EKONOMISTA | **ARTYKUŁY**

2024, 3, 275–298
DOI: 10.52335/ekon/189393

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Evaluation of housing conditions in Europe using the TOPSIS method

Ocena warunków mieszkaniowych w Europie z zastosowaniem metody TOPSIS

Abstract

This article assesses the housing conditions in European countries, and classifies those countries according to the state of their housing. Its main contribution is the use of a synthetic meter that uses the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) to classify housing conditions. The article utilises a wide set of variables that go beyond the scope of housing deprivation and take account of the impact of micro-district on housing quality. This paper fills a research gap in that it describes and compares housing conditions in European countries. Microdata from the European Union Statistics on Income and Living Conditions (EU-SILC) were used for this study. The conducted research shows that housing conditions in the vast majority of European countries are far from ideal. They are also considerably varied, both between and within countries, with respect to the assessment criteria.

Keywords: TOPSIS, housing conditions, housing quality, housing in Europe, measuring housing conditions.

JEL: I30, I32, I39

Streszczenie

Artykuł ma na celu ocenę warunków mieszkaniowych w krajach europejskich, a także klasyfikację krajów europejskich ze względu na stan mieszkalnictwa. Jego głównym wkładem jest wykorzystanie syntetycznego licznika wykorzystującego metodę TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) do klasyfikacji warunków mieszkaniowych. Niniejsza praca wypełnia lukę badawczą polegającą na braku aktualnych badań opisujących i porównujących warunki mieszkaniowe w krajach europejskich. W pracy wykorzystano szeroki zestaw zmiennych, wykraczający poza zakres deprywacji mieszkaniowej, a także uwzględniono wpływ okolicy na jakość zamieszkania. W badaniu wykorzystano mikrodane z badania EU-SILC (European Union-Statistics on Income and Living Conditions). Z przeprowadzonych badań wynika, że stan mieszkań w zdecydowanej większości krajów europejskich jest daleki od idealnego rozwiązania. Zauważalne jest także duże zróżnicowanie warunków mieszkaniowych, zarówno pomiędzy krajami, jak i w obrębie poszczególnych krajów, z uwzględnieniem wyróżnionych obszarów oceny.

Słowa kluczowe: TOPSIS, warunki mieszkaniowe, mieszkalnictwo w Europie, jakość mieszkalnictwa, pomiar warunków mieszkaniowych.

JEL: I30, I32, I39

1. Introduction

Housing is necessary for the everyday life for every individual. It enables the fulfilment of physiological needs (eating, sleeping, protection from the elements), gives a sense of security, and is also a means of meeting higher-order needs, such as the need for belonging, recognition, or self-fulfilment (Oleńczuk-Paszel and Sompolska-Rzechuła, 2017; Wu, 2016). Ensuring appropriate housing conditions is a contextual need and varies between different user groups (Sengupta and Tipple, 2007). Different needs may arise from: the number of household members; their age and state of health; different preferences and aspirations on the part of household members; and external factors, such as climate. Fernandes et al. (2017) conducted research on housing quality by constructing an index of housing comfort that comprised the two dimensions of basic and complementary comfort. Within each dimension, three subdimensions were considered, viz. housing conditions, housing equipment, and communication and leisure equipment. Based on microdata from the Household Budget Survey for Portugal, it was claimed that differences between households derive mainly from complementary comfort and to a lesser extent from basic comfort items.

Housing quality is therefore a multidimensional phenomenon that describes the extent to which housing needs are satisfied. It incorporates use value, emotional value, and prestige value (Rasnaca, 2017). The quality of housing has major implications for many aspects of life. Housing quality is considered to be an important component of wellbeing (Howden-Chapman et al., 2021; Walther et al., 2020; Rabe et al., 2018), life satisfaction (Knies et al., 2021; Mao and Wang, 2020; Zhang et al., 2018), and quality of life (Chimed-Ochir et al., 2021; Szydło et al., 2021; Mittal et al., 2020).

The inability to adequately meet housing needs is the essence of housing poverty (Dudek and Wojewódzka-Wiewiórska, 2024; Wojewódzka-Wiewiórska and Dudek, 2023; Galeota Lanza and De Martino, 2022; Ulman and Ćwiek, 2021; Patel et al., 2020; Łuczak and Kalinowski, 2020; Ulman and Ćwiek, 2020; Sikora-Fernandez, 2018; Desmond and Bell, 2015). The scale of housing poverty in Poland, which used a multi-dimensional tool to measure housing quality, and employed the Integrated Fuzzy and Relative (IFR) methodology, was the focus of recent research conducted by Ulman and Ćwiek (2021). This approach allowed for inclusion of 26 quantitative and qualitative variables that describe five fields of housing quality: (i) standard of the building; (ii) housing conditions; (iii) objective housing standard; (iv) subjective housing standard; and (v) state of the surrounding area. This approach resolves the issue of correlation between variables by assigning weights, rather than by adopting the approach of limiting the number of variables that had been used previously. This study used microdata from the Household Budget Survey conducted by Statistics Poland. For their part, Ayala et al. (2022) conducted research on housing deprivation in European countries in the context of the Covid-19 lockdown. The authors devoted much attention to the possibility of remote work and the medical consequences of inadequate housing conditions. They used a fuzzy set approach in which they analysed 15 variables grouped into 5 dimensions: (1) standard housing deprivation; (2) living space; (3) technology; (4) environment and neighbourhood; and (5) economic stress. The study was conducted using 2019 EU-SILC data.

The fuzzy set approach to measuring material deprivation in Poland from a multidimensional perspective was used also by Dudek and Szczesny (2021). Their study was based on EU-SILC data and included a set of nine-item material deprivation indicators. Two of them, viz. the inability to keep the home adequately warm, and the inability to pay the rent/mortgage or utility bills, are also symptoms of housing poverty. A zero-inflated beta regression model that enabled the mechanisms behind the risk and the intensity of material deprivation to be understood was used. The same indicators of material deprivation were taken into account in a study analysing the relationship between income poverty and material deprivation in 25 European countries conducted by Fusco et al. (2011). This study concluded that income poverty and material deprivation are associated. The level of material deprivation tends to decrease with higher income, but this relationship is neither monotonic (individuals with the lowest income are not always the most deprived) nor linear (the slope of this reduction varies across the distribution).

Assessing the level of material deprivation in EU member states was the purpose of an article by Łuczak and Kalinowski (2020). Nine variables describing material deprivation were used. Based on the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS), five groups of countries were described in terms of their level of material deprivation. The TOPSIS method was also used to identify and evaluate changes in housing poverty in EU member states in a paper by Kozera et al. (2017). The variables for the construction of the synthetic meter derived from the EU-SILC and initially comprised nine items describing the percentage of the population living in flats: (1) without a flush toilet; (2) without a bathtub or shower, (3) without a bathtub, shower and flush toilet; (4) with a leaking roof, and/or damp walls and/or floors, (5) percentage of the population describing their housing conditions as poor; (6) percentage of the population living in overcrowded apartments; (7) percentage of the population suffering from housing deprivation; (8) percentage of the population unable to afford a washing machine; and (9) percentage of the population unable to afford a colour TV. Due to the correlation between the variables, four of them (1, 2, 7, and 8) were eventually removed. Kozera and Kozera (2014) constructed a synthetic measure using the same reference method to classify EU member states in terms of housing conditions. The original list of variables included: (1) burden on household budgets with housing expenses and energy carriers (%); (2) percentage of the population living in households in which total housing costs consume more than 40% of disposable income; (3) percentage of the population living in apartments without a flush toilet (%); (4) percentage of the population living in apartments without a bathtub or shower (%); (5) average number of residential rooms per person; (6) percentage of the population living in overcrowded apartments (%); (7) percentage of the population living in apartments with a leaky roof or dampness (%); (8) housing deprivation rate (%); and (9) percentage of the population defining housing conditions as bad (%). Similarly, in this case, it proved necessary to eliminate two variables (4 and 8) due to their correlation with other variables.

Research on inadequate housing conditions often examines not only its scale but also its determinants. Dudek and Wojewódzka-Wiewiórska (2024) conducted research on severe housing deprivation in Poland, based on EU-SILC 2019 data. As a result of applying the multinomial logit model it was found that the significant contributing factors to the failure to meet basic housing needs are dwelling type, tenure status, household type, household income, age of household members, their level of education, and the presence of disabled and unemployed people. The level of housing poverty in Poland based on microdata from the Household Budget Survey was studied by Ulman and Ćwiek (2020). Results of research conducted using the IFR approach, shows that households with three or more children, single-parent households, households dependent on unearned sources of income, and rural households are most at risk of housing poverty. Research conducted by Wojewódzka-Wiewiórska and Dudek (2023), and based on EU-SILC data (2017-2020), concludes that the risk of housing deprivation is negatively correlated with household income and level of education, and positively correlated with the presence of an unemployed person in the household. The authors considered three symptoms of housing deprivation: (1) having a leaking roof, damp walls/floors/foundations, or rot in window frames/floors; (2) having neither a bath nor a shower; and (3) not having an indoor flush toilet. A household was treated as housing deprived if at least one of these symptoms occurred. Random effects probit modelling approach was used to find those household characteristics that determine housing deprivation.

These papers indicate that two research directions dominate in the literature on the subject. The first concerns housing deprivation and is often limited to a single country or region. The second, per contra, treats substandard housing as a component of overall deprivation. In this context, there is a research gap in that there are few, if any, studies that describe and compare housing conditions in European countries. The present study fills this gap by assessing the housing conditions in 32 European countries, both in general and in three separate areas (technical, financial, and environmental), and by classifying European countries according to the state of their housing. Its main contribution is the use of a synthetic meter consuming the TOPSIS for the classification of housing conditions in European countries. This uses a wide set of variables and goes beyond the scope of housing deprivation by taking the micro-district and its impact on the housing quality into account.

2. Data and research methods

The present study used EU-SILC microdata. This is an annual survey carried out in the EU and some non-EU countries. It aims to obtain comparable cross-sectional and longitudinal data on income, poverty, social exclusion, and living conditions, including health, education, and housing. An extensive methodological description is available (European Commission, 2021; Wirth and Pforr, 2022). In terms of housing conditions, EU-SILC contains data on the technical characteristics of apartments, their surroundings, and the economic conditions for maintaining them. Housing in

EU-SILC, although covered by a relatively small number of indicators, nevertheless allows for a comparative analysis of housing conditions on an international scale.

The present study considers 32 countries. It was initially intended to base the comparative analysis of the housing situation on 2020 data. However, not every country reported all the required indicators for this year. It was therefore decided to use the data from the most recent year for which a full set was available in these cases. Accordingly, 2019 data were used for Poland and 2018 data were used for Iceland and the United Kingdom. The set of indicators available in the EU-SILC data sets is presented in Table 1. The questions asked during the study along with the answer options and the definitions of the variables are described in the Methodological Guidelines and Description of EU-SILC Target Variables (European Commission, 2021). The type of ownership was initially included in the set of variables, but due to the results of the study by Filandri and Olagnero (2014), who found that despite the average difference in wellbeing between homeowners and non-owners (in favour of the former), home ownership cannot be considered as a favoured category, it was decided not to include this variable. Most of the variables used to describe housing conditions can also be used to describe housing deprivation. The variable *number of rooms per person* does not fall within this scope. However, the main difference between housing deprivation and housing conditions research concerns the approach to the research, not the scope of variables.

Table 1.
Variables used in the study

Designation	Variable	Number of categories	Area
HH040	Leaking roof, damp walls/floors/foundation/ or rot in window frames or floors	2	Technical
HH081	Bath or shower in dwelling	3	Technical
HH091	Indoor flushing toilet for the sole use of household	3	Technical
HS160	Problem with the dwelling: too dark, not enough light	2	Technical
HX120	Overcrowding rate	-	Technical
	Number of rooms per person		Technical
HH050	Ability to keep home adequately warm	2	Financial
HS011	Arrears on mortgage or rental payments	3	Financial
HS140	Financial burden of the total housing cost	3	Financial
HS170	Noise from neighbours or from the street	2	Environmental
HS180	Pollution, grime, or other environmental problems	2	Environmental
HS190	Crime, violence or vandalism in the area	2	Environmental

Source: own elaboration based on microdata from European Union-Statistics on Income and Living Conditions.

For each variable and for each country, the proportion of respondents who chose a given category was calculated based on microdata sets. The shares thereby obtained were used to construct the aggregated data set at the individual country level.

As the number of categories differs between variables, it was decided to transform those variables characterized by more than two ordered categories in such a way that their values fell within the range [0-1]. This was done by applying the formula:

$$x_{ij} = \frac{\sum_{s=0}^{S-1} s * w_{ijs}}{S-1}, \qquad (1)$$

where: w_{ijs} is the proportion of respondents who chose the *sth* category of response to the problem included in the original *jth* variable (ordinal with S categories) for the *ith* country (Ulman, 2019). The ascending order of these categories reflects an increasing betterment in the housing situation. The new variable would be assigned a value of 0 if all the respondents assessed a given aspect of the housing situation, in terms of the original variable, at the lowest level, while a value of 1 would be assigned if all the respondents gave it the highest rating. The values of variable x_{ij} obtained by the formula (1) are not interpretable, but they enable the housing situation in the surveyed countries to be assessed and compared against the criterion of the *jth* variable. Applying this formula to variables with two categories yields the proportion of respondents who indicated a good housing situation on the criterion of that variable. For example, the variable HH040 has two categories: *Yes* and *No*. For a given country, we can determine the share of respondents indicating a given category. Category *No* indicates a good housing situation, so we assign it a value of 1, otherwise a value of 0. Multiplying the share belonging to the category marked with a value of 1 by this value gives the proportion of respondents who did so. The variables yielded by applying formula (1) are the drivers of the housing situation. Table 2 contains the set of indicators that were included in the set of diagnostic variables.

Table 2.

Descriptive statistics of the indicators used

Indicator	Mean	Standard deviation	Minimum	Maximum
x_{HH040}	86.14	6.74	61.22	95.68
x_{HH081}	97.18	4.61	77.93	100.00
x_{HH091}	97.14	5.04	77.00	100.00
x_{HS160}	94.21	2.08	89.16	97.39
$x_{1-\text{HX120}}$	0.81	0.19	0.05	0.98
$x_{room/person}$	2.01	0.38	1.22	2.75
x_{HH050}	92.08	7.29	69.63	99.82
x_{HS011}	97.80	1.59	92.38	99.78
x_{HS140}	51.50	16.38	22.44	80.20
x_{HS170}	83.66	5.65	69.13	92.38

Indicator	Mean	Standard deviation	Minimum	Maximum
x_{HS180}	87.40	5.05	69.90	94.58
x_{HS190}	90.54	5.02	77.69	97.66

Source: own elaboration based on microdata from European Union-Statistics on Income and Living Conditions.

Table 2 presents the diagnostic variables used to analyse the differentiation and linear order of the housing situation in the surveyed countries. It has to be emphasized that all calculations were carried out using the weights provided with the data set. These weights allow for obtaining data aggregates that are reliable and representative of each analysed country.

A synthetic variable was calculated for the purpose of arranging the countries under examination linearly and comparing their housing situations. This aggregate approach was necessitated by the multidimensional nature of the subject. Standard of living and prosperity (or poverty) are obviously what motivate the multidimensional measurement of socio-economic issues. For example, Kolm (1977), Atkinson and Bourguignon (1982), and Aristei and Bracalente (2011) wrote about the need to assess economic status in a multidimensional approach that included inequality and social welfare. In the 1990s and early 2000s, an approach to the multidimensional analysis of poverty known as Totally Fuzzy and Relative (TFR) gained considerable popularity. It was proposed by Cerioli and Zani (1990), developed by Cheli and Lemmi (1995), and applied in various areas, including quality of life, by Betti (2016) and Dudek and Szczesny (2017), and housing poverty by Ulman and Ćwiek (2021).

In the present study, it was decided to use the linear ordering method, proposed by Hwang and Yoon (1981), known as TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). The objective here is to compare individual countries and rank them – both in each area and in relation to all areas. The TOPSIS method makes it possible to create a single synthetic variable from many component variables, thereby enabling these sorts of comparisons. This method has wide applications (not only in social or economic problems), as shown in a review article (Behzadian et al., 2012).

Any method of aggregating variables (information) requires unifying their nature, reducing them to a similar order of magnitude, and removing their units of measurement. A popular method of normalizing variables that implements these postulates is zero unitarization, which applies the formula:

$$z_{ij} = \frac{x_{ij} - min_i\left\{x_{ij}\right\}}{max_i\left\{x_{ij}\right\} - min_i\left\{x_{ij}\right\}}, \tag{2}$$

where: x_{ij} denotes the value of the *jth* variable for the *ith* object (here: country). This formula refers to variables that are stimulants. In the case of a destimulant, an analogous formula can be given that normalizes the original variable while transforming it into a stimulant (Kukuła, 1999). This normalization method transforms the variables in such a way that they take values in the range [0-1].

In the second step of the TOPSIS method, Euclidean distances from the pattern z_j^+ and the anti-pattern z_j^- of the housing situation are calculated for individual objects in accordance with the following formulas (Behzadian et al., 2012; Zalewski, 2012):

$$d_i^+ = \sqrt{\sum_{j=1}^{m} \left(z_{ij} - z_j^+\right)^2}\,; \tag{3}$$

$$d_i^- = \sqrt{\sum_{j=1}^{m} \left(z_{ij} - z_j^-\right)^2}\,. \tag{4}$$

In the third stage of the procedure, the values of the synthetic variable that determine the similarity of a given object to the ideal solution are determined:

$$S_i = \frac{d_i^-}{d_i^+ + d_i^-}. \tag{5}$$

This variable assumes values in the range [0-1]; the higher the value, the better the housing situation. The procedure for constructing a synthetic variable, as described above, was applied separately for three areas: technical, financial, and environmental. To obtain a single value for this variable, the TOPSIS procedure was repeated for area synthetic variables.

An important consideration when preparing diagnostic variables is the information scope of those that make up particular synthetic variables. It is contended that their correlation and variability should be considered when selecting diagnostic variables. Two approaches are used in this regard. One is to eliminate variables with low variability and/or high correlation. In the second approach, variables are weighted: the lower the correlation with other diagnostic variables and the higher the variability, the greater the weight. In other words, variables with a higher level of correlation and/or a low level of variability are marginalized, but not removed from the set of diagnostic variables. This method has been used by Betti et al. (2006), Betti et al. (2015), Betti et al. (2016), Dudek (2018), Panek (2010), and others. The second approach appears to be a better solution when there are relatively few diagnostic variables, and was therefore employed in the present study. Betti and Verma (1999) accordingly used the following weighting system:

$$w_{hj} = w_{hj}^a \cdot w_{hj}^b,\ h = 1, 2, \ldots, m;\ j = 1, 2, \ldots, k_h \tag{6}$$

where:

w_{hj}^a measures the information level of the *jth* diagnostic variable from the *hth* area;

w_{hj}^b measures the discriminating ability of the diagnostic variable from the *hth* area.

As mentioned above, the weights based on the correlation of individual diagnostic variables are determined so as to ensure that those variables that are least correlated with other variables are weighted most heavily, and conversely, those with the greatest correlation are weighted least heavily. The correlation matrices are included in the appendix. The application of the following formula fulfils this postulate (Panek, 2010):

$$w_{hj}^{a} = \left[\frac{1}{1 + \sum_{j'=1}^{k_h} \left| r_{x_{hj,hj'}} \right| \mid r_{x_{hj,hj'}} < r_{x_{hj}}^{*}} \right] \left[\frac{1}{\sum_{j'=1}^{k_h} \left| r_{x_{hj,hj'}} \right| \mid r_{x_{hj,hj'}} \geq r_{x_{hj}}^{*}} \right],$$

$$j,j' = 1, 2, \ldots, k_h\, ;\ h = 1, 2, \ldots, m, \tag{7}$$

where:

$r_{x_{hj,hj'}}$ is the correlation coefficient corresponding to the *jth* and *j'th* diagnostic variables from the *hth* area;

$r_{x_{hj}}^{*}$ is the threshold value of the correlation coefficient due to the *jth* variable in the *hth* region, which can be determined as follows:

$$r_{x_{hj}}^{*} = \min_{j} \max_{j'} \left| r_{x_{hj,hj'}} \right|,\ j,j' = 1, 2, \ldots, k_h\, ;\ j \neq j'. \tag{8}$$

The weights of w_{hj}^{a} were calculated for each diagnostic variable separately in each of the previously mentioned areas.

The classic coefficient of variation (CV), viz. the ratio of the standard deviation to the arithmetic mean, was used to measure the discriminating ability of the diagnostic variables. The CV of each diagnostic variable is given in the appendix. The weights thereby obtained were used in the second step of the TOPSIS procedures.

The procedure outlined above allows for a linear ordering of the surveyed countries according to standard of residence. These linearly ordered countries can then be divided into classes using the following approach:

Table 3.

Method of classifying countries by housing conditions

Group	Boundary conditions
G1	$s_i \geq \overline{s} + S(s)$
G2	$\overline{s} + S(s) > s_i \geq \overline{s}$
G3	$\overline{s} > s_i \geq s_i - S(s)$
G4	$s_i < \overline{s} - S(s)$

Source: own elaboration based on Malina (2004).

where:

$\overline{s}$ – arithmetic mean of the synthetic variable

S(s) – standard deviation of the synthetic variable.

3. Results

Table 4 contains the values of synthetic variables for individual countries, respectively, within the three separate areas and total housing conditions.

Table 4.
TOPSIS analysis results for individual areas

Country	Technical area	Financial area	Environmental area	Total
Austria	0.7941	0.7727	0.7482	0.6747
Belgium	0.7204	0.6672	0.6367	0.5175
Bulgaria	0.6141	0.4061	0.5481	0.3765
Switzerland	0.7969	0.5278	0.7120	0.6139
Cyprus	0.3558	0.2374	0.7070	0.5314
Czech Republic	0.8153	0.5418	0.8004	0.7287
Germany	0.7705	0.6975	0.5932	0.4710
Denmark	0.7082	0.8929	0.6758	0.5775
Estonia	0.7912	0.7782	0.8848	0.8512
Greece	0.6746	0.0916	0.3177	0.1428
Spain	0.6090	0.2519	0.5054	0.3119
Finland	0.8953	0.5984	0.7389	0.6608
France	0.6477	0.6914	0.3877	0.2329
Croatia	0.6936	0.3589	0.9825	0.8399
Hungary	0.5606	0.7959	0.8343	0.7456
Ireland	0.6858	0.4837	0.7116	0.5976
Iceland	0.6507	0.6609	0.8883	0.8147
Italy	0.5607	0.3484	0.6781	0.5306
Lithuania	0.7269	0.5523	0.8071	0.7285
Luxembourg	0.7409	0.4843	0.5431	0.3921
Latvia	0.5769	0.6280	0.7429	0.6323
Malta	0.8548	0.5252	0.2974	0.2228
Netherlands	0.7284	0.8842	0.3658	0.2591
Norway	0.9048	0.8737	0.8339	0.7988
Poland	0.6817	0.3334	0.7597	0.6457
Portugal	0.4890	0.5441	0.6079	0.4447
Romania	0.6816	0.4435	0.6700	0.5423
Serbia	0.6131	0.3212	0.6349	0.4813
Sweden	0.8249	0.9169	0.5965	0.4954
Slovenia	0.5506	0.4744	0.6720	0.5293
Slovakia	0.7568	0.4228	0.8589	0.7781
United Kingdom	0.6746	0.7249	0.3773	0.2354

Source: own elaboration based on microdata from European Union-Statistics on Income and Living Conditions.

Table 3 shows that housing conditions in Europe vary considerably – both within individual areas and in general. For the technical area, the difference between the highest and lowest value of the synthetic variable (i.e., the range) is the smallest and amounts to 0.56. For the financial area, the diversity is greater, and the range is 0.83. The range for the environmental area is 0.69. The value closest to the ideal solution (0.98 for Croatia) was also recorded in this area. The relatively good situation in the environmental aspect of housing in European countries is confirmed by the high arithmetic mean of the synthetic variable. This value equals 0.66 and is 18% higher than the arithmetic mean describing the financial area, but 5% lower than that describing the technical area. Moreover, the distribution of the synthetic variable describing the environmental area is negatively skewed: only 14 countries achieved values below the average, while 18 countries achieved values above the average.

The synthetic variable obtained for the financial area is particularly disturbing, as it is less than 0.54 for half the surveyed countries. Moreover, the values in this area are furthest from the ideal solution (0.09 for Greece). Cyprus (0.24), Spain (0.25), Serbia (0.32), Poland (0.33), Italy (0.35), and Croatia (0.36) also score low.

The TOPSIS analysis for total housing conditions also reveals a large range in the value of the synthetic variable. The arithmetic mean is 0.54, with the lowest value recorded for Greece (0.14) and the highest for Estonia (0.85). It is worth noting that this arithmetic mean is lower than those for the three individual areas. This may prove that each of the surveyed countries is struggling with some housing issues. Even the highest-rated country overall is quite far from the ideal solution. Table 5 lists all the surveyed countries and presents the rankings for their overall housing situation along with the rankings of the individual areas used to calculate it.

Table 5.
Overall country rankings and rankings for individual areas

Country	Technical area	Financial area	Environmental area	Total
Austria	7	7	10	9
Belgium	14	11	20	20
Bulgaria	24	25	25	26
Switzerland	6	18	13	13
Cyprus	32	31	15	17
Czech Republic	5	17	8	7
Germany	9	9	24	23
Denmark	15	2	17	15
Estonia	8	6	3	1
Greece	20	32	31	32
Spain	26	30	27	27
Finland	2	14	12	10
France	23	10	28	30
Croatia	16	26	1	2
Hungary	29	5	5	6
Ireland	17	21	14	14
Iceland	22	12	2	3
Italy	28	27	16	18
Lithuania	13	15	7	8

Country	Technical area	Financial area	Environmental area	Total
Luxembourg	11	20	26	25
Latvia	27	13	11	12
Malta	3	19	32	31
Netherlands	12	3	30	28
Norway	1	4	6	4
Poland	18	28	9	11
Portugal	31	16	22	24
Romania	19	23	19	16
Serbia	25	29	21	22
Sweden	4	1	23	21
Slovenia	30	22	18	19
Slovakia	10	24	4	5
United Kingdom	21	8	29	29

Source: own elaboration based on microdata from European Union-Statistics on Income and Living Conditions.

Applying the TOPSIS method to the technical area showed that Norway, Finland, and Malta have the best housing conditions in this respect, while Slovenia, Portugal, and Cyprus have the worst. Malta's high ranking was partly due to having the highest average number of rooms per person in the EU (2.3, which is 0.7 higher than the EU average) (Housing in Europe, 2022). On the other hand, the financial burden of maintaining a home is greatest in Greece, Cyprus, and Spain. Sweden, Denmark, and the Netherlands came closest to the ideal solution in this respect. In the environmental area, Croatia has the best housing conditions, followed by Iceland and Estonia, and Malta, Greece, and the Netherlands have the worst. When the area synthetic variables are aggregated into an overall assessment of housing conditions, Estonia, Croatia, and Iceland are best countries, and Greece, Malta, and France the worst.

The extent to which the rankings for the individual areas differ is striking. For example, Malta, which is ranked third in the technical area, is ranked 19th in the financial area, i.e., in the bottom half (due to financial housing conditions), and last (32nd) in the environmental area. Malta occupies the penultimate place in the overall ranking. Croatia is an interesting case. It ranks first in the environmental area, 16th in the technical area, and 26th in the financial area. The average position of this country in the technical area and low in the financial area did not have much influence on the overall results: Croatia was ranked second in the final ranking. A similar situation can be seen in Iceland, which ranks 22nd, 12th, 2nd, and 3rd respectively in the technical, financial, environmental, and total housing condition areas.

Table 6 presents the results of grouping countries using the method presented in Table 3. The first and second groups include countries with above-average housing conditions. The third and fourth groups have synthetic variable values lower than the mean, and in the case of the fourth group, the distance between the values of the synthetic variable from the mean is greater than the standard deviation.

Table 6.
Results of grouping countries by area

Area	Group 1	Group 2	Group 3	Group 4
Technical area	Czech Republic, Finland, Malta, Norway, Sweden	Austria, Belgium, Switzerland, Germany, Denmark, Estonia, Croatia, Lithuania, Luxembourg, Netherlands, Slovakia	Bulgaria, Greece, Spain, France, Ireland, Iceland, Latvia, Poland, Romania, Serbia, United Kingdom	Cyprus, Hungary, Italy, Portugal, Slovenia
Financial area	Austria, Denmark, Estonia, Hungary, Netherlands, Norway, Sweden	Belgium, Germany, Finland, France, Iceland, Latvia, United Kingdom	Bulgaria, Switzerland, Czech Republic, Croatia, Ireland, Lithuania, Luxembourg, Malta, Portugal, Romania, Slovenia, Slovakia	Cyprus, Greece, Spain, Italy, Poland, Serbia
Environmental area	Estonia, Croatia, Hungary, Iceland, Norway, Slovakia	Austria, Switzerland, Cyprus, Czech Republic, Denmark, Finland, Ireland, Italy, Lithuania, Latvia, Poland, Romania, Slovenia	Belgium, Bulgaria, Germany, Spain, Luxembourg, Portugal, Serbia, Sweden	Greece, France, Malta, Netherlands, United Kingdom
Total housing conditions	Estonia, Croatia, Hungary, Iceland, Norway, Slovakia	Austria, Switzerland, Czech Republic, Denmark, Finland, Ireland, Lithuania, Latvia, Poland,	Belgium, Bulgaria, Cyprus, Germany, Italy, Luxembourg, Portugal, Romania, Serbia, Sweden, Slovenia	Greece, Spain, France, Malta, Netherlands, United Kingdom

Source: own elaboration based on microdata from European Union-Statistics on Income and Living Conditions.

Estonia, Croatia, Hungary, Iceland, Norway, and Slovakia have the best overall housing conditions. This first group of countries is characterised by high natural values, and implements Nordic and Central/Eastern European (EASPD, 2014) social policy. Their synthetic variable is greater than 0.74. Despite this, however, it cannot be said that their housing is free from defects. Thus, the problem of leaking roofs, damp walls/floors/foundations, or rot in window frames or floors affects from 4.99% of apartments in Slovakia to over 20% in Hungary. Similarly, 7% of dwellings in Estonia have no access to a bathroom and 5% do not have a flush toilet. Less than 2% of Croatian and Hungarian dwellings have deficiencies in sanitary infrastructure. This figure is less than 1% in the case of Iceland, Norway, and Slovakia. Overcrowding is a major issue in the technical area. It affects from 6% of dwellings in Norway to 36% of dwellings in Croatia. When it comes to the financial area, Croatia ranks lowest in this group. Forty-five percent of apartments have excessive maintenance costs, and it is difficult to regulate the temperature in 8%. As for the other countries in the group, the proportion of domiciles with excessive housing costs ranges from 5% in Norway to 27% in Slovakia, and the proportion with heating problems ranges from 0.8% in Norway to 6.33% in Slovakia. So far as the environmental area is concerned, the first group is generally in a fairly good situation. The biggest problem is the excessive noise level coming from the street and from the neighbourhood. This problem affects from 8% of dwellings in Estonia to 15% of dwellings in Norway. The percentage of dwellings adversely affected by pollution varies from 5% in Croatia to 12% in Hungary. Finally, crime in the immediate vicinity affects from 3% of apartments in Croatia to 5% in Estonia.

The second group of countries in terms of overall housing conditions comprises Austria, Switzerland, the Czech Republic, Denmark, Finland, Ireland, Lithuania, Latvia, and Poland. In this group, the Central/Eastern European model of social policy and the privatized rental model of housing policy dominate (EASPD, 2014). The values of the synthetic variable for the countries in this group vary from 0.54 to 0.74. The percentage of dwellings with a leaking roof, damp walls/floors/foundations, or rot in window frames or floors ranges from 4% in Finland to 17% in Ireland. Lithuania and Latvia have the worst sanitation, with less than 10% of dwellings equipped with a bathroom. Ten percent of Lithuanian, and 9% of Latvian, dwellings do not have a flush toilet. As for the rest of the group: 2% of dwellings in Poland do not have a bathroom or a flush toilet; the corresponding figures for Denmark are 2% and 1%; and for the remaining countries, less than 1%. Overcrowding varies considerably, affecting only 3% of dwellings in Ireland, but 42% in Latvia. Lithuania stands out in terms of keeping warm, with more than 25% of flats being too cold in winter. As for the other countries in the group, difficulties in regulating temperature affect from 0.1% of flats in Switzerland to 8% in Latvia. This group is characterized by onerous housing costs. This affects from 8% of flats in Denmark to as much as 55% of flats in Poland. In Switzerland, Ireland, and Latvia, over 20% of dwellings are overburdened with housing maintenance costs. Excessive noise levels affect 15% of flats on average. This problem is most severely felt in Denmark (20%) and least severely felt in Ireland (10%). A slightly smaller scale was observed in the case of contamination of the immediate vicinity. This problem affects 11% of dwellings in the group on average, with Latvia (15%) most affected and Ireland (8%) least affected. Crime is only a problem for more than 10% of housing in Ireland (11%). As for the remaining countries in this group, this problem affects from 2% of dwellings in Lithuania to 8% in Finland.

The third group, in terms of overall housing conditions, is the most numerous and consists of Belgium, Bulgaria, Cyprus, Germany, Italy, Luxembourg, Portugal, Romania, Serbia, Sweden, and Slovenia. The continental model of social policy dominates in these countries. The values of the synthetic variable for this group range from 0.35 to 0.54. In the technical area, the biggest problem is overcrowding. On average, it affects 21% of dwellings, with a whopping 45% in Romania and 53% in Serbia. The second biggest cause of housing deprivation is a leaking roof, damp walls/floors/foundations, or rot in window frames or floors. This applies to an average of 17% of flats in the group. Sweden is least affected (7%) and Slovenia (22%), Portugal (25%), and Cyprus (39%) are most affected. Romania and Bulgaria lag behind when it comes to equipping apartments with sanitary facilities. In Romania, as many as 22% of dwellings do not have a bathroom and 23% do not have a flush toilet. In Bulgaria, the problem is slightly less severe, but still well above the EU average, i.e., 7% of dwellings without a bathroom and 13% of dwellings without a flush toilet. Another inconvenience that people living in Bulgaria have to deal with is the inability to regulate the temperature. This applies to almost one-third of dwellings. Cyprus and Portugal are also highly affected (20% and 19% respectively).

As for the remainder of the group, inadequate heating affect from 3% of dwellings in Sweden to 11% in Serbia. Even though a large percentage of apartments in Cyprus are in poor technical condition and inadequately heated in winter, more than half (56%) are subject to fees and charges, which are a heavy burden for the occupants. A high percentage of apartments are similarly affected in Serbia (54%). On average, 30% of dwellings in the group are excessively burdened with housing costs. Only in Sweden is the proportion of such housing less than 10%.

Housing conditions in the third group suffer significant deterioration on account of environmental issues. The proportion of dwellings in high crime areas is twice as high as in the first group. The highest proportion of dwellings in high crime areas was observed in Bulgaria (18%) and Sweden (14%), and the lowest in Portugal (7%). The highest proportion of dwellings located in heavily polluted areas are in Serbia and Slovenia (17% and 16%, respectively). Noise levels are also a serious problem in this group. On average, this problem concerns 17% of dwellings and is more severe in Portugal (25%) and Germany (22%), and least severe in Bulgaria (9%).

The fourth group comprises Greece, Spain, France, Malta, the Netherlands, and the United Kingdom, and has the poorest overall housing conditions. The Mediterranean/Southern social policy model is implemented in most of the them. Interestingly, the technical condition of dwellings in this group is, on average, better for each variable than in the third group. This obviously does not mean that apartments in the fourth group are free from defects. For example, leaking roofs, damp walls/floors/foundations, or rot in window frames or floors affect from 7% of apartments in Malta to 19% of apartments in Spain. Not only that, but 30% of dwellings in Greece are overcrowded (although less than 10% of dwellings in the remainder of the group are). The percentage of dwellings with access to a bathroom and toilet is also surprisingly high (over 98%), given that the group has the worst overall housing conditions. The financial area is also rated higher on average in the fourth group than in the third. Both the percentage of flats where it is difficult to regulate temperature and where maintenance costs pose an excessive burden are slightly lower than in the third group. Greece (18%) and Spain (11%) have the highest proportion of flats with heating problems. This proportion does not exceed 10% in the rest of the group. Greece also has the highest proportion of flats with high maintenance costs, which is a heavy burden for the residents (57%). The respective figures for Spain, France, and Malta are 40%, 25% and 23%, and for the Netherlands, a relatively small 7%.

The poor results in the environmental area had a major impact on the classification of countries in the fourth group. The percentage of dwellings affected by excessive noise, pollution, or crime in the immediate vicinity is significantly higher than in the third group. The percentage of homes affected by excessive noise levels is the lowest in the UK at 19.5%. In other countries it is over 20%, and in Malta over 30%. The proportion of dwellings affected by environmental problems, including dirt and pollution, ranges from 12% in Spain to 32% in Malta. In turn, crime affects from 12% of dwellings in Malta to 22% in the UK.

4. Discussion

Housing conditions play a crucial role in shaping quality of life (Chimed-Ochir et al., 2021; Szydło et al., 2021; Mittal et al., 2020) for both individuals and societies as a whole. For individuals, a safe, comfortable, and well-maintained living space is essential to foster their overall wellbeing (Howden-Chapman et al., 2021; Walther et al., 2020). The physical environment of a house can significantly impact mental and emotional health (Rashmi et al., 2021; Mosha, 2020; Tusting et al., 2020; Diderichsen et al., 2019), as well as social relationships (McCoy et al., 2022; Choi et al., 2021; Christner et al., 2021). The COVID-19 pandemic has shown how important the technical condition of an apartment is (sufficient space for each resident, lack of moisture, and access to functional sanitary facilities) for the health of its residents. (Amerio et al., 2020; Boyraz and Legros, 2020). A well-designed and properly maintained domicile provides a sense of security, privacy, and stability, which are all essential factors in promoting a positive living experience. Moreover, housing that is affordable and accessible allows individuals to allocate resources towards other aspects of their lives, such as education, healthcare, and leisure, thereby improving their overall life satisfaction (Knies et al., 2021; Mao and Wang, 2020; Zhang et al., 2018). According research, the technical area has the highest average score among the surveyed areas, although there are significant inequalities in this aspect between European countries. While the 'old EU' countries generally have a higher rating in the technical area, there are exceptions. This confirms research findings that monetary poverty and material deprivation do not strictly coincide (Dudek and Szczesny, 2020; Ayllón and Gábos, 2017). The diversity of large housing estates in 14 European cities was also highlighted by Hess et al. (2018). Interestingly, some studies indicate that the difference in subjective wellbeing between people with spacious flats and people with small flats is greater in countries with a lower average quality of housing (Herbers and Mulder, 2017). This is consistent with the theory of relative deprivation (Merton and Kitt, 1950), according to which the quality of housing has a greater impact on the subjective wellbeing of individuals if inequalities in the quality of housing in their environment are greater.

Economically, housing poverty can trap individuals in a cycle of poverty, as the cost of housing consumes a large portion of their income, leaving little for other necessities such as food, healthcare, and education. This lack of financial stability can limit opportunities for upward mobility and make it difficult for individuals to escape their current living situation. These findings on housing conditions in the financial area are consistent with research on energy poverty that contrasts the good situation of the Scandinavian countries (Halkos and Gkampoura, 2021) with the poor situation of Greece, Cyprus, and Spain (Bollino and Botti, 2017). The difficult situation of Greece in the financial area is confirmed by Eurostat research that found the highest rates of onerous urban housing costs in Greece (32.4%), Denmark (21.9%), and the Netherlands (15.3%), and the highest rates of onerous rural housing costs in Greece (22.0%), Bulgaria (13.3%) and Romania (10.8%) (Housing in Europe, 2022).

The results obtained in the present study differ significantly from those obtained by Norris and Shiels (2007). These authors developed a typology of differences in housing conditions between countries on the basis of housing quality, accessibility, and affordability. This typology revealed good housing conditions in the old northern EU Member States, intermediate conditions in most of the other relatively old Member States, and poor housing conditions in many of the new CEE Member States. Kraff et al. (2022) also wrote about the geographical concentration of areas of housing poverty, based on satellite imagery, in southern Europe. However, it should be noted that this study includes areas of poverty, such as 'ghettos' or 'trailer parks', that are mainly inhabited by refugees, ethnic minorities, and socioeconomically disadvantaged people, and which are not included in EU-SILC research.

Studies conducted by applying the TOPSIS method to 2011 data produced different results again. The best living conditions of the population in terms of housing conditions were observed in Malta, Ireland, Luxembourg, Spain, and Finland (Kozera and Kozera, 2014). It is worth noting, however, that this study included fewer variables, and focused on the financial and technical areas (including overcrowding) to the exclusion of the environmental area. It is therefore safe to conclude that the selection of variables will have a key impact on the results of any study of housing conditions.

5. Conclusions

The present study shows that housing conditions in the vast majority of European countries are far from ideal. Although, on average, dwellings are in an almost good technical condition, this result cannot be considered satisfactory, as many European dwellings are overcrowded, have leaking roofs, damp walls/floors/foundations, or rot in window frames or floors, or suffer from poor sanitation. Even in those countries with the best average housing conditions, there is no shortage of apartments in poor technical condition or which have financially overburdened occupants. The second important conclusion from this study is the large diversity of housing conditions, both within and between countries, as assessed by technical, financial, and environmental criteria.

Given the enormous impact of adequate housing conditions on the wellbeing of individuals and families, and the potential costs of housing poverty, there is a strong case for more research on ways to improve housing conditions in each of the abovementioned areas. It should be noted that while some problems can be dealt with by household members on their own (e.g., repairing a leaking roof), and others can be solved as a result of an improvement in the household's economic situation, certain issues (e.g., environmental pollution or crime) cannot be resolved without the involvement of the authorities. The authorities at different levels of government should therefore focus on this topic, as unresolved problems in the vicinity of the apartment affect the health and wellbeing of the occupants.

6. Limitations and future research

In the present study of housing conditions, the statistical unit was the flat (or apartment). The TOPSIS analysis, therefore, concerns the state of housing in European countries. However, it should be remembered that the distribution of people in apartments is not steady. As a rule, wealthy people live in larger apartments that are better equipped, free from defects such as leaking roofs or insufficient daylight. As all the variables used in the study are stimulants and there is a positive correlation between most of them, it may be that, in at least some countries, poor housing conditions apply to a larger percentage of people than houses/flats. This is the case, for example, in the absence of an indoor flush toilet in Romania. This problem affects 22.98% of dwellings, but 24.2% of the population. For this reason, future research on housing conditions should take into account the percentage of the population living in housing of varying quality.

This raises the question as to which method of weighting the variables used is optimal. In this paper, the weights used resulted from the selected statistical procedure. Nevertheless, perhaps the weights of individual variables should be assigned in an expert manner, recognizing that some of them have a greater impact on the quality of housing than others. In the literature describing the problem of multidimensional comparative analysis, it is not possible to find an unequivocally optimal solution in terms of weighing individual factors (symptoms of the housing situation).

The final dilemma concerns the scale of measurement of variables. Most of the variables used in the present study are qualitative variables and often do no more than indicate whether or not a given problem occurs in an apartment. However, there is no information about the intensity of the problem. It is also worth emphasizing that this type of data is subjective, which is an immanent feature of assessing living conditions (as generally understood). Research on housing conditions should nevertheless take perceptions into account, and propose solutions to those housing problems that are subjectively socially most severe.

Funding

The publication presents the result of the Project no 092/EIT/2024/POT financed from the subsidy granted to the Krakow University of Economics.

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Appendix

Correlation matrices and coefficients of variation
Technical area:

	x_{HH040}	x_{HH081}	x_{HH091}	x_{HS160}	$x_{1\text{-}HX120}$	$x_{room/person}$
x_{HH040}	1.0000	-0.1418	-0.1458	0.1058	-0.2266	-0.2022
x_{HH081}	-0.1418	1.0000	0.9778	-0.1435	0.5686	0.3898
x_{HH091}	-0.1458	0.9778	1.0000	-0.1232	0.5918	0.4005
x_{HS160}	0.1058	-0.1435	-0.1232	1.0000	-0.1574	-0.3108
$x_{1\text{-}HX120}$	-0.2266	0.5686	0.5918	-0.1574	1.0000	0.9157
$x_{room/person}$	-0.2022	0.3898	0.4005	-0.3108	0.9157	1.0000

x_{HH040}	x_{HH081}	x_{HH091}	x_{HS160}	$x_{1\text{-}HX120}$	$x_{room/person}$
0.0783	0.0474	0.0518	0.0221	0.2360	0.1914

Financial area:

	x_{HH050}	x_{HS011}	x_{HS140}
x_{HH050}	1.0000	-0.0130	0.4691
x_{HS011}	-0.0130	1.0000	0.0623
x_{HS140}	0.4691	0.0623	1.0000

x_{HS160}	$x_{1\text{-}HX120}$	$x_{room/person}$
0.0792	0.0162	0.3181

Environmental area:

	x_{HS170}	x_{HS180}	x_{HS190}
x_{HS170}	1.0000	0.5758	0.4532
x_{HS180}	0.5758	1.0000	0.3628
x_{HS190}	0.4532	0.3628	1.0000

x_{HS170}	x_{HS180}	x_{HS190}
0.0676	0.0578	0.0554

Total:

	x_T	x_F	x_E
x_T	1.0000	0.4385	0.0466
x_F	0.4385	1.0000	0.0851
x_E	0.0466	0.0851	1.0000

x_T	x_F	x_E
0.3738	0.3694	0.2596

Source: own elaboration based on microdata from European Union-Statistics on Income and Living Conditions.