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Pro-Environmental Behaviour in the European Union Countries

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Abstract: The purpose of the presented research is to assess pro-environmental behaviour (PEB) in European Union countries in 2009 and 2019. The study used a synthetic measure developed using the TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) benchmark method. This method enables distinguishing classes and ranks of countries depending on the adopted characteristics. Basic measures of descriptive statistics, i.e., average, standard deviation and the coefficient of variation, were used in the analysis of the data set. The main research question addressed in this study concerns the relationship between the level of PEB and economic, demographic, and educational factors—not only on a micro scale but also from the macroeconomic perspective. The research has revealed a wide variety throughout the European Union (EU-27) countries in terms of pro-environmental behaviour. Sweden, Finland, and Denmark top the ranking, while Malta, Greece, Spain, and Romania are at the bottom of it. Northern European countries can therefore be identified as a group that represents a positive benchmark in terms of PEB across the European Union (EU-27). The correlation between PEB and selected economic, demographic, and education-related variables was also investigated. Country-level PEB is correlated with demographic and economic variables, but it is not correlated with education-related variables.

Keywords: environment; pro-environmental behaviours; TOPSIS; European Union; households

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1. Introduction

Some environmental problems are, at least to some extent, direct or indirect consequences of much of people's everyday behaviour. Consumption of energy from various sources, travel by particular means of transport, or the production and treatment of waste (both municipal and organic) are behaviours that are not indifferent to the environment [1,2]. People in their everyday lives are repeatedly confronted with a variety of choices and their decisions may have a positive impact on themselves but a negative impact on the environment—or, conversely, they may bring negative consequences for themselves but positive ones for the environment [1]. The individual benefits of travelling by car instead of public transport are immediate—greater mobility, convenience, and time saving. The adverse consequences of these behaviours on the environment, such as air pollution, noise, and high consumption of non-renewable energy, are often not felt until in the future [3,4]. Sorting and recycling of household waste is an important form of solid waste management, but it is often considered to be messy and time-consuming, thus undesirable by some households [1,5,6]. Modern society depends on the consumption of energy—for heating homes and water, and for household electrical appliances. Excessive consumption of non-renewable energy reveals the need to reduce the amount of energy used by households [7]. However, saving energy may be viewed as a factor reducing the standard of living and therefore often avoided [1].

Environmental protection and restoration are some of the major challenges that contemporary society is facing. Numerous environmental problems resulting from human activity may be resolved through exerting an impact on this activity. For this reason, the concept of pro-environmental behaviour (PEB) was created, the aim of which is to consciously influence human behaviour and reduce—to the greatest extent possible—the negative consequences of human activity on the environment [8]. Due to the complexity of the problem, several theoretical models related to PEB have been proposed, including the Norm Activation Model (NAM) [9], Theory of Planned Behaviour (TPB) [10], or Value-Belief-Norm Theory (VBN) [11]. The existing empirical analyses highlight the importance of personal and social factors that influence PEB. These include demographic (gender, age, education), external (e.g., economic, social, and institutional), and internal factors (motivation, values, environmental awareness). These factors are usually examined on the basis of interviews with respondents. Different behaviour is observed for men and women [12–14], and stronger pro-environmental attitudes can be seen among elderly people [15,16] or people with higher education [17]. Nevertheless, it should be pointed out that pro-environmental decisions and actions do not solely depend on individual characteristics, but also on the characteristics of the entire family or household [18]. Often, the decision-making process can be regarded in terms of the whole household rather than its individual members.

For years, the European Union has been taking measures to reduce the negative aspects of human activity on the environment, both at the EU level and at the level of its individual member states. Despite its close integration on various levels, the European Union is made up of countries with diversified economic development. It can be assumed that similar discrepancies also exist in terms of the intensity of pro-environmental actions undertaken by individual nations. It is therefore advisable to attempt to assess pro-environmental actions taken by individual EU member states in order to search for good practices that promote desirable behaviour. To the best of the authors' knowledge, this is the first study that attempts the creation of such a ranking.

This study differs from the existing research in two fundamental aspects, both of which concern the assessment of pro-environmental behaviour. Most empirical studies have so far taken into account individual types of behaviour, such as separate waste collection [19], energy conservation [20], or the generally understood pro-environmental behaviour [21]. In this study, pro-environmental behaviour includes several aspects, including the use of renewable energy, waste separation, and the use of public transport. Another point of difference is that the authors assess pro-environmental behaviour not on the basis of the respondents' declarations [22], but on macroeconomic data, which instead show the actual results of pro-environmental actions. Such an assessment is dictated by the fact that people's attitudes and actions regarding environmental protection often tend to differ. People's actions do not reflect a high level of environmental awareness [23]. Such a contradiction between attitudes and actions was also mentioned in earlier studies [24]. It may likely be attributed to the form of questions or prompts used in the questionnaire. Another reason is the so-called "acquiescence bias", which is the tendency to select a specific response category regardless of the content of the question [25]. Respondents tend to unconsciously or automatically choose positive answers so as to meet certain social expectations or to fulfil one's sense of moral or social worth. Kaiiser et al. [26] and Milfont [27] assumed that social approval is one of the factors explaining a large gap between attitudes and behaviour.

In order to achieve the research objectives, a specific structure of the paper was adopted. After an introduction and a review of the literature on pro-environmental behaviour, the objectives of the research are presented, and the material and research methods are described. Subsequently, the results are discussed. The last part of the paper is a summary and conclusions.

2. Literature Review

It can be concluded that today's household behaviour is not sustainable, which leads to the emergence or enlargement of environmental problems. This is a global problem and needs to be urgently addressed by stimulating pro-environmental behaviour (PEB).

Pro-environmental behaviour can be defined as deliberate action that can reduce adverse impact upon the environment [11]. It might apply to individuals or groups of people [28]. These behaviours can therefore include activities that benefit the environment (e.g., recycling), but also refraining from activities that cause harm to the environment (e.g., avoiding air travel) [29].

Pro-environmental behaviour is viewed as a combination of self-interest (e.g., action aimed at minimising one's own health risks) and concern for other people, future generations, and the ecosystem as a whole (e.g., reducing environmental pollution, which may threaten the health of others and the climate as a whole) [30]. In other words, people who behave in a pro-environmental way consider the public consequences of their own consumption or use their purchasing power to trigger social change [31].

Pro-environmental behaviour is often described using other interrelated terms, including pro-ecological behaviours [32,33], environmentally significant behaviours [11], green consumer behaviour [34,35], ecological behaviour [36], environmentally responsible behaviours [37], environmentally-supportive behaviour [38], responsible environmental behaviours [39], and environmentally friendly behaviour [40].

Pro-environmental behaviours include a variety of operationalised types, such as recycling [41,42], use of transport [43–45], waste management [46–48], energy consumption [49,50], and purchase of eco-friendly products [51,52]. Stern [11], on the other hand, has divided pro-environmental behaviour into public and private spheres and has distinguished environmental activism, non-activist behaviour in the public sphere, private sphere environmentalism, and other environmentally significant behaviours. Stern emphasised the distinction between environmental activism (e.g., active involvement in environmental organisations) and non-activist activities in the public sphere. Non-activist measures include environmental citizenship (e.g., petitioning on environmental issues, joining and contributing to environmental organizations) as well as support or acceptance of public policies (e.g., stated approval of environmental regulations, willingness to pay higher taxes for environmental protection). Admittedly, these actions do not have a direct impact on the environment, but by influencing and shaping public policy, the behaviour of many people and organisations can be changed at the same time.

Another classification distinguishes the following pro-environmental behaviours: basic environmental behaviour, environmental behaviour related to decision-making, interpersonal environmental behaviour, and civic environmental behaviour [37].

Activities in the private sphere have been of interest to many researchers [53–56], while activities in the public sphere have received much less attention. This is because the private sphere activities are the ones that directly affect the environment [57,58], while the public sphere activities can only affect the environment indirectly.

A very broad classification of pro-environmental activities has been presented by Kurisu [59]. They can be divided into behaviours in personal, shared, and public spaces, based on where they occur. Each of these spheres is distinguished by a different degree of pressure from family members or people important to the person and a different level of influence from the external environment, i.e., the behaviour of others. In terms of the participants of pro-environmental behaviour, we can speak of individual and group actions. Such groups include companies, organisations, or non-profit organisations. The area of influence of these behaviours is another of Kurisu's criterion for division. This criterion is based on the behavioural objective, e.g., measures aimed at saving energy, reducing waste, reducing greenhouse gas emissions, etc. A further division of pro-environmental behaviours can be based on determining the cost–benefit relationship. This classification includes the category of the trade-off condition or win-win behaviour. Pro-environmental behaviours in a trade-off setting are behaviours that entail some costs on top of the benefits. Such costs should be considered not only in financial terms but also concerning time and labour costs. Considering time and convenience, if you commute by bicycle instead of car, it will of course reduce the burden on the environment, but it will also involve dedicating more time and effort to the commute. The win-win situations, on the other hand, imply both a reduced environmental impact and time and effort savings (e.g., using a dishwasher). Of course, the latter type of behaviour promises better prospects for large-scale application. Kurisu also distinguished categories of pro-environmental behaviour in households. These can be broken down into food, clothing, and housing, but they can also be divided into three phases: purchase, use, and disposal. The final aspect of pro-environmental behaviour presented by Kurisu is repetition. This can involve one-off behaviours or repeated (daily) behaviours. Hence, buying an energy-efficient washing machine is a behaviour, while taking a shower instead of a bath is a behaviour that occurs with high frequency.

Many factors explain occurrences of pro-environmental behaviour. Based on the literature study, Kollmuss and Agyeman [24] divided these factors into three main categories: demographic factors (gender and years of education), external factors (institutional, economic, social, and cultural ones), and internal factors (motivation, knowledge of the environment, values, attitude, environmental awareness, emotional commitment, locus of control, responsibility, and priorities). Steg and Vlek [8] classified these factors as: motivational factors (weighing costs and benefits, moral and normative concerns and affects), contextual factors (physical infrastructure, technical equipment, availability or product features and habits. McDonald [60] classified the previously discussed factors into five groups: interpersonal factors, motivational factors, psychosocial factors, interpersonal factors, and factors resulting from environmental education. Lastly, Kurisu [59] summarised all factors as the following categories: barriers and accelerators, psychological factors (standards, attitudes, cognitive dissonance), costs and benefits (monetary costs and time and effort), knowledge, socio-demographic factors (gender, age, education and income), personality, and situational factors.

Identifying the multiple factors that influence pro-environmental behaviour has resulted in a number of theories explaining these correlations. The first models were based on simple and linear relationships between PEB and environmental awareness, which was considered the strongest determinant of these behaviours. The slight effect of increasing environmental education on increasing pro-environmental behaviour has been identified as a limitation of this theory. In spite of this limitation, the model underpins many non-profit organisations' activities as well as various public programmes aimed at boosting PEB [24]. Subsequent theories can be described as more comprehensive as they include more variables. These theories can be broken down into two groups: the ones related to general behaviour that can be applied to PEB, and the models specific to PEB [59]. The norm activation model (NAM) by Schwartz identifies three variables that generate altruistic behaviour (which includes PEB). These variables are personal norms, awareness of consequence, and responsibility of denial [9]. In the theory of reasoned action (TRA), Fishbein and Ajzen argued that it is not attitude and subjective standards that directly influence an individual's behaviour, but their intention. If an individual has this intention, the behaviour will follow. In fact, such a consequence does not always occur [61]. The theory of planned behaviour (TPB) put forward by Ajzen [10], commonly used in the literature, takes into account not only the intention to behave, but also the individual's perception of behavioural control, i.e., the belief in one's own ability or capacity to perform a certain behaviour or, in other words, the sense of self-efficacy.

Among the models that directly relate to PEB, the Value-Belief-Norm Theory (VBN) by Stern [11] is the most frequently cited one in the literature. This theory lists four elements that determine an individual's pro-environmental behaviour: (1) personal values, (2) an environmentally friendly worldview, (3) awareness of consequences and a sense of duty, and (4) personal standards.

Enhancing pro-environmental behaviours requires an empirical study to analyse the current situation and structure of households' pro-environmental behaviours. The European Union has taken a number of measures to reduce adverse human impact for many years. In 2019, the European Commission's Communication on the European Green Deal set out policy initiatives to help the EU achieve its goal of climate neutrality by 2050. The Green Deal is the EU's new growth strategy, the purpose of which is to put Europe on the transition path to a climate-neutral, fair, and prosperous society with a modern, resource-efficient, and competitive economy [62]. According to the Eurobarometer results, European citizens believe that climate change is the most serious problem the world faces. More than 9 in 10 respondents consider climate change to be a serious problem (93%), with almost 8 in 10 (78%) consider it a very serious problem. When asked about the most serious problem that the world faces, more than a quarter (29%) cited climate change (18%), deterioration of nature (7%), or health problems caused by pollution (4%). Most (64%) EU citizens already take individual actions to address climate issues and consciously make sustainable choices in their daily lives [63]. Opinions and declarations, however, do not always translate into measurable action. It, therefore, seems appropriate to assess the environmental behaviour of EU households. An analysis of the literature on cross-cultural pro-environmental research revealed that there is a research gap on the subject. There are multiple studies on behaviour in individual countries [19,64,65], there have been studies covering several countries [66–68], or only single areas of pro-environmental behaviour have been analysed [61,69]. The purpose of the study was to draw up a ranking of EU countries in terms of pro-environmental behaviour of households in 2009 and 2019, as well as changes in this ranking and the factors shaping the rank position. Pro-environmental behaviour was determined based on macroeconomic data available in the EUROSTAT database. Indicators were selected, based on which the society's behaviour can be assessed as more (stimulants) or less (destimulants) pro-environmental. Then, using the classical TOPSIS method, one value for each country was calculated, whereby countries with a higher value of the indicator can be assessed as more pro-environmental, while a lower value of the indicator means that the household behaviour in the given country is assessed as less pro-environmental.

There are numerous studies on the factors that shape pro-environmental behaviour. They can all be divided into two groups: research focused on the influence of socio-demographic factors on pro-environmental behaviour (1) and analyses of values, beliefs, and other psychological aspects related to such behaviour (2). The conducted study aimed to identify the correlation between the level of pro-environmental behaviour and demographic and socio-economic factors.

The results of the study indicate that the pro-environmental behaviour of the inhabitants of northern Europe stems from their strong sense of responsibility for the environment [70]. Due to the geographical and economic conditions, northern European and, particularly, the Baltic Sea region (BSR) countries are especially predisposed to biomass production and bioenergy generation [71]. Energy demand in the European Union countries is diverse due to the specific geographical and climatic conditions—quite larger in northern Europe and quite smaller in southern Europe [72]. Northern European countries are Norway, Sweden, Denmark, Finland, Iceland, United Kingdom, Ireland, Lithuania, Latvia, and Estonia [73]. Consequently, it can be assumed that:

Hypothesis 1 (H1). *Northern European countries manifest a higher level of pro-environmental behaviour than others.*

The research of Poortinga et al. [74] shows that more environmentally friendly behaviour is positively correlated with the amount of income, so it can be assumed that:

Hypothesis 2 (H2). *There is a positive correlation between the level of pro-environmental behaviour and the level of economic development as measured by the level of GDP per capita.*

Some research shows that younger individuals are more likely to behave in a more sustainable manner [74,75]. Other research has found that older individuals are more likely to behave in a pro-environmental manner [15]. The research of Otto and Kaiser [76] shows that individuals below 30 and between 60 and 69 years tend to act more ecologically than other age groups. The finding of Salehi et al. [77] shows that environmental attitude is moderated by factors determined by gender, for example, Japanese female students have greater knowledge of climate changes than male students. Consequently, it can be assumed that:

Hypothesis 3 (H3). *There is a correlation between the level of pro-environmental behaviour and the age structure of the population.*

Although environmental knowledge is the most important and increases the likelihood of PEB [78], education level also increases PEB [79]. Consequently, it can be assumed that:

Hypothesis 4 (H4). *There is a positive correlation between the level of pro-environmental behaviour and the percentage of people with higher education.*

3. Materials and Methods

This study was conducted using the desk research method. The empirical data used in this study was based on currently available Eurostat statistics [80] for the period 2009–2019. The research covers 27 European Union countries (the United Kingdom was not included in the study).

Statistica 13.1 and Microsoft Excel were used for calculations and visualisation of the results.

The tools used to evaluate the diversity of various types of objects in terms of distinguishable characteristics include multivariate analyses, which involve classification and grouping [81]. Linear ordering methods can be used to determine the order of the analysed objects. These methods include the TOPSIS taxonomy method [82].

The TOPSIS method was first described in 1980 by K. Yoon [83] and developed in 1981 by C. L. Hwang and K. Yoon [84]. Its principles consist in determining the distance of the considered objects from an ideal solution (benchmark) and an anti-ideal solution (anti-benchmark). A synthetic indicator ranking the studied objects is the final result of the conducted analyses. The object with the shortest distance to the ideal solution and the longest distance to the anti-ideal solution is considered the best one [85]. The advantages of the classic TOPSIS method include the option to analyse both quantitative and qualitative values.

The algorithm of the TOPSIS method involves [86]:

1. Choice of diagnostic variables (simple characteristics), which are partial determinants of the considered complex phenomenon. From the database of available data, the authors chose those that could describe the pro-environmental behaviour of households. Using our own research experience and findings of other authors, we chose those variables that best reflect the level of pro-ecological behaviour.
2. Verification and selection of variables in terms of their informative value, considering two basic criteria:
   a. Discriminative capacity (variability of characteristics against the tested objects). The coefficient of variation, which is a relative measure of dispersion, is calculated using the formula below:

$$V_j = \frac{S_j}{\overline{x}_j}, \quad (1)$$

where: V_j—coefficient of variation for the j-th variable, S_j—standard deviation for the j-th variable, where:

$$S_j = \sqrt{\frac{\sum_{j=1}^{n} (x_{ij} - \overline{x_j})^2}{n}}, \quad (2)$$

where: x_j—arithmetic mean of the j-th variable, where:

$$x_j = \frac{\sum_{i=1}^{n} x_{ij}}{n}. \quad (3)$$

If the coefficient of variation takes high numerical values, this fact indicates the heterogeneity of the investigated statistical community. Conventionally, it is assumed that if V factor does not exceed 10%, the characteristics show little variation. Such a community is considered homogeneous.

b. The capacity of the variables (the degree, to which they are correlated with other characteristics). Calculation of the Pearson correlation coefficient, which takes the following form:

$$r_{xy} = \frac{\sum_{j=1}^{n} (x_j - \overline{x})(y_j - \overline{y})}{\sqrt{\sum_{i=1}^{n} (x_j - \overline{x})^2 \sum_{i=1}^{n} (y_j - \overline{y})^2}} \quad (4)$$

where: r_{xy}—Pearson's linear correlation coefficient, x, y—measurable statistical features, $\overline{x}$, $\overline{y}$—arithmetic mean of the features x and y, respectively.

Strong correlation between the analysed variables may cause duplication of the information resources contained in them, thus amplifying their impact on the synthetic variable. It is therefore necessary to set a limit value for the correlation coefficient, above which one of the variables is eliminated. The level of this value should not be too high due to the duplication of information, but it should not be too low either, as this might lead to a significant loss of information.

3. Determining the nature of the variables: stimulants, destimulants.
4. Developing a normalised data matrix according to the formula below:

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \text{ for } i = 1, 2, \ldots, m \text{ and } j = 1, 2, \ldots, n \quad (5)$$

where: x_{ij}—observation of the j-th variable for the object i.

5. Consideration of the weights assigned to each characteristic:

$$v_{ij} = w_j \cdot z_{ij} \text{ for } i = 1, 2 \ldots, m;\ j = 1, 2 \ldots, n, \quad (6)$$

where: w_j—weight of the j-th variable, $\sum_{j=1}^{n} w_j = 1$.

6. Determining the model coordinates of the benchmark and anti-benchmark. The values of the benchmark (A^+) and anti-benchmark (A^-) are defined as [85]:

$$A^+ = \{(max\ v_{ij} | j \in J_Q),\ (min\ v_{ij} | j \in J_C)\} = (a_1^+, a_2^+, \ldots,\ a_n^+) i = 1, \ldots, m\ i = 1, \ldots, m \quad (7)$$

$$A^- = \{(min\ v_{ij} | j \in J_Q),\ (max\ v_{ij} | j \in J_C)\} = (a_1^-, a_2^-, \ldots,\ a_n^-) i = 1, \ldots, m\ i = 1, \ldots, m \quad (8)$$

where: J_Q—collection of stimulants, J_C—collection of destimulants.

7. Calculation of Euclidean distances of the analysed objects from the ideal solution (benchmark) and the anti-ideal solution (anti-benchmark) according to the formulas below [87]:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - a_j^+)^2} \quad \ldots \text{for } i = 1, 2, \ldots, m \text{ and } j = 1, 2, \ldots, n \quad (9)$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - a_j^-)^2} \quad \ldots\text{.for } i = 1, 2, \ldots, m \text{ and } j = 1, 2, \ldots, n \quad (10)$$

where: d_i^+Euclidean distance of the *i*-th object from the pattern, d_i^-—Euclidean distance of the *i*-th object from the anti-pattern.

8. Determining the ranking coefficient which defines the similarity of objects to the ideal solution:

$$S_i = \frac{d_i^-}{d_i^+ + d_i^-} \ldots . \text{ for } i = 1, 2, \ldots, m, \text{ where } 0 \leq S_i \leq 1. \tag{11}$$

The smaller the distance of a given object from the model object—the benchmark, and thus the greater the distance from the other pole—the anti-benchmark, the closer is the value of the synthetic measure to 1. The highest value of the Si coefficient indicates the best solution (object) in the considered linear ranking problem.

9. Linear ordering and designation of types based on statistical criteria using the arithmetic mean and standard deviation of the synthetic measure values [88]. The obtained values of the synthetic measure were divided into four class intervals:
   - Class I (high): $q_i \geq \overline{q} + s_q$.
   - Class II (upper medium): $\overline{q} \leq q_i < \overline{q} + s_q$.
   - Class III (lower medium): $\overline{q} - s_q \leq q_i < \overline{q}$.
   - Class IV (low): $q_i < \overline{q} - s_q$.

   where: $\overline{q}$arithmetic mean of the value of the synthetic feature, s_q—standard deviation from the value of the synthetic measure, q_i—value of the synthetic measure.
10. Calculating the basic statistics for the pooled characteristics in each country class.
11. Determining the Spearman rank correlation between the obtained rank and selected demographic, economic, and education-related variables. The Spearman's rank correlation coefficient is more appropriate than Pearson's linear correlation coefficient in the case of outliers [89] in the sample, or for a small number of observations [90]. It is calculated according to the formula below [91]:

$$r_S = 1 - \frac{6 \sum_{i=1}^{n} d_i^2}{n(n^2 - 1)} \tag{12}$$

where: d_i—differences between the ranks of the corresponding features x_i and feature y_i ($i = 1, 2, \ldots, n$).

4. Results and Discussion

Six indicators from the Eurostat database were initially selected for the analysis of PEB-level variation with the TOPSIS method (Table 1). These variables were selected due to seven key aspects: (1) relevance from the point of view of the analysed phenomena, (2) unambiguity and precision of definition, (3) exhaustiveness of the scope of the phenomenon, (4) logical nature of mutual interrelations, (5) preservation of proportionality of representation of partial phenomena, (6) measurability (in the sense of possibility of numerical expression of the level of a given characteristic), and (7) availability and completeness of statistical information (for all examined objects).

Measurable, available, and complete variables were selected for the study, while variable x_3 was disregarded. Subsequently, the variables were subjected to variability-correlation verification. For the purposes of the study, the threshold value of the coefficient of variation was assumed at the level of $V_i = 0.1$ and Pearson correlation coefficient at the level of $r > 0.8$. Table 2 presents the Pearson correlation coefficients between the diagnostic variables. These coefficients have values ranging between -0.177 and 0.541. It can therefore be assumed that there are no strong linear correlations between the variables. Hence, it was assumed that there was no need to eliminate variables due to an excessively high level of correlation.

Table 1. Statistical indicators of household pro-environmental behaviour selected for study.

Variable Symbol	The Name of the Variable
x_1	Final energy consumption in households per capita
x_2	Generation of municipal waste per capita
x_3	Population connected to at least secondary wastewater treatment (in %)
x_4	Share of busses and trains in total passenger transport (in %)
x_5	Recycling rate of municipal waste (in %)
x_6	Renewable energy sources in heating and cooling (in %)

Table 2. Pearson correlation coefficients between the diagnostic variables.

Diagnostic Variables	x_1	x_2	x_4	x_5	x_6
x_1	1.000				
x_2	0.211	1.000			
x_4	0.178	−0.168	1.000		
x_5	0.541	0.237	−0.175	1.000	
x_6	0.367	−0.047	−0.253	−0.175	1.000

In the next step, the significance and logic of the correlations between the variables from the point of view of the analysed phenomenon, as well as the influence of the variables on the final ranking, was taken into account. Variable x_1 was found to be correlated with the level of development of the country. Households in more developed countries consume more energy probably due to the fact that they are equipped with more electronic devices. In less developed countries, energy consumption is lower likely due to less equipment of this kind. Climate is another factor that has a great impact on the energy consumption required for heating or cooling interiors. It may, therefore, not be reliable to assess environmental behaviour solely on the basis of energy consumption. For this reason, variable x_1 was eliminated from the analysis and the share of renewable energy in energy consumption was taken into account. Unfortunately, the Eurostat database lacks information related to the use of renewable energy by households, and the data is available only for consumption sectors. The authors assumed that despite the shortcomings of variable x_6, it better describes pro-environmental behaviour than variable x_1. Although variable x_6 does not apply only to households, it reflects the level of involvement of society in the use of renewable energy. The authors also had similar doubts as to variable x_2. Eurostat reports stress that data on municipal waste management is to be treated with caution, especially for making comparisons between individual member states, due to different data collection methods, the wide range of waste types, and the complexity of waste treatment streams [92]. Waste generation itself—in the authors' view—does not fully reflect the pro-environmental behaviour of households, either. In a circular economy context, waste management focuses on preserving the value and properties of waste materials by delivering high-quality secondary raw materials to the economy [93]. For this reason, variable x_2 was eliminated and variable x_5 was adopted instead. As a result, three variables describing PEB in European Union (EU27) countries were considered (Table 3) The same weights were adopted for all variables.

Table 3. Statistical indicators concerning pro-environmental behaviour of households.

Variable Symbol	The Name of the Variable	Definition	Character [1]
x_6	Renewable energy sources in heating and cooling	The share of renewable energy in the total energy used for heating and cooling in households, industry, hospitals, schools, etc.—in %	S
x_4	Share of busses and trains in total passenger transport	The share of collective transport means in the total land work of passenger transport—in %. Mass transport refers to buses, including coaches, trolleybuses, and trains.	S
x_5	Recycling rate of municipal waste	Share of recycled municipal waste in total municipal waste generation—in%. Recycling includes material recycling, composting, and anaerobic digestion.	S

[1] S—stimulant.

The values of the *Si* synthetic measure calculated using the TOPSIS method within the classical approach allowed the analysed countries to be ranked in a linear way and for typological classes to be distinguished. The countries were divided into classes separately for 2009 and 2019. The research results are presented in Table 4 and Figure 1. Table 4 presents descriptive statistics for the indicators included in the synthetic measure of *Si*.

Table 4. Typological classification of European Union countries by level of pro-environmental behaviour, based on TOPSIS synthetic measure values in 2009 and 2019.

2009				2019				
Rank	Country	The Value of the Synthetic Indicator (S_i)	Typological Group	Rank	Country	The Value of the Synthetic Indicator (S_i)	Typological Group	Change in Rank
1	Sweden	0.718	I	1	Sweden	0.673	I	unchanged
2	Austria	0.531	I	2	Finland	0.566	I	↑2
3	Germany	0.468	I	3	Denmark	0.517	I	↑2
4	Finland	0.412	II	4	Lithuania	0.514	I	↑9
5	Denmark	0.406	II	5	Latvia	0.487	I	↑1
6	Latvia	0.395	II	6	Austria	0.467	II	↓4
7	Belgium	0.389	II	7	Germany	0.458	II	↓4
8	Estonia	0.337	II	8	Slovenia	0.447	II	↑10
9	Netherlands	0.328	II	9	Estonia	0.437	II	↓1
10	Luxembourg	0.302	II	10	Netherlands	0.352	II	↓1
11	Portugal	0.275	II	11	Belgium	0.345	II	↓4
12	Hungary	0.226	III	12	Italy	0.316	III	↑7
13	Lithuania	0.21	III	13	Portugal	0.299	III	↓2
14	France	0.201	III	14	Luxembourg	0.29	III	↓4
15	Croatia	0.191	III	15	Hungary	0.275	III	↓3
16	Spain	0.189	III	16	France	0.274	III	↓2
17	Ireland	0.183	III	17	Bulgaria	0.245	III	↑5
18	Slovenia	0.176	III	18	Slovakia	0.242	III	↑6
19	Italy	0.162	III	19	Croatia	0.237	III	↓4
20	Romania	0.159	III	20	Czechia	0.233	III	↑3
21	Poland	0.153	III	21	Cyprus	0.213	III	↑5
22	Bulgaria	0.148	III	22	Ireland	0.187	III	↓5
23	Czechia	0.14	III	23	Poland	0.178	IV	↓2
24	Slovakia	0.116	III	24	Spain	0.168	IV	↓8
25	Greece	0.11	IV	25	Greece	0.166	IV	unchanged
26	Cyprus	0.09	IV	26	Romania	0.136	IV	↓6
27	Malta	0.072	IV	27	Malta	0.122	IV	unchanged

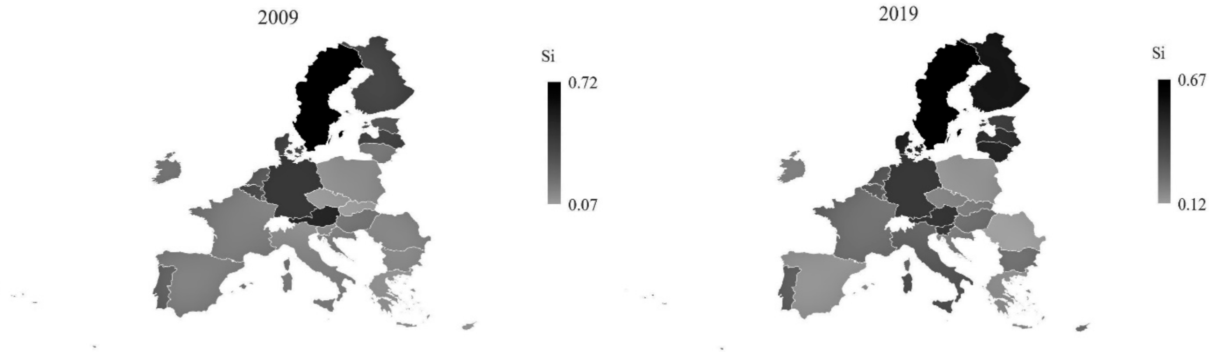

Figure 1. Spatial delimitation of pro-environmental behaviour in European Union countries in 2009 and 2019.

The research procedure identified four classes of European Union countries differentiated by PEB (Table 5). In 2009, Sweden, Austria, and Germany formed the first typological class, showing the highest level of pro-environmental behaviour (synthetic measure above 0.460). In these countries, two of the three sub-measures, i.e., the share of renewable energy in heating and cooling and municipal waste recycling, achieved the highest values. Countries of the second class, with an upper medium level of pro-environmental behaviour (*Si* between 0.412 and 0.275), had significantly lower levels of municipal waste recycling and a lower share of renewable energy—by 22.8 and 7 p.p., respectively—in comparison with the countries of the first group. The share of public transport in total passenger transport in both classes was similar, at around 16.5%.

The third class (13 countries) stands out with the highest share of public transport in total passenger transport (nearly 19%) and low average values for the other two indicators (below 20%). Countries in this group display a medium-low level of PEB. Three countries of the fourth group, namely, Greece, Cyprus, and Malta, performed the worst in 2009 in terms of the analysed characteristics. This group had the lowest share of renewable energy used for heating and cooling (12.19%) and a very low level of waste recycling (10.3%).

The year 2019 saw changes in the ranking of European Union countries. Five countries were classified in the first class (*Si* > 0.480): Sweden, Finland, Denmark, Lithuania, and Latvia. These countries show the highest share of renewable energy used for cooling and heating in the Union by far: Sweden (66.1%), Latvia (57.8%), Finland (57.5%). This class is the least diverse in terms of the selected characteristics (Table 5). Class two (upper medium Si level) includes: Austria, Germany, Slovenia, Estonia, the Netherlands, and Belgium. This group has the highest average municipal waste recycling rate. The countries of this group, excluding Estonia, recycled more than half of their waste in 2019, while Germany exceeded the European Commission's proposed 2030 target of 65%. Due to the value of the synthetic measure (*Si* between 0.316 and 0.187), PEB in the third class can be considered lower medium. Similarly to 2009, this class shows the highest share of buses and trains in passenger transport in the entire European Union (more than 19%). The fourth class consisted of five countries: Poland, Spain, Greece, Romania, and Malta. The very low level of municipal waste recycling makes this class rank lowest in PEB across the European Union (EU-27). It should be noted that three countries (Romania, Cyprus, and Malta) processed less than 25% of their municipal waste in 2019. This is an extremely alarming situation as, according to the EU waste requirements, the level of preparation for re-use and recycling that each EU Member State must achieve is 50% in 2020 and 55% starting from 2025.

The years 2009 and 2019 were marked by changes in each country's ranking positions. Ten countries recorded a ranking increase, 13 saw a decrease, while three countries remained stable in their ranking. The greatest improvement was recorded by Slovenia, which ranked 18th in 2009 and rose to 8th position in 2019, and Lithuania, which improved from 13th to 5th position. The main reason for the changes in the ranking that had a positive effect on the PEB issue in these countries was primarily the increase in the municipal waste recycling rate: from about 19 to almost 59% in Slovenia and from 8.5 to 52.5% in Lithuania.

The greatest drop (by 8 places) was seen in Spain, which ranked 16th in 2009 and dropped to 24th in 2019. This rank is classified in the category of countries with the lowest PEB level. The change in Spain's position was largely due to a decline in the share of public transport in total passenger transport and negligible positive changes for the other indicators. In both years, the leading position in the ranking was maintained by Sweden, with almost two thirds of its heating and cooling energy coming from renewable sources. The last spot in both 2009 and 2019, on the other hand, was held by Malta, which has a very poor recycling rate of around 10%. This is the worst result in the entire European Union (Table 5).

Table 5. Descriptive statistics for selected indicators of pro-environmental behaviour for European Union countries in 2009 and 2019.

Typological Group	Descriptive Statistics	2009			2019		
		Renewable Energy Sources in Heating and Cooling	Share of Busses and Trains in Total Passenger Transport	Recycling Rate of Municipal Waste	Renewable Energy Sources in Heating and Cooling	Share of Busses and Trains in Total Passenger Transport	Recycling Rate of Municipal Waste
I	Average	33.78	16.60	58.07	55.35	15.50	43.14
	Maximum	60.57	20.30	63.10	66.12	18.00	52.50
	Minimum	11.16	14.00	49.20	47.36	9.60	25.20
	Standard deviation	20.39	2.69	6.29	6.98	3.03	9.62
	Coefficient of variation	60.35	16.19	10.83	12.62	19.57	22.30
II	Average	26.74	16.59	35.26	22.88	16.12	52.86
	Maximum	47.89	20.50	53.90	52.28	22.90	67.10
	Minimum	3.37	10.60	7.70	7.08	13.60	28.00
	Standard deviation	17.80	3.43	16.02	16.23	3.30	12.17
	Coefficient of variation	66.56	20.65	45.44	70.96	20.48	23.02
III	Average	18.62	19.12	17.87	24.25	19.29	35.44
	Maximum	33.72	30.90	35.30	41.65	29.40	49.80
	Minimum	4.19	7.70	1.10	6.32	11.60	16.50
	Standard deviation	8.76	5.61	11.41	11.09	5.39	9.63
	Coefficient of variation	47.06	29.36	63.86	45.73	27.94	27.18
IV	Average	12.19	17.93	10.30	23.29	18.06	21.96
	Maximum	17.32	18.10	18.90	30.19	20.70	34.80
	Minimum	2.01	17.60	3.70	15.98	15.10	10.00
	Standard deviation	7.20	0.24	6.36	5.15	1.97	10.67
	Coefficient of variation	59.05	1.31	61.79	22.09	10.88	48.60

The size of each class of countries in 2019 also changed against 2009. The first class with the highest level of pro-environmental behaviour grew from three to five countries. Sweden is the only country that was classified in this group in 2009. Austria and Germany progressed to class 2 in 2019, while class 1 saw Finland, Denmark, and Latvia advance from class 2 and Lithuania from class 3. Likewise, the fourth class with the lowest PEB level experienced changes. Greece and Malta were joined by Poland, Spain, and Romania. Cyprus, on the other hand, rose from the second-to-last place in the ranking to the 21st position included in class three.

The research has some limitations. Not all of the variables used in the study ($\times_4$, $\times_5$, $\times_6$) fully reflect the PEB of households. The $\times_6$ variable concerns not only households but also other economic entities. Individual motivation, as well as the country policy, affects the variable $\times_5$. The variable $\times_4$ is also determined by the level of transport infrastructure in a given country.

The Spearman rank correlation coefficient between the value of the synthetic variable measuring PEB in 2019 and a number of demographic, economic, and education-related variables was determined (see Table 6) using the data for 2019 and 2018 (when the data for 2019 was incomplete).

Table 6. Spearman's rank correlation coefficient between the synthetic variable measuring PEB in 2019 and selected demographic, economic and education-related variables in EU countries.

Variable	r_S	*p*-Value
Demographic variables		
Proportion of population aged 0–14 years	0.208	0.297
Proportion of population aged 15–24 years	0.081	0.689
Proportion of population aged 25–49 years	−0.606	0.001
Proportion of population aged 50–64 years	0.370	0.057
Proportion of population aged 65 and over	0.345	0.078
The share of households with dependent children in total households	−0.657	0.000
Total fertility rate	0.266	0.180
Women per 100 men	−0.065	0.747
Economic variables		
Adjusted gross disposable income of households per capita in PPS	0.385	0.057
GDP per capita in PPS	0.366	0.060
The share of people at risk of poverty or social exclusion	−0.326	0.097
Education-related variables		
At least upper secondary educational attainment, age group 25–64 (the share)	0.387	0.046
Early leavers from education and training	−0.179	0.327
Students in tertiary education—as % of 20–24 years old in the population	0.005	0.979

In the group of demographic variables for the adopted 0.10 significance level, the correlations between the country synthetic variable, which describes PEB, and the percentage of the population aged 25–49 (negative correlation), the percentage of the population aged 50–64 (positive correlation), and the percentage of the population aged 65 and over (positive correlation) turned out to be statistically significant. The obtained results remain in contrast to those from the 1980s suggesting that younger individuals are more likely to behave more sustainably [75,78]. They are, however, in line with more recent findings indicating that older individuals are more likely to behave in a pro-environmental manner [15], which is observed both at the individual level and for countries with a higher proportion of senior citizens [94]. The findings are also consistent with the research suggesting that the young adult age group is relatively less inclined to pro-environmental behaviour [95]. The research also indicates that there is a statistically significant negative correlation between PEB at the country level and the proportion of households with children in total households, which on the one hand indicates that young people do not show higher PEB, but also that the countries at lower levels of economic development have a higher proportion of households with children. No correlation, however, has been found between PEB and the number of women per 100 men, which is consistent with the results of studies showing that men and women manifest similar pro-environmental behaviour [21].

In the group of economic variables, there is a positive significant correlation between PEB and the adjusted gross disposable income of households per capita in PPS and GDP per capita in PPS and a negative significant correlation between PEB and the share of people at risk of poverty and social exclusion. This confirms the research results that indicate that more environmentally friendly behaviour is positively correlated with the amount of income [74]. The positive statistically significant correlation between PEB and income may also stem from the fact that the low-income countries recycle less than 50% of their waste, while the high-income countries recycle up to 90% [96]. It is worth mentioning that an increase in income is often related to a reduction of available free time, with a possible reduction of recycling behaviour [97], so on the individual level, the correlation coefficient between income and PEB can either be positive or negative.

Among education-related variables, PEB is significantly positively correlated only with the percentage of at least upper secondary educational attainment, age group 25–64. The findings of research to date, however, indicate that the main determinant of PEB is formally provided environmental education, environmental knowledge, and building of environmental awareness, especially in the developing countries [98]. Meanwhile, the mere percentage of people involved in tertiary education does not determine the tendency to pro-environmental behaviour.

For the 0.05 significance level, PEB was correlated with only 3 variables: proportion of the population aged 25–49, the share of households with dependent children in total households, and the share of at least upper secondary educational attainment, age group 25–64.

Analysis of the determinants of pro-environmental behaviour should consider that it is a complex phenomenon and each area of pro-environmental behaviour may have different determinants [99], and that people are more inclined to take pro-environmental actions that do not require more effort [100].

This study provides a contribution to the existing knowledge, as well as arguments that PEB can be assessed not only at the individual level, but also at the national level using macroeconomic data. By using appropriate indicators, international variation in terms of pro-environmental behaviour can be assessed more accurately. A similar study was conducted by Aral and López-Sintas [61], who attempted to present the differentiation of various European countries in terms of PEB by analysing three types of pro-environmental behaviour: the use of public transport, eco-friendly purchases, and reduced resource consumption. The results of that study indicated a division of Europe into two groups with higher and lower levels of PEB. The group of countries with higher PEB included seven of the 11 countries classified as countries with the high and highest PEB level in this study. This study, however, allows for more accurate results in terms of the classification of countries (four classes) thanks to the use of the TOPSIS linear ordering method, as a result of which it is also possible to create their ranking.

5. Conclusions

The study presents the options of using and the usefulness of the TOPSIS method to investigate spatial differentiation of pro-environmental behaviour across European Union countries (EU-27). The analysis presents three macroeconomic indicators used to build a ranking of EU countries by level of PEB in 2009 and 2019. In both years analysed, the share of renewable energy used for heating and cooling proved to be the variable with a major impact on the rank achieved by a given country in terms of pro-environmental behaviour, followed by the rate of municipal waste recycling. The share of public transport in total passenger transport was the least significant measure for the countries. Furthermore, it should be noted that the final ranking of countries was fundamentally influenced not only by the initial choice of diagnostic variables, but also by the way in which the variables were standardised and normalised.

In spite of various initiatives, there is great diversity in pro-environmental behaviour throughout the European Union. In 2019, the Scandinavian countries: Sweden, Finland, and Denmark, ranked top in the presented list of EU countries scaled by PEB, while the southern European countries: Malta, Greece, Spain, and Romania, plus Poland, occupied the last places. Based on the above results, one can therefore identify northern European countries as a group of countries representing a positive benchmark in the European Union in terms of PEB, which confirms hypothesis H1.

PEB assessment carried out in the community countries using the TOPSIS synthetic measure, in addition, allows the conclusion that the countries with very low and very high PEB accounted for 18% of the total countries in 2019. Countries with an average level of PEB (lower medium) were most represented, at over 40%. It can be predicted that the disproportion in pro-environmental behaviour in EU countries will change in the years to come. The differences between the individual countries should become less pronounced, which is largely determined by the European environmental policy. This is, however, a lengthy process.

The analysis allowed identification of factors significantly correlated with the described behaviours.

Similarly to other studies, the H2 hypothesis of a correlation between PEB and the level of economic development, as measured by GDP per capita, can be confirmed. One can presume that the higher the level of income, the greater the tendency to desire a better quality environment. In contrast, the lower income countries are more committed to solving economic problems and less concerned about the environment. Environmentally friendly behaviour is also frequently more financially demanding, which is possible with higher income levels.

The analysis supported hypothesis H3 that there is a correlation between PEB and the age structure of the population. In our study, societies with a higher proportion of the 25–49 age group were more likely to manifest less environmentally friendly behaviour. The correlation between age and PEB is not clearly confirmed in the literature. The diversity of EU Member States in terms of economic development may also affect the obtained results. It is possible that on a macroeconomic scale, pro-environmental behaviour of households is more frequently observed in countries with higher levels of economic development and a lower proportion of the youngest population.

H4 hypothesis could not be positively verified. The prevalence of a larger group of people with tertiary education in the community had no statistically significant association with PEB. This might be the impulse for a change in thinking about the relevance of environmental education in EU societies.

This paper provides a contribution to the existing literature on the subject by offering a method of the assessment of pro-environmental behaviour based on external data (collected by external institutions) rather than declarations made by respondents.

The analyses conducted provide information on macroeconomic variables that are important for the assessment of PEB in EU countries. In addition, the research undertaken is consistent with one of the core Sustainable Development Goals (Goal 13): Climate Action. Monitoring changes in pro-environmental behaviour in individual EU countries is important for the evaluation and verification of the effectiveness of actions undertaken under the EU's Common Climate and Energy Policy. In order to attract interest in environmental protection issues, what is required is a properly implemented environmental policy that encourages all economic entities to adopt pro-environmental behaviour in all areas of human activity.

The research area covered by this study is considerably wide. The importance of pro-environmental behaviour for socioeconomic development is indisputable. It is planned to further extend the analysis using the TOPSIS procedure to other research objects (e.g., all European countries). The proposed research method can also be used to analyse and evaluate other regional or global environmental problems, in particular climate change.

Future objectives of research using the linear ordering method will also include other algorithms for normalisation and assigning differentiated weights to diagnostic variables.

The presented findings prove that the comprehensive indicator obtained by the TOPSIS method is a valuable research tool. What is particularly advantageous about the technique based on the synthetic indicator is that the comprehensive indicator provides a uniform assessment for the whole set of data, regardless of the measurement scale used for observations, and that it allows avoidance of the direct linking of distinct information provided by the variables. In addition, the results of the analyses can be easily interpreted. On the other hand, TOPSIS is quite a sensitive method mainly due to the adopted method of selection and normalisation of variables. This may significantly influence the final ordering of the objects. The selection of the normalisation method and weights should be made taking into account the properties of given formulas and the preferences of the decision maker.

The authors emphasise that this study has certain limitations, resulting, for instance, from the use of the available and measurable indicators only. The authors are aware that their selection of variables does not fully reflect the level of PEB in EU countries. At the same time, it should be noted, however, that the selection of variables for the analysis of international phenomena is difficult and was dictated primarily by the availability of statistical data. Furthermore, another significant limitation in terms of the selection of variables turned out to be the factors of the exhaustiveness of the scope of the phenomenon by the variables and the logic of their interrelations.

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