along with experiences in cooperation, they can contribute to the development of urban green areas.

A range of linked benefits is underestimated both by societies and by city planners. This knowledge gap is a challenge that must be rejected in favour of fostering a socio-ecological agenda of environmental management in cities. It is important to examine the needs and ideas of citizens to incorporate forests into urban areas in an effort to build sustainable cities.

Materials and methods

The general outlook on conditions of urban forests' development in Silesian cities (Poland)

In Poland, there are three main acts of law concerning urban forests. These are The Environmental Protection Act (2001) and The Act on Spatial Planning and Management (2003), The Act on the Protection of Nature (2004). Taken together, they form integrative instruments which seek to

establish the right proportion between built-up and biologically vital areas. These include the regulations regarding local plans that require a minimal size of the area covered by vegetation in relation to a plot size (ratio of biologically vital areas, RBVA). What is more, The Act of March 8th 1990 regarding local government in Poland, defines the development and maintenance of green spaces as public tasks which lie within the competences of local self-governments, who are tasked with commissioning documents that inform the local planning of green urban spaces and forests. The most important document of this kind is 'The study of preconditions and directions for the spatial development of communities'. This study is a comprehensive, strategic plan that defines a city's spatial structure and its land use.

The Silesian (Śląskie) Voivodeship is located in the south of Poland. It is the most industrialised region in the country. Currently, the cities of the region are in the process of transformation, moving away from their ties to the mining industry. It is a long-term process, and full decarbonisation is estimated to last until the middle of this century. Silesia is also the most densely populated region in Poland and houses the largest conurbation of cities, numbering 41 cities and more than 3 million people.

Due to its industrial past, the environment in the region is very polluted. The biggest challenge is low-emission pollution from burning coal in domestic stoves and also transportation emissions. Greening the cities and urban forests development is a crucial element of the new 'Green Deal' policy in Silesia.

According to the statistics of the General Office of Geodesy and Cartography (GUGIK), the median value of the share of forests in Silesian cities in 2018 was 24.15%. However, significant disproportions among individual cities should be noted, with the min-max values being 2.28% – 85.32%. Figure 1 shows the distribution of forest areas within the city limits of the Silesian Voivodeship in 2019 based on satellite data from OpenStreetMap (OSM). Moreover, the OSM data was analysed in terms of the indicator of inhabitants' accessibility to separate, coherent, larger green complexes within the administrative boundaries of the cities. The accessibility indicator value is expressed as the share of people living within a 15-minute walk to these complexes. The total number of such inhabitants for any given city is above 92% for all cities. This situation changes if a 5-minute walk time is adopted as the time to cover a distance of about 500 m, as an adjustment for persons with reduced physical stamina, i.e. children, seniors or disabled people. In the case of this indicator, the median is 83.29%, and the min-max values are 28.12% – 99.97%. Therefore, the above data indicate significant differences, both in terms of share and accessibility to urban forests in the cities of the Silesian Voivodeship.

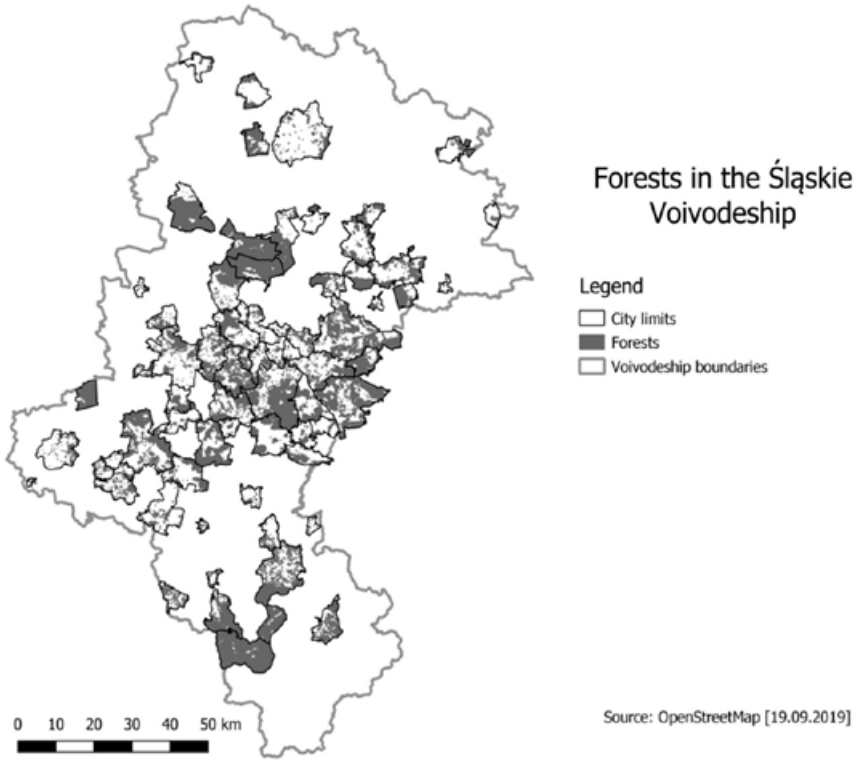

Figure 1. Urban forests in Silesian (Śląskie) Voivodeship

Methods and statistics

The study was based on an auditory questionnaire survey conducted in April-June 2019. The students of four different disciplines i.e., Spatial economy, Economics, Biology and Psychology were asked questions classified into ecological, economic and social issues. A total of 278 students were interviewed. In this study, we used a questionnaire to characterise the multidimensional context of urban forests.

In the first part, the questionnaire included 18 general knowledge questions related to ecological, social and economic aspects of urban forests. In ecological questions, we tried to get to know the respondents' knowledge about, among other things, the scale of deforestation on the Earth, how forest areas in the city affect air quality, biodiversity, hydrological situation, climatic conditions in cities, as well as the tendency to leave these areas without interference, including leaving deadwood. Regarding economic questions, we surveyed students' knowledge of the scale of the forest areas in the city

economic value, whether they accept the urban policy allocating these areas for other purposes, and whether they would be willing to incur higher costs if they had a choice of real estate near forest areas. Regarding questions from the social category, we included questions testing respondents' knowledge (the impact of forest areas on learning outcomes or convalescence) and their personal feelings about the willingness to live near forests and consent to change their use. In the second part, we asked about students' valuations, preferences, motivation and engagement in the usage and design of urban forests. For each question, several possible answers were proposed, as well as leaving room for other suggestions.

The normality of data was tested with the Kolmogorov-Smirnov test. Data were also tested for homogeneity of variance by using the Levene's test of equality of error variances and skewness. The use of a non-parametric test was dictated by the heavily skewed data distributions in the examined groups, and the fact that attempts to transform the data to that of normal distribution did not provide the expected results. The Kruskal-Wallis test was used to determine the differences among the four tested student groups. To identify differences among responses of the student groups, the multiple comparison test was done. The Mann-Whitney U test was used to test statistically significant differences in answering the ecological, economic and social category questions regarding gender. The level of significance for all statistical tests was accepted at $\alpha = 0.05$. Analyses were carried out using STATISTICA 13.1 software.

Results

Regarding ecological questions, statistically significant differences in some answers were noted. Significant differences were noted when answering the question: "Do forest areas in the city improve air quality?". Biology students answered the question slightly differently. The lowest percentage of Biology students (87%) answered positively on this question. This seems a very surprising result. The general percentage of students who answered this question positively was between 96% and 100%.

Statistically significant differences were also noted when answering the following question: "Do forest areas in the city improve the hydrological situation of cities?". There were significant differences among the answers given by students of Economics, Psychology and students of Spatial economy and Biology. Students of Biology (78%) and Spatial economy (68%) more often answered this question positively. The lowest percentage of correct answers among Biology students is also surprising with regard to the question about

the possible growth of forest areas on our planet. Between 59% (Biology) to 84% (Spatial economy and Psychology) of students answered correctly.

Most students (from 80% – Economics to 94% – Spatial economy, Psychology) indicated that forest areas in the city affect the increase in biodiversity. It is amazing that this percentage is not equal to or near the maximum. From 77% (Economics) to 89% (Psychology) of students said that urban areas in the city improve cities' climate. The percentage of students who indicated that forest areas in the city should be left to natural succession, in which we leave dead wood, was much lower (from 48% – Economics to 65% – Biology). The percentage of Biology students responding positively to this issue was the highest, although quite low. The assumption did not bear fruit that among naturalists, the percentage would be significantly higher than people who had other professional and intellectual interests. In general, statistically significant differences among groups of students were noted for questions classified as ecological (Kruskal-Wallis test, $H=10.86613$, $p<0.0125$).

Regarding questions on economic issues, statistically, significant differences were noted for the following question: "Do the city's forest areas add value to nearby properties?" Students of Spatial economy most often gave a positive answer to this question (86%). From 51% (Economics) to 62% (Psychology), students claim that the city's forest areas are used economically. A low number of students (from 12% – Economics to 28% – Biology) accepted the urban policy of reassigning forest areas in cities to fulfil other urban functions. There were no statistically important differences among the answers; however, it is telling that the highest percentage of students came from the discipline of Biology. The percentage of students declaring a readiness to pay more for the property due to its location in the vicinity of forest areas was relatively high and similar throughout all the examined groups (68-76%). Taking the four economic questions together, there were no statistically significant differences among the examined groups of students (Kruskal-Wallis test, $H=2.251050$ $p<0.5220$).

Similarly, in the case of questions included in the social category, statistically significant differences were noted in the case of one of the four questions: "Can the location of forest areas in the vicinity of schools positively influence the learning outcomes of students of such a school?" Biology (74%) and Psychology (80%) students more often answered this question positively. The proportion of students declaring their willingness to live near the forest areas in the city was high and similar in all examined groups (85-96%). The number of students claiming that the location of forest areas in the vicinity of a hospital may positively affect the recovery of patients was high and similar in all groups (84-92%). The smallest number of Biology students answered this question in the affirmative. The percentage of students who

believed that natural forest areas in urban areas should be transformed in order to increase their accessibility for residents was quite diversified in the studied groups. It was the lowest for Biology students (37%) and the highest for Spatial economy students (60%). In general, there were no statistically significant differences among the examined groups of students with regard to the social questions (Kruskal-Wallis test, H=5.85794 p=0.1187).

The differences in responses were also analysed, taking into account the gender of students. Statistically significant differences were noted only for questions from the ecological category. Female students of Economics were more likely to correctly answer ecological questions than male students of Economics (The Mann-Whitney U test, U=393, p<0.02744).

Students were also asked four open questions concerning citizens' preferences, motivation and engagement in the usage and design of urban forests. In general, there were statistically significant differences in students' proposals concerning the directions of forest development in urban areas (Kruskal-Wallis test, H=131.0934, p =0.000). One-third of students proposed leaving urban forests in a natural state. The largest number of Biology students proposed this solution (43%). Most students, irrespective of their faculties, proposed setting up walking and cycling paths in urban forests (usually over 80%). Interestingly enough, only 68% students of Biology proposed such a solution. There were statistically significant differences regarding this proposal (Kruskal-Wallis test, H=10.35948, p<0.0157). A similar number of students of all faculties suggested the placement of topographic signs and maps, or the placement of benches in forests. Such solutions enjoyed the least recognition among Biology students.

Another question was to determine how often a person spends time in the forest areas of his/her city. The „several times a month" option was most often chosen by students of all faculties (Kruskal-Wallis test, H=164.3872, p=0.000). The option „several times a week" was most often indicated by Biology students, although it was only 5% of students. Students were asked to identify their motives for spending time in the forest areas of their city. Most often, students indicated the need for a walk (over 80%), followed by contact with nature (about 60%). There were no statistically significant differences for these proposals among the groups of students studied. Educational significance was the least frequently indicated. Biology students most often pointed to this proposal (32%, Kruskal-Wallis test, H=43.61472, p=0.000). Biology students most often pointed to the role of collecting forest gifts (46%, Kruskal-Wallis test, H=13.77951 p<0.0032).

The last survey question concerned the type of actions that the respondent has taken so far for the benefit of trees and forests in their place of residence. Most often, students of all faculties pointed to a conversation with

others, the purpose of which was to recognise the importance of forests in human life (between 50% to 60%). Planting trees was indicated by respondents as the second most frequently undertaken action (24% to 43%). Biology students most often chose both of these activities. Other activities (signing a protest, photography, participation in a happening, a new form of nature protection) were rarely undertaken by students of all faculties (Kruskal-Wallis test, H=507.4831, p=0.000).

Discussion and conclusions

Despite so many ecological, social and economic benefits, urban forests are not universally recognised and appreciated. The research has discovered that urban forests are underestimated resources. The study shows that the young generation of Poles does not fully recognise the multi-beneficial aspects of urban forests. This lack of awareness probably has a direct connection to the limited activities of these young people, both in terms of usage and in terms of their engagement in the development of these areas.

The respondents' knowledge below expectations concerning the important role of urban forests, especially among Biology students, proved to be most revealing. Their answers regarding preferences, motivation and engagement in the usage and design of urban forests pointed to rather low awareness of the role and importance of these areas. Nevertheless, we should not overlook the fact that there are high discrepancies in terms of accessibility to urban forests in the cities of the Silesian Voivodeship. Limited accessibility, in turn, affects both the manner in which these areas are used, as well as people's general perceptions of them.

Urban forestry presents multidisciplinary aspects of sustainable cities that should be widely incorporated into the stages of planning and management. We still lack a holistic understanding of the benefits delivered by urban forests. There is a clear need to share and promote knowledge about the efficacy of urban forests. An important aspect of this is to learn from the great potential embedded in experiences and studies that have so far been documented and to explore what specific actions may be required to enact progress. There is a need to share information among countries and disciplines to facilitate mutual learning and foster the development of urban forests. Understanding the complexity of urban and natural relationships requires approaches from both natural and social sciences. We need to examine the evidence of the local and global benefits of urban forests and communicate this information to local communities. As our study shows, there is a need to fill in the knowledge gap in this field. The research adds to the understanding

of the complex meaning of forests in cities. It is beyond the scope of this paper to elaborate further on the detailed issues of urban forestry.

Originally focused on more natural and rural areas, a growing number of studies show the potential of ecosystem services for an urban world (Krasny et al., 2014; McPhearson et al., 2015). We observe an increasing recognition of the importance of urban green spaces for the quality of life in cities. In urban areas, the co-benefits of the availability of urban green spaces should include their multi-functionality. The environmental aspects should be linked to socio-economic factors, as well as to the general quality of life. Achieving this involves developing joint links with approaches from the domains of environmental, social and economic sciences. The concept of ecosystem services expresses that human and natural factors and processes are interlinked and impact each other.

In order to unlock the potential of urban forests, the development of the governance approach is a key challenge. Rapid urbanisation requires more active citizens who are aware of the ecological, social and economic difficulties. Adopting a mosaic of the governance approach in tandem with urban forestry delivers a diversity of benefits that produce better outcomes for cities. Combining the strategy of public participation and urban forestry is a direction that leads towards sustainable cities. Fostering stewardship activities that engage local citizens in designing and maintaining urban forests can be an important strategy for increasing awareness and engagement with these spaces. The governance model and inclusive methods of shaping urban forests increase the ecological and social resilience of cities.

Knowledge about the specific impact of urban forests on both the environment and residents is an essential part of general sustainable strategies for cities. What is more, the urban ecological footprint extends far beyond municipal boundaries. Urban areas play a pivotal role in global ecosystems. A significant consequence of urban development is habitat loss that results in widespread loss of biological diversity. While scientists have made great strides in determining principles and key factors fundamental to preserving biodiversity, their work will have little impact unless it is understood and implemented by those who are making on-the-ground decisions pertaining to land use.

Do residents want their cities to be greener and more natural? The positive answer to this question should be adopted within the practices of local governmental policy.

The contribution of the authors

Agnieszka Sobol: conception – 50%, literature review – 50%, acquisition of data – 50%, analysis and interpretation of data – 50%

Piotr Skubała: conception – 50%, literature review – 50%, acquisition of data – 50%, analysis and interpretation of data – 50%

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THE FIELD OF STUDY AS A FACTOR DIFFERENTIATING STUDENTS' LEVEL OF ENVIRONMENTAL AWARENESS

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ABSTRACT: The aim of the research presented in this paper was to identify differences in environmental awareness among students of degree programmes in various fields of study. A research hypothesis was adopted stating that the field of science within which a given field of study is conducted influences students' perception of environmental problems. Based on surveys conducted using an original questionnaire among 418 students representing 106 fields of the study carried out at 44 Polish universities, within the framework of all fields of science, a number of regularities were revealed. It was shown that each of the distinguished groups of students has its own, separate characteristics. The greatest similarities can be found between the students of medical, natural and social sciences. Students of the humanities and technical sciences differ significantly from them.

KEYWORDS: environmental awareness, environmental protection, the field of study, the field of science

Introduction

Pro-environmental attitudes and behaviour and attitudes towards environmental protection are among the issues that largely reflect generational differences. One of the main reasons for such a discrepancy is when environmental issues have become widespread. The visible effects of environmental devastation on the one hand, and the emergence of environmental movements publicising environmental problems on the other, have contributed to this.

The very concept of 'environmental awareness' is not defined unambiguously. Thus, first of all, broader and narrower approaches are distinguished (Hull, 1984; Domka, 1998; Papuzinski, 2006; Poskrobko, 2007), it is also analysed in relation to basic types of cognition (Gorka, Poskrobko, Radecki, 2001) and its structural and substantive features are also indicated (Cherdymova et al. 2018).

The most common definitions of environmental awareness in the literature emphasise its following components:

- knowledge: 'knowledge among actors in an ecological community of the role of organisations as one class of members in the natural environment whose actions have the potential to affect every class of members' (Strong, 1996), 'a set of information and beliefs about the natural environment and the perception of relations between the state and nature of the natural environment and human living conditions and quality of life' (Burger, 1986),
- awareness: 'a form of social consciousness that is reflected in the experiences and thinking of individuals and socially functioning norms for understanding and valuing the natural environment' (Frątczak, 1995),
- information and beliefs: 'information and beliefs about the natural environment and the perception of links between the state and the character of the natural environment and the conditions and the quality of human life' (Prévot-Julliard et al., 2011),
- perception: 'seeing and appreciating the importance of the relation between the economic activities of society and the process of devastation and degradation of nature' (Papuzinski, 2006),
- attitudes: 'a person's attitude towards the natural environment, a set of information and beliefs about it, as well as the value system that this person is guided by towards it in his/her behaviour' (Kiełczewski, 2001).

Ecological awareness in a broad sense is the totality of recognised ideas, values, opinions about the environment as the place of human (society) life and development shared by defined social groups in a particular historical period comprises all internalised ideas, values and opinions about the envi-

ronment as the place of human (social) life and development shared by defined groups in a particular historical period. In a narrower sense it is defined as the state of knowledge, opinions and beliefs people share about the role of the environment in human life, the degree of exploitation, hazard and protection including the state of knowledge about measures and instruments of environmental management (Jaska, 2009). As its components indicated are:

- environmental attention: the concentration of consciousness on a certain natural object or phenomenon, which provides a particularly clear reflection of it,
- environmental memory: associated with a number of complicated mental processes actively mastering which a person manages the acquisition and preservation in the mind of useful information about natural objects (phenomena), its reproduction at the right time,
- environmental perception: the perception by the consciousness of signals coming from objects of nature (animals, plants) and natural phenomena (such as rainfall),
- environmental affect: states of pleasure or displeasure associated with perceptions, emotions, feelings, and passions, thoughts caused by natural objects or phenomena,
- environmental thinking: concentrates three types of thinking – aimed at finding the single best solution to the problems encountered in the natural environment, aimed at finding many possible solutions to the problem associated with nature and characterised by originality and ingenuity of possible solutions to natural objects and phenomena (Cherdymova, 2011; Cherdymowa et al., 2018).

According to Mirowski (1996), ecological awareness consists of ecological knowledge expressed through the acquaintance with and understanding of the means of coexistence between man and nature, ecological sensitivity, or emotional attitude to nature and pro-ecological attitude, or actions undertaken to protect the natural environment. Partanen-Hertell et al. (1999) indicate motivation, knowledge and skills as components of environmental awareness.

Among the sources of environmental awareness primarily indicated are educational institutions (family, school, workplace), mass media and social experience. The factors shaping environmental awareness are divided into subjective and objective. The former include 'the properties of the individual, related to his general psychic structure (intellect, emotional system). The latter include such phenomena as the conditions of existence (economic, political, cultural) and the activity of state institutions and social groups aimed at the direct shaping of consciousness' (Szulborski, 2001).

The above definitions and ways of understanding and describing environmental awareness indicate that it is a complex concept, manifested in different dimensions, although at the same time rooted in society and reflected in specific attitudes. The determinant of ecological awareness, in its broadest sense, is primarily respect for the surrounding nature, adherence to the principles of environmental protection, and also counteracting threats.

Literature Review – ecological awareness of society and students

Research on environmental awareness is of interest to many disciplines and fields of science, as well as practitioners, including authorities at various levels and third sector actors. Studies relating to whole societies (including cyclical studies) are often conducted (Kłos, 2015; Ministerstwo Środowiska i Klimatu, bd.; *Badania świadomości i*…, 2020; Rosa, Collado, & Profice, 2018), as well as comparative studies between countries and societies using various data from public statistics and authors own research ideas (Schultz and Zelezny, 1999; Gleissen, 2007; Marquart-Pyatt, 2007; Mostafa, 2012; Franzen and Vogl, 2013; Kokkinen, 2014; Harju-Autti and Kokkinen, 2014; Rydzewski, 2016; Pisano and Lubell, 2017; Chen et al., 2019). The results of most studies show that respondents describe the state of the environment as unsatisfactory and constantly deteriorating, while at the same time, their awareness of tools and ways to care for the environment is increasing. For example, in surveys covering Poland, over 96% of respondents declare that they regularly segregate waste. According to 94% of respondents, climate change is an important or very important problem. More than three-quarters of Polish residents are willing to spend more on 'clean' energy, and nearly 6 in 10 plan to change their furnace to a more environmentally friendly energy source. Moreover, the most frequently indicated reason for protecting the environment is a concern for future generations, and seven out of ten Poles consider climate change to be a severe problem (*Badania świadomości i*…, 2020).

Students are a particularly frequently surveyed group in this regard. This may be due to the fact that for some researchers they are a natural group on which it is possible to test certain research methods and assumptions. Some researchers also emphasise that students are a group that in the near future will be important in terms of shaping the attitudes of other members of society – as parents, teachers or people functioning in the work environment, performing decision-making functions or otherwise influencing the environment (Abbas and Singh, 2014).

Among students, both their general attitudes towards environmental issues and their environmental awareness are analysed (Wong, 2003; Kryk, 2007; Ozil et al. 2008; Oğuz, 2010; Abbas and Singh, 2014; Maravic, Cvjeticanin and Ivkovic, 2014; Kłos, 2014; Moryń-Kucharczyk, 2016; Amérigo et al., 2017; Mohiuddin et al. 2018; Boca and Saraçlı, 2019; Arshad et al., 2021), as well as awareness about functioning of specific environmental components or attitudes towards specific issues (Chen and Tsai, 2016; Kazakova et al., 2020). The general conclusion of the research is that the level of awareness among students changes over time and is strongly correlated with the country in which the research is conducted and factors that include the field of study, gender, age, material status or place of residence.

Another interesting strand of research is the analysis of changes in the pattern and content of education or changes in the curriculum, as well as the use of innovative technologies and determining the impact of the actions are taken on students' attitudes and behaviour (Capdevila et al., 2002; Uzunboylu et al., 2009). This issue is directly related to the 'green-curriculum' trend that developed especially in the early 2000s and its implementation at different levels of education (Haigh, 2005; Wang et al., 2013; Louw, 2013; Xiong et al., 2013; Bernaciak and Kozłowska, 2017). Most studies emphasise the importance of environmental content and changing the approach to how students are educated.

Materials and Methods

The research aimed to identify differences in environmental awareness among students of degree programmes in various fields of study. A research hypothesis was adopted stating that the field of science within which a given field of study is conducted influences students' perception of environmental problems. Differentiation is revealed in the assessment of own knowledge concerning the environment, assessing the level of contemporary ecological threats, individual pro-ecological activity, and evaluating the importance of individual pro-ecological activities.

It was assumed that students' environmental awareness is differentiated by several formal and non-formal conditions specific to the field of study. The former include elements of education: the type and nature of the knowledge taught, the skills acquired, and the attitudes formed during the studies. The latter includes all activities undertaken by students outside the study time, which may have an impact on their individual knowledge and attitudes, including, e.g., individual interests, interests of other persons from student groups, contacts with lecturers, discussions undertaken in student groups,

additional classes, voluntary work, work. Formal and non-formal factors create an atmosphere characteristic of a given field of study, influencing the formation of environmental awareness. The fields of study realised within a given discipline show some similarity in terms of formal and non-formal factors, which enables their aggregation for the analyses conducted.

Assuming the above-mentioned assumptions, a comparative analysis between the groups of fields of study was carried out within individual fields of science was conducted. The aggregation of fields of study was made by classifying them into one of the five areas: humanities, technical sciences, medical sciences, natural sciences, and social sciences. Students of faculties related to arts were included in the field of humanities, while students of agricultural faculties were included in the field of technical sciences. Mathematics students were included in the natural sciences.

The conducted research had a pilot character. It covered 418 students representing 106 fields of study at 44 Polish universities in all fields of science (table 1)[1]. The diagnostic survey was conducted from 4 to 31 March 2021.

Table 1. Size of the research sample in particular groups

Item No.	Field of science	Number of respondents
1.	Humanities (including arts)	50
2.	Technical sciences (including agricultural sciences)	52
3	Medical sciences	72
4.	Life sciences	37
5.	Social sciences	207
Total		418

Source: authors' work.

The research was performed with the use of the CAWI method. The subject of the research was ecological awareness and its components: knowledge and attitudes. An original survey form was used in which 11 questions

[1] The total number of students in Poland at the end of 2019, according to Central Statistical Office data, was 1.2 million (in public and private schools in total). Due to the inability to obtain data on the entire population and to perform the sampling frame, the selection of the sample was deliberate. The structure of the sample by fields of study is somewhat similar to the structure of the population – 47.9% of students study social sciences in Poland (50% in our study), 10% humanities including arts (12% in our study), 22.6% technical sciences including agriculture (12% in our study), 3.8% life sciences (9% in our study), 11.5% medical sciences (17% in our study).

were asked. Questions asked were concerning: 1) assessment of own knowledge in the field of ecology and environmental protection, 2) assessment of the state of the natural environment, 3) the greatest contemporary threats to the environment, 4) sources of knowledge in the field of ecology and environmental protection, 5) taking action to protect the environment, 6) motivation to take action, 7) type of action taken 8) assessment of the actual impact of action taken on the state of the environment, 9) reasons for not taking action to protect the environment 10) readiness to lower the level of quality of life for environmental reasons and 11) readiness to limit tourist trips.

Results of the research

Students rather positively assess the level of their knowledge about the environment – 52% assess it as good or very good, and 46% describe it as moderate (figure 1). There is a big difference between the assessments made by students from different fields of study. It is best rated by students of natural sciences, whereas many as 73% consider its level as good or very good. Nobody in this group assesses the level of their knowledge as bad or very bad. However, what is surprising is the moderate assessment of knowledge in the field of ecology and environmental protection by students of medical and technical faculties. Among the latter, even 4% assess this knowledge as 'bad'. Humanists rate their knowledge very similarly. Against this background, the assessment made by students of social sciences, who have the least connection with the content of ecology and environmental protection, is very interesting. In this case, the majority, as many as 55%, of students assess their knowledge well or very well.

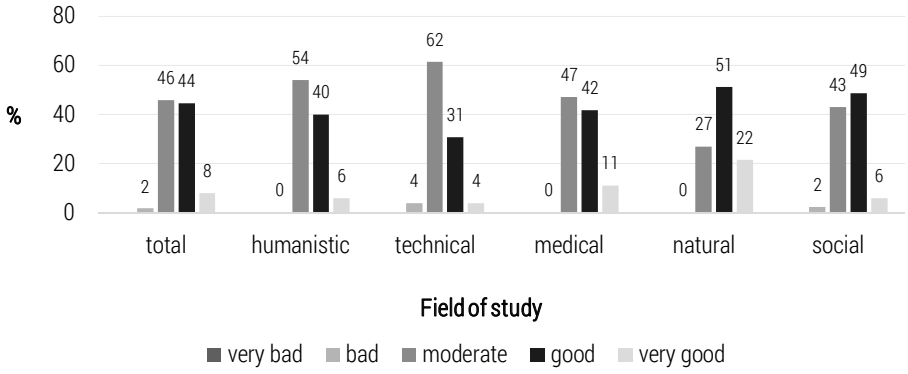

Figure 1. Assessment of knowledge in the field of ecology and environmental protection

Source: authors' work.

The basic source of knowledge for the respondents is the information available on the Internet (table 2). Social media (75% of indications) and online articles and podcasts reach (72%) a definite advantage over other, traditional sources of information. It is worth noting that scientific journals are used to gain knowledge about the state of the environment and its protection by only 27% of the students surveyed. Apart from the previously mentioned Internet sources, films and TV programmes are more popular than scientific magazines. School education also has more indications.

News via social media is the primary source for students in the humanities (95%), technology (69%) and medicine (69%). On the other hand, online articles and podcasts are the main sources of information for students in the natural sciences (73%) and social sciences (76%). It is important to note the relatively high importance attached to classical sources of knowledge by natural science students. In this group, school education (51%), scientific journals (41%) and conferences (24%) are significantly more indicated than in the other groups. Students of technical sciences also attach great importance to school education, where as much as 62% indicate it as a source of knowledge about the environment and its condition.

Table 2. Sources of knowledge about ecology and the state of the environment (% of indications)

Source	Total	Humanistic	Technical	Medical	Natural	Social
School education	40	20	62	31	51	41
TV programmes	45	44	56	35	32	48
Educational films	45	50	48	43	43	44
Radio programmes	10	8	12	13	3	11
Advertisements	18	18	29	14	5	14
Leaflets	6	8	12	7	3	5
Information brochures	14	20	13	14	11	13
Posters/Billboards	19	18	31	15	3	20
Internet article/podcasts	72	80	62	63	73	76
Scientific journals	27	24	27	35	41	22
Conferences/information meetings/ training sessions	12	10	12	8	24	12
Social media	75	94	69	69	65	75

Source: authors' work.

The assessment of the state of the environment is dominated by the categories bad and very bad. This is how it is perceived by 73% of respondents (figure 2). Students of humanities are the most critical in their assessments, where the condition of the environment is perceived in these categories by as many as 94% of the respondents. On the other hand, students of technical sciences are least pessimistic about the environment. In this case, its condition is described as bad or very bad by 'only' 58% of students, and as many as 10% perceive it as good (6%) or very good (4%). It is worth noting that in the case of students from other disciplines, no one describes the state of the environment as 'very good', and only 3% of students from social sciences assess it as good. In the case of students from other disciplines, the results are similar. The bad or very bad state of the environment is indicated by 78% of students of medical and natural sciences and 70% of students of social sciences.

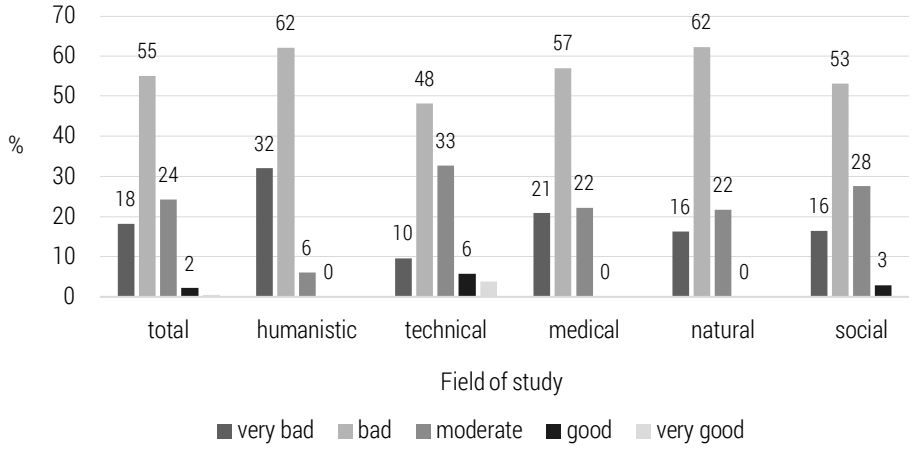

Figure 2. Assessment of the condition of the environment

Source: authors' work.

Assessments of the greatest contemporary threats to the environment are very similar (table 3). Respondents clearly indicated water and air pollution (85%). Bad waste management comes second (69%) and deforestation third (64%).

The vast majority of students declare that they take action in their everyday life to protect the environment. In total, it is 87% of respondents. The results of most of the surveyed groups are around 90%. The exception is students of technical sciences, where 'only' 67% of respondents declare taking such actions.

Table 3. Most important threats to the environment (% of indications)

Category	Total	Humanistic	Technical	Medical	Natural	Social
Deforestation	64	70	60	64	65	63
Mineral resources extraction	38	34	33	39	32	41
Loss of natural habitats	50	50	42	57	54	48
Water and air pollution	85	86	90	78	81	86
Poor waste management	69	72	73	63	62	71
Cultivation and breeding of GMOs	5	2	10	7	3	5
Consumer lifestyle	62	68	46	68	73	61
Low level of environmental education	40	42	33	35	46	42

Source: authors' work.

The most popular pro-ecological activities undertaken by students include waste segregation, using reusable bags and taking care of green infrastructure (table 4).

Table 4. Pro-environmental actions taken (% indications)

Category	Total	Humanistic	Technical	Medical	Natural	Social
Waste segregation	76	84	56	83	73	76
Use of reusable bags	77	84	60	83	73	78
Taking care of greenery	68	84	50	72	68	68
Choosing reusable products	57	72	40	64	62	54
Saving water	64	64	50	61	70	67
Saving energy	49	64	35	44	51	50
Use of energy-efficient products	61	62	54	64	41	65
Use of public transport	45	50	25	56	49	44
Choosing products with biodegradable packaging	16	40	12	44	22	0
Cycling	22	18	15	24	24	24
Choosing natural cleaning products	15	18	8	19	22	14
Following the 'zero waste' principle	18	16	6	25	19	18

Source: authors' work.

Moreover, students of natural sciences pay much attention to saving water, while technical faculties pay much attention to using energy-efficient products. Perhaps surprisingly, a relatively small percentage of students use a bicycle as a means of transport (22%). On the other hand, twice as many indicate public transportation as a way to get around town. Also, relatively unpopular among students are: choosing natural cleaning products, choosing products with biodegradable packaging and avoiding waste, following the 'zero waste' principle.

People undertaking activities aimed at environmental protection are rather sceptical about their actual positive influence on the natural environment. This influence is assessed as small or very small by 37% of respondents and as large or very large by 31% (figure. 3).

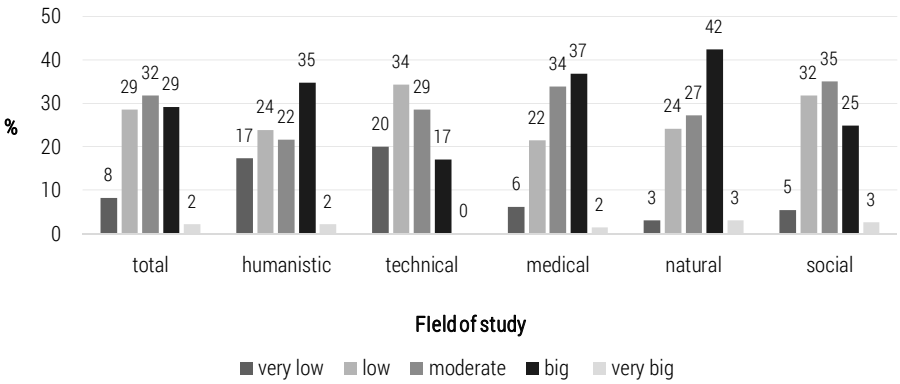

Figure 3. Assessment of the actual impact on the environment of the undertaken pro-environmental activities

Source: authors' work.

Students of natural sciences and medical faculties should be perceived as optimists in this respect. In these groups, the percentage of those assessing the impact of their actions as large and very large exceeds the percentage of those assessing it as small or very small. In the case of natural science students, the difference between these ratings is 18 percentage points and in the case of medical students, 11 percentage points. The opposite situation is recorded for the other student groups. Students of technical subjects show the greatest scepticism. The difference between the sum of marks for the categories bad and very bad and great and very good is as much as 37 percentage points favouring the former. In the case of social science students, the difference is 10 percentage points, and in the humanities, it is 4 percentage points.

When analysing the issue of not taking protective measures – students perceive that the reasons for this lie primarily in themselves, and to a lesser extent, in external factors (table 5). First of all, they indicate the fast and comfortable lifestyle (72%) and the associated difficulty in changing habits (65%). As the cause, they also perceive insufficient knowledge about the state of the environment and its protection (66%) and the belief that individual actions are not effective in achieving protection goals (61%). Much less indicated are reasons that can be considered external: lack of inspiration and motivation from the authorities (42%), high costs of pro-environmental activities (35%) or lack of possibilities to undertaking such activities (12%).

Table 5. Reasons for not taking up pro-ecological activities (% of indications)

Category	Total	Humanistic	Technical	Medical	Natural	Social
Little knowledge of the state of the environment and ways of protecting it	66	72	46	65	73	68
Belief that individual action is not effective	61	78	67	32	68	64
Fast and convenient lifestyle	72	70	67	74	73	73
Belief in high costs of taking action	35	32	27	67	27	29
Inability to take action	12	14	8	18	19	10
Lack of initiative and motivation on the part of the authorities	43	44	44	51	30	42
Difficulties in changing habits	65	66	67	67	70	63

Source: authors' work.

The surveyed students declare their consent to a potential decrease in the quality of life if it would be necessary to protect the environment from further degradation. Such attitude is characteristic of 67% of the surveyed (figure 4). In this case there is also quite a large variation between the particular groups surveyed. The highest percentage of people willing to make such a sacrifice is found in the group of medical science students – 76% and among humanists – 74%. At the other extreme are students of natural sciences and engineering, among whom readiness to reduce the quality of life for environmental reasons is declared by 54% and 56%, respectively.

The situation is reversed in the case of declarations concerning willingness to limit tourist trips to one every five years due to environmental protection. Only 33% of respondents declare such willingness (fig. 5). In this case, we can also observe differentiation between particular groups. The least

willing to make such a sacrifice are students of social sciences (26%) and medical sciences (32%). The largest group of people willing to make such a challenge is found among natural sciences students (54%).

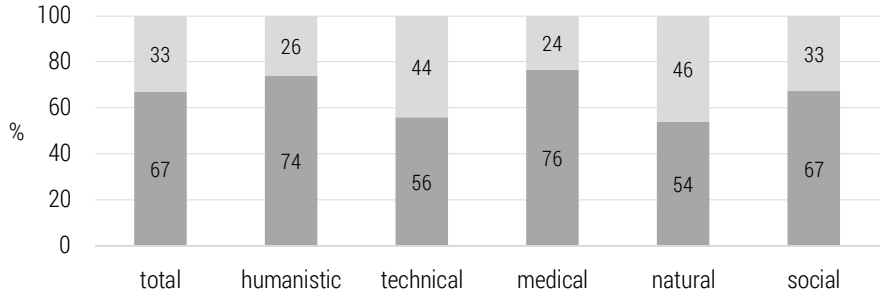

Figure 4. Readiness to lower the quality of life due to environmental protection
Source: authors' work.

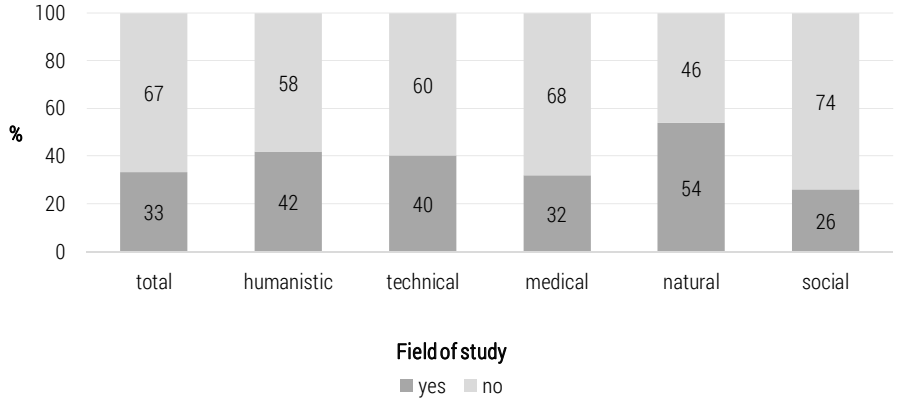

Figure 5. Readiness to limit holiday trips due to environmental protection
Source: authors' work.

In conclusion, it is worth pointing out the differences in environmental awareness revealed between students of majors pursued in different fields of science. Each of the distinguished groups of students has its own, separate characteristics. The greatest similarities can be found between the students of medical, natural, and social sciences. Students of the humanities and technical sciences differ significantly from them (table 6).

Table 6. Generalised characteristics of students' environmental awareness – comparison by field of study

Category	Humanistic	Technical	Medical	Natural	Social
Environmental knowledge (declaration)	Average	Little	Average	High	Average
Assessment of the condition of the environment	Very bad	Moderate	Bad	Bad	Bad
Sources of knowledge	Modern	Modern/ traditional	Modern	Modern/ traditional	Modern
Taking action (declaration)	Yes	Yes/no	Yes	Yes	Yes
Readiness to sacrifice	Very high	Average	High	High	Average

Source: authors' work.

Students of the humanities are characterised by a moderate assessment of their knowledge of ecology and a very pessimistic view of the current state of the environment. They draw their knowledge in this area almost exclusively from modern sources. They declare undertaking many pro-ecological activities and high readiness to make sacrifices for the environment.

Students of technical faculties estimate their knowledge about the environment rather low, not having at the same time a very negative assessment of its current state. They use modern sources of knowledge to a large extent, but they also appreciate the role of traditional sources. They are not eager to undertake pro-environmental activities, and their willingness to sacrifice in this respect is not particularly high.

Medical students declare an average level of knowledge about the environment. They perceive the bad condition of ecosystems. They gain knowledge in this area mainly from modern sources. They declare taking pro-ecological actions and express a high willingness to sacrifice. Awareness similar to medical students characterises students of natural sciences. The difference between them lies primarily in the latter's declared greater knowledge of the environment and their wider use of traditional sources of knowledge.

Students of social sciences are also similar to students of medical and natural sciences in the scope in question. In this case, however, the level of willingness to sacrifice for the environment is lower.

Summary

Ecological awareness in a broad sense is the totality of recognised ideas, values, opinions about the environment as a place of life and development of a human (society), common for specific social groups in a given historical period, and one of its key components is knowledge. Its acquisition may be formal – through the acquisition of information in the course of education, acquisition of skills and shaping of attitudes within the educational process. At the same time, it is possible to acquire knowledge in an informal way – through all activities undertaken outside the time of learning, which may affect individual knowledge and attitudes. For the purposes of the study, it was assumed that students' environmental awareness is differentiated by a number of formal and non-formal conditions specific to the field of study, and the hypothesis posed was that the area of science within which a particular field of study is conducted influences students' perceptions of environmental problems.

It was shown that differentiation is revealed in the assessment of their knowledge of the environment, assessment of the level of contemporary environmental threats, individual pro-ecological activity, assessment of the importance of individual pro-ecological activities undertaken, which was revealed in the observation that each of the distinguished groups of students has its own distinct characteristics. The greatest similarities can be found between the students of medical, natural, and social sciences. Students of the humanities and technical sciences differ significantly from them. Other results indicate that students rather positively assess the level of their knowledge about the environment, although they derive this knowledge from different sources. On the other hand, they negatively assess the state of the environment and identify manifestations of this fact in similar areas. The vast majority of students declare taking actions in their daily lives aimed at protecting the environment and declare their consent to a potential reduction in the level of their quality of life if this would be necessary to protect the environment from further degradation, although, in the case of an unambiguous declaration concerning the readiness to limit tourist trips, to one in five years, due to environmental protection, they are mostly not ready to make concessions.

The pilot study has revealed a number of regularities that require further verification in research involving a wider group. It also seems interesting to undertake research involving students from other countries, including countries from other cultural circles.

The contribution of the authors

Arnold Bernaciak: conception – 60%, literature review – 10%, acquisition of data – 10%, analysis and interpretation of data – 70%

Anna Bernaciak: conception – 20%, literature review – 80%, acquisition of data – 10%, analysis and interpretation of data – 20%

Martyna Janicka: conception – 20%, literature review – 10%, acquisition of data – 90%, analysis and interpretation of data – 10%

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SUMMARIES IN POLISH

STRESZCZENIA POLSKOJĘZYCZNE

Beata SKUBIAK

CZYNNIKI JAKOŚCIOWE ROZWOJU NA OBSZARACH PROBLEMOWYCH

STRESZCZENIE: Celem artykułu jest analiza czynników jakościowych w zakresie tworzenia potencjału rozwojowego, który umożliwi budowę lub odbudowę lokalnych społeczności i gospodarek, zwłaszcza na obszarach problemowych. Analizę czynników jakościowych przeprowadzono w oparciu o przeprowadzone indywidualne wywiady pogłębione. Umożliwiło to sformułowanie rekomendacji dla decydentów w zakresie tworzenia potencjału rozwojowego na obszarach problemowych. Przeprowadzone badania pozwalają na sformułowanie następujących wniosków: obszary problemowe wciąż tkwią w starym paradygmacie rozwoju, w którym rozwój upatruje się w czynnikach twardych, a to z kolei przekłada się na podejmowane decyzje i kierunki wydatkowania środków finansowych; małe znaczenie w rozwoju czynników miękkich takich jak: przywództwo, współpraca, partycypacja społeczna, jakość edukacji; poziom finansowania i współfinansowania programów o charakterze innowacyjnym jest niski i sprowadza się w zasadzie do zakupu przez indywidualnych rolników nowoczesnego sprzętu i rozszerzanie zakresu upraw; pomimo tego, że gminy na obszarach problemowych są liderami w pozyskiwaniu środków zewnętrznych to nie przekłada się to na poprawę ich sytuacji ekonomicznej.

SŁOWA KLUCZOWE: obszar problemowy, czynniki rozwoju

Mirosław BRONIEWICZ, Elżbieta BRONIEWICZ, Karolina DEC, Szymon LUBAS

BARIERY W STOSOWANIU SŁUPÓW KOMPOZYTOWYCH W INFRASTRUKTURZE

STRESZCZENIE: Słupy z materiałów kompozytowych wzmacnianych włóknem (FRP) są, obok słupów drewnianych, bardziej ekologicznym rozwiązaniem niż tradycyjne słupy stalowe czy betonowe. Oprócz mniejszego negatywnego wpływu na środowisko, cechują się trwałością, wytrzymałością i odpornością na korozję. Niestety, zasięg ich stosowania, zarówno w Polsce, jak i na całym świecie jest ograniczony. Autorzy, w niniejszej pracy próbują zidentyfikować najważniejsze bariery szerokiego stosowania słupów FRP w budownictwie infrastrukturalnym. Proponują również szereg działań mających na celu zmianę tej niekorzystnej, z punktu widzenia zrównoważonego rozwoju, sytuacji.

SŁOWA KLUCZOWE: słupy kompozytowe, zrównoważony rozwój, bariery

Krystyna RAUBA

WARTOŚĆ URZĄDZEŃ GOSPODARKI ŚCIEKOWEJ NA OBSZARACH WIEJSKICH W OPINII LOKALNYCH SPOŁECZNOŚCI NA PRZYKŁADZIE GMINY WYSZKI

STRESZCZENIE: Celem artykułu jest przedstawienie społecznego odbioru realizacji przydomowych oczyszczalni ścieków na terenie Gminy Wyszki. Do poznania opinii mieszkańców w kwestii realizacji przydomowych oczyszczani ścieków posłużono się metodą wyceny warunkowej CVM, wykorzystującą badanie gotowości do zapłaty (WTP). Metoda wyceny warunkowej została zrealizowana w oparciu o przeprowadzone badania ankietowe. Próba badawcza przeprowadzona została metodą wywiadu bezpośredniego wśród 105 mieszkańców gminy Wyszki. Ankieta zawierała między innymi pytania dotyczące rodzajów systemu odprowadzania i oczyszczania ścieków na terenie gminy. Na potrzeby artykułu wzięto pod uwagę odpowiedzi mieszkańców gminy, którzy nie byli podłączeni do kanalizacji lub posiadali zbiornik bezodpływowy.

SŁOWA KLUCZOWE: metoda wyceny warunkowej, społeczna akceptacja inwestycji, pytania dotyczące oczyszczalni ścieków, przydomowe oczyszczalnie ścieków

Elżbieta GOŁĄBESKA

KORZYŚCI WYNIKAJĄCE Z POPRAWY STANU TECHNICZNEGO BUDYNKU W KONTEKŚCIE EFEKTYWNOŚCI ENERGETYCZNEJ

STRESZCZENIE: Niniejszy artykuł dotyczy wpływu zabiegów termomodernizacyjnych na efektywność energetyczną budynku. Postawiono tezę, że poprawa stanu technicznego poprzez: zwiększenie izolacyjności cieplnej ścian, modernizację systemu wentylacji, regularne przeglądy i remonty kotłów centralnego ogrzewania, modernizację systemów przygotowania ciepłej wody użytkowej, wprowadzanie alternatywnych źródeł energii, bądź też stosowanie nowoczesnych technologii w budownictwie, wpływa na wzrost efektywności energetycznej tego budynku.

SŁOWA KLUCZOWE: efektywność energetyczna budynku, stan techniczny budynku, zabiegi termomodernizacyjne obiektów budowlanych

Ewa OŁDAKOWSKA, Jakub OŁDAKOWSKI

FINANSOWY ASPEKT WYKORZYSTANIA GRANULATU ASFALTOWEGO W MIESZANKACH PRZEZNACZONYCH DO PODBUDÓW DROGOWYCH

STRESZCZENIE: Granulat asfaltowy to wartościowy materiał budowlany przydatny do produkcji mieszanek mineralno-asfaltowych. Jego wykorzystanie we współczesnym budownictwie drogowym jest opłacalne nie tylko ze względów ekologicznych, ale również z uwagi na aspekt ekonomiczny związany z oszczędnością kruszyw naturalnych i asfaltu (materiałów, które pochodzą ze źródeł nieodnawialnych) oraz oszczędnością kosztów budowy nawierzchni drogowych (koszty realizacji każdej inwestycji drogowej w znaczący sposób zależą od cen i dostępności wykorzystanych materiałów). Celem przeprowadzonych analiz kosztowych było ustalenie korzyści finansowych wynikających z zastosowania w mieszankach mineralno-asfaltowych granulatu asfaltowego. Kalkulacje kosztów dotyczyły podstawowych składników mieszanek mineralno-asfaltowych oraz kosztów wykonania warstwy konstrukcji nawierzchni, do której mieszanki zostały przeznaczone. Analizami objęto mieszanki mineralno-asfaltowe typu beton asfaltowy AC 22P z różną zawartością granulatu asfaltowego nabytego w różnych cenach, przeznaczone do warstw podbudowy nawierzchni drogowych obciążonych ruchem kategorii KR3 i KR4. Z przeprowadzonej, w oparciu o szczegółową metodę kalkulacji, oceny kosztów jednoznacznie wynika, że obecność granulatu asfaltowego wpływa na obniżenie cen mieszanek mineralno-asfaltowych i kosztów ich wbudowania.

SŁOWA KLUCZOWE: granulat asfaltowy, analiza kosztów, recykling, podbudowa dróg, zrównoważony rozwój

Marta NALEWAJKO

WPŁYW KOSZTÓW OGRZEWANIA BUDYNKÓW MIESZKALNYCH NA ICH WARTOŚĆ

STRESZCZENIE: Niniejszy artykuł dotyczy istoty wpływu czynników, związanych z różnymi źródłami ciepła, na wycenę nieruchomości. Podstawowym celem opracowania jest ukazanie, że zastosowany system ogrzewania ma wpływ na koszty utrzymania i eksploatacji budynku. Postawiono tezę, że rodzaj użytego źródła ciepła w celu ogrzewania nieruchomości jest czynnikiem istotnie wpływającym na wartość, ponieważ jego efektywność oraz ogólna charakterystyka może znacząco wpływać na wysokość kosztów użytkowania budynku. Z tego powodu wskazane jest, aby sposób ogrzewania obiektów budynkowych był atrybutem uwzględnianym w trakcie wyceny dokonywanej przez rzeczoznawcę majątkowego.

SŁOWA KLUCZOWE: nieruchomość budynkowa, wycena nieruchomości, wartość nieruchomości, koszty ogrzewania budynku

Lidia KŁOS

GOSPODARKA WSPÓŁDZIELENIA W OPINII POLSKICH KONSUMENTÓW

STRESZCZENIE: Artykuł poświęcony jest zagadnieniu dotyczącemu ekonomii współdzielenia. W Polsce gospodarka współdzielenia jest obszarem relatywnie nowym, jednak o dużej dynamice rozwoju. Celem artykułu jest odpowiedź na pytanie: „czy społeczeństwo polskie jest gotowe na przyjęcie koncepcji gospodarki współdzielenia".

W Polsce występuje luka badawcza w kontekście gospodarki współdzielenia a zjawisko konsumpcji wspólnej w odniesieniu do polskich konsumentów jest stosunkowo nowym obszarem, który wymaga dokładnych badań. W tym celu wykorzystano badanie pilotażowe z zastosowaniem metody sondażu diagnostycznego techniką kwestionariusza ankiety.

Zaprezentowane wyniki badań wskazują, iż z pojęciem ekonomia współdzielenia zetknęło się 39,7% respondentów. Nieznajomość pojęcia nie oznacza jednak, że badani nie korzystali z usług bazujących na założeniach ekonomii współdzielenia. 56,7% badanych skorzystała z przynajmniej jednej świadczonej przez ekonomię współdzielenia usługi. Widoczna jest zależność pomiędzy wiekiem i wykształceniem badanych a świadomością w zakresie gospodarki współdzielenia. Najwyższa znajomość gospodarki współdzielenia wystąpiła w grupie wiekowej poniżej 36 roku życia oraz wśród respondentów z wykształceniem wyższym. Większość badanych popiera kierunki działań jakie prezentuje gospodarka współdzielenia i korzysta z jej usług.

Przeprowadzone badania mają charakter pilotażowy ale pozwalają zwrócić uwagę na istotne zagadnienie w kontekście akceptacji nowych rozwiązań związanych z zastosowaniem ekonomii współdzielenia przez starsze pokolenie polskich konsumentów. Stanowi to pole do dalszych badań już na znacznie szerszej próbie badawczej.

SŁOWA KLUCZOWE: gospodarka współdzielenia, zrównoważona konsumpcja, zrównoważony rozwój

Agnieszka SOBOL, Piotr SKUBAŁA

POSTRZEGANIE ORAZ ZADOWOLENIE Z LASÓW MIEJSKICH PRZEZ STUDENTÓW W NAJBARDZIEJ UPRZEMYSŁOWIONYM REGIONIE POLSKI

STRESZCZENIE: W obliczu rosnącej powierzchni terenów zurbanizowanych obecność lasów miejskich i ich odpowiednie kształtowanie jest jednym z kluczowych wyzwań dla współczesnej urbanistyki. Znaczenie lasów utożsamiane jest głównie z funkcjami przyrodniczymi, ekonomicznymi, czy społecznymi na terenach pozamiejskich. Jednocześnie tereny leśne niosą istotną wartość na terenach zurbanizowanych. W wielu krajach obserwujemy rosnącą świadomość znaczenia lasów dla zdrowia fizycznego i psychicznego mieszkańców oraz prawidłowego kształtowania się relacji społecznych. Sąsiedztwo lasów pozytywnie wpływa na jakość życia mieszkańców miast. Interesujące poznawczo jest na ile mieszkańcy miast w Polsce mają świadomość roli lasów w miastach oraz w jaki sposób

z nich korzystają. W artykule dokonano diagnozy wielowymiarowych korzyści funkcji terenów leśnych na obszarach miejskich. W oparciu o badania empiryczne przedstawiono percepcję wartości lasów miejskich w ocenie młodego pokolenia województwa śląskiego (studenci). Na podstawie przeprowadzonej analizy roli lasów autorzy zaprezentowali kierunki wsparcia polityki lokalnej ukierunkowanej na zrównoważony rozwój. Zdaniem autorów, w obliczu poważnych zagrożeń dla funkcjonowania ziemskiego ekosystemu niezbędna jest kampania na rzecz obecności lasów i drzew w naszych miastach.

SŁOWA KLUCZOWE: usługi ekosystemowe, planowanie lokalne, polskie miasta, lasy miejskie

Arnold BERNACIAK, Anna BERNACIAK, Martyna JANICKA

KIERUNEK STUDIÓW JAKO CZYNNIK RÓŻNICUJĄCY POZIOM ŚWIADOMOŚCI EKOLOGICZNEJ STUDENTÓW

STRESZCZENIE: Celem badań prezentowanych w niniejszym opracowaniu była identyfikacja różnic w świadomości ekologicznej pomiędzy studentami kierunków studiów prowadzonych w obszarach różnych dziedzin nauki. Przyjęto hipotezę badawczą stanowiącą, że dziedzina nauki, w ramach której prowadzony jest dany kierunek studiów wpływa na postrzeganie przez studentów problemów środowiskowych. Na podstawie przeprowadzonych badań ankietowych z wykorzystaniem autorskiego kwestionariusza wśród 418 studentów reprezentujących 106 kierunków studiów realizowanych na 44 polskich uczelniach wyższych, w ramach wszystkich dziedzin nauki, ujawniono szereg prawidłowości. Wykazano, że każda z wyróżnionych grup studentów posiada własną, odrębną charakterystykę. Największe podobieństwa odnaleźć można pomiędzy studentami nauk medycznych, przyrodniczych i społecznych. Znacznie różnią się od nich studenci nauk humanistycznych oraz nauk technicznych.

SŁOWA KLUCZOWE: świadomość ekologiczna, ochrona środowiska, kierunek studiów, dziedzina nauki

Types of Publications

1. Scientific Papers

Authors are invited to submit original research manuscripts on theoretical and empirical aspects of Sustainable Deve¬lopment and Environmental Management and Environmental Economics and Natural Resources.

A model form can be found in TEMPLATE. Submissions should have up to 25.000 characters, excluding abstract and reference list, with a clearly defined structure (Introduction, Chapters, Sub--chapters, Ending/Conclusions). Please strictly observe the number of characters. Each additional 1.000 characters of the text are charged (25 PLN or 6 EUR net).

Papers should be submitted on the website http://ekonomiaisrodowisko.pl to Peer Review process. Submission of a manuscript implies that the work described has not been published previously and is not considered for publication elsewhere.

After considering our reviewers ' comments, the article is treated as the final text. Authors can only make possible corrections resulting from the editorial composition on pdf files sent for our approval. Any modifications should concern only the errors resulting from the work on the text during the composition.

Please proofread the paper before sending them to us, as only the papers without any grammatical and spelling errors will be accepted.

Please use the correct scientific English. The Editorial Office may publish abridged versions of papers or change titles.

Author's Fees: PLN 1500, or 350 EUR.

The fee is charged after accepting the paper for publication.

2. Book Review

We invite you to submit reviews of books that are related to the field of economics and the environment.

Authors of a submitted manuscript must sign the CONTRACT, confirm that the paper has not been published previously and transfer the propriety copyrights concerning the Publisher's work.

3. Information on Academic Conferences, Symposia or Seminars

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