Research paper

Housing projects on post-industrial sites in Poland and Slovakia from the perspective of potential homeowners

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Abstract: In order to meet the high housing demand and location requirements, developers in large cities increasingly often purchase former industrial sites for conversion and redevelopment. The authors in the article conducted a survey to gauge interest in residential development on post-industrial sites in two countries (in Poland and Slovakia) and determined the group of people interested in this sector. The main focus of the survey was to gain insight into the factors that motivate the purchase of real estate and influence the choice of residential property location. Another goal of the study was to determine the importance of factors that influence decisions to purchase real estate in a post-industrial area. As a result of the survey, the authors also determined whether potential buyers paid attention to the previous development of a property and whether they were aware of the potential risks associated with converting a brownfield site to residential use.

Keywords: brownfields, demand, housing project, residential real estate, supply, surveys

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1. Introduction

Having one's own apartment satisfies the basic human need for shelter and brings a sense of security. Many countries face longstanding housing overcrowding shortages. Depending on the real estate market and its specificity, a potential buyer considers different factors when looking for an apartment [1]. In small towns, location is not as important an aspect as in large metropolitan areas. In order to meet the high demand [2], while meeting siting requirements, developers based in large cities with highly developed real estate market increasingly often purchase former industrial sites for redevelopment. Such sites emerge as a result of active deglomeration, i.e., the relocation of industrial plants outside the boundaries of an agglomeration. [3] As a result, many sites become unused, contaminated areas with extensive urban infrastructure and high potential for reuse.

To determine the interest in housing on brownfield sites while defining the group of people interested in purchasing properties located on such sites, the authors conducted primary research using an online survey on a group of people who were looking to purchase real estate in two countries – Poland and Slovakia.

2. Materials and methods

2.1. Essential information about brownfields in Poland and Slovakia

Table 1 below compares essential information on brownfields in Poland and Slovakia.

Table 1. Comparison of essential information on brownfields in Poland and Slovakia

	Poland	Slovakia
Definition of brownfields	Decayed, unused or underutilized land originally intended for economic activity that has ceased [4].	The term 'brownfield' refers to sites that have been impacted by previous uses of the site itself as well as its surroundings and that are neglected, unused or underused, may suffer from actual or unconfirmed contamination problems, are predominantly located in areas of developed urbanization, and require intervention to return them to a beneficial condition [5].

Continued on next page

Table 1 – *Continued from previous page*

	Poland	**Slovakia**
Ways to repair and further use brownfields (definitions)	REMEDIATION – subjecting soil, land and groundwater to measures that remove or reduce the amount of hazardous substances, control these substances, and limit their spread, so that the site no longer poses a threat to human health or the environment, accounting for the current and, if possible, planned future use of the site. Remediation may consist of self-purification if it provides the greatest environmental benefit [6]. REMEDIATION ACTIONS – mitigating or temporary actions taken to repair or replace in an equivalent manner negatively affected natural elements or their functions, remediation measures include, in particular, remediation [7]. PREVENTIVE ACTIONS – actions taken in connection with an event, act or omission that has caused an imminent threat of environmental damage, to prevent or reduce the damage, in particular, the elimination or reduction of emissions [7]. EMISSION – introduced directly or indirectly, as a result of human activity, into the air, water, soil or land of substances, energy, organisms or microorganisms [7]. REUSE OF A SITE – the reuse of a site or building in a way that changes the conditions of: fire safety, flood safety, labor, health, hygiene and sanitation, environmental protection, or the size or arrangement of loads [8].	RECLAMATION – restoration of the conditions in an area so that they correspond to those of a greenfield. DEMOLITION AND SANITATION – demolition and removal of buildings and other structures, removal (if appropriate) of underground structures, disposal of hazardous waste (asbestos, etc.),or unexploded ammunition. DECONTAMINATION – purification (or removal and storage) of contaminated soil, purification of contaminated groundwater, removal or cleaning of waste from previous use. RESTORATION AND LANDSCAPING – soil stabilization (if necessary), landscaping of the area (planting grass, trees, etc.). NEW CONSTRUCTION – completion of the transformation of an unused "brownfield" into an area that can be fully used. OPERATION AND MAINTENANCE – the goal is to ensure the daily operation of the brownfield, its further development and adaptation to the changing requirements of users and the operator [9].

Table 1 – *Continued from previous page*

	Poland	**Slovakia**
Legal acts	Development Program for Post-industrial Areas, Warsaw, 2004 [4]. Regulation of the Minister of the Environment of September 1, 2016, on the method of assessing soil surface contamination [10]. Regulation of the Minister of the Environment of September 9, 2002, on soil and earth quality standards [11]. Act of April 13, 2007, on Environmental damage prevention and repair [7]. Act of April 27, 2001, Environmental protection law [6]. Act of March 27, 2003, on spatial planning and development [12]. Act of February 3, 1995, on farm and forest land protection [13]. Act of October 9, 2015, on revitalization [15].	"Policy of urban development of the Slovak Republic until 2030;" ""Act No 50/1976 Coll. – Act on Spatial Planning and Building Code (Building Act); Decree No 55/2001 Coll. Of the Ministry of the Environment of the Slovak Republic on spatial planning documents and spatial planning documentation; Act of the National Council of the Slovak Republic No. 220/2004 Coll. On the protection and use of agricultural land and on amendment of Act No. 245/2003 Coll. On integrated pollution prevention and control and on amendment and supplementation of certain acts; Act of the Slovak National Council No 369/1990 Coll. On Municipal Establishment [16].
Number of brownfields in Poland and Slovakia	Based on Statistics Poland data [17] in Poland, the area of decayed and devastated land in 2022: Total area: 61,961 ha Devastated areas: 54,149 ha Decayed areas: 7,812 ha	Based on data from the ENSURE – Slovakia spin-off Final Report, 544 locations were contaminated in Slovakia as of April 2022: Total area of sites: 1874 ha Potentially contaminated site: 261 ha Contaminated site: 170 ha Renovated, reclaimed site: 33 ha Unregistered locations: 1409 ha [16].

Table 1 – *Continued from previous page*

	Poland	**Slovakia**
Risk factors associated with brownfields	1. Land contamination. 2. Poor identification of existing buildings' technical condition, possible presence of unknown underground infrastructure. 3. Presence of listed heritage buildings. 4. Existing buildings may be in inadequate/poor technical condition. 5. Risk of damage to nearby buildings in compact urban development. 6. The size, form, layout and structural systems of post-industrial buildings are demanding due to previous use specificity. 7. Difficulty in adapting buildings to be reused as housing. 8. Soil instability and poor load-bearing capacity may necessitate deep foundations. 9. Change of groundwater relations that may be caused, for example, by land leveling, faulty implementation of stormwater drainage, lack of proper drainage, introduction of an obstacle, such as a wall. 10. Potential presence of obstacles such as structures or unexploded munitions. 11. Incompatibility of the location/form/layout of existing buildings with contemporary needs.12. Inability to accurately estimate final project costs due to risks caused by unforeseen events (requiring significant financial expenditure). [18–26].	1. Institutional/legislative, legal and ownership problems and challenges: absence of a definition of the term denoting unused and neglected areas. 2. Economic problems and challenges: no economic classification, no supporting economic and especially financial instruments, technological changes in industry, agriculture, but also in administration and services causing the rapid moral obsolescence of buildings. 3. Political problems and challenges: sectoral approaches in urban development planning and the revitalization of unused and neglected areas. 4. Organizational and planning problems and challenges: we do not know where unused and neglected spaces are located, lack of monitoring and databases, mapping, excessively long planning permission and building permit obtainment, absence of strategic planning. 5. Environmental: environmental burdens such as environmental debts that either prevent the use of a site, or reduce its attractiveness for new, or old environmental uses. Burdens such as high risk without clear determination of who bears it, natural disasters and the effects of climate change 6. Social problems and challenges: low awareness of the issue of unused and neglected areas among residents and especially local governments, lack of awareness of the economic impacts of extensive development and the complexity of the problem of unused and neglected areas. 7. Functio-structural and area-specific technical problems and challenges: increasing dynamics of urban development, urban sprawl, construction on green areas and resettlement despite free areas in settlements [27].

Table 1 – *Continued from previous page*

	Poland	Slovakia
Examples of completed projects on brownfield sites	Wroclaw –Lofty Platinum Bialystok – estate 'Tytoniowka' Cracow – Drukarnia Narodowa Apartments	Prešov – Solivar Košice – Tabačka Kulturfarbik Košice – Kasárne Kulturpark

2.2. Survey methodology

A study's research method should be selected based on the research problem under investigation [28]. In the case of surveys, we analyze human opinions, such as those of potential customers or users [29]. Surveys are often a preliminary stage [30, 31] for further research and analysis that is useful in civil engineering [32], and are a source of data used to support decision-making [33].

The main part of this research was to identify the group of people who formed demand for residential real estate, determine preferences in the purchase of such real estate and provide insight into attitudes toward this real estate located on brownfield sites. To achieve this, a primary survey was designed and carried out using the online survey method. A randomly selected sample of people interested in buying residential real estate in Poland and Slovakia took part in the survey. The living conditions in both countries at the time of the survey were similar, while their populations differed significantly. According to 2021 data, the population of Poland was 37.75 million, while in Slovakia it was 5.45 million. The respondents were interested in different real estate markets, e.g., in terms of their size, which contributed to the significant relevance of the insight gained.

The survey was conducted in 2023 in Poland and Slovakia using a questionnaire. A link with the questionnaire was posted to websites and web portals dedicated to people interested in purchasing housing properties. The first set of questions the respondents were to answer asked about their interest in purchasing real estate. The survey sample consisted of 239 respondents interested in the residential real estate market in Poland (173 respondents) and Slovakia (66 respondents). The difference in the sample sizes for Poland and Slovakia stemmed from the difference in the number of residents these countries. The survey was anonymous and included both closed and open-ended (in-depth) questions and a demographic section. This primary research enabled the analysis of the group of people that created demand. Insight into home-buyer preferences and attitudes toward residential properties developed on brownfield sites was gained as a result.

2.3. Survey sample characteristics

In terms of the gender structure of the Polish part of the sample, 83% of the respondents were women looking for a residential property, the rest of the respondents (17%) were men. In terms of age, the largest group (44%) was between 26 and 35 years of age, 40% of the

respondents were between 19 and 25 years of age, 10% were between 36 and 45 years of age, 5% were between 46 and 55 years of age, and 1% (2 people) were less than 19 years of age. Currently employed persons made up 73% of the sample, 17% of respondents reported being university students, while 9% self-described as being both students and employed, one person (1%) indicated that they were neither employed nor studying at the time of the survey. Residential properties were mainly sought by those from two-person households – who amounted to 31% of respondents. People who lived in four-person households formed 21% of the sample, 20% of the respondents formed one-person households, 16% were from three-person households, and 12% were a part of five-person or larger households.

The composition of the sample from the Slovak Republic in terms of gender consisted of 56% women and 44% men. In terms of age, the largest group was between 19 and 25 years of age (44%), the groups – aged between 26 and 35 and between 36 and 45, amounted to 18%, respondents aged 46 to 55 years formed 9%, respondents aged 56 to 60 years formed 6%, and 3% were respondents in the age categories under 19 and 61 or older. In terms of employment, the largest portion of the Slovakian sample consisted of respondents with an employment contract (44%), followed by students (41%), employees in other forms of employment (6%) and business owners (6%). Only 3% of the respondents stated that they were unemployed at the time of the survey. In terms of household size, persons who were a part of two-person households were the most represented in Slovakia, amounting to 32%, of the sample, followed by those who formed households with four (24%) or five or more persons (23%), and three persons households (21%).

The respondents were also asked to disclose their income in relation to the current national average in Poland as of February 2023 (i.e., PLN 6883.96 before tax, i.e., EUR 1480.42 according to the exchange rate for September 17, 2023: 1 EUR = 4.65 PLN). As many as 39% of the respondents had an income level below the national average, slightly less (34%) had an income equal to the national average,, while 23% earned an above-average income. The remaining respondents reported receiving college scholarship (1%), being dependent on their parents (2%), or did not wish to disclose their income in the survey (1%).

In terms of income, respondents in Slovakia participated in the survey mainly with an income below the national average in Slovakia – below EUR 1295 (specifically 53%). The second most numerous group were respondents with an income above the national average in Slovakia – above EUR 1295, namely 27% of respondents. Persons with an income at the level of the national average – EUR 1295 – were the third group in terms of number. The remainder of the respondents were unemployed, were pensioners or did not want to disclose the amount of their income.

3. Results

3.1. Property preferences

The respondents were also asked about their planned method of financing and the amount they want to spend on the property purchase. Of the Polish respondents, 71% wanted to finance their purchase with a mortgage loan. The largest number of respondents (30%) planned to

spend between PLN 451.000,00 and PLN 600.000,00 (i.e., EUR 97.043,51–129.104,45) on the purchase of a residential property, while 26% of respondents, planned to spend from PLN 301.000,00 to PLN 450,000.00, i.e., EUR 64.767,40–96.828,33. The smallest group, which comprised 3% of the sample declared that they planned to spend more than PLN 900.000,00 for this purpose, (namely more than 193.656,67 EUR). Of the Slovakian respondents, 74% considered financing the purchase of their property primarily through a mortgage loan. Only 16% of the respondents considered buying real estate using their own funds exclusively, and 10% indicated a loan as a source of finance. As many as 32% of the respondents in Slovakia declared that they planned to spend between EUR 100.000,00 and EUR 135.000,00. Approximately 23% of the respondents planned to spend between EUR 136.000,00 and EUR 165.000,00 or less than EUR 70.000,00. The remaining respondents planned to spend between EUR 71.000,00 and EUR 100.000,00 or between EUR 166.000,00 and EUR 200.000,00 (approximately 3%).

The survey asked respondents to disclose their current place of residence and their motivations for buying real estate. For 41% of respondents in Poland, the current place of residence was the family home, while slightly less (38%) reported renting an apartment or house, with 18% of respondents reporting having their own dwelling. The remainder (4%) lived in a dormitory, with family or in a communal apartment. For 59% of respondents, the motivation for buying a home was to own their own property (29% of the respondents expressed a desire to stop renting an apartment and having one of their own, while 27% wanted to move out of the family home). Other motivations of Polish respondents are presented in Fig. 1.
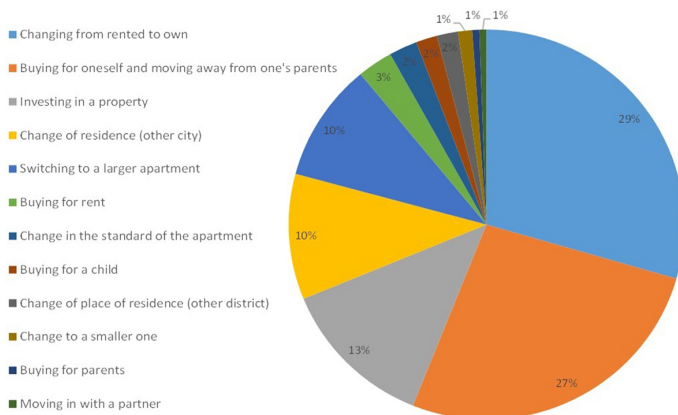
Fig. 1. Percentage of respondents by motivation for purchasing residential property in Poland (original work)

Respondents in Slovakia cited the following reasons as the main motivation for buying an apartment: 27% reported a desire to buy their own dwelling and to move away from their parents, 15% wished to invest in real estate, 12% wished to switch from renting to owning their own home, 12% wanted to occupy a larger dwelling, 9% wished to buy-to-let, 6% wished to purchase property for their child and other respondents gave reasons for changing housing standards or buying property for parents. Up to 44% of the Slovak respondents reported having

their own apartment or house, 35% reported living with their parents and 12% reported living in a dormitory. Only about 6% of respondents reported renting an apartment/room or house and 3% lived abroad.

Respondents in Poland showed the greatest interest in apartments between 36 m^2 and 50 m^2 – this preference was reported by 36% of the sample. Larger apartments between 51 m^2 and 70 m^2, were sought by 23% of respondents. Only one person (1%) of those taking part in the survey was looking for a property that had a floor area smaller than 25 m^2. Of the respondents, 18% did not have a strictly defined floor area range for a residential property. Only 8% of the respondents were interested in a property with an area of 36 m^2 to 70 m^2, 1% wished to buy a property with an area of 25 m^2 to 50 m^2. For 2% of respondents, the usable floor area of the property they were looking for did not matter. In terms of size, respondents in Slovakia were most interested in apartments ranging from 71 m^2 to 90 m^2 (31%), followed by apartments from 51 to 70 m^2 and from 36 to 50 m^2 (both preferred by groups amounting to 22% of the sample). Only about 16% of the respondents were considering buying an apartment with a floor area above 90 m^2. The remaining respondents were considering buying an apartment the size of 25 to 35 m^2 (6%) and in the size of less than 25 m^2 (3%).

3.2. Choosing a property located on a brownfield site

The set of closed and open-ended (in-depth) questions that followed asked the respondents about their attitudes toward choosing a residential property located on a brownfield site. In Poland, 71% of those who took part in the survey reported not being familiar with residential projects on brownfield sites. The remaining 29% of respondents reported being aware of housing projects located on brownfield sites during their search for a residential property.

As part of the survey in Slovakia, we asked respondents if they would be interested in buying a property in a brownfield. As many as 70% of respondents answered no. The respondents gave the following answers as the main reasons for their lack of interest: they had not heard of such an option in their area, they were already looking for a different type of property – a new building – or they were distrustful of this type of building due to its technical condition.

To more than half of the respondents (75%), previous land use did not matter. The remaining respondents (25%), to whom previous development was of great importance, reported through answers to an open-ended question that they mainly focused on the current development of a site's context (distance to the city center, public transportation or other services that they used). The respondents also paid attention to safety resulting from possible pollution from previous use (the respondents pointed to visual and aesthetic issues, low rates of soil and air pollution, and low groundwater levels).

The respondents were also asked about their attitude toward buying a residential property on a brownfield site. As many as 57% of the respondents expressed a willingness to consider buying a non-residential property on a brownfield site, while the remaining 43% were opposed to this. Through an open-ended question, the respondents were asked about the reason for these concerns. This was mainly due to ignorance about the purification of brownfield sites and fear of contamination, or looking for a property in a specific location/district where such sites were not present.

Next, respondents were asked about their concerns about complications arising from previous land use and the designation of sites for industrial uses. As many as 64% of the respondents expressed concerned about complications during the use of the property. The respondents were concern about land contamination, the impact of hazardous substances, landslides, sinkholes, noise coming from the surroundings, poor soil quality and vegetation problems, the occurrence of dampness in the property in use and potential health complications, the faster deterioration of facilities, the suboptimal layout of rooms in converted facilities, as well as prolonged administrative proceedings related to such projects.

We asked Slovak respondents whether they cared about the previous development of sites. As many as 82% of respondents answered no. The respondents who answered affirmatively said that although they cared about the previous development of the site, it would not affect their decision to buy in any way.

We asked the respondents in Slovakia how the fact that a property is located in a brownfield or in its close proximity affected the decision to buy it. The respondents said that it depends primarily on the individual assessment of the property near the brownfield. Furthermore, the respondents mentioned the possible risks associated with the low load-bearing capacity of the soil and the methods of previous use. It was interesting to find that the majority of respondents, about 70%, stated that they did not think that it would affect their decision. As part of the survey, we were also interested in whether the respondents thought that, during the use of a property located in a brownfield, complications may arise due to the current use of the land and the planned use of a building. In reference to this question, 53.3% of the respondents did not anticipate any complications, approximately 40% of the respondents anticipated complications, and the remaining respondents could not tell. At the same time, we asked what they thought were the possible complications. The following answers were given: possible complications depended on the technical condition of the building, on an either unprofessional assessment of possible threats or their underestimation, the previous form of use and possible health risks and the presence of pollutants in the environment.

In order to determine the preferences of potential buyers in choosing a residential property located on a brownfield site, the respondents were asked, through an open-ended question, to identify the two most important criteria that could lead to a positive decision in this regard. For 66% of respondents in Poland, when choosing a property, the most important factor was the broadly defined location (proximity to the city center, workplace, service establishments, public facilities, sports facilities, green areas, distance from family and friends, low traffic in the area, quiet surroundings of the estate). Only 17% of the respondents reported that the most important criterion were amenities such as the availability of parking spaces, well-developed infrastructure around the estate and the public transportation network, as well as the estate's landscaped surroundings). As little as 10% of the respondents focused on the property price, while 5% listed other criteria (safety of the neighborhood, history of the building, air quality). The smallest group, comprising 2%, pointed to housing preferences (size and standard of the apartment).

In Slovakia, the respondents mainly mentioned the following criteria in response to this question: location (quiet location, proximity to the city center, proximity to nature);

approximately 49% of the respondents listed amenities (amenities, parking, accessibility and availability of public transport) – approximately 42% of the respondents, and only 9% saw the price of the property as an important criterion.

The respondents were then asked via an open-ended question to identify up to three property features they were willing to give up when buying a brownfield property.

For 58% of the respondents in Poland, the least important factors in choosing a property were their own preferences concerning the size of the apartment and the layout of the apartment (an extra bedroom/room, a separate kitchen, having a balcony or terrace, a bicycle, stroller or storage unit, or requirements for the height of buildings in the neighborhood. A group comprising 15% of the respondents admitted that they could give up location requirements (proximity to public transportation, green areas, public facilities), 13% could give up amenities such as the presence of parking spaces or an elevator, and the same group of respondents (13%) did not list criteria they could give up when deciding to buy a property. Slovak respondents answered the question: "Which properties of real estate are you willing to give up when buying real estate?" as follows. As many as 50% of respondents mentioned the height of the building as a feature they were willing to give up. The following were listed: 38% – no bicycle/stroller storage space; 34% absence of a separate kitchen; 31% – insufficient proximity to public transport; 28% – orientation of the apartment relative to the cardinal directions; 25% – absence of an elevator; 22% – absence of a balcony/terrace; 16% - one less bedroom or room; 16% – lack of storage space; 13% – problems with parking (missing parking space); 3% - further distance to the city center.

The respondents were asked to rate, using a five-point scale, the criteria proposed by the survey's authors in terms of importance when buying a residential property on a brownfield site. Fig. 2 shows the importance of these factors as rated by respondents from Poland, while Fig. 3 shows the importance of these factors as rated by respondents from Slovakia.

In Poland, the most important factors were the price of the property (71%) and the standard of construction (69%). On the other hand, the least important factors in choosing the location of a property were the historical qualities of the redeveloped site/facility (48%) and the prestige of the neighborhood (46%). In Slovakia, the most important factors mentioned by the respondents were the price of the property (63%), the results of soil contamination tests (42%) and the level of noise/light pollution (42%). The respondents cited the size of the housing estate (15%) and the prestige of the property (16%) as the least important factors.

The respondents were also asked via an open-ended question how their decision could be influenced by the fact that a residential property is located on a brownfield site. For many respondents in Poland (38%), this was a negative aspect, which meant they would not consider buying such a property. More than half (51%) of the respondents believed that the preservation of architectural details that highlight the former industrial development of an area increases the attractiveness of the residential property. In Slovakia, to 63% of respondents, the preserved historical value of a post-industrial area was not important when deciding to buy a property, but up to 63% believed that the preservation of architectural details that emphasize the former industrial development of the area increases the attractiveness of the area's residential property.
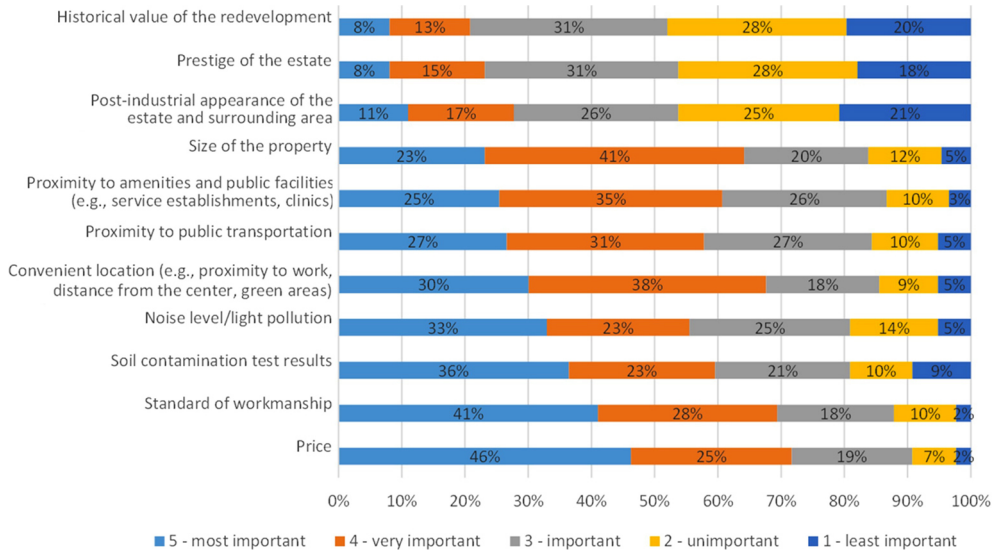
Fig. 2. Importance of criteria in selecting the location of a residential property located on brownfield sites in Poland (original work)
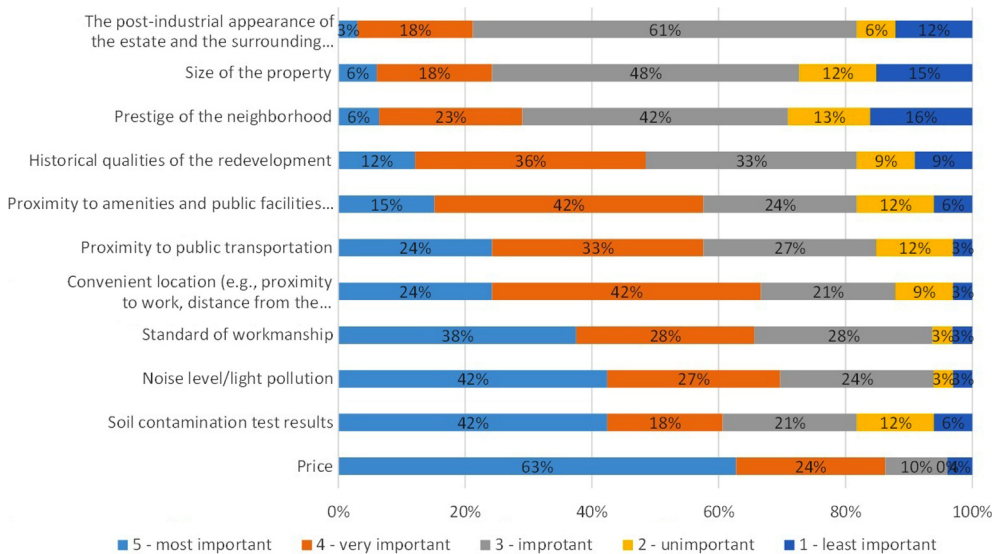

Fig. 3. The importance of criteria in choosing the location of a residential property located in post-industrial areas in Slovakia (original work)

3.3. Correlation

The use of information obtained through a survey method carries the risk of inconsistent results. The extracted data were verified for consistency, by means of investigating the relationships between the characteristics under study. Correlation analysis allows you to quantify the strength of relationships between two or more study variables [34, 35]. Pearson's linear correlation coefficient is used to determine how strong a linear relationship exists between the studied characteristics. The value of Pearson's linear correlation coefficient is in the range [−1, 1]. If there is no relationship between the variables under study, the value of the correlation coefficient is 0, while the more it deviates from 0, the stronger the correlation. The sign of the correlation coefficient tells us about the direction of the correlation, while its absolute value tells us about the strength of the relationship.

$$(3.1) \qquad r = 0 \quad \text{no correlation} \quad r = 0$$

$$(3.2) \qquad 0 < r < 0.1 \quad \text{low correlation} \quad -0.1 < r < 0$$

$$(3.3) \qquad 0.1 < r < 0.4 \quad \text{moderate correlation} \quad -0.4 < r \leq -0.1$$

$$(3.4) \qquad 0.4 < r < 0.7 \quad \text{average correlation} \quad -0.7 < r \leq -0.4$$

$$(3.5) \qquad 0.7 < r < 0.9 \quad \text{high correlation} \quad -0.9 < r \leq -0.7$$

$$(3.6) \qquad r \geq 0.9 \quad \text{very strong correlation} \quad r \leq -0.9$$

In order to check whether a correlation actually existse and that the r coefficient did not differ from zero only at random, a significance test for the correlation coefficient was performed. The null hypothesis was that a correlation did not exist:

$$(3.7) \qquad H_0 : \quad \rho = 0$$

while the alternative hypothesis took the form of:

$$(3.8) \qquad H_1 : \quad \rho \neq 0$$

If the null hypothesis was true, the t-statistic would have had a Student's distribution with $(n-2)$ degrees of freedom [36].

Table 2 and Table 3 present the results showing all the results on the relationships between the variables.

The strongest relationships are between: the importance of the price of the property, and the importance of the location being convenient to the respondent ($r = 0.6955$ for Poland, $r = 0.7071$ for Slovakia), size in terms of the number of rooms vs size in terms of floor area square meters of the property planned to be purchased ($r = 0.6349$ for Poland, $r = 0.8022$ for Slovakia), the importance of the location being convenient to the respondent vs. the importance of the land surveys performed regarding pollution ($r = 0.5538$ for Poland, $r = 0.7550$ for Slovakia). Similar results regarding the strength and direction of the relationship can be observed for the analysis based on the results of the surveys in Poland and Slovakia.

For the surveys conducted in Poland (number of responses $n = 173$) and Slovakia ($n = 66$), the correlation between the variables was examined for a significance level of $\alpha = 0.05$. For

Table 2. A matrix of Pearson's linear correlation coefficients for the survey performed in Poland (own elaboration)

Column key (same set of variables as rows; 1.0000 on the diagonal):
1 = Gender; 2 = Age; 3 = Size (in terms of square meters) planned to be purchased; 4 = Size (in terms of number of rooms) of the property planned for purchase; 5 = The amount of funds planned to be used for the purchase of real estate; 6 = Importance of previous land use; 7 = Respondents' consideration of buying a property on a brownfield site; 8 = Opinion on complications arising from previous land use; 9 = Performed soil tests for contamination; 10 = Convenient location; 11 = Price of the property; 12 = Historical value of the redevelopment; 13 = Prestige of the neighborhood; 14 = Proximity of public transportation; 15 = Proximity of amenities and public facilities; 16 = Post-industrial appearance of the estate and surrounding area; 17 = Size of the estate; 18 = Noise level/light pollution; 19 = Standard of construction

Variable		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Gender	r	1.0000																		
	p	0.0000																		
Age	r	0.0758	1.0000																	
	p	0.3213	0.0000																	
Size (in terms of square meters) of the property planned to be purchased	r	-0.1713	-0.0562	1.0000																
	p	0.0242	0.4624	0.0000																
Size (in terms of number of rooms) of the property planned for purchase	r	-0.1695	-0.0044	0.6349	1.0000															
	p	0.0262	0.9541	0.0000	0.0000															
The amount of funds planned to be used for the purchase of real estate	r	0.0040	-0.0163	0.3779	0.2937	1.0000														
	p	0.9588	0.8311	0.0000	0.0001	0.0000														
Importance of previous land use	r	0.0741	0.1370	-0.2575	-0.1574	0.0661	1.0000													
	p	0.4312	0.1442	0.0055	0.0844	0.4818	0.0000													
Respondents' consideration of buying a property on a brownfield site	r	-0.1749	-0.0895	0.0916	0.3023	0.0193	-0.3218	1.0000												
	p	0.0214	0.2417	0.2305	0.0076	0.8009	0.0005	0.0000												
Opinion on complications arising from previous land use	r	0.1020	0.0383	-0.0510	-0.0706	-0.0531	0.2014	-0.3081	1.0000											
	p	0.1885	0.6119	0.5111	0.3643	0.4945	0.0309	0.0000	0.0000											
Performed soil tests for contamination	r	-0.1437	-0.0351	-0.0075	0.1132	-0.0183	-0.0074	0.1343	-0.2289	1.0000										
	p	0.1132	0.6444	0.9216	0.1394	0.8114	0.7713	0.0780	0.0028	0.0000										
Convenient location	r	0.0592	0.0082	0.0075	0.0963	-0.0059	0.1037	0.1003	-0.0026	0.5538	1.0000									
	p	0.4464	0.9148	0.9221	0.2088	0.9280	0.2703	0.1892	0.9734	0.0000	0.0000									
Price of the property	r	-0.0999	-0.0603	-0.0167	0.0785	-0.0080	0.0876	0.0899	-0.0067	0.4728	0.6955	1.0000								
	p	0.1910	0.4305	0.8272	0.3058	0.9171	0.3518	0.3394	0.9311	0.0000	0.0000	0.0000								
Historical value of the redevelopment	r	-0.1228	-0.0644	0.0435	0.0700	0.0675	-0.2136	0.1172	-0.0085	0.2385	0.1765	0.0956	1.0000							
	p	0.1076	0.4000	0.5700	0.3615	0.3773	0.0219	0.1247	0.9133	0.0025	0.0202	0.1970	0.0000							
Prestige of the neighborhood	r	-0.2790	-0.1331	0.1840	0.1717	0.0663	-0.1759	0.2243	-0.0910	0.1349	0.2172	0.0736	0.5786	1.0000						
	p	0.0002	0.0808	0.0154	0.0243	0.3865	0.0601	0.0030	0.2407	0.0767	0.0041	0.3428	0.0000	0.0000						
Proximity of public transportation	r	-0.1912	-0.0612	0.0068	0.0579	0.0150	0.1459	0.0692	-0.0237	0.4408	0.6029	0.5413	0.2293	0.3242	1.0000					
	p	0.0117	0.4240	0.9291	0.4508	0.8449	0.1197	0.3657	0.7115	0.0000	0.0000	0.0000	0.0024	0.0000	0.0000					
Proximity of amenities and public facilities	r	-0.2133	-0.0556	0.1312	0.1388	0.0566	0.0290	0.0608	-0.0463	0.4090	0.5529	0.4724	0.3280	0.4128	0.6766	1.0000				
	p	0.0048	0.4676	0.0853	0.0695	0.4596	0.7585	0.4271	0.5515	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000				
Post-industrial appearance of the estate and surrounding area	r	-0.1244	-0.0729	0.1782	0.0623	0.0873	-0.2011	0.0227	-0.0545	0.1087	0.0858	0.0347	0.4666	0.5135	0.2416	0.4117	1.0000			
	p	0.1029	0.3406	0.0190	0.4171	0.2533	0.0311	0.7670	0.4831	0.1545	0.2619	0.6507	0.0000	0.0000	0.0014	0.0000	0.0000			
Size of the estate	r	-0.1524	0.0248	0.0850	0.1306	0.0438	-0.0257	0.0654	-0.0920	0.5367	0.5552	0.4851	0.3233	0.3209	0.4617	0.5695	0.3022	1.0000		
	p	0.0433	0.7460	0.2662	0.0877	0.5673	0.7851	0.3928	0.2356	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000		
Noise level/light pollution	r	-0.1544	0.0425	0.1288	0.1731	-0.0369	-0.2166	0.3069	-0.1411	0.4593	0.3813	0.3389	0.3005	0.3807	0.3710	0.5063	0.3647	0.4969	1.0000	
	p	0.0555	0.4445	0.0913	0.0232	0.6300	0.0201	0.0000	0.0631	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
Standard of construction	r	-0.1417	0.1191	0.0476	0.1242	0.0879	-0.0153	0.1761	-0.1079	0.5629	0.5653	0.5433	0.2317	0.2520	0.4922	0.6023	0.1916	0.6323	0.5936	1.0000
	p	0.0630	0.1187	0.5342	0.1044	0.2501	0.8670	0.0204	0.1659	0.0000	0.0000	0.0000	0.0022	0.0008	0.0000	0.0000	0.0116	0.0000	0.0000	0.0000

Table 3. A matrix of Pearson's linear correlation coefficients for the survey performed in Slovakia (own elaboration)

Column legend (same order for rows and columns):
1. Gender
2. Age
3. Size (in terms of square meters) of the property planned to be purchased
4. Size (in terms of number of rooms) of the property planned for purchase
5. The amount of funds planned to be used for the purchase of real estate
6. Importance of previous land use
7. Respondent's consideration of buying a property on a brownfield site
8. Opinion on complications arising from previous land use
9. Performed soil tests for contamination
10. Convenient location
11. Price of the property
12. Historical value of the redevelopment
13. Prestige of the neighborhood
14. Proximity of public transportation
15. Proximity of amenities and public facilities
16. Post-industrial appearance of the estate and surrounding area
17. Size of the estate
18. Noise level/light pollution
19. Standard of construction

Variable	stat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1 Gender	r	1.0000																		
	p	0.0000																		
2 Age	r	-0.0339	1.0000																	
	p	0.7835	0.0000																	
3 Size (m²) to be purchased	r	0.1398	0.5663	1.0000																
	p	0.2706	0.0000	0.0000																
4 Size (rooms) for purchase	r	-0.1526	0.5530	0.8023	1.0000															
	p	0.2404	0.0000	0.0000	0.0000															
5 Amount of funds	r	-0.0058	0.1410	0.4414	0.4300	1.0000														
	p	0.9645	0.2744	0.0003	0.0007	0.0000														
6 Importance of previous land use	r	-0.1130	0.0933	-0.2697	-0.3006	0.0545	1.0000													
	p	0.3588	0.4493	0.0311	0.0186	0.6738	0.0000													
7 Respondent's consideration	r	-0.0052	-0.0663	-0.0685	0.0255	-0.2019	-0.2343	1.0000												
	p	0.9672	0.4417	0.5906	0.8456	0.1156	0.0121	0.0000												
8 Opinion on complications	r	-0.0341	0.1147	0.2232	0.1356	-0.0383	0.1726	-0.0049	1.0000											
	p	0.8010	0.3954	0.1015	0.3378	0.7853	0.1653	0.9693	0.0000											
9 Performed soil tests	r	0.0530	0.2816	0.1894	0.1715	0.0693	0.1116	0.1718	-0.2100	1.0000										
	p	0.6728	0.0220	0.1404	0.1941	0.5990	0.3724	0.1746	0.1168	0.0000										
10 Convenient location	r	0.2464	0.1439	0.2026	0.0119	0.0226	-0.0299	0.4012	0.1067	0.7550	1.0000									
	p	0.0461	0.2490	0.1143	0.9286	0.8638	0.8115	0.0322	0.4012	0.0000	0.0000									
11 Price of the property	r	0.1981	0.1140	-0.0143	-0.2545	-0.0675	-0.1199	0.3453	0.5456	0.4515	0.7071	1.0000								
	p	0.1108	0.3621	0.9122	0.0517	0.6603	0.1358	0.6083	0.0000	0.0001	0.0000	0.0000								
12 Historical value	r	0.0422	0.0651	0.1521	0.0611	0.4302	-0.0699	0.4480	0.4339	0.0621	0.0425	0.4009	1.0000							
	p	0.7363	0.6035	0.2380	0.6457	0.0009	0.5892	0.0008	0.0003	0.6317	0.0036	0.0008	0.0000							
13 Prestige of the neighborhood	r	0.1680	0.3528	0.3956	0.2879	0.0009	-0.0432	0.0054	-0.0438	0.6317	0.7432	0.3325	0.5313	1.0000						
	p	0.1917	0.0049	0.0021	0.0314	0.9391	0.7305	0.9659	0.6117	0.0000	0.0000	0.0000	0.0000	0.0000						
14 Proximity of public transportation	r	0.2574	0.0776	0.0716	0.0100	0.2760	0.0648	-0.2098	0.0041	-0.4975	0.5582	0.3288	0.2068	0.1289	1.0000					
	p	0.0369	0.5355	0.5804	0.9401	0.0328	0.6052	0.0962	0.9741	0.0000	0.0000	0.0070	0.0973	0.3180	0.0000					
15 Proximity of amenities and public facilities	r	0.2485	0.1658	0.0824	-0.1637	0.0858	-0.0766	-0.0770	0.0402	0.4485	0.6603	0.5215	0.2477	0.1910	0.1370	1.0000				
	p	0.0442	0.1835	0.5242	0.2153	0.5145	0.5410	0.5452	0.7664	0.0002	0.0000	0.0000	0.0449	0.1370	0.0000	0.0000				
16 Post-industrial appearance	r	0.0654	0.1862	-0.1301	-0.2799	-0.2177	0.0540	-0.0460	-0.0013	0.1973	0.3109	0.4179	0.4436	0.2136	0.2258	0.5517	1.0000			
	p	0.6128	0.1343	0.3136	0.0318	0.0948	0.6667	0.7180	0.9922	0.1122	0.0111	0.0005	0.0002	0.0955	0.0684	0.0000	0.0000			
17 Size of the estate	r	0.2814	0.1420	-0.0569	-0.1470	0.0101	0.0193	-0.1419	0.0361	0.1388	0.2831	0.1890	0.0353	0.1739	0.3092	0.4223	0.5800	1.0000		
	p	0.0221	0.2554	0.6603	0.2666	0.9391	0.8777	0.2634	0.7898	0.2664	0.0212	0.1285	0.7786	0.1764	0.0115	0.0004	0.0000	0.0000		
18 Noise level/light pollution	r	0.0769	0.2565	0.0342	-0.0440	0.2666	0.0213	0.0078	-0.3275	0.4393	0.3767	0.4277	0.3125	0.0569	0.1958	0.2832	0.3580	0.2834	1.0000	
	p	0.5395	0.0376	0.7917	0.7408	0.0440	0.8650	0.9515	0.0129	0.0002	0.0018	0.0003	0.0106	0.6604	0.1150	0.0212	0.0032	0.0211	0.0000	
19 Standard of construction	r	0.2403	0.1361	-0.0390	-0.1667	-0.2685	0.1005	0.0347	0.0318	0.3780	0.4714	0.4844	0.1620	-0.0387	0.3558	0.1648	0.3042	0.4172	0.6059	1.0000
	p	0.0519	0.2757	0.7635	0.2071	0.0381	0.4150	0.7822	0.8141	0.0018	0.0001	0.0000	0.1999	0.7650	0.0034	0.0026	0.0130	0.0005	0.0000	0.0000

Importance of factors in choosing a property located in a brownfield site

one of the strongest correlations, i.e. the importance of the price of the property, and that of a convenient location to the respondents, in Poland ($r = 0.6955$) the probability value was less than α, indicating a correlation. For the same relationship in Slovakia ($r = 0.7071$), the probability value was also less than α, and this indicates the presence of correlation.

4. Discussion

This research was conducted using an online survey on a group of people currently looking for real estate in Poland and Slovakia. The research showed that residential real estate was mainly sought by young, employed people, and that two- and three-room apartments were the most popular. The differences in preferences concerning apartment floor area (in Slovakia, larger apartments – with an area of 70 m^2 or more – were more popular) were due to the characteristics of the survey sample. In Slovakia, the respondents older and owned their own apartments, and their motivation was to improve living standards. In Poland, the surveyed group of people was younger, and lived in family homes or rented apartments, and their main motivation was to acquire their own dwellings. In contrast, in both countries, the most important factors influencing the decision to buy a property were location and price.

In recent years, the real estate market across Europe has been undergoing dynamic changes related to rising property prices. According to the Property Index 2023 report, the average price of real estate in 2022 in Poland was EUR 1,975 per square meter (a year-on-year increase of 14.1%), while in Slovakia it was significantly more, as much as EUR 3,156 per square meter (a year-on-year increase of 19.1%). Of course, average real estate prices between regions or cities can vary significantly. The time it takes to purchase a 70 m^2 apartment is an indicator of housing availability. As of the writing of this paper, Poles had to spend 8.1 gross annual salaries to set aside funds for this purpose, while Slovaks had to work the longest in Europe and set aside 14.1 gross annual salaries for this purpose [37]. Of those surveyed, the respondents based in Poland most often planned to set aside between EUR 97,043.51 and EUR 129104.45 for the purchase of a residential property, while in Slovakia they planned to set aside EUR 100,000 and EUR 135,000. These values are similar. Importantly, respondents in both Poland and Slovakia were not familiar with residential developments located on brownfield sites. When asked about the dangers of purchasing a property located on a redeveloped brownfield site, the respondents were mainly concerned about environmental contamination and, as a consequence, health and technical complications. The respondents, in the case of interest in a property located on a brownfield site, mainly required additional testing to confirm the site's safety. Nevertheless, many respondents, after being informed about the way the site was previously developed, declared that this was a reason to consider not purchasing a home in this location. Despite concerns about previous land use, housing preferences for real estate in both cases do not change. For respondents, the most important features when deciding whether to purchase a property are location and price. In contrast, the respondents showed that they were most often able to give up their own preferences for housing features.

5. Conclusions

Projects on brownfield sites require considerable analysis [38,39], real estate developers take the risks involved in transforming a site and bringing housing development to the market [40]. In each case, this requires a custom solution [41] to meet the relevant requirements of the site [42, 43]. Developments are built on brownfield sites, where the visual aspect is mainly based on post-industrial history. Developers, by combining modern architecture with surviving architectural detail and giving a building a new use, create prestigious spaces that restore the luster of post-industrial areas. The historical aspect of a property, the high standard of new buildings, a location desired by buyers and the risk taken by the developer related to unforeseen events during project execution often increase the price of a property located on a post-industrial area.

The authors, through an online survey of a group of people currently looking for real estate, determined that housing development in Poland was mainly of interest to young people, which is reflected in other studies [44]. The importance of factors that influence the decision to purchase a residential property was also determined. After the analysis, it can be concluded that the most important factors when deciding to buy real estate are location and price. Analogous research was also conducted in Slovakia. After analyzing the results of the survey, it can be concluded that the requirements of potential buyers in both markets were similar. Residential real estate in Slovakia was also of interest to young people, whose motivation was to buy their own apartment in order to move out of the family home. The most important factor for potential buyers of apartments in Slovakia was also their price.

This research has shown that for potential buyers, information about previous land use can cause concerns about both technical and health complications, but the preferences of potential buyers did not necessarily change depending on how the land had been previously developed.

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Inwestycje mieszkaniowe na terenach poprzemysłowych w Polsce i na Słowacji w ocenie potencjalnych użytkowników

Słowa kluczowe: badania ankietowe, inwestycje mieszkaniowe, nieruchomości mieszkaniowe, podaż, popyt, tereny poprzemysłowe

Streszczenie:

Aby sprostac wysokiemu popytowi na nieruchomości mieszkaniowe, przy równoczesnym spełnieniu wymagań dotyczących lokalizacji deweloperzy w dużych miastach coraz częściej wykupują tereny po dawnych zakładach przemysłowych celem ich przekształcenia i ponownego zagospodarowania. Spośród zalet terenów poprzemysłowych zlokalizowanych w miejskiej zabudowie niewątpliwie można wskazac m.in. atrakcyjną lokalizację oraz bogato rozwiniętą infrastrukturę, a także często dużą powierzchnię terenu, którą można wielowariantowo wykorzystac podczas wdrażania nowego planu zagospodarowania terenu. Z uwagi na malejącą dostępność obszarów niezabudowanych w dużych aglomeracjach miejskich inwestorzy coraz częściej planują przekształcenia terenów poprzemysłowych, a w konsekwencji realizację inwestycji mieszkaniowych na tych obszarach. Ponowne zagospodarowanie terenów poprzemysłowych pozwala w pełni wykorzystac istniejącą infrastrukturę, a prawidłowe wprowadzenie zmian pozwala odpowiednio połączyc budownictwo mieszkaniowe z infrastrukturą transportową oraz zniwelowac nadmierny rozwój przestrzenny. Autorzy artykułu poddali rozważaniom problem przekształcenia terenów poprzemysłowych na cele mieszkaniowe. Przeprowadzili badania pierwotne metodą ankiety na grupie osób aktualnie poszukujących nieruchomości mieszkaniowych w Polsce i na Słowacji. Celem przeprowadzonego badania było określenie

zainteresowania budownictwem mieszkaniowym na terenach poprzemysłowych przy jednoczesnym zdefiniowaniu grupy osób zainteresowanych tym sektorem. Przy pomocy badania zostały określone czynniki motywujące do zakupu nieruchomości oraz wpływających na wybór lokalizacji nieruchomości mieszkaniowej. Kolejnym celem badania było określenie ważności czynników wpływających na decyzje o zakupie nieruchomości na terenie poprzemysłowym. W rezultacie przeprowadzonych badań ankietowych autorzy również określili czy potencjalni kupujący zwracają uwagę na poprzedni sposób zagospodarowania nieruchomości oraz czy znają potencjalne ryzyka związane z przekształceniem terenu poprzemysłowego na cele mieszkaniowe. Badanie ankietowe zostało wykonane w 2023 roku w Polsce oraz na Słowacji przy pomocy anonimowego kwestionariusza ankiety. Odnośnik z kwestionariuszem ankiety został umieszczony na stronach internetowych zrzeszających osoby poszukujące mieszkań. W ankiecie wzięło udział łącznie 239 respondentów zainteresowanych rynkiem nieruchomości mieszkaniowych w Polsce (173 respondentów) oraz na Słowacji (66 respondentów). W obu badanych krajach warunki życia są do siebie zbliżone, różnica liczebności próby w Polsce i na Słowacji przyjętej w badaniu wynika z różnicy liczby mieszkańców w omawianych państwach. Na podstawie przeprowadzonych rozważań, autorzy określili, iż budownictwem mieszkaniowym w Polsce zainteresowane są głównie osoby młode, a ich główną motywacją jest nabycie swojej pierwszej nieruchomości. Na Słowacji największą motywacją było polepszenie standardów życia i kupno kolejnego mieszkania. Różnice w badaniach wynikają z obecnego statusu badanych, ich wieku, aktualnego miejsca zamieszkania. W badaniu została również określona ważność czynników wpływających na decyzje o zakupie nieruchomości mieszkaniowej. Po przeprowadzonej analizie wyników badań, można stwierdzic, iż wymagania potencjalnych kupujących na obu rynkach są podobne. Najistotniejszym czynnikiem podczas podejmowania decyzji o zakupie nieruchomości jest lokalizacja oraz cena. Co ważne, przeprowadzone przez autorów badania dowiodły, iż dla potencjalnych kupujących informacja o poprzednim zagospodarowaniu terenu powoduje obawy dot. komplikacji zarówno technicznych jak i zdrowotnych, jednakże preferencje potencjalnych kupujących nie zmieniają się w zależności od sposobu poprzedniego zagospodarowania terenu i nie wpływają znacznie na podjęcie decyzje o zakupie nieruchomości.