Analysis of retail customers in the field of environmentally conscious behavior with respect to home, mobility, heating and cooling, and governance*

Gábor Vona
Department of Sustainability Management and Environmental Economics Institute of Sustainable Development Corvinus University of Budapest, Hungary
Email: gabor.vona@uni-corvinus.hu

This study aims to determine the factors to be improved to achieve a more elevated level of environmental awareness depending on the type of retail customers. By relying on the household survey conducted by ENABLE.EU team with the purpose of identifying the drivers of individual energy choices and behaviors regarding home, mobility, heating and cooling, and governance, the findings widen the knowledge about environmentally conscious consumer behavior. The dataset of the countries Hungary, Spain, and Ukraine served as a basis for the calculations. By addressing the research questions, the study applied both hierarchical and non-hierarchical cluster analyses, plus asymptotic independent samples z tests. The results reveal that the generalizability of environmental awareness can be declined: the most environmentally aware customers demonstrate a less conscious attitude in particular facets of mobility and governance. According to social and economic characteristics, this group is the most homogeneous, as it is composed of the most educated, economically active urban citizens with family and stable financial background. In the case of respondents lagging behind the best performers, a few favorable attitudes can be traced back to economic or demographic reasons. The findings enable decision-makers to conceive targeted approaches when raising awareness.

Keywords:
environmentally conscious consumer behavior, environmental awareness, sustainable consumption

* The study, conducted by the – Enabling the Energy Union – ENABLE.EU team between 2016 and 2019, examines the results of Hungary, Spain, and Ukraine from 11 European countries.

Introduction

Ensuring sustainable consumption and production patterns is one of the 17 Sustainable Development Goals (SDGs), part of the 2030 Agenda for Sustainable Development, which was adopted in 2015 in New York (United Nations 2015: pp. 1, 14). Although nearly half of the planned period elapsed at the advent of 2023, advancements are still far from the time-proportional results. Over and above this underperformance of progress toward the achievement of the SDGs, the current mainstream practices exacerbate climate change, biodiversity loss, and pollution of the environment. Focus areas are food waste, electronic waste, and the increasing exploitation of natural resources instead of moving toward the dematerialization of the economy. The abovementioned planetary problems represent severe threats to the SDGs, but responsible consumption is one of the means that can alleviate them by relying on the circular economy and ceasing excessive, careless resource use (United Nations – Department of Economic and Social Affairs 2022: pp. 50–51).

Decarbonization targets lessening or removing greenhouse gases responsible for anthropogenic (i.e., originating in human activity) climate change. Instead of tackling it, preventive mitigation should be given priority so that the augmentation in global average temperature in the 21st century can be limited not only to the jointly accepted 2°C but preferably to 1.5°C relative to preindustrial levels in accordance with the legally binding Paris Agreement, which is an international treaty in force after its ratification since 2016 (United Nations 2022). The estimated potential of the energy and mobility turn is an 80 to 90% reduction in carbon dioxide emissions (Bild der Wissenschaft 2019: p. 9). Creating different scenarios beyond 1.5°C pathways enables decision-makers to assess the impacts and risks related to global warming. In the case of successful mitigation, the global surface temperature change until 2100 is projected to remain within the limit of 1.5°C. If an extreme scenario lacking both mitigation and adaptation is realized, the increase in global average temperature will be close to 5°C. Exacerbating the corollaries of increasing greenhouse gas emissions commensurately engenders harm to and damage in terrestrial, freshwater, and ocean ecosystems. Societies are likely to undergo climate-sensitive health outcomes, such as galloping heat-related morbidity and mortality. In addition to the general global perils, regional risks emerge, e.g., Africa will face aggravating food production from crops, fisheries, and livestock, while loss and degradation will diminish coral reefs in Australia (IPCC 2022: pp. 16–17). Consequently, by opting for decarbonization pathways, countries should be urgently impelled to realize steeper slopes in the reduction of greenhouse gases, which enable them to remain within the ecological threshold. Worsening of many indicators (among others, Earth Overshoot Day, Living Planet Index, carbon dioxide concentration in Earth's atmosphere, share of urban population breathing air polluted by particulate matters, frequency of extreme

weather events, quantity of plastic pollution in both fresh- and saltwater, intensity of deforestation) are omens hinting at deepening global crises.

Worldwide, the urban population compared to the total population reached 57% by 2021 and is expected to keep monotonously augmenting to approximately 70% by 2050 (World Bank 2022a, b). Most countries are facing biocapacity deficits, as their ecological footprint is exceeding their biocapacity. Although urbanization may entail a larger urban ecological footprint than the average national ecological footprint (for instance, in the case of Athens, Barcelona, or Cairo), residents of cities have ample opportunities for diminishing their individual ecological footprint and its part, i.e., the carbon footprint. Globally, the carbon footprint equals 60% of the ecological footprint. The scope of means encompasses their nutritional habits, the energy use of their households, their waste management, their personal transportation, and the purchase of other goods and services (Global Footprint Network 2015: pp. 22–23, 2023). In particular, the per capita residential final energy consumption (without any kind of transport) in 2020 was 25.6 gigajoules in Hungary, 23.2 GJ in Poland, 21.3 GJ in Serbia, and 14.4 GJ in Bulgaria. Although the dissimilarities in the energy use of the households are partially due to systemic specificities at the national level or to climatic conditions, pro-environmental behavior (e.g., in the field of heating and cooling) offers leeway for reduction (HCSO 2022, Statista 2022).

This analysis attempts to identify the main manifestations of environmental awareness in the circle of retail customers based on their energy-related choices and behaviors. Hence, the objective is to provide applicable information about how to promote the penetration of environmentally friendly decisions in societies. Based on a dataset of the ENABLE.EU team, cluster analyses and concomitant asymptotic independent samples z tests were performed to address the research questions (RQs). First, the routines of the most environmentally aware customers were inventoried by distinguishing between their strengths and weaknesses (RQ1). This served as a basis for further conclusions and recommendations. Second, the relationship between environmental awareness and socioeconomic attributes was investigated (RQ2). The significance of practice for decision-makers emerges in identifying the focus areas of environmental awareness depending on its current level, plus pointing to additional general social and economic areas that should be subject to measures when deciding how to heighten awareness.

Literature review

The critical review encompasses articles about environmentally conscious consumer behavior and residential energy consumption in different countries, including comparative analyses.

Many authors have set up a theoretical model for exploring the linkage among the influencers of ecologically conscious consumer behavior and tested it empirically.

Barbarossa–Pastore (2015: pp. 188, 192, 195, 201) scrutinized a so-called green purchasing gap in the circle of 51 environmentally conscious Italian consumers. The gap captures the failure of exercising their positive attitudes toward the environment. By investigating the relationships among the most relevant barriers, the authors concluded that scarce availability, higher perceived prices, and improper mass media and in-store communication hinder green purchasing. The geographical scope of the cross-cultural study of Raletić Jotanović et al. (2016: pp. 561–562, 566–567) is the ex-Yugoslavian republics. On the one hand, the authors pointed to national differences in pro-environmental consumer behavior among the involved countries; on the other hand, they found evidence that specific demographic and socioeconomic characteristics such as educational level and the monthly income of the household influence environmental responsibility on the consumer level. In line with the previous findings, Zalega (2018: pp. 120–121, 124, 126, 129) derived statements valid for Polish seniors in the field of green consumerism by identifying the factors resulting in sustainable consumption patterns (gender, age, educational background, monthly disposable income, place of residence, and attending courses of the University of the Third Age at state universities). Nevertheless, the primary triggering motive of seniors is saving money, whereas environmental protection appears as a concomitant secondary advantage. This sheds light on the elevated price of eco-friendly solutions that restrains environmentally conscious consumer actions.

Craig (2016: p. 667) underlined the role of positive attitudes and behaviors related to energy efficiency in the energy consumption of residential electricity consumers. Clients who are aware of energy efficiency programs have more favorable perceptions about utility motives; in addition, they realize reductions in both consumption and emissions (i.e., through participating in programs, supporting subsidies and clean energy use by utilities). Eon et al. (2018: p. 291) found in a sample of Australian houses that the energy use per square meter varied by up to 33%. Major determinants in energy use are, among others, the technology of heating and cooling systems installed in real estate, practices of heating and cooling, knowledge, and components of behavior. Kashour (2023: pp. 47–48) examined the interrelatedness between residential energy consumption and the three components of the human development index at the country level for the member states of EU-27. The education index has no significant link to energy consumption, while life expectancy has a negative impact and gross national income (GNI) has a positive impact.

Lake et al. (2017: p. 423) emphasized the advantage of district heating and cooling systems in the field of efficiency by comparing them with individual energy systems. They urged the spread of district energy. Werner (2017: pp. 617, 628) identified the major global hindrances of district heating and cooling systems. These are low and varying country-specific penetration of district heating in buildings, still mediocre commitment to district heating, lack of susceptibility to carbon dioxide emission reductions, and feeble general awareness of the district heating and cooling benefits.

Nevertheless, district heating and cooling systems have future promising harvestable potential. Ge et al. (2018: p. 1139) pointed to the range of 3–15 years of the payback period of solar heating and cooling systems depending, among others, on components, geographic location, and subsidy. From an economic point of view, initial cost and allowance can influence the spread of these systems advantageously. Chen et al. (2022: p. 11) endeavored to find the optimal heating and cooling system as a mixture of solar thermal, photovoltaics, and energy storage devices installed on different types of buildings. They stated that noteworthy energy savings and economic benefits can be realized; however, the cost of devices and the price of grid electricity are crucial factors. Finally, long-term forecasts attempt to project future energy use and its drivers (Ürge-Vorsatz et al. 2015, Santamouris 2016).

Following my objective of providing easily implementable findings, the attributes of the most conscious customers from a broader perspective are a possible research gap. Consequently, this research endeavors to align statements contributing to enhancing environmental awareness by relying on the practices appertaining to various levels of consciousness. The nexus between customers' behavior and their socioeconomic background creates an appropriate framework for the analysis. Based on the literature review and the available data, two RQs were formulated. This study aims to disclose the following:

- First, which characteristics describe the most environmentally aware customers and their less conscious counterparts by relying on the countries Hungary, Spain, and Ukraine and applying a commonly used standard for ensuring comparability? Ultimately, the overarching question emerges whether the most environmentally aware customers demonstrate excellence in each field. (RQ1)
- Second, which socioeconomic phenomena do prevail in Hungary regarding environmentally conscious consumer behavior? (RQ2)

Methodology

Method

Quantitative analyses were carried out.

RQ1: For identifying the most aware customers, cluster analyses (both hierarchical cluster analysis and non-hierarchical cluster analysis, the latter also known as k-means cluster analysis) enabling the creation of relatively homogeneous customer groups were employed. After the cluster analyses, asymptotic independent samples z tests were performed. They are apt to test the equality of means as – contrary to the prerequisites of independent samples z or t tests – neither the normal distribution of the samples nor the homogeneity of variances, merely finite standard deviations and large samples are required, which are ensured (Hunyadi et al. 2000: pp. 468–469).

RQ2: Answering this question necessitates asymptotic independent samples z tests.

Both hierarchical cluster analysis and non-hierarchical cluster analysis were performed in the statistical software IBM SPSS Statistics Version 29 (Szüle 2016: pp. 9–18). The asymptotic independent samples z tests were carried out in Microsoft Excel.

Data collection

Between 2016 and 2019, the ENABLE.EU team undertook a project with the purpose of disclosing the drivers of individual energy choices and behaviors with the participation of 11,265 retail customers from eleven countries (Bulgaria – 1,000 persons, France – 1,500, Germany – 711, Hungary – 1,022, Italy – 1,025, Norway – 1,221, Poland – 1,000, Serbia – 1,000, Spain – 760, Ukraine – 1,011, and the United Kingdom – 1,015). The team compiled a questionnaire for conducting a household survey so that influencing social and cultural factors could be revealed. The survey comprises seven sections: home/building characteristics and household possessions, mobility, prosumers (etymologically, a prosumer unifies the producer and the consumer in one single individual), heating and cooling, electricity, governance, and social and economic characteristics. The dataset contains 473, predominantly nominal and ordinal scale variables (ENABLE.EU team 2019). Table 1 recapitulates the sections split by country.

Table 1

Dataset: available combinations of sections and countries

Country	Home	Mobility	Prosumer	Heating and cooling	Electricity	Govern-ance	Socio-economic
Bulgaria	x	–	–	–	x	x	x
France	–	–	–	x	–	x	x
Germany	x	–	–	x	x	x	x
Hungary	x	x	–	x	–	x	x
Italy	x	x	x	–	–	–	x
Norway	x	x	x	–	–	x	x
Poland	x	x	–	–	–	x	x
Serbia	x	–	x	–	x	x	x
Spain	x	x	–	x	–	–	x
Ukraine	x	–	x	x	–	x	x
United Kingdom	x	–	x	–	x	x	x
Number of countries	10	5	5	5	4	9	11

RQ1: By selecting Hungary as an initial point, the datasets appertaining to the sections on home/building characteristics and household possessions, mobility, heating and cooling, plus governance bear importance for the comparative analysis of this study.

RQ2: The socioeconomic conclusions rest on the section on social and economic characteristics.

Data analysis

Prior to applying the mentioned techniques, data transformation was performed. The rationale was relying on customer attitudes expressed with a few interval scale variables instead of applying numerous simple, from an ecological point of view relevant, ordinal scale variables indicated directly by customers in the course of the survey. Depending on the nature of the newly introduced variables, if a variable follows decreasing monotonicity, the lower the value is, the more conscious the customer is. In the case of increasing monotonicity, higher values entail more awareness. The statements listed in the questionnaire can be considered either positive or negative. To unify the points given to statements of both types, either the positive or the negative statements were fixed depending on the underlying variable, and the opposite statements were transformed in such a way that their point was deducted from 6 or 5 because of the possible range between 1 and 5 or 4. Table A1 in the Appendix summarizes the 19 variables used for the analysis by indicating their composition if the original variable was transformed (ENABLE.EU team 2019: pp. 5–26).

RQ1: One of the limitations of the tremendous dataset (size: 11,265x473) is the presence of missing values, which restricts its usability. To overcome this deficiency, the original dataset was filtered to obtain solely full records in the section on heating and cooling, which selection enables the maximum number of records apt for analysis. For this reason, the variables BILL_INFORM_MOD, FIN_CONS_MOD_HIND, and COOL_HEAT_HAB_INF were applied for cluster analysis (see later in Table 2). In terms of the countries, Hungary, Spain, and Ukraine provide sufficient full records (HU: 569 full records from a total of 1,022 records, ES: 102 from 760, UA: 89 from 1,011), whereas France and Germany cannot meet this requirement (FR: 0 from 1,500, GE: 3 from 711). First, hierarchical cluster analysis was carried out on the dataset composed of the three countries to determine the presumed number of clusters. The result suggested by the dendrogram is 4 clusters by using the three interval scale variables, squared Euclidean distance as a measure, and Ward's method as a cluster method with a cut value of 8 as a rule of thumb.

Second, k-means cluster analysis was carried out by applying k=4 and k=3. The ANOVA tables confirm that the participating clients diverge significantly based on each of the three variables. The numbers of customers split by clusters are enumerated in Table 2. Cluster 1 represents the most aware customers thanks to the lowest final cluster centers for each variable. The further clusters are not ordered based on environmental awareness.

Table 2

Results of the non-hierarchical cluster analyses: cluster sizes (the distribution is denoted in parentheses), 760 cases, 3 countries

Run	Cluster			
	1	2	3	4
k=4	163 (21.45%)	141 (18.55%)	227 (29.87%)	229 (30.13%)
k=3	286 (37.63%)	203 (26.71%)	271 (35.66%)	–

Table 3 details the values of the three variables in a comparative way for both runs. The range is calculated as the product of the number of variables and the minimum (1) or the maximum (5) of the possible points. To underpin the subsequent findings, k=3 was chosen because it can ensure a higher cluster size due to the less stringent conditions – apart from COOL_HEAT_HAB_INF – of qualifying as a most environmentally aware customer.

Table 3

Final cluster centers, 760 cases, 3 countries

Name of the introduced variables	Range	Final cluster centers of Cluster 1	
		k=4	k=3
BILL_INFORM_MOD	9–45	21.88	24.93
FIN_CONS_MOD_HIND	12–60	24.63	26.19
COOL_HEAT_HAB_INF	11–55	24.45	24.36

Third, the variables of Table A1 in the Appendix render a more profound evaluation of environmentally conscious consumer behavior possible. In addition to heating and cooling, the investigated fields encompass home, mobility, and governance as well. After excluding the records with at least one missing value in the supplementary nine variables of the mentioned sections, 480 cases remained from the original set of 760 records. A series of null hypotheses ($H_0: \bar{y} - \bar{x} = 0$) with the one-sided alternative hypotheses ($H_1: \bar{y} - \bar{x} > 0$) or ($H_1: \bar{y} - \bar{x} < 0$) was carried out by dint of the formula of the asymptotic independent samples z test:

$$Z = \frac{\bar{y} - \bar{x} - \delta_0}{\sqrt{\frac{s_Y^2}{n_Y} + \frac{s_X^2}{n_X}}} \rightarrow N(0,1) \quad (1)$$

On the one hand, $\bar{y}$ denotes the value in question of the most conscious customer group (Cluster 1), and $\bar{x}$ refers to the corresponding best or second-best value (Cluster 2 or 3); on the other hand, $\delta_0 = 0$. Under the square root stand variances (s^2) and sample sizes (n) (Hunyadi et al. 2000: pp. 468–469).

These tests reveal the variables testifying to a significant difference in means. Based on the differentiating factors, conclusions can be drawn with respect to practices where more advancement is recommended for raising awareness.

RQ2: To disclose the socioeconomic phenomena among the clusters, seven variables (S1, S2, S3, S4, S5, S6, S8 from the section on social and economic characteristics, see Table A1 in the Appendix) were involved in the asymptotic independent samples z tests. On the one hand, country specificities (e.g., urbanization, educational level of the population) may distort the results; on the other hand, both Spain and Ukraine do not have any valid full records; therefore, further scrutiny is restricted to Hungary. The non-hierarchical cluster analysis (k=3) provided the required sample sizes so that each Hungarian cluster could be qualified as a large sample. Table 4 illustrates the composition of 760 respondents divided into cluster-country combinations for both runs (k=4 and k=3). An additional 75.46% increment in the size of the best cluster argues for k=3.

Table 4

Number of cases split by cluster and country, k=4 and k=3, 760 cases, 3 countries

Cluster/Country	Hungary		Spain		Ukraine		Total	
	k=4	k=3	k=4	k=3	k=4	k=3	k=4	k=3
Cluster 1	116	223	25	30	22	33	163	286
Cluster 2	129	171	5	6	7	26	141	203
Cluster 3	189	175	7	66	31	30	227	271
Cluster 4	135	–	65	–	29	–	229	–
Total	569		102		89		760	

Findings

RQ1: Which characteristics describe the most environmentally aware customers and their less conscious counterparts by relying on the countries Hungary, Spain, and Ukraine and applying a commonly used standard for ensuring comparability?

Table 5 derives the significance level (p-value) for each variable. If the value of the most conscious customer group (Cluster 1) is the most favorable, it is marked with bold font type, while the corresponding best or second-best values of the remaining clusters are marked with italic font type.

Table 5

Mean and standard deviation of the variables for each cluster (k=3), significance level of the asymptotic independent samples z tests, 480 cases, only Hungary (missing cases excluded listwise)

Variable (better value)	Range	Cluster 1 Mean	Cluster 2 Mean	Cluster 3 Mean
H12B (lower)	1–5	**2.62**	*2.93*	3.01
AGR_NEG_STAT (lower)	5–20	**10.48**	11.09	*11.05*
TIME_SHARE_ PREF_MODE (higher)	0–100%	50.74%	*63.32%*	54.53%
TOT_DIST_PER_WEEK (lower)	[km] 2–12,000	244.21	*120.87*	130.13
ENV_FR_MOB (higher)	2–10	**8.06**	*6.91*	6.72
SCORE_TRANS_SYS (higher)	6–30	**22.11**	*21.27*	20.64
SEV_TRAF_PROB (higher)	5–25	**16.96**	*16.56*	15.85
BILL_INFORM_MOD (lower)	9–45	**25.88**	33.71	*26.64*
FIN_CONS_MOD_HIND (lower)	12–60	**26.07**	37.17	*35.52*
COOL_HEAT_HAB_INF (lower)	11–55	**24.01**	*28.77*	34.36
LESS_ENERGY_CONS (higher)	0–3	0.59	*0.78*	0.70
AGR_INCONV_EFM (lower)	3–15	9.83	9.83	*9.42*
Number of cases		191	138	151

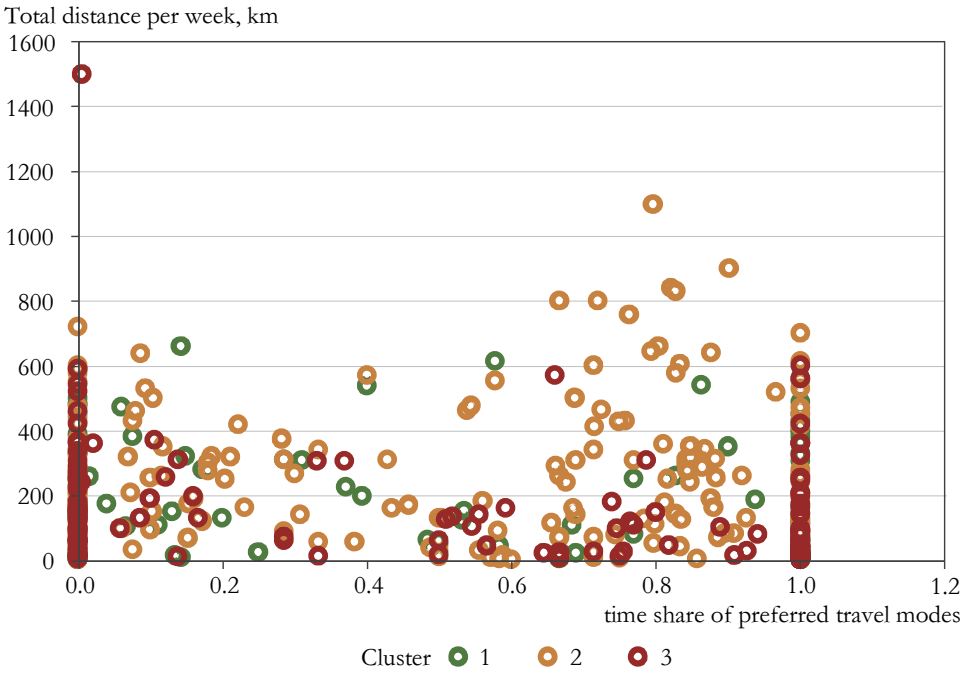
Variable (better value)	Range	Cluster 1 Std. dev.	Cluster 2 Std. dev.	Cluster 3 Std. dev.	z test	p-value
H12B (lower)	1–5	1.25	1.55	1.48	–1.95	0.025
AGR_NEG_STAT (lower)	5–20	2.16	2.51	2.24	–2.38	0.009
TIME_SHARE_ PREF_MODE (higher)	0–100%	0.41	0.44	0.46	–2.62	0.004
TOT_DIST_PER_WEEK (lower)	[km] 2–12,000	218.07	156.31	142.04	5.98	0.000
ENV_FR_MOB (higher)	2–10	2.06	2.47	2.10	4.47	0.000
SCORE_TRANS_SYS (higher)	6–30	3.94	5.36	4.13	1.56	0.059
SEV_TRAF_PROB (higher)	5–25	3.88	4.53	4.59	0.84	0.201
BILL_INFORM_MOD (lower)	9–45	4.58	3.88	3.20	–1.80	0.036
FIN_CONS_MOD_HIND (lower)	12–60	3.89	5.53	4.76	–19.74	0.000
COOL_HEAT_HAB_INF (lower)	11–55	3.27	4.17	3.91	–11.17	0.000
LESS_ENERGY_CONS (higher)	0–3	0.72	0.61	0.69	–2.59	0.005
AGR_INCONV_EFM (lower)	3–15	2.00	2.13	1.75	2.02	0.022

By assuming that the cluster indexed with 1 unifies the most environmentally aware customers amounting to 191 in Hungary, at a significance level of 5%, the null hypothesis can be declined for H12B, AGR_NEG_STAT, ENV_FR_MOB, BILL_INFORM_MOD, FIN_CONS_MOD_HIND, and COOL_HEAT_HAB_ INF. At a significance level of 10%, the former list of variables is complemented with SCORE_TRANS_SYS. A significant difference in the case of SEV_TRAF_PROB cannot be underpinned. Furthermore, the best cluster should be propelled to make advancements in the variables TIME_SHARE_PREF_MODE,

TOT_DIST_PER_WEEK, LESS_ENERGY_CONS, and AGR_INCONV_EFM. Figure 1 illustrates that both Clusters 2 and 3 occupy a more favorable position than the most environmentally aware group.

Figure 1

Customers in the mobility aspect space



The position of Clusters 2 and 3 is ambiguous. The variables H12B, AGR_NEG_STAT, TOT_DIST_PER_WEEK, ENV_FR_MOB, SCORE_TRANS_SYS, and LESS_ENERGY_CONS proved to be not significant at a significance level of 10%. At a significance level of 10%, Cluster 2 outpaces the customers of the third group in two areas (SEV_TRAF_PROB, COOL_HEAT_HAB_INF), and it outdoes both other clusters in TIME_SHARE_PREF_MODE. In contrast, at a significance level of 5%, Cluster 3 surpasses Cluster 2 in BILL_INFORM_MOD and FIN_CONS_MOD_HIND, while the third group ranks number one in AGR_INCONV_EFM.

The most environmentally aware customers replaced, on average, more than 50% of the old classic bulbs with energy-efficient bulbs in their homes. In addition, they can identify themselves mostly with environmental issues and excel in all dimensions of heating and cooling. Moreover, they attribute the most importance to air quality and CO_2 emissions when making decisions about mobility, and they testify to the most supportive attitude toward government actions ameliorating the transportation system. Surprisingly, the most and less conscious customers perceive traffic problems

to a similar extent. Finally, the most environmentally aware customers are recommended to achieve improvements in opting for more environmentally friendly alternatives concerning mobility (controversial to the mentioned concerns regarding air quality and CO_2 emissions) and household appliances, moderating the traveled distance coupled with CO_2 emissions, and accepting environmentally friendly measures that may cause inconvenience for them. All things considered, the findings refute the generalizability (i.e., excellence in each field: home, mobility, heating and cooling, governance) of environmental awareness in the circle of retail customers. In the case of Cluster 2, a group can be identified that occupies an environmentally friendly position in mobility based on the means. Nevertheless, this cluster cannot be considered environmentally aware, as it underperforms in many scrutinized dimensions (ENABLE.EU team 2019: pp. 5–24).

Apart from four variables (TOT_DIST_PER_WEEK, BILL_INFORM_MOD, LESS_ENERGY_CONS, AGR_INCONV_EFM), the group of the most environmentally aware customers can be considered the most homogeneous, as being environmentally aware means reaching almost the same high level of awareness; thus, the criteria of environmental awareness can be narrower defined. The considerable within-group differences in Clusters 2 and 3 point to the broad range of levels representing less environmental awareness. Table 6 expounds the suggestions for ameliorating customer behavior by applying a significance level of 10%. Instead of applying an isolated approach, the overlapping dimensions argue for combining actions and merging clusters.

Table 6

Combinations of proposed actions and affected clusters based on Hungary, significance level = 10%

Variable (denomination)	Cluster		
	1	2	3
H12B (energy-efficient bulbs inside homes)	–	x	x
AGR_NEG_STAT (identification with environmental issues)	–	x	x
TIME_SHARE_PREF_MODE (opting for preferred travel modes)	x	–	x
TOT_DIST_PER_WEEK (total traveled distance per week)	x	–	–
ENV_FR_MOB (air quality and CO_2 emissions impact in decisions about mobility)	–	x	x
SCORE_TRANS_SYS (supporting government actions affecting the transportation system)	–	x	x
SEV_TRAF_PROB (severity of traffic problems)	–	–	x
BILL_INFORM_MOD (issues related to billing and the provided information about modernization)	–	x	x
FIN_CONS_MOD_HIND (financing the refurbishment and further hindrances of carrying out the modernization)	–	x	x
COOL_HEAT_HAB_INF (cooling and/or heating habits plus their influencers)	–	x	x
LESS_ENERGY_CONS (less energy consumption: mobility and household appliances)	x	–	–
AGR_INCONV_EFM (accepting the inconvenience arising from environmentally friendly measures)	x	x	–

RQ2: Which socioeconomic phenomena prevail in Hungary regarding environmentally conscious consumer behavior?

Table 7 contrasts the mean of the cluster with outstanding environmental awareness with that of their counterparts in analogy with Table 5. Each asymptotic independent samples z test relies on the descriptive statistics of the most conscious customer group (Cluster 1) and the closest mean of the corresponding remaining cluster (Cluster 2 or 3). The latter figures are marked with cursive font type.

Table 7

Mean and standard deviation of the variables for each cluster (k=3), significance level of the asymptotic independent samples z tests, 477 cases, only Hungary (missing cases excluded listwise)

Variable (description)	Cluster 1 Mean	Cluster 2 Mean	Cluster 3 Mean
S1 [number of persons of the household]	2.68	2.25	*2.41*
S2 [highest level of studies]	3.15	2.81	*2.85*
S3 [current employment status]	1.51	2.54	*2.19*
S4 [year of birth]	1970.15	1963.19	*1966.45*
S5 [gender]	1.59	1.56	*1.61*
S6 [type of area]	2.36	*3.15*	3.29
S8 [financial status]	2.12	2.57	*2.57*
Number of cases	190	137	150

Variable (desription)	Cluster 1 Std. dev.	Cluster 2 Std. dev.	Cluster 3 Std. dev.	z test	p-value
S1 [number of persons of the household]	1.17	1.16	1.21	2.04	0.021
S2 [highest level of studies]	0.55	0.72	0.64	4.57	0.000
S3 [current employment status]	1.23	1.61	1.63	–4.25	0.000
S4 [year of birth]	11.63	14.74	14.61	2.53	0.006
S5 [gender]	0.49	0.50	0.49	–0.32	0.374
S6 [type of area]	1.23	0.91	0.76	–6.67	0.000
S8 [financial status]	0.57	0.68	0.62	–6.82	0.000

At a significance level of 5%, the null hypothesis can be declined for each variable except for S5. The total number of persons living in the household for at least 6 months of the year is the highest in the case of the most environmentally aware customers. They demonstrate the most favorable educational level: 92.63% of the cluster (176 persons) completed at least secondary or post-secondary non-tertiary education. As economically the most active and youngest group, 84.74% of the members (161 persons) are employed full-time. With 149 respondents (78.42%), this cluster has the largest share of urban citizens. Their overall financial status is the most advantageous: only 30 individuals (15.79%) find it difficult on present income. Interestingly, the distribution of the genders is independent of the clusters: the share of women is almost 60% in each cluster. A salient share of pensioners and rural inhabitants (both 40.15%), plus their income category explain the environmentally

friendly position of Cluster 2 in mobility; consequently, these circumstances cannot be traced back to environmental awareness. (See Table 8, ENABLE.EU team 2019: pp. 25–26) Not counting the type of area of residence, Cluster 1 demonstrates nearly the lowest dissimilarities: it incorporates the youngest, the most educated, and economically active urban customers with family and stable financial background. Tables 6 and 8 provide orientation when deciding on the details of actions.

Table 8

Distribution of the clusters based on social and economic characteristics, only Hungary (k=3)*

(%)

Variables [denomination], available answers[a)]	Cluster 1		
	1	2	3
S1 [total number of persons in the household]			
1	12.6	25.5	19.3
2	38.4	46.0	45.3
3	25.8	13.1	20.0
4	17.4	10.9	8.7
5–8	5.8	4.4	6.7
S2 [highest level of studies]			
At the most primary education	7.4	31.4	24.0
Secondary and post-secondary non-tertiary education	69.5	53.3	65.3
Tertiary education (bachelor, master, PhD)	23.2	15.3	10.7
S3 [current employment status]			
Employed full-time or part-time	84.7	52.6	64.0
Without employment for more than 3 months	0.5	2.2	1.3
Retired/pensioner	12.1	40.1	29.3
Other economically inactive persons (incl. students)	2.6	5.1	5.3
S6 [type of area of residence]			
A city with more than 0.5 million people: in its center	41.6	10.2	4.7
A city with more than 0.5 million people: outside its center	2.1	4.4	4.7
A town or a city with less than 0.5 million people	34.7	45.3	48.0
A village	21.6	40.1	42.7
S8 [financial status]			
Living comfortably on present income	7.4	2.9	0.7
Coping on present income	76.8	45.3	48.0
Finding it difficult on present income	12.1	43.8	45.3
Finding it very difficult on present income	3.7	8.0	6.0

* The indicated percentages are correct. The alteration from a total of 100% is due to rounding in the decimal place.

a) (ENABLE.EU team 2019: pp. 25–26).

Discussion

RQ1: The asymptotic independent samples z tests were repeated by applying the results of the 4-means cluster analysis. Table 9 aligns the significance level (p-value) for each variable. The legend remains unaltered: a value denoted with bold font type

in the column of Cluster 1 refers to the best attitude. Italic font type symbolizes the corresponding best or second-best values of the less conscious clusters.

Table 9

Mean and standard deviation of the variables for each cluster (k=4), significance level of the asymptotic independent samples z tests, 480 cases, only Hungary (missing cases excluded listwise)

Variable (better value)	Cluster 1 Mean	Cluster 2 Mean	Cluster 3 Mean	Cluster 4 Mean
H12B (lower)	**2.40**	3.18	*2.76*	2.99
AGR_NEG_STAT (lower)	**10.18**	11.19	*10.81*	11.11
TIME_SHARE_PREF_MODE (higher)	48.80%	*65.19%*	55.49%	52.66%
TOT_DIST_PER_WEEK (lower)	276.22	127.52	175.45	*122.12*
ENV_FR_MOB (higher)	**8.66**	6.90	*7.24*	6.61
SCORE_TRANS_SYS (higher)	**22.80**	*21.65*	21.16	20.33
SEV_TRAF_PROB (higher)	**17.36**	*17.00*	16.31	15.55
BILL_INFORM_MOD (lower)	**22.83**	33.00	30.61	*25.83*
FIN_CONS_MOD_HIND (lower)	**24.40**	41.01	*30.14*	33.87
COOL_HEAT_HAB_INF (lower)	**23.91**	32.70	*25.01*	33.98
LESS_ENERGY_CONS (higher)	0.62	0.62	0.71	*0.74*
AGR_INCONV_EFM (lower)	9.71	*9.56*	9.88	9.57
Number of cases	99	105	160	116

Variable (better value)	Cluster 1 Std. dev.	Cluster 2 Std. dev.	Cluster 3 Std. dev.	Cluster 4 Std. dev	z test	p-value
H12B (lower)	1.17	1.52	1.39	1.48	–2.23	0.013
AGR_NEG_STAT (lower)	2.22	2.52	2.20	2.21	–2.21	0.014
TIME_SHARE_PREF_MODE (higher)	0.41	0.44	0.43	0.46	–2.76	0.003
TOT_DIST_PER_WEEK (lower)	221.15	154.24	195.97	134.62	6.04	0.000
ENV_FR_MOB (higher)	1.67	2.41	2.22	2.22	5.84	0.000
SCORE_TRANS_SYS (higher)	3.87	5.13	4.45	4.10	1.82	0.035
SEV_TRAF_PROB (higher)	3.92	4.32	4.03	4.85	0.63	0.264
BILL_INFORM_MOD (lower)	3.86	4.26	3.37	3.15	–6.17	0.000
FIN_CONS_MOD_HIND (lower)	3.37	4.24	4.23	3.85	–12.06	0.000
COOL_HEAT_HAB_INF (lower)	3.18	4.56	3.32	3.61	–2.67	0.004
LESS_ENERGY_CONS (higher)	0.75	0.54	0.70	0.71	–1.25	0.106
AGR_INCONV_EFM (lower)	1.95	1.81	2.16	1.85	0.55	0.291

Halving the group of the most environmentally aware customers results at a significance level of 5% in a significant outperformance in the variables H12B, AGR_NEG_STAT, ENV_FR_MOB, SCORE_TRANS_SYS, BILL_INFORM_MOD, FIN_CONS_MOD_HIND, and COOL_HEAT_HAB_INF. With regard to SEV_TRAF_PROB, no significant difference can be stated at a significance level of 10% in spite of the best value achieved by Cluster 1. Although this cluster underperforms in the dimensions LESS_ENERGY_CONS and AGR_INCONV_EFM, the null hypotheses cannot be declined at a significance level of 10%. Finally, catch-up is required in mobility (TIME_SHARE_PREF_MODE and TOT_DIST_PER_WEEK). These results overwhelmingly coincide with those of Table 5,

including the refusal of general best performance in each field of environmental awareness. The comparison of the means of the clusters of both runs renders it possible to identify three phenomena. First, the more environmentally aware a customer is, the more favorable values can be achieved except for TIME_SHARE_PREF_MODE and TOT_DIST_PER_WEEK. Oddly, the more environmentally aware customers travel more and attribute less importance to opting for preferred travel modes. Second, the best cluster of run k=4 (in the case of 12 involved variables: 99 customers) is a subset of the best cluster of run k=3 (191 customers). By restricting the investigation to the three initial variables, Table 10 reinforces the former statement about the relation between the two best clusters at the national level as well; however, being a subset of a larger group does not imply a stricter requirement (see the two exceptions). This sheds light on the relativity and difficulty of determining the criteria for being qualified as environmentally aware.

Table 10

Means of the variables in the case of Cluster 1 split by country, 760 cases, 3 countries

Name of the variables	k=4			K3		
	Hungary	Spain	Ukraine	Hungary	Spain	Ukraine
BILL_INFORM_MOD	22.65	20.28	19.68	25.76	21.27	22.67
FIN_CONS_MOD_HIND	24.32	26.88	23.73	26.15	27.23	25.48
COOL_HEAT_HAB_INF	23.94	**26.08**	**25.32**	24.05	25.83	25.15
Number of cases	116	25	22	223	30	33

Third, none of the clusters of the run k=4 can be assigned to Cluster 2 (showing environmentally friendly mobility but heterogeneous in the remaining fields) of Table 5 (k=3); however, 52.90% of its members can be found in Cluster 2 of Table 7 (k=4). As a consequence, not only the total number of clusters but also building clusters from less environmentally aware customers are malleable. These results partly modify the combinations of proposed actions and affected clusters highlighted in Table 6, e.g., no cluster-specific action is required for LESS_ENERGY_CONS and AGR_INCONV_EFM.

RQ2: The socioeconomic differences are reflected in Table 11 by applying k=4. Each asymptotic independent samples z test makes use, on the one hand, of the means and the variances of the most conscious customer group and, on the other hand, of those of the remaining cluster with the closest mean (marked with cursive font type).

Table 11

Mean and standard deviation of the variables for each cluster (k=4), significance level of the asymptotic independent samples z tests, 477 cases, only Hungary (missing cases excluded listwise)

Variable (description)	Cluster 1 Mean	Cluster 2 Mean	Cluster 3 Mean	Cluster 4 Mean
S1 [number of persons]	2.72	2.19	2.48	*2.50*
S2 [level of studies]	3.23	2.78	*2.98*	2.87
S3 [employment status]	1.23	2.45	*2.02*	2.29
S4 [year of birth]	1971.04	1963.14	1966.52	*1967.66*
S5 [gender]	1.58	1.57	*1.57*	1.63
S6 [type of area]	2.18	3.21	*2.83*	3.24
S8 [financial status]	2.02	2.59	*2.36*	2.57
Number of cases	98	104	160	115

Variable (desription)	Cluster 1 Std. dev.	Cluster 2 Std. dev.	Cluster 3 Std. dev.	Cluster 4 Std. dev.	z test	p-value
S1 [number of persons]	1.25	1.12	1.10	1.27	1.32	0.093
S2 [level of studies]	0.51	0.71	0.60	0.68	3.68	0.000
S3 [employment status]	0.87	1.63	1.52	1.69	–5.27	0.000
S4 [year of birth]	10.67	14.23	13.30	15.55	1.87	0.031
S5 [gender]	0.50	0.50	0.50	0.48	0.20	0.420
S6 [type of area]	1.23	0.87	1.11	0.81	–4.26	0.000
S8 [financial status]	0.48	0.58	0.71	0.64	–4.54	0.000

At a significance level of 10%, the null hypothesis can be declined for each variable except for S5, which is identical to the previous results (see Table 7). Cluster 1 produced more advantageous means thanks to larger households, higher educational levels, more full-time employment, younger members, more accentuated prevailing of urbanization, and more favorable financial background. The distribution of women and men remained at approximately 60%:40% in each cluster. Cluster 2 demonstrates merely slight alterations compared to the group of the same index in Table 7 that confirms that primarily economic inactivity, higher age, the considerable share of rural inhabitants, and coping with financial difficulties entail the seemingly eminent position concerning mobility. (ENABLE.EU team 2019: pp. 25–26)

The findings are in accordance with the results of other authors. Table 12 establishes a connection between the results of this analysis and the statements of cited articles by relying on Tables 6 and A1.

Table 12

Reflecting on the statements from the literature review

Name of the author(s)	Statement(s) of the cited authors	Appearance in this study
Barbarossa–Pastore	Higher perceived prices and improper communication as impediments	Confirmation: AGR_INCONV_EFM and BILL_INFORM_MOD, both needing improvement
Raletić Jotanović et al.	1. Differences in pro-environmental consumer behavior among nations 2. Role of demographic and socioeconomic characteristics (e.g., educational level, monthly income)	1. Confirmation: Table 10 2. Confirmation: Tables 7 and 11
Zalega	Factors resulting in sustainable consumption patterns: gender, age, educational background, monthly disposable income, place of residence, and attending courses of the University of the Third Age	Regardless of gender and attending courses confirmation: Tables 7 and 11
Craig	Clients being aware of energy efficiency programs realize reductions in both consumption and emissions.	From a broader perspective confirmation as the correlation between FIN_CONS_MOD_HIND and COOL_HEAT_HAB_INF is +49.70%.
Werner	Lack of susceptibility for carbon dioxide emission reductions	Confirmation in governance, refutation in mobility, the means of the variables [best value]: M5H as part of ENV_FR_MOB: 3.91 [5] M8D as part of SCORE_TRANS_SYS: 3.42 [5] M9F as part of SEV_TRAF_PROB: 4.23 [5] LESS_ENERGY_CONS: 0.68 [3] G5B and G5D as part of AGR_INCONV_EFM: 2.78 [5] and 4.59 [1]
Ge et al.	Role of initial cost and allowance in the spread of solar heating and cooling systems	Confirmation: FIN_CONS_MOD_HIND, needing improvement
Chen et al.	Role of the cost of devices and the price of grid electricity, emphasizing realizable energy savings and economic benefits	BILL_INFORM_MOD, G5B and G5D as part of AGR_INCONV_EFM, each of them needing improvement
Eon et al.	Role of technology, practices, knowledge, and behavior in heating and cooling	BILL_INFORM_MOD, FIN_CONS_MOD_HIND, COOL_HEAT_HAB_INF, each of them needing improvement

RQ1: The findings elucidated that none of the clusters can be considered a paragon. Even the most environmentally aware customers demonstrate less conscious attitudes in several aspects of mobility and governance. Evaluating the

declared attitudes of customers by means of cluster analyses and asymptotic independent samples z tests identified the territories to be dealt with.

RQ2: In view of socioeconomic attributes, the group of the most environmentally aware customers is the most homogeneous, as it embodies the most educated, economically active urban citizens with family and stable financial background.

Conclusion, limitations, and further research

RQ1: This study attempted to describe the type of customer appertaining to various levels of environmental awareness by virtue of selected fields of the sections on home, mobility, heating and cooling, plus governance. Subsequently, the directions of increasing consciousness were designated in a tailored manner with respect to the level of environmental awareness. In addition, the scrutiny disclosed concomitant phenomena. The more environmentally aware a customer is, the more favorable values can be achieved except for the share of preferred travel mode and the total traveled distance. Decision-makers must face the inherent relativity and difficulty of narrowly determining the criteria for being qualified as environmentally aware. Not only the total number of different levels of awareness but also building clusters from less environmentally aware customers are malleable.

RQ2: Social and economic characteristics play a crucial role in shaping the choices of customers toward environmentally conscious consumption. The group of the most environmentally aware customers can be identified by reason of their qualities emerging in higher educational level and monthly income, economically active employment status, living in urban areas in a household with on average 2.7 members. Less conscious groups are more heterogeneous by demonstrating significant deviations from the best performers.

Limitations and future research

The results have some limitations. First, one of the limitations is engendered by the missing values represented by the 'Do not know' or 'Did not answer/No answer/Refuse to answer' or 'Not applicable' records in the dataset. The greater the number of involved variables is, the more this general deficiency prevails. Table 13 outlines the impacts of missing values resulting in decreasing datasets and restricted circles of countries suitable for analysis. Ignoring missing values for the sake of a larger dataset is not recommended, as it would render particular attitudes incomparable plus would lead to incorrect conclusions, e.g., empty cells would produce many favorable low values in the case of the variables of heating and cooling, which is not due to environmental awareness. Likewise, the opposite direction remains problematic, as achieving a smaller value cannot be traced back to conscious value declarations arising from a low level of environmental awareness. Hence, by

dealing with the trade-off between larger datasets and the quality of results, the latter was given priority in this article.

Table 13

Number of records split by countries

Country	All records irrespective of missing values	Number of full records		
		3 variables (Heating and cooling)	+9 extra variables (Home, Mobility, Governance)	+7 socioeconomic variables
Hungary	1,022	569	480	477
Spain	760	102	0	0
Ukraine	1,011	89	0	0
Total	2,793	760	480	477

Second, Table 1 foreshadowed a limitation with respect to the sections. Only a subset of countries proved to be appropriate in merit for analysis in spite of the 11 ones in the ENABLE.EU database. By applying a balanced initial point in light of the trade-off between involving more states and assessing more topics, the final results rest solely on Hungarian data.

Future research may provide more profound insights into single sections and reveal the interrelatedness between the sections on prosumer and electricity.

Seeking a remedy for global problems begins with educating and mobilizing customers so that they act in an environmentally conscious way. Although the hypothesis of the simultaneous presence of best-practice routines could not be buttressed, a general approach may prove to be the most effective instrument when raising the awareness of less conscious groups of the population to bolster improvements and hence greening a larger slice of the economy.

Reducing resource consumption (including energy use) in the areas of housing and mobility habits and transforming households into prosumers are globally viable means coupled with a high standard of living. These cover shifting toward local vegan/plant-based/nutritional habits, applying energy efficiency and relying on renewable energy sources in dwellings, collecting waste selectively, making use of public transport or private electric vehicles, prolonging the effective lifespan of products, seeking repairs and further services with a low environmental load. In addition, environmental awareness will advantageously impact the assessment of and identification with national policies.

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APPENDIX

Table A1

Set of the original and transformed variables

Section	Name of the variable applied for the analysis [Brief description of the variable] /Monotonicity of favorable values/	Name of the original variables and their brief description
Home/Building characteristics and household possessions	H12B [proportion of energy-efficient bulbs inside homes] /decreasing/	
	AGR_NEG_STAT [agreeing with negative statements about environmental issues] /decreasing/ =H15A+H15B+H15C+(5-H15D)+H15E	H15A [refusing to act] H15B [environmental impacts being overstated] H15C [shifting problems to future generations] H15D [making compromises in current lifestyle] H15E [financial consequences of environmental policies]
Mobility	TIME_SHARE_PREF_MODE [time share of preferred travel modes] /increasing/ $= \frac{\sum_{i=A}^{E}\left[\sum_{j\in j*} M3(i)2\_Time\_(j)\right]\cdot M1(i)}{\sum_{i=A}^{E}\left[\sum_{j=1}^{11} M3(i)2\_Time\_(j)\right]\cdot M1(i)}$	M1(i) [weekly number of days split by destinations, 5 variables] M3(i)2_Time_(j) [travel time split by travel mode, 11 variables] (i) is the index of the most frequent destinations, i={A, B, C, D, E} (j) is the index of the travel mode, j={1, 2, …, 11}, thereof preferred are j*=j\{1,4,11}
	TOT_DIST_PER_WEEK [total distance per week] /decreasing/ $= 2\cdot\sum_{i=A}^{E} M1(i)\cdot M4(i)$	M1(i) [weekly number of days split by destinations, 5 variables] M4(i) [distance from home to destination in km split by destinations, 5 variables] (i) is the index of the most frequent destinations, i={A, B, C, D, E}
	ENV_FR_MOB [environmentally friendly mobility] /increasing/ =M5G+M5H	M5G [importance of air quality impact in decisions] M5H [importance of CO_2 emissions impact in decisions]

(Table continues on the next page.)

(Continued.)

Section	Name of the variable applied for the analysis [Brief description of the variable] /Monotonicity of favorable values/	Name of the original variables and their brief description
Mobility	SCORE_TRANS_SYS [score of supporting government actions affecting the transportation system] /increasing/ $= \sum_{i=C}^{H} M8(i)$	M8C [bike lanes and speed controls] M8D [tests and manufacturer emissions standards] M8E [faster public car-sharing and public transport] M8F [more attractive public transport] M8G [reducing transportation distances] M8H [compressed workweeks and home office]
	SEV_TRAF_PROB [severity of traffic problems] /increasing/ $= \sum_{i\in\{A,B,C,D,F\}} M9(i)$	M9A [traffic congestion] M9B [traffic noise] M9C [excessive presence of vehicles] M9D [local air quality] M9F [global warming]
Heating and cooling	BILL_INFORM_MOD [issues related to billing and the provided information about modernization] /decreasing/ =C4D+C5A+C5C+(6–C6A)+(6–C6B)+(6–C6C)+(6–C6D)+(6–C7A)+(6–C7B)	C4D [payback of investment] C5A [regularity of feedback on energy consumption] C5C [interpretation of energy bills] C6A [comparative feedback on energy consumption] C6B [providing information on smart and easy techniques] C6C [frequency of measuring and billing] C6D [energy-saving tips and reminders for energy-saving actions] C7A [advice on energy savings from experts] C7B [advice on energy savings in the media]

(Table continues on the next page.)

(Continued.)

Section	Name of the variable applied for the analysis [Brief description of the variable] /Monotonicity of favorable values/	Name of the original variables and their brief description
Heating and cooling	FIN_CONS_MOD_HIND [opportunities and difficulties emerging when financing the refurbishment and further hindrances of carrying out the modernization] /decreasing/ =C4A+C4B+C4C+C4E+C4F+C4K+C4L +C4M+(6–C7C)+(6–C7D)+(6–C7E)+ (6–C7F)	C4A [lack of money for refurbishment or insulation] C4B [available loans with unfavorable conditions] C4C [missing subsidies for refurbishment] C4E [large dwelling with high heating costs] C4F [the owner differs from the tenant, missing willingness to save energy] C4K [difficulties caused by the dependence on all tenants] C4L [limitations coupled with old buildings] C4M [burdensome nature of renovations] C7C [financing the investment from energy savings] C7D [refurbishment at an affordable price due to the help of local actors] C7E [national energy efficiency grants and assistance] C7F [expanding energy subsidies programs]
	COOL_HEAT_HAB_INF [cooling and/or heating habits plus their influencers] /decreasing/ =C4G+C4H+C4I+C4J+(6–C5B)+(6–C5D)+(6–C5E)+C5F+C5G+C5H+C5I	C4G [being at home and heating during daytime] C4H [lack of individual metering] C4I [unworthiness of refurbishment in the case of old and inefficient dwellings] C4J [energy bill dependent on the consumption of other households] C5B [low and/or affordable amount of energy bills] C5D [heating with own garbage] C5E [seizing available energy-saving opportunities] C5F [not energy-conscious neighbors] C5G [forgotten control of the room temperature] C5H [postponing saving plans] C5I [neighbors heating with garbage]

(Table continues on the next page.)

(Continued.)

Section	Name of the variable applied for the analysis [Brief description of the variable] /Monotonicity of favorable values/	Name of the original variables and their brief description
Governance	LESS_ENERGY_CONS [less energy consumption thanks to environmentally friendly alternatives] /increasing/ =G1A1+G1A2+G1A3	G1A1 [new car with low fuel consumption] G1A2 [walking, biking, public transport, car-sharing] G1A3 [more energy-efficient household appliances]
	AGR_INCONV_EFM [agreeing with the inconvenience arising from environmentally friendly measures] /decreasing/ =G5A+(6–G5B)+G5D	G5A [severe limitations in city centers for cars causing air pollution] G5B [affordability of renewable energy solutions] G5D [paying a higher price for electricity from renewable energy sources]
Social and economic characteristics	S1 [total number of persons living in the household for at least 6 months of the year] =S1Ac1+S1Ac2+S1Ac3+S1Bc1+S1Bc2+S1Bc3	S1Ac1 [women under the age of 18 years] S1Ac2 [women aged between 18 and 65 years] S1Ac3 [women older than 65 years] S1Bc1 [men under the age of 18 years] S1Bc2 [men aged between 18 and 65 years] S1Bc3 [men older than 65 years]
	S2 [highest level of completed studies]	
	S3 [current employment status]	
	S4 [year of birth]	
	S5 [gender]	
	S6 [type of area of residence]	
	S8 [category of household's current income]	

Note: Example for the interpretation: In the case of COOL_HEAT_HAB_INF, smaller values are better due to decreasing monotonicity. A low total score expresses the ease of reducing energy consumption and/or its costs, while a higher total score hints at difficulties in their diminution.

REFERENCES

BARBAROSSA, C.–PASTORE, A. (2015): Why environmentally conscious consumers do not purchase green products *Qualitative Market Research: An International Journal* 18 (2): 188–209. https://doi.org/10.1108/QMR-06-2012-0030

BILD DER WISSENSCHAFT (2019): Vol. September.

CHEN, Y.–HUA, H.–XU, J.–WANG, J.–LUND, P. D.–HAN, Y.–CHENG, T. (2022): Energy, environmental-based cost, and solar share comparisons of a solar driven cooling and heating system with different types of building *Applied Thermal Engineering* 211: 118435. https://doi.org/10.1016/j.applthermaleng.2022.118435

CRAIG, C. A. (2016): Energy consumption, energy efficiency, and consumer perceptions: A case study for the Southeast United States *Applied Energy* 165: 660–669. https://doi.org/10.1016/j.apenergy.2015.12.069

EON, C.–MORRISON, G. M.–BYRNE, J. (2018): The influence of design and everyday practices on individual heating and cooling behaviour in residential homes *Energy Efficiency* 11: 273–293. https://doi.org/10.1007/s12053-017-9563-y

GE, T. S.–WANG, R. Z.–XU, Z. Y.–PAN, Q. W.–DU, S.–CHEN, X. M.–MA, T.–WU, X. N.–SUN, X. L.–CHEN, J. F. (2018): Solar heating and cooling: Present and future development *Renewable Energy* 126: 1126–1140. https://doi.org/10.1016/j.renene.2017.06.081

HUNYADI, L.–MUNDRUCZÓ, G.–VITA, L. (2000): *Statisztika* Aula, Budapest.

KASHOUR, M. (2023): Interlinkages between human development, residential energy consumption, and energy efficiency for the EU-27 member states, 2010–2018 *Regional Statistics* 13 (1): 36–54. https://doi.org/10.15196/RS130102

LAKE, A.–REZAIE, B.–BEYERLEIN, S. (2017): Review of district heating and cooling systems for a sustainable future *Renewable and Sustainable Energy Reviews* 67: 417–425. https://doi.org/10.1016/j.rser.2016.09.061

RALETIĆ JOTANOVIĆ, S.–SUDAREVIĆ, T.–KATIĆ, A.–KALINIĆ, M.–KALINIĆ, Č. (2016): Environmentally responsible purchasing – Analysis of the ex-Yugoslavian republics *Applied Ecology and Environmental Research* 14 (3): 559–572. https://doi.org/10.15666/aeer/1403_559572

SANTAMOURIS, M. (2016): Cooling the buildings – past, present and future *Energy and Buildings* 128: 617–638. https://doi.org/10.1016/j.enbuild.2016.07.034

ÜRGE-VORSATZ, D.–CABEZA, L. F.–SERRANO, S.–BARRENECHE, C.–PETRICHENKO, K. (2015): Heating and cooling energy trends and drivers in buildings *Renewable and Sustainable Energy Reviews* 41: 85–98. https://doi.org/10.1016/j.rser.2014.08.039

WERNER, S. (2017): International review of district heating and cooling *Energy* 137: 617–631. https://doi.org/10.1016/j.energy.2017.04.045

ZALEGA, T. (2018): Environmental awareness, green consumerism and environmentally conscious consumer behaviour of Polish seniors *Problemy Zarzadzania – Management Issues* 16 (3(75)): 114–131. https://doi.org/10.7172/1644-9584.75.7

INTERNET SOURCES

ENABLE.EU TEAM (2019): *Households survey questionnaire.* http://www.enable-eu.com/wp-content/uploads/2019/10/enable_eu_dataset_households.zip (downloaded: July 2022)

GLOBAL FOOTPRINT NETWORK (2015): *How can Mediterranean societies thrive in an era of decreasing resources?* https://www.footprintnetwork.org/content/documents/MED_2015_English.pdf?_ga=2.210816080.430637697.1666889887-1797493940.1666889887 (downloaded: October 2022)

GLOBAL FOOTPRINT NETWORK (2023): *Earth overshoot day.* https://www.overshootday.org/ (downloaded: January 2023)

HUNGARIAN CENTRAL STATISTICAL OFFICE (HCSO) (2022): *22.1.3.3. Mid-year population [million persons].* https://www.ksh.hu/stadat_files/nep/en/nep0054.html (downloaded: January 2023)

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) (2022): *Climate change 2022: Impacts, Aaaptation and vulnerability. Contribution of working group II to the sixth assessment rport of the intergovernmental panel on climate change.* https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FullReport.pdf (downloaded: August 2022)

STATISTA (2022): *Final energy consumption in Central and Eastern Europe (CEE) in 2020, by sector and selected country.* https://www.statista.com/statistics/1353421/cee-final-energy-consumption-by-sector/ (downloaded: January 2023)

SZÜLE, B. (2016): *Introduction to data analysis* Corvinus University of Budapest, Faculty of Economics, Budapest. http://unipub.lib.uni-corvinus.hu/2317/1/Introduction_to_data_analysis.pdf (downloaded: April 2020)

UNITED NATIONS (2015): *A/RES/70/1 Transforming our world: the 2030 Agenda for sustainable development.* https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf (downloaded: October 2022)

UNITED NATIONS (2022): *The Paris agreement.* https://www.un.org/en/climatechange/paris-agreement (downloaded: August 2022)

UNITED NATIONS – DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS (2022): *The sustainable development goals report 2022.* https://unstats.un.org/sdgs/report/2022/The-Sustainable-Development-Goals-Report-2022.pdf (downloaded: October 2022)

WORLD BANK (2022a): *Urban development.* https://data.worldbank.org/topic/urban-development (downloaded: October 2022)

WORLD BANK (2022b): *Urban development overview.* https://www.worldbank.org/en/topic/urbandevelopment/overview (downloaded: October 2022)