HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

Exploring the patterns of electricity consumption behavior of Hungarian households in the context of sustainability

THESES OF DOCTORAL (PhD) DISSERTATION

NAÁR ANTAL TAMÁS

GÖDÖLLŐ
2022

The name of the doctoral school is: Doctoral School of Economics and Regional Sciences

Discipline of the doctoral school: management and organizational sciences

Head of the doctoral school: **Prof. Dr. Zoltán Lakner**
university professor, correspondent member of the Hungarian Academy of Sciences
Hungarian University of Agricultural and Life Sciences
Institute of Agricultural and Food Economics

Supervisor: **Dr. Vinogradov Szergej**
associate professor
Hungarian University of Agricultural and Life Sciences
Institute of Agricultural and Food Economics

…………………………………   …………………………………
  Approval of the Head of School   Approval of the Supervisor

CONTENT

1. INTRODUCTION

The study of energy-saving behavior of households has been highlighted in modern research (MARTINSSON et al. 2011, YUE et al. 2013, BATIH - SORAPIPATANA 2016, TROTTA 2018). Encouraging the improvement of household energy efficiency is important for sustainability. BOOGEN (2017) examined the electricity consumption of Swiss households and found that energy loss accounts for 20–25% of household energy consumption.

The terms sustainability and sustainable development appeared in scientific context at the end of the 20th century. At the beginning of the 20th century, they began to spread rapidly in the public consciousness. The basic values of sustainability are social justice, a systematic approach and a good quality of the environment (GYULAI 2011). The significance of sustainability as the main attribute of development today lies in the fact that, as the scientific results of recent decades have shown, the current way of life of humankind cannot be sustained in the long-term. If we fail to change the usual attitude patterns, thinking and actions based on them, the history of mankind may reach a dead end fairly quickly (FODOR 2020).

The 'Common Future' report (Brundtland report): After almost four years of work, the Commission published its 'Our Common Future' report in 1987, which called sustainable development the way that meets the needs of the present. A way that does not jeopardize the needs of future generations. It is probable that since man has existed on earth, he has been preoccupied with the idea that he should protect his environment (GYULAI 2011).

In the words of LÁNYI (2007), we suffer from the "global interdependence", of the consequences of irresponsible decisions.

In connection with environmental awareness, it is very important to understand the behavior of individual consumers, to analyze and forecast their values, attitudes, motivations and behavior. Which are the subjects of my research.

In my dissertation, I am looking for the answer to what the factors that influence the energy awareness of Hungarian households are, for which I have compiled four groups of questions. In line with the research goals, I formulated eight research hypotheses and five sub-hypotheses for five out of eight.

Through the course of the literature review, I analyze the concept of sustainability, describe the models of environmentally conscious behavior, examine consumer behavior, attitudes towards environmental awareness and energy-saving behavior, and present the energy consumption trends of households.

Next, in the Material and Methods chapter, I describe the process of empirical research, the conceptual model of the research, the process of data collection, and the main features of the sample. I cover the use of electrical appliances in households, self-assessment of the factors influencing customer behavior, and a description of the statistical methods used.

In the results chapter I present the analysis of the validity of studied dimensions, the results belonging to the structural model, the effect of socio-demographic characteristics and the characteristics of residential properties on environmental awareness and energy-saving behavior.

I will then present my four new scientific findings, as well as my conclusions and suggestions.

1.1. Description of the research topic

My empirical research consists of two main modules: the first is to explore the relationships between the dimensions of environmental awareness and energy-saving behavior (structural model), and the second is to examine significant differences in the values of the studied dimensions (type of household, type of dwelling, etc.). The subject of the research is the attitudes and behavioral elements related to the electricity consumption of Hungarian households.

In my dissertation, I am looking for the answer to the factors that influence the energy awareness and energy saving behavior of Hungarian households.

1.2. Significance of research

My chosen research topic is topical in several respects. The International Energy Agency has estimated the evolution of the World's energy reserves and energy needs for the coming

decades, which it published in its annual report (IEA-WEO: World Energy Outlook). According to the Paris-based organization, the World's population is expected to grow by 1.7 billion between 2010 and 2035, bringing the world's population to well over 8.5 billion in 2035. According to the organization, the most significant population growth is expected in Asia and Africa. For example, by 2025, India's population is projected to exceed 1.5 billion, most likely going beyond that of China. The outlined growth of the population in the EU Member States has led to a decrease in energy demand. This process is further strengthened by the fact that the value of the urbanization rate (ie the degree of urbanization) is expected to increase significantly in parallel with population growth.

Sustainability and environmental awareness have been high on the political agenda for decades. Several studies (KARJALAINEN 2011, WANG et al. 2011, SANQUIST et al. 2012) have been conducted to explore the possibilities of reducing household energy consumption. In my research, I aimed to develop a model that would help better understand how the environmental awareness of households is integrated into their decisions about electricity use. However, LI et al. (2021) found that environmental awareness alone does not necessarily lead to an actual reduction in energy consumption, and the role of subjective factors may also be significant. Households' subjective attitudes can significantly influence decisions to buy more energy-efficient products and encourage environmentally friendly behavior. The research results allow us to draw political conclusions that justify a more active role of the state in shaping social environmental awareness related to sustainable development.

In addition to the factors related to energy saving attitudes of individuals, the economic environment of households can also play a significant role in shaping energy-saving consumer behavior. Hungarian electricity prices have also risen significantly over the past six months, making the war in Ukraine an even more precarious influence. Futures and spot electricity prices on the Hungarian stock exchange rose drastically in parallel with gas prices. Institutions that are currently entering into a new contract or whose electricity costs are adjusted to stock prices are worse off with the drastic rise in prices.

As defined by the World Energy Council, sustainability in the energy sense rests on three essential factors: energy security, equity in access to energy, and energy sustainability. Energy efficiency also plays an important role in the index set by the energy trilemma theory and in creating sustainable development.

Based on the targets set by the European Council in October 2014, a 27% increase in energy efficiency by 2030 (compared to 2014) should be achieved. This value will be refined in 2020, which is likely to aim for an increase in energy efficiency levels to 30% within the European Union. An increase in energy efficiency of 1% is estimated to lead to a 2.6% reduction in gas imports, thus reducing the Union's energy dependence.

Data from 2019 show that the level of energy consumption in the EU is roughly the same as in 1990, as only half of the Member States (14 states) reduced their gross domestic energy consumption between 1990 and 2019. I would also like to emphasize, citing statistical calculations, that households are responsible for 25.2% of final energy consumption, which is roughly the same as the final energy consumption of the Industry. This is fundamentally due to the inadequate energy efficiency of 74.9% of the housing stock in the European Union. Investment habits and consumer expectations have also undergone fundamental changes, making the issue of energy efficiency even more pressing. The Member States of the European Union must take steps to exploit the energy efficiency potential of buildings, primarily at regional and local level (CSEGŐDI - NAÁR 2018).

I consider the analysis of this area to be particularly important because the 2012 Energy Efficiency Directive requires Member States to increase the level of energy efficiency in public buildings by 3% per year (CSEGŐDI - NAÁR 2017). For example, the 2010 Energy Performance of Buildings Directive stipulates that from 2021, all new buildings must have near-zero emissions. According to the questionnaires, the Hungarian population living in smaller settlements considers themselves to be fundamentally environmentally conscious, and the state has established the National Energy Network to reduce the energy consumption of public institutions, businesses and the population. However, achieving energy efficiency would not only be a matter of regulation, but would also require financial incentives from the state in this area. It is also essential to have up-to-date information from outside about application opportunities, legislation and other available resources.

The cost of gas-fired power plants' production plays an important role in the development of electricity prices. The significant rise in gas prices has a similarly significant impact on the growth of electricity prices. Before the Russian invasion of Ukraine, the price of line electricity on the Hungarian commodity exchange was 140-150 Euros / MWh which, rose to 338 Euros

afterwards. Then, in the second half of December 2021, the gas exchange price reached a new all-time high, reaching € 420 due to the uncertainty of Russian gas supplies.

Due to risky gas supplies from Russia, several European countries, including Germany and Poland, are demanding a full energy embargo, so scenarios are also being drawn up to cut off Russian gas supplies.

1.3. Research goals, hypotheses

In this subchapter, I describe my research goals and hypotheses formulated during my doctoral research.

During my doctoral research, I formulated the following research goals:

> 1. To explore the attitudes and norms that influence environmental awareness.
>
> 2. To determine the impact of environmental awareness and subjective factors (f.e. household income situation, condition of residential real estate, etc.) on household energy-conscious behavior related to electricity consumption, such as the choice of energy-saving products.

One of the starting hypotheses of my research was that one of the important measures of interest in the environment is the extent to which the respondent is interested in the possibilities of preserving the condition of the nearest environment, i.e. the property he owns. I began from the premise that if the respondent attaches great importance to the protection of his / her property in terms of his / her demanding environment, this will also be true from the approach that the respondent expects to pay more attention to the protection of his / her environment.

The other group of questions in my work therefore concerned what the respondent's attitude towards his or her home was, how important he or she considered it, and how likely he or she was to make the decisions he or she made. To this end, I have made three statements.
The next group of questions in my study was about the extent to which the residents of the property consider themselves independent factors, i.e. independent decision-makers, and the extent to which they have ideas and a definite opinion on how they would like to further develop their property.

The fourth set of questions in my research was openness to innovation.

In line with the research objectives, I formulated eight research hypotheses, the first five of which relate to attitudes and elements of the social and market environment influencing energy awareness and energy-saving behavior. The sixth relates to the relationship between energy awareness and energy-saving behavior, and the last two to socio-demographic, and the impact of residential property characteristics on environmental awareness and energy-saving behavior, as well as on the attitudes and factors that influence them:

H1. Consistency as well as autonomy in decision making have a positive impact on environmental awareness.

    H1a. Consistency in household energy management is correlates positively with the autonomy of decision-making.

    H1b. Consistency has a positive effect on environmental awareness.

H2. Perceptions of energy saving efficiency as well as openness to novelty have a positive impact on environmental awareness.

    H2a. Openness to novelty correlates to the perceived efficiency of energy saving.

    H2b. Perceived efficiency has a positive effect on environmental awareness.

H3. Supporting the pursuit of energy saving from the direct human environment (psychological empowerment) has a positive effect on environmental awareness, and reinforces energy-saving behavior.

    H3a. The immediate human environment that encourages energy conservation has a positive effect on environmental awareness.

    H3b. The immediate human environment that encourages energy conservation has a positive effect on energy-saving behavior.

H4. Supporting the pursuit of energy saving from the more extensive human environment (social support) increases environmental awareness, and has a positive effect on energy-saving behavior.

    H4a. Social support has a positive effect on environmental awareness.

H4b. Social support has a positive effect on energy-saving behavior.

H5. Financial and professional support for the development of energy-saving systems (market incentives) has a positive effect on environmental awareness, and a positive effect on energy-saving behavior.

H5a. Market incentives have a positive effect on environmental awareness.

H5b. Market incentives have a positive effect on energy-saving behavior.

H6. A higher level of environmental awareness has a visible impact on energy-saving behavior.

H7. The sociodemographic characteristics of individuals and households (gender, age, education, household size and composition, income, region) significantly influence their attitudes towards environmental awareness and energy saving.

H8. The characteristics of residential real estate (form of ownership, type of residential real estate, age, condition) significantly influence the attitudes of individuals towards environmental awareness and energy saving.

2. MATERIAL AND METHOD

The chapter is divided into three parts. In the first subchapter, the process of empirical research is presented, in the second part, the process of data collection and the main features of the sample are introduced. The third subchapter describes the statistical methods used, and the software used for data analysis.

2.1. The process of empirical research

The course of the research is illustrated on Figure 1. The empirical research consists of two main parts: the first is to explore the relationships between the dimensions of environmental awareness and energy-saving behavior (structural model), and the second is to examine significant differences in the values of the studied dimensions(type of household, type of dwelling, etc.).

```
┌─────────────────────────────────────────────────────────────┐
│        Literature review and conceptualization of research   │
│              (identifying research dimensions)               │
└─────────────────────────────────────────────────────────────┘
                              ↓
┌─────────────────────────────────────────────────────────────┐
│     Survey on energy saving behavior among Hungarian         │
│                      households                              │
│                        (n=602)                              │
└─────────────────────────────────────────────────────────────┘
                              ↓
┌─────────────────────────────────────────────────────────────┐
│ Exploring the factors influencing energy saving behavior in  │
│ the case of Hungarian households                             │
│ (exploratory factor analysis, checking the internal          │
│ consistency of constructs identified on the                  │
│ basis of the literature: Cronbach's alpha, CR, AVE)          │
└─────────────────────────────────────────────────────────────┘
                              ↓
┌─────────────────────────────────────────────────────────────┐
│          Validation of research constructions                │
│ (confirmatory factor analysis, structural equation modeling, │
│                          SEM)                               │
└─────────────────────────────────────────────────────────────┘
            ↓                               ↓
┌──────────────────────────┐   ┌───────────────────────────────┐
│  Examining relationships │   │ Analysis of the significant   │
│  among constructs        │   │ differences in the values of  │
│  (structural model, SEM, │   │ the research dimensions among │
│  checking model fit:     │   │ the groups formed on the      │
│  χ2/df , CFI, TLI,       │   │ basis of the sociodemographic │
│  RMSEA)                  │   │ characteristics and the       │
│                          │   │ dwelling characteristics      │
│                          │   │ (Mann-Whitney test,           │
│                          │   │ Kruskal-Wallis test,          │
│                          │   │ Dunn-Bonferroni post hoc test)│
└──────────────────────────┘   └───────────────────────────────┘
```

Figure 1. The course of the research
Source: Self-made

2.2. Operationalization of the research model

The measurement and structural model, which incorporates attitudes and behavioral elements related to environmental awareness and energy-saving behavior, contains nine latent constructs (Figure 2).

According to the original conceptual model, eleven research dimensions were identified, two target dimensions (environmental awareness and energy-saving behavior) and nine explanatory dimensions. Two explanatory dimensions (Self-Knowledge and Beliefs) were omitted from the model due to their low internal consistency.
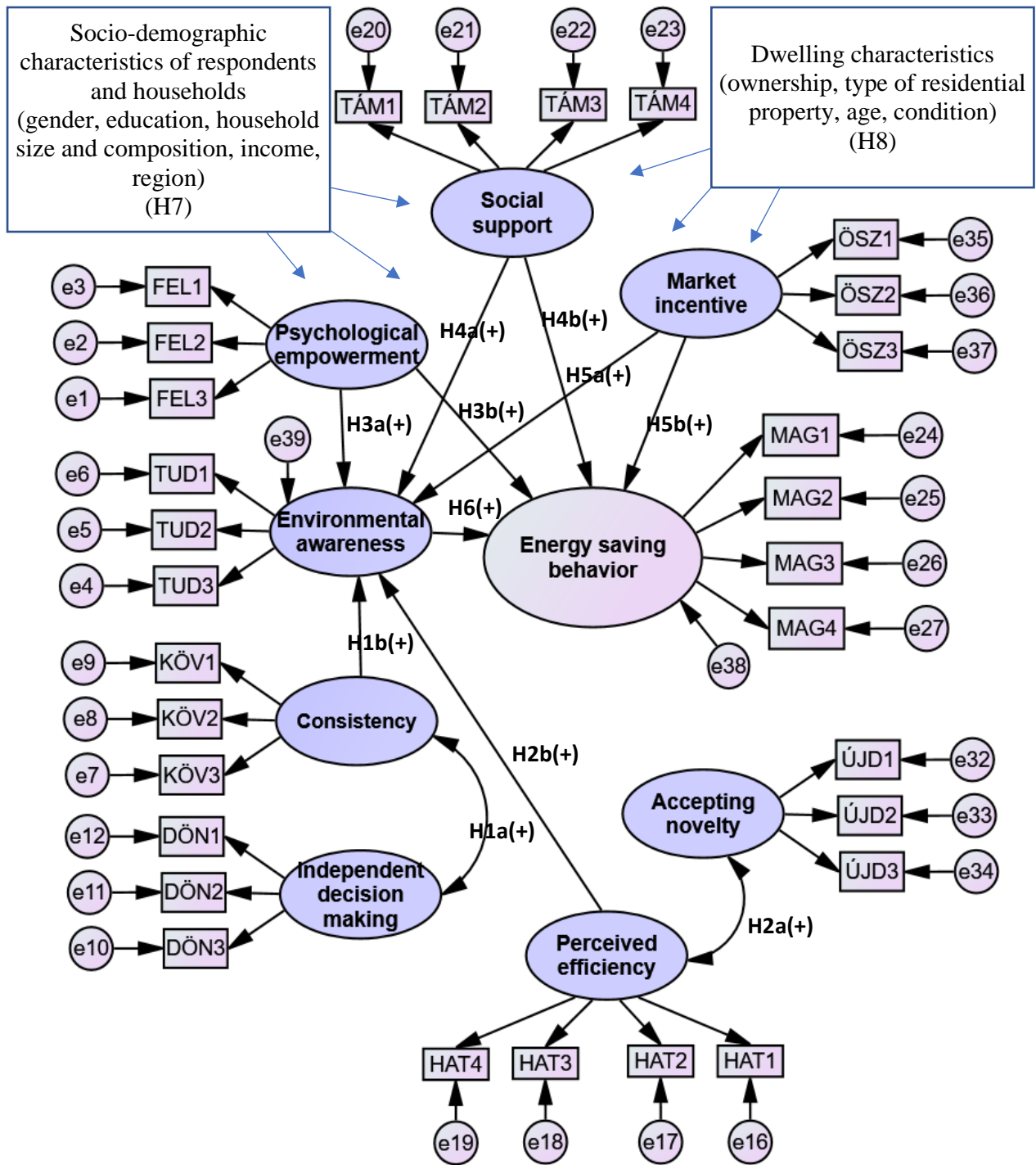
Figure 2. Operationalized research model
Source: Own research

The operationalized research model consists of a measurement model presenting the components of each research dimension (constructs) and a structural model analyzing the relationships between the dimensions. The operationalized model also includes socio-demographic characteristics of respondents and households, as well as characteristics of

residential real estate. According to the seventh and eighth research hypotheses, these characteristics significantly influence attitudes and behavioral elements related to environmental awareness and energy-saving behavior.

2.3. *The process of data collection, and the main features of the sample*

The data needed for the empirical research was obtained from our own online questionnaire survey. The online interface of the questionnaire was structured with the LimeSurvey questionnaire editing software. The target population was Hungarian households. Participation in the survey was voluntary, and the questionnaires were completed anonymously based on a random sample.

Statements measured on a five-point Likert scale were used to measure the energy awareness of Hungarian households. One value on the scale corresponded to total disagreement and five to total agreement.

The questionnaire contained 53 questions, the full text of which can be found in Annex 2.

The main groups of questions were:

1.   Socio-demographic data of respondents and households (5 questions).
2.   Data on residential real estate (11 questions).
3.   Statements examining the sustainability aspects of electricity consumption in Hungarian households (14 questions).
4.   Questions related to the purchase of energy saving appliances / household appliances (2 questions and 21 statements).

The online interfaces were open for completion between October 14, 2021, and December 6, 2021, and data from 602 fully completed questionnaires were accepted.

The main sociodemographic data of the respondents and the households are summarized in Table 1. 66.3% of the respondents are women and 33.7% are men. In terms of average age, the vast majority of respondents were in the 31-50 age group. More than forty percent (42.6%) of all respondents were in this age group. One-third of the respondents were members of the 18- to 25-year-old generation, and the proportion of respondents over the age of 51 in the sample was about ten percent.

Table 1. Main sociodemographic and other characteristics of the sample

Variable	Category	Frequency	Percentage
Gender	Female	399	66.3
	Male	203	33.7
Age	18-25 years old	209	34.7
	26-30 years old	82	13.6
	31-40 years old	122	20.3
	41-50 years old	134	22.3
	51-65 years old	49	8.1
	over 65 years old	6	1.0
Education	Secondary vocational education	164	27.2
	Higher vocational programme	73	12.1
	College	178	29.6
	University/PhD	187	31.1
Region	Budapest	162	26.9
	Southern Great Plain (Bács-Kiskun, Békés, Csongrád)	41	6.8
	Southern Transdanubia (Baranya, Somogy, Tolna).	90	15.0
	Northern Great Plain (Hajdú-Bihar, Jász-Nagykun-Szolnok, Szabolcs-Szatmár-Bereg)	24	4.0
	Northern Hungary (Borsod-Abaúj-Zemplén, Heves, Nógrád)	82	13.6
	Central Transdanubia (Fejér, Komárom-Esztergom, Veszprém)	39	6.5
	Western Transdanubia (Győr-Moson-Sopron, Vas, Zala)	30	5.0
	Pest	134	22.3
Household size	one person	52	8.6
	two people	188	31.2
	3-4 people	263	43.7
	more than 4 people	99	16.4
Type of household (composition) *	Single-person household	52	8.6
	Two adults, no dependent children, both adults under 65 years of age	154	27.2
	Two adults, no dependent children, at least one adult has reached retirement age (65 years)	18	3.2
	Single - parent household, one or more dependent children	43	7.6
	Two adults, one dependent child	85	15.0
	Two adults with more than one dependent child	136	24.0
	Other households with dependent children (eg. more than two adults)	44	7.8
	Other households without dependent children (eg. more than two adults)	37	6.5
Net monthly income of the household per capita, thousand HUF*	Under 100 thousand HUF	45	7.5
	HUF 101-150 thousand	95	15.9
	151-200 thousand HUF	102	17.1
	201-250 thousand HUF	101	16.9
	251-300 thousand HUF	88	14.7
	over HUF 300 thousand HUF	166	27.8

* *Absolute and percentage distribution of evaluable responses*

Source: Own survey, n = 602

From the perspective of the regional distribution of respondents, it is clear that the proportion of the population in the region of Borsod-Abaúj-Zemplén, Heves and Nógrád counties in

northern Hungary was the highest, making up more than a quarter of this sample. The proportion of inhabitants in the South Transdanubia region was also significant: those living in Baranya, Somogy and Tolna counties accounted for 22% of the sample.

In terms of the regional distribution of the respondents, it is clear that the proportion of residents in the Budapest region was the highest, accounting for more than a quarter of the sample (26.9%). The proportion of residents in the Pest County region was also significant (22.3%). Those living in the region of northern Hungary (Borsod-Abaúj-Zemplén, Heves, Nógrád) accounted for 13.6% of the sample.

From the perspective of representativity, the regional distribution of the sample cannot be considered representative, but it contains respondents from the entire country, so it can be considered suitable to reflect the opinions and thinking of people living in different areas of the country based on the regional distribution. Based on the age distribution of the sample, we may note that it includes respondents of active age who are able to make meaningful decisions about households. In terms of gender distribution, the sample is also non-representative, but this is not an issue from the perspective of the research goals. There are profound historical reasons for this. The proportion of women is higher (66.3%), almost double that of male respondents (33.7%).

Regarding the education level of the respondents, it can be stated that those with higher education were over-represented in the sample, compared to secondary school, the combined proportion of those with higher vocational education based on this represented about 40%. The share of those with a college or university degree in the sample was 60% in the sample. This distribution is not suitable for forming an opinion for the Hungarian population as a whole. However, this distribution can be considered favorable according to education, in such a way that we have the opportunity to get to know the opinion of the respondents with higher qualifications, who have more favorable conditions due to their financial situation and existential position.

Examining the distribution by occupation, we can observe that a significant proportion of the respondents, more than 70%, were employed. The proportion of entrepreneurs of 14% is also noteworthy, with the proportion of those working in middle or senior management positions being around 15% in the sample.

Overall, it can be stated that the examined sample cannot be considered representative from the perspective of the entire population of the country, however, this was not my goal, instead, I fundamentally tried to get to know and explore the thinking of the Hungarian middle class in a broader sense. The sample used served this purpose remarkably well, because it is clear from the composition of the sample that those with higher education were represented in the sample by active economic operators, whose qualifications and education were also higher than the national average. I consider it extremely important to emphasize this, because due to this feature of the sample, it is an open way to get to know the leading layer of the opinion.

It was known in sociology literature since more than half a century ago that the leaders of opinion who are accepted as such by the various groups are of great importance in shaping the opinion formed on social issues and in shaping the thinking of the society. This issue was first analyzed on the example of the American electoral system and electoral practice (KATZ 1957). In the comprehensive work of KATZ and LAZARSFELD (2017), it has been established that in order to achieve a leading role in local opinion, three requirements must be met:

1. personal acceptance and formation of certain values,
2. competence, and
3. the strategic position in the given medium.

The opinion leadership position within a group may vary depending on time and topic. VALENTE and PUMPUANG (2007) emphasize that opinion leadership position usually means higher socioeconomic status and broader awareness, as well as higher involvement in exam problems. It is also an intensely debated issue if the opinion leadership position naturally requires personal characteristics, such as

1. lovability,
2. the ability to gain trust,
3. higher education, as well as
4. confidence.

Based on the studied literature (LI-DU 2011), it can be stated that the higher education and higher social status of the participants in the examined sample potentially enable them to play a leading role in local opinion, to influence their attitudes and behavior related to the topic. From this we can state that due to the composition of the sample, in addition to the characterization of the Hungarian middle class as a whole, it is also suitable for exploring the

opinions of local opinion leaders and the social knowledge potential ones (BAMAKAN et al. 2019).

The next group of questions in my research concerned the characteristics of households, as it is obvious that the nature of the household fundamentally influences the environmental behavior of the respondents. According to results of my research, it can be concluded that based on household size, the majority of the sample included households where two adults live without a minor child. This is particularly important because it is well known that in households where the household life curve category corresponds to an empty nest household, the proportion of disposable income is high. This means that while in the case of a relatively high-income household, if there is a minor to raise, a significant proportion of the income cannot be considered as free income because a significant part of it is spent on socialization tasks in raising a minor. At the same time, in a relatively lower-income, empty nest-type household, the share of free disposable income per capita is high.

The two-earner family model can be considered common in the surveyed households, i.e. at least two people in 60% of the households had an income from active employment.

The proportion of households in which no member of the household was active was only 2%. The nature of the empty nest of households is also clear when examining the development of the number of dependents. More than 40% of households had no dependents; either because they had no children yet, or because the children were already living independent lives. The number of families with up to two dependents accounted for 46% of the sample. This means that about 80% of the sample was characterized by up to two main dependents. It also follows that the vast majority of households in the sample were those with high economic activity. In terms of household type, based on the net income of a household per capita, more than half of the households had an income level of less than HUF 250,000 per capita, and the proportion of households with a monthly net income per capita exceeded this value was only 42.5%. It is noteworthy that the share of households with an income level below HUF 100,000 per month at the lowest income level did not reach ten percent (7.5%), while the share of households with an income level above HUF 300,000 was relatively high (27.8%).

The consumption data presented above are described in accordance with the Household Statistics data of the Central Statistical Office (Figure 3). It can be stated that the income level of the households in the examined sample was far above the national average. This can be considered favorable for the evaluation of the further results of the research in that the consumer patterns of higher-income households always precede the consumer patterns of relatively lower-income households, showing patterns of behavior and consumption patterns for lower-income households as a point of reference. As a result, if we map the consumption habits of higher-income households, we can also form an idea of how the consumer pattern of households, which currently make up the majority of Hungarian society, is expected to develop in the future. This aspect is especially important in studies where a given consumer decision is influenced not only by utility, but also by values in many ways. It also suggests that if we get to know the thinking of the decision-makers of households with higher education, higher social status and higher income about environmentally conscious behavior, we will have the opportunity to make projections about the expected future behavior of relatively lower-income households. (Figure 3).
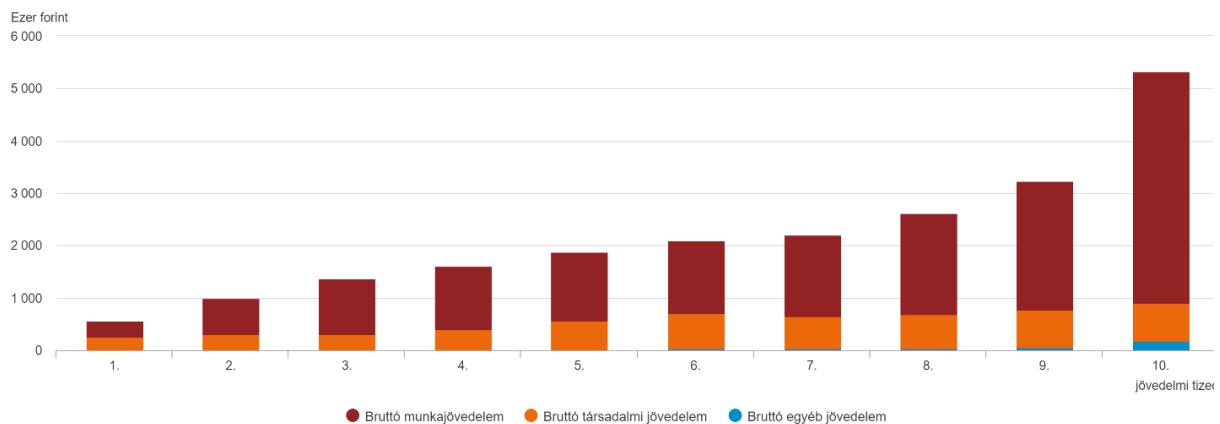
Figure 3. Distribution of annual gross income per capita by income category, 2020
Source: KSH Household Statistics, 2022

The main characteristics of residential real estate are summarized in Table 2. A significant proportion of the households surveyed have their own property. 88.9% of all households can own a house or flat, the share of rented property is significantly lower, only 11.1%. This aspect is also of paramount importance because it is clear that in the case of self-owned property, investments related to the development of the property play a different role than when it comes

to the possible development of a leased property. The type of real estate can be characterized by the fact that the proportion of flats is significantly lower, only 31.5%. Semi-detached and terraced house-type solutions are still relatively rare in rural areas in Hungary, their proportion did not reach 9% in the sample. It also follows that the examined sample fundamentally provides an opportunity to get to know the way of thinking of respondents with a higher income and a higher social status who have a family house.

Table 2. The main characteristics of residential real estate in the sample

Variable	Category	Frequency	Percentage
The house / flat is owned or rented	property	510	88.9
	rented	64	11.1
Residential property type	flat	187	31.5
	terraced house	23	3.9
	semi-detached house	28	4.7
	detached house	356	59.9
Age of the residential real estate	Under 5 years	29	4.8
	5 - 10 years	28	4.7
	11 to 15 years	47	7.8
	16 - 20 years	66	11.0
	21 - 30 years	107	17.8
	31 - 40 years	101	16.8
	41 - 50 years	88	14.6
	Over 50 years old	136	22.6
Building condition	to be renovated	73	12.1
	partially renovated, in average condition	351	58.3
	newly built, renovated	178	29.6

Source: Own survey, n = 602

The age distribution of the houses reflects the entire Hungarian housing stock. More than half of the surveyed properties were built more than 30 years ago, but 22% of all properties are older than 50 years. In terms of the technical condition of the properties, the partially renovated category characterizes the examined properties the most, their share is almost 60%. The proportion of newly built renovated properties is (29.6%), while the proportion of properties in need of renovation is about (12.1%). This confirms that the sample is relatively representative of today's Hungarian real estate and housing conditions.

Analyzing the floor area of dwellings, we can see that the sample is dominated by the larger dwellings / properties. The average most common size of dwellings was between 66 and 150 square meters, this property size accounted for more than half of the sample. The proportion of very small flats / properties was negligible at 3.5% for properties below 35 square meters. The proportion of those with more than 150 square meters of property was close to 16% in the

sample. This larger property size than the national average also means that those with higher, larger properties may obviously have a higher propensity to invest in energy-saving solutions.

The next question of my research was the nature of the heating used in the household. Based on this, I found that about a quarter of the respondents use electric heating in the apartment. This is obviously the result of the general trend that has characterized Hungary in recent decades. After all, heating solutions (such as night-time heat storage stoves) that were suitable for the extensive use of electric heating have received significant support in the past.

Nowadays, gas-fired solutions increasingly dominate the energy consumption of Hungarian households. If electric heating is used, the most typical forms were electric oil radiators and water radiators. Due to their nature, they are most suitable for auxiliary heating, the determining part of the heating, even where electric heating is used, serves primarily auxiliary heating purposes.

A significant proportion of dwellings, more than 57%, produce hot water with gas. The use of an electric boiler is 42%. A significant proportion of dwellings already have air conditioning, but their share does not reach half of all households. Based on the self-assessment of lighting systems, it can be concluded that the use of conventional light bulbs is still relatively significant in households. These account for more than half of all households. According to the respondents' self-assessment, about 40% of households with modern energy-saving systems use lighting not only for subsistence activities, but also for aesthetic purposes in the household, or to increase their quality of life. It is noteworthy that 260 respondents, 43% of all respondents, stated that they also have garden lighting. I consider the issue of the use of solar cells to be of paramount importance for my research. In 15% of all responding households, household buildings were equipped with a solar cell.

2.4. Statistical methods used, SEM

The exploratory analysis of the latent constructs was performed by principal component analysis. The validity of the hypothetical model and the reliability of the latent variables forming the research dimensions were checked by confirmatory factor analysis (CFA). Confirmatory factor analysis was performed within Structural Equation modeling (SEM) (BYRNE 2010).

I checked the internal consistency of the latent structures based on Cronbach's alpha. Although the value of Cronbach's alpha indicating the corresponding internal consistency (TABER 2018) is not clearly defined in the literature, this value also depends on the number of items (statements) that make up the latent construct. Therefore, I considered the Cronbach's alpha values in the 0.65-0.80 value range recommended by several researchers (CORTINA 1993, NUNNALLY − BERNSTEIN 1994, HENSON 2001, VASKE et al. 2017) to be appropriate when examining the internal consistencies of latent constructs.

I used the average variance extracted (AVE) and the composition reliability (CR) indicators to check the validity of the latent constructs. The value of AVE indicates the average proportion of the variances of the indicators that make up a given latent variable in the artificial variable. A value higher than 0.5 is considered acceptable (HAIR et al. 2009, BAUMGARTNER - HOMBURG 1996). The composition reliability index (CR) expresses the common variance ratio for the observed indicators (statements) that form the given latent structure. Based on the threshold value for the CR value, the CR value of all latent variables in the model should reach 0.7 (HAIR et al. 2009), but for exploratory research, a value above 0.6 is sufficient to confirm the reliability of the model. (NUNALLY - BERNSTEIN 1994). If the value of the mean explained variance index does not reach the threshold value of 0.5, but the value of the composition reliability index exceeds 0.7, the reliability of the latent structures is acceptable (LAM 2012, FORNELL - LARCKER 1981).

Following the validation of the measurement model, I explored the relationships between each pillar of relational capital and subjective well-being and perceived living environment by modeling structural equations (SEM). The tests were performed using IBM SPSS Statistics 25.0 and AMOS 23.0 software.

I checked the validity of the structural models based on the indicators in Table 3.

Table 3. Fit indices in structural equation modeling (SEM)

Fit index	Acceptance criterion
χ^2/df (relative chi-square, absolute fit index)	≤ 5 (MARSH – HOCEVAR 1985, WHEATON ET AL. 1977)
CFI (Comparative fit index)	≥ 0,90 (BAUMGARTNER − HOMBURG 1996)
TLI (Tucker-Lewis index)	≥ 0,90 (BAUMGARTNER − HOMBURG 1996)
RMSEA (Root-meansquare error approximation)	≤ 0,08 (HU – BENTLER 1999)

Source: own editing

As the normal distribution of values could not be verified for several study dimensions based on the significant result of the Kolmogorov – Smirnov test, the differences between the two categories (eg. gender, whether the residential property is owned) were examined with the Mann – Whitney nonparametric test. in the case of several categories, I used the Kruskal – Wallis test to detect significant differences between the categories in the values of the examined dimensions. In the case of a significant result of the Kruskal − Wallis test, I used the Dunn − Bonferroni post hoc test to determine the groups with significant differences. I used the Friedman test to examine the differences in the evaluation of the research dimensions.

3. RESULTS AND DISCUSSION

3.1. Examining the dimensions of the measurement model and their reliability

Examining the reliability of latent constructs for measuring research dimensions confirms the appropriate validity of the elements of the measurement model (Table 4). The weight values obtained as a result of the control factor analysis are greater than 0.6 for each statement (the lowest value is 0.651). The lowest value of the Cronbach's alpha index, which measures the internal consistency of the scales, is 0.720, indicating a strong internal consistency of the constructs. The mean extracted (explained) variance (AVE) did not reach 0.5 for four latent variables, but the composition reliability index (CR) exceeded 0.7 for each of these constructs, so the research dimensions are well measurable in the model.

Table 4. Descriptive statistics and reliability indicators for statements or constructs

| Construction / Items	Code	Mean	SD	Loading	Cr.alpha	CR	AVE
Consistency		3.76	0.83		0.833	0.908	0.646
What I take in mind about the development of the apartment / house, I will do	KÖV1	3.52	1.07	0.887			
I am consistent about things in the apartment / house	KÖV2	3.83	0.91	0.857			
I usually do what I think is good	KÖV3	3.94	0.87	0.860			
Independent decision making		3.13	1.06		0.750	0.849	0.535
I make independent decisions about the energy things in the house	DÖN1	2.98	1.27	0.859			
I will allocate the money available for the development of the apartment / house	DÖN2	2.82	1.40	0.871			
I have a clear idea of what and how I want in the apartment / house	DÖN3	3.82	1.07	0.711			
Accepting novelty		3.71	0.90		0.720	0.825	0.515
I am happy to try new, energy-saving solutions in my household	ÚJD1	3.90	0.99	0.855			
I'm interested in energy-saving news	ÚJD2	3.85	1.09	0.872			
I like to surround myself with a smart, easy-to-use device, "gadgets"	ÚJD3	3.21	1.29	0.697			
Perceived efficiency		3.78	0.82		0.778	0.858	0.485
It is financially worthwhile to renovate the apartment energy-efficiently	HAT1	3.75	1.11	0.711			
It is worth paying attention to the data on the energy consumption of my household, because this way I know when and where to intervene, what will be needed more care	HAT2	3.82	1.02	0.739			
The emissions of the apartment can be significantly reduced with a small investment and a little attention	HAT3	3.58	1.09	0.820			
In many cases, even a little attention can be enough to significantly reduce the environmental impact of the apartment / house.	HAT4	3.96	0.97	0.834			
Psychological empowerment		3.44	1.09		0.806	0.882	0.600
My family supports us to live more energy efficiently	FEL1	3.66	1.14	0.779			
We discuss things related to the energy consumption of the apartment / house with those close to me	FEL2	3.17	1.32	0.897			
I have someone to talk to about the energy supply of the apartment / house	FEL3	3.57	1.33	0.865			
Market incentive		3.88	0.98		0.772	0.862	0.573
I would do even more to implement energy saving solutions in my home / house if we got more support to design the systems	ÖSZ1	3.84	1.18	0.882			
If I got more help with planning and construction, I would be more likely to get involved in energy-saving developments	ÖSZ2	3.81	1.17	0.893			
If energy saving were to be recognized with a lower electricity charge, more	ÖSZ3	4.06	1.09	0.702			

people would choose to design energy saving systems							
Social support		3.05	0.98		0.723	0.814	0.411
My environment supports making the apartment house as energy efficient as possible	TÁM1	3.50	1.10	0.651			
I love to see my neighbors and friends see that I try to do the same to reduce pollution	TÁM2	2.98	1.38	0.797			
I have a job that is a social expectation of environmentally conscious behavior	TÁM3	2.79	1.41	0.700			
I usually talk to those close to me about what we can do to reduce pollution	TÁM4	3.02	1.26	0.807			
Environmental awareness		3.90	0.82		0.774	0.773	0.415
I try to use my money for the apartment / house as consciously as possible	TUD1	4.12	0.96	0.810			
I try to live as environmentally consciously as possible	TUD2	4.10	0.88	0.823			
I carefully consider things related to the energy management of the apartment	TUD3	3.53	1.07	0.861			
Energy saving behavior		2.75	0.92		0.808	0.860	0.483
I regularly monitor the development of electricity and water consumption	MAG1	3.26	1.34	0.725			
I am constantly learning how to reduce water and energy consumption	MAG2	2.79	1.19	0.861			
I regularly pay attention to the offer of energy-saving household appliances	MAG3	2.24	1.16	0.785			
I regularly calculate whether it would be worthwhile to use energy-saving solutions / machines	MAG4	2.08	1.15	0.786			

Source: Own survey, n = 602

Evaluations of the statements show greater dispersion in the dimensions of Self-Determination, Psychological Empowerment and Social Support, and Energy-Saving Behavior. The average values determined on a five-point Likert scale are the lowest for energy-saving behavior claims. This indicates that energy-saving behavior based on environmental awareness is weakly reflected in the decisions concerning the use of electricity by Hungarian households.

The average values of the dimensions of the model determined on a five-point Likert scale (Figure 4) confirm that energy-saving behavior is less typical for Hungarian households. The average value for this dimension alone (2.75) is lower than the "indifferent" triple level of the scale. Interestingly, the measured level of environmental awareness (average of the scale: 3.90) is relatively high in the case of Hungarian households. Among the examined dimensions, environmental awareness has the highest average value.
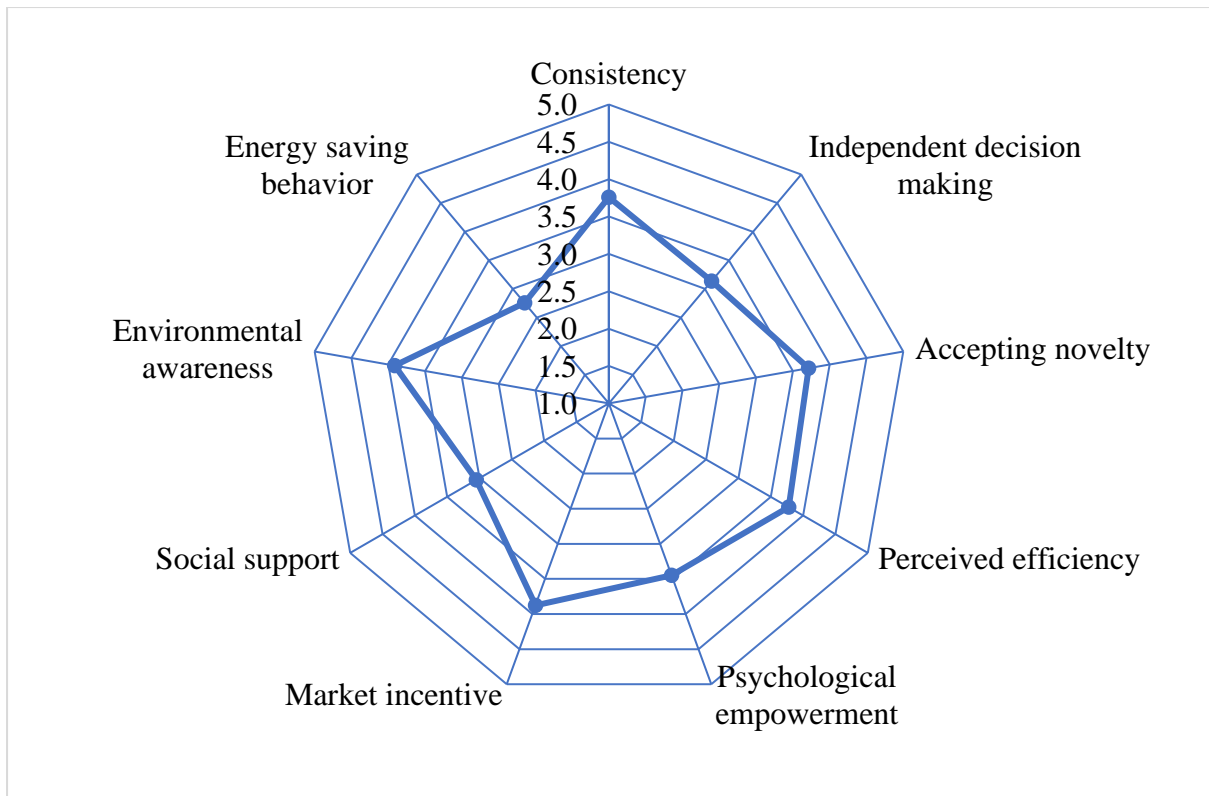
Figure 4. Mean values of the test dimensions measured on a five-point Likert scale

Source: Own survey, n = 602

The Friedman test confirms significant differences (Chi^2 = 956.96, df = 7, p <0.001) in the distribution of mean values determined for each element of the measurement model (latent constructs). A post hoc test performed with a significant result of the Friedman test that confirms that energy-saving behavior is characterized by significantly lower values compared to all other dimensions. Environmental awareness received significantly higher values compared to all other dimensions examined. The perception of perceived efficiency is more favorable compared to all dimensions except environmental awareness. Independent decision-making and social support have significantly lower average values compared to the other elements of the measurement model, with a more favorable assessment only compared to energy-saving behavior.

As a result of comparing the average values obtained for the research dimensions, it can be concluded that the relatively high value of environmental awareness is not associated with the higher value of energy-saving behavior. Energy-saving behavior, which is an important

element of sustainable consumption, influences in the decisions of Hungarian households only slightly. Strengthening social support can be important in encouraging energy-saving behavior.

3.2.   *Results for the structural model*

The results for the measurement and structural model are shown in Figure 5. The values for the arrows connecting the dimensions of the model are standardized regression coefficients measuring the strength of the relationships. Based on the coefficients of the structural model, it can be stated that among the examined psychological factors, the direct human environment (psychological empowerment, $ß = 0.461$, $p < 0.001$) and consistency ($ß = 0.487$, $p < 0.001$) have the strongest influence on environmental awareness in Hungarian households.

The weak positive relationship between environmental awareness and energy-saving behavior ($ß = 0.351$, $p < 0.001$) suggests that the higher level of environmental awareness in Hungarian households is not always associated with energy-saving behavior. The role of subjective situational factors in decisions affecting energy consumption is significant.
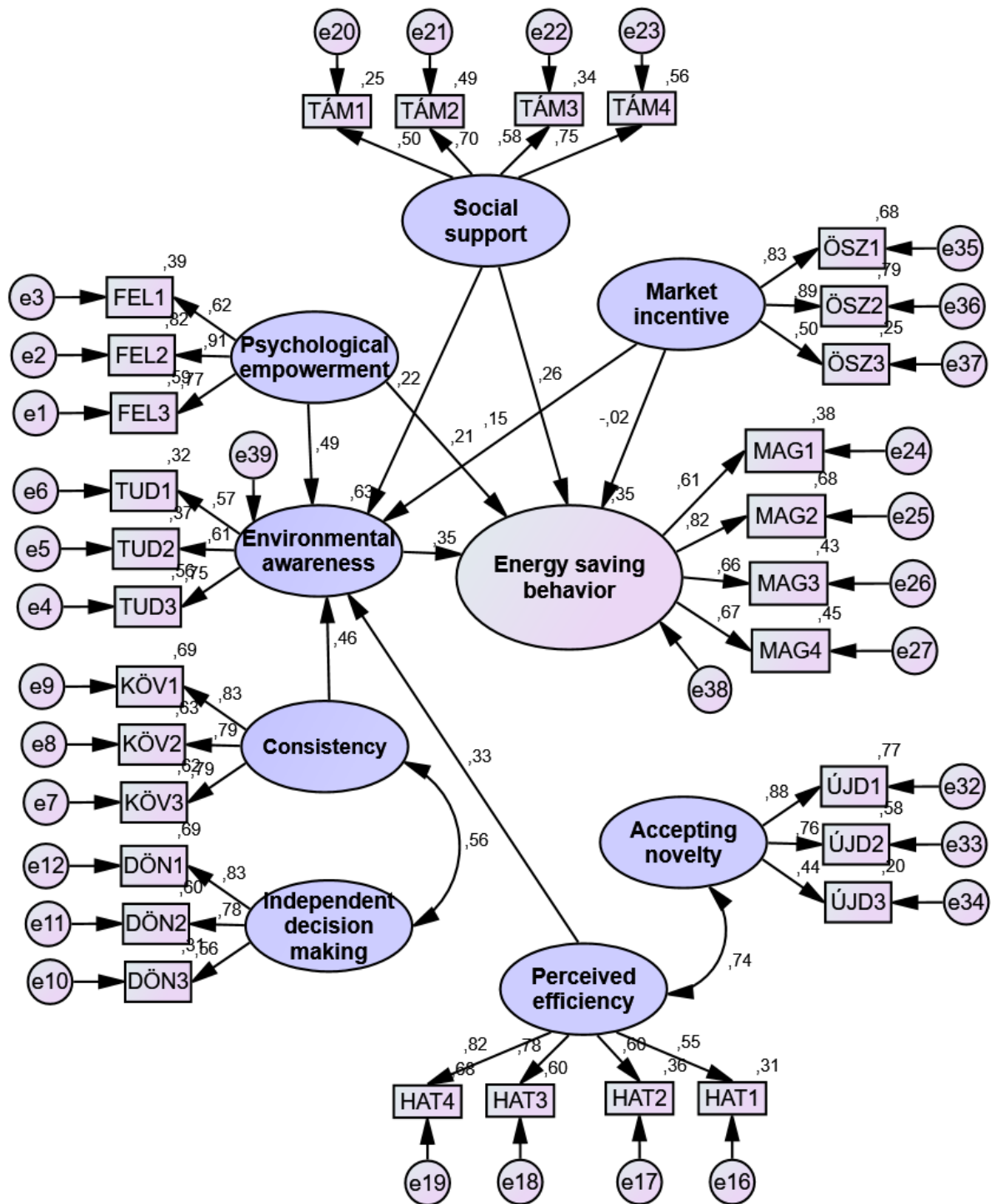
$\chi^2/df = 4.839$; CFI = 0.874; TLI = 0.851; RMSEA (90% CI) = 0.057 (0.036–0.078)
Figure 5. Measurement and structural model
Source: Personal research

The evaluation of my hypotheses for the structural model based on the SEM results is summarized in Table 5. Overall, all research hypotheses have been validated, based on the results of empirical research. The sub-hypothesis of a link between the market incentive effect

and energy-saving behavior alone has been invalidated. One possible explanation for this can be found in the distorting effect of "overhead reduction" on energy-saving consumer behavior: in the case of Hungarian households, e.g. the incentive effect of high producer energy prices on energy saving.

Table 5. Evaluation of hypotheses based on SEM results

Hypothesis	Standardized regression coefficient (beta)	S.E.	p-value	Result	Conclusion
H1a. Consistency ↔ Independent decision making	0.556*	0.027	<0.001	There is a moderately strong positive correlation between the ability to make independent decisions and consistency in household energy management.	H1 accepted
H1b. Consistency → Environmental awareness	0.461	0.048	<0.001	Consistency has a moderately strong positive effect on Environmental awareness.	
H2a. Perceived efficiency ↔ Accepting novelty	0.737*	0.040	<0.001	The perceived efficiency of energy savings and the acceptance of novelty show a strong positive correlation.	H2 accepted
H2b. Perceived efficiency → Environmental awareness	0.329	0.054	<0.001	Perceptions of energy saving efficiency have a weak positive effect on Environmental awareness.	
H3a. Psychological empowerment → Environmental awareness	0.487	0.032	<0.001	Psychological empowerment has a moderately strong positive effect on Environmental awareness.	H3 accepted
H3b. Psychological empowerment → Energy saving behavior	0.213	0.042	<0.001	Psychological empowerment has a weak positive effect on Energy saving behavior.	
H4a. Social support → Environmental awareness	0.222	0.034	<0.001	Social support has a weak positive effect on Environmental awareness.	H4 accepted
H4b. Social support → Energy saving behavior	0.259	0.043	<0.001	Social support has a weak positive effect on Energy saving behavior.	

H5a. Market incentive → Environmental awareness	0.154	0.030	<0.001	Market incentive has a weak positive effect on Environmental awareness.	
H5b. Market incentive → Energy saving behavior	-0.016	0.036	0.724	The effect of market incentive on Energy saving behavior cannot be justified.	H5 partially accepted
H6. Environmental awareness → Energy saving behavior	0.351	0.073	<0.001	Environmental awareness has a weak positive effect on Energy saving behavior.	H6 accepted

* correlation coefficient
Source: Own research

The results obtained on the basis of the structural model confirm the significant effect of psychological factors on environmental awareness as well as energy-saving consumer behavior.

3.3. Impact of socio-demographic characteristics and residential characteristics on environmental awareness and energy saving behavior

Based on the results of non-parametric tests, sociodemographic characteristics have no significant effects on environmental awareness or energy-saving behavior. Only in the case of household size can a significant difference be observed in the environmental awareness of one- and two-person households: the level of environmental awareness is higher in the case of two-person households compared to one-person households.

The social and behavioral factors that determine environmental awareness and energy-saving behavior (consistency, independent decision-making, acceptance of novelty, perceived efficiency, psychological empowerment, market stimulation, social support) are not clearly shown to be socio-demographic either. No significant differences in any of the social or psychological factors can be justified between the groups formed on the basis of the region of residence. NAIR et al. (2010) have shown that regional disparities can result, for example, in measures of varying intensity and effectiveness by municipalities to encourage and reward energy efficiency in households. I hypothesize that regional infrastructural differences (f.e. difficulty in accessing individual energy-saving solutions in individual regions) may also

significantly influence environmentally conscious consumer behavior in decisions affecting household energy use.

There is only a significant difference in the perceived effectiveness between the sexes (Figure 6): women perceive the effectiveness of environmentally conscious solutions better than men (Mann − Whitney test: $Z = -3.975$, $p < 0.001$). Gender differences in socio-economic conditions and lifestyle differences can affect the energy-saving consumer behavior of men and women. For example, ZELEZNY and colleagues (2000) have shown that women have a stronger environmental awareness than men. This research also failed to demonstrate significant differences in men's and women's environmental awareness and energy-saving behaviors.
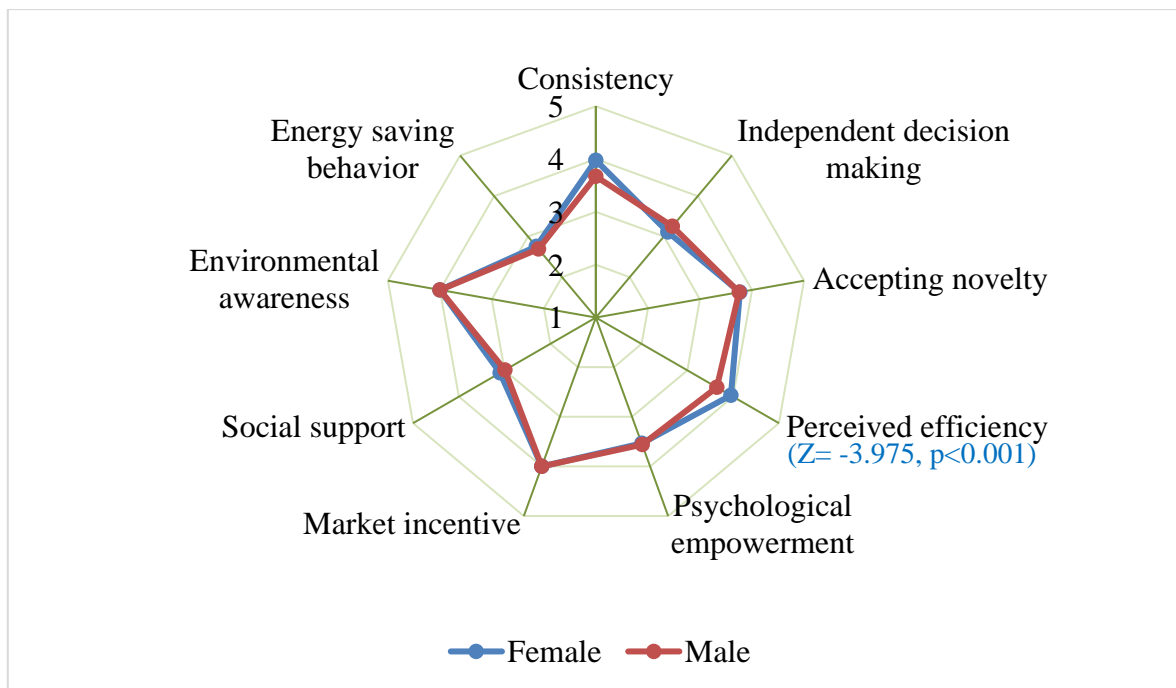
Figure 6. Examining the differences between men and women in the evaluation of research dimensions

Source: Own survey, n = 602

Independent decision-making ability is significantly stronger in the older age groups compared to those aged 18–25 (Kruskal – Wallis test: $H = 94.14$, $p < 0.001$, Figure 7). Consistency is significantly higher among those aged 41–50 years compared to those aged 18–25 years ($H = 13.76$, $p = 0.017$).
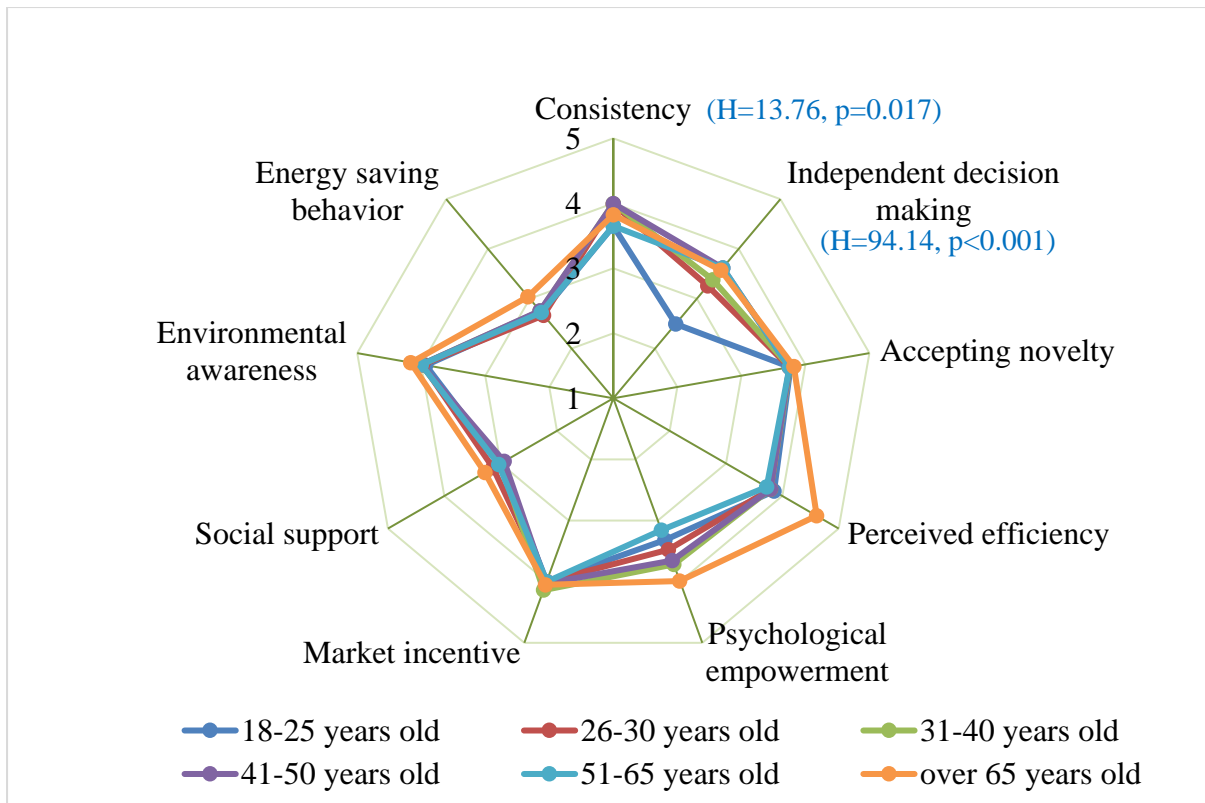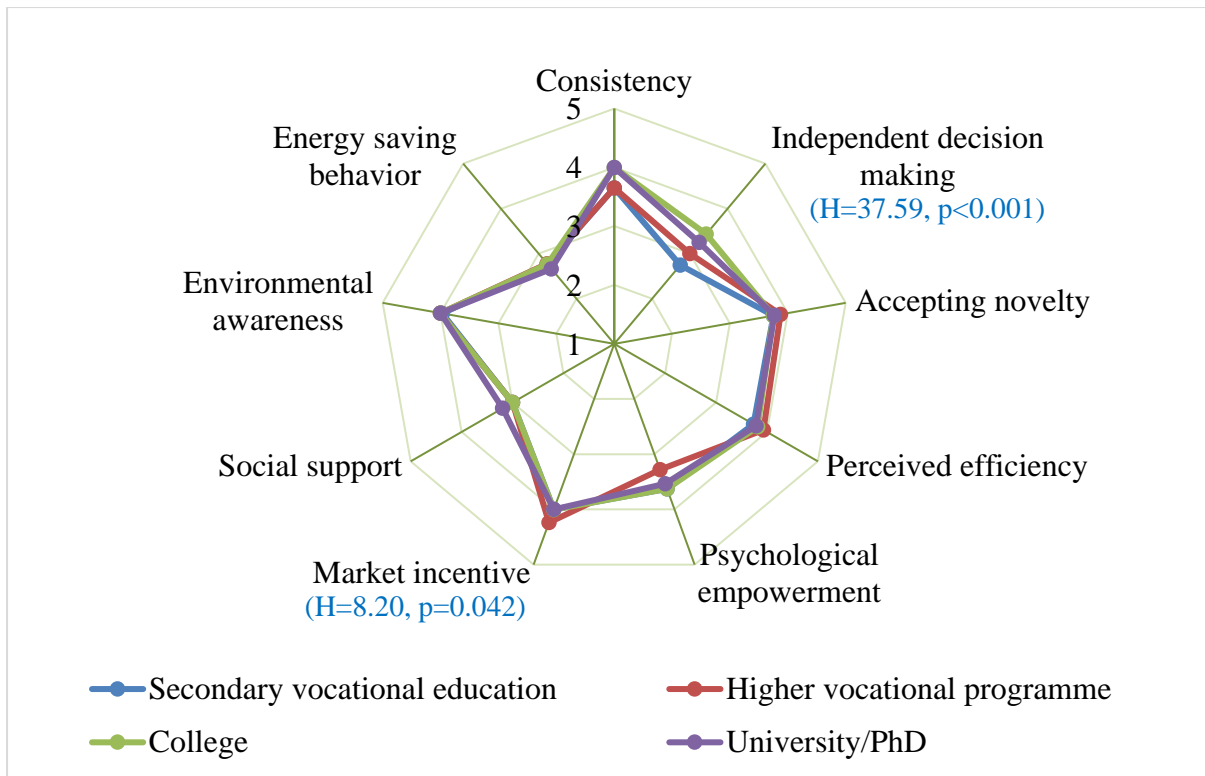
Figure 7. Examining differences between age groups in the evaluation of research dimensions
Source: Own survey, n = 602

Based on the results of previous research (POWERS et al. 1992, POORTINGA et al. 2003), I hypothesize that the age of the household may have an impact on energy consumption as well as on environmentally friendly consumer behavior. For example, older people are less open to new technologies that increase energy efficiency, they are less concerned with energy-related problems, and have different needs, such as for heating the apartment. My research results do not conclude a significant difference between the age groups in the level of environmental awareness or the certification of energy-saving behavior.

Those with a college or university degree are more able to make independent decisions than those with a high school or postgraduate degree (H = 37.59, p <0.001, Figure 8). However, the incentive effect of the market is significantly weaker among those with a university degree compared to those with an postgraduate degree (H = 8.20, p = 0.042).

Figure 8. Examining differences between education levels in the evaluation of research dimensions

Source: Personal survey, n = 602

Some studies (SCOTT 1997, NAIR et al. 2010) have found a significant impact of education on environmentally friendly behavior in household energy use: those with higher education are more environmentally conscious in their decisions about energy consumption. My research results did not show a significant difference between the levels of education in environmental awareness or energy-saving behavior.

Based on the research results, no significant difference can be observed in the environmental awareness and energy-saving behavior of Hungarian households belonging to different income levels (Figure 9). However, similar research in other countries has, in several cases, shown a significant impact of income on households 'environmental awareness and energy-saving behavior. For example, BROADSTOCK et al. (2016) found that Chinese households with higher incomes are less energy efficient. TROTTA (2018) came to similar findings when examining the energy-saving behavior of UK households: middle- and high-income households typically pay much less attention to energy saving compared to low-income households.
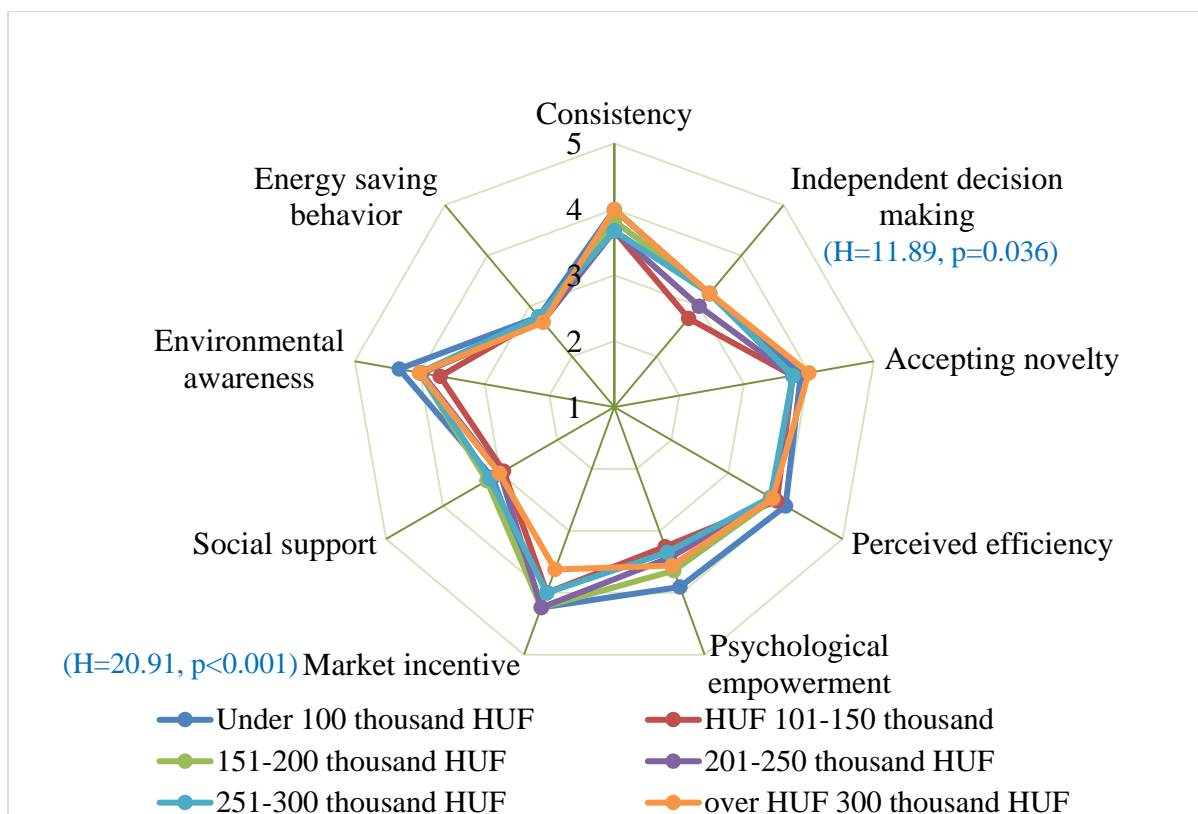
Figure 9. Examining differences in income levels in the evaluation of research dimensions

Source: Own survey, n = 602

According to the research results, the role of market stimulus is significantly weaker for higher-income households compared to lower-income households. Decision-making autonomy, on the other hand, is more common in higher-income households than in those with lower incomes.

Based on the research results, among the sociodemographic factors, only the significant effect of household size on environmental awareness could be confirmed: the level of environmental awareness is significantly higher in the case of two-person households compared to one-person households. The obtained result is difficult to interpret, as no significant difference can be established between households with two or 3-4 persons or more than 4 persons, and between households with one person and 3-4 persons and more than 4 persons.

Independent decision-making is most common in single-person households compared to multi-person households (Figure 10). Due to the size of the household, support for the immediate human environment, market incentives and social support are significantly weaker for one-person households.
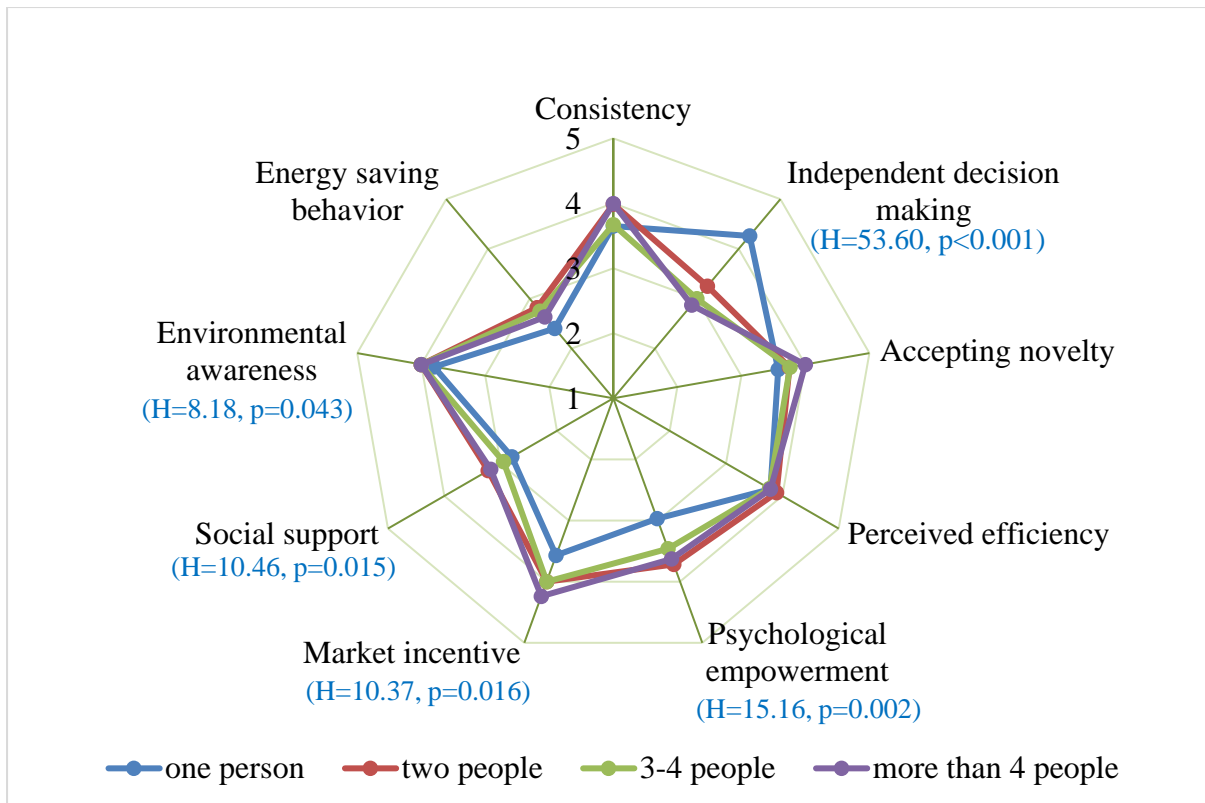
Figure 10. Examining the differences between household size groups in the evaluation of research dimensions
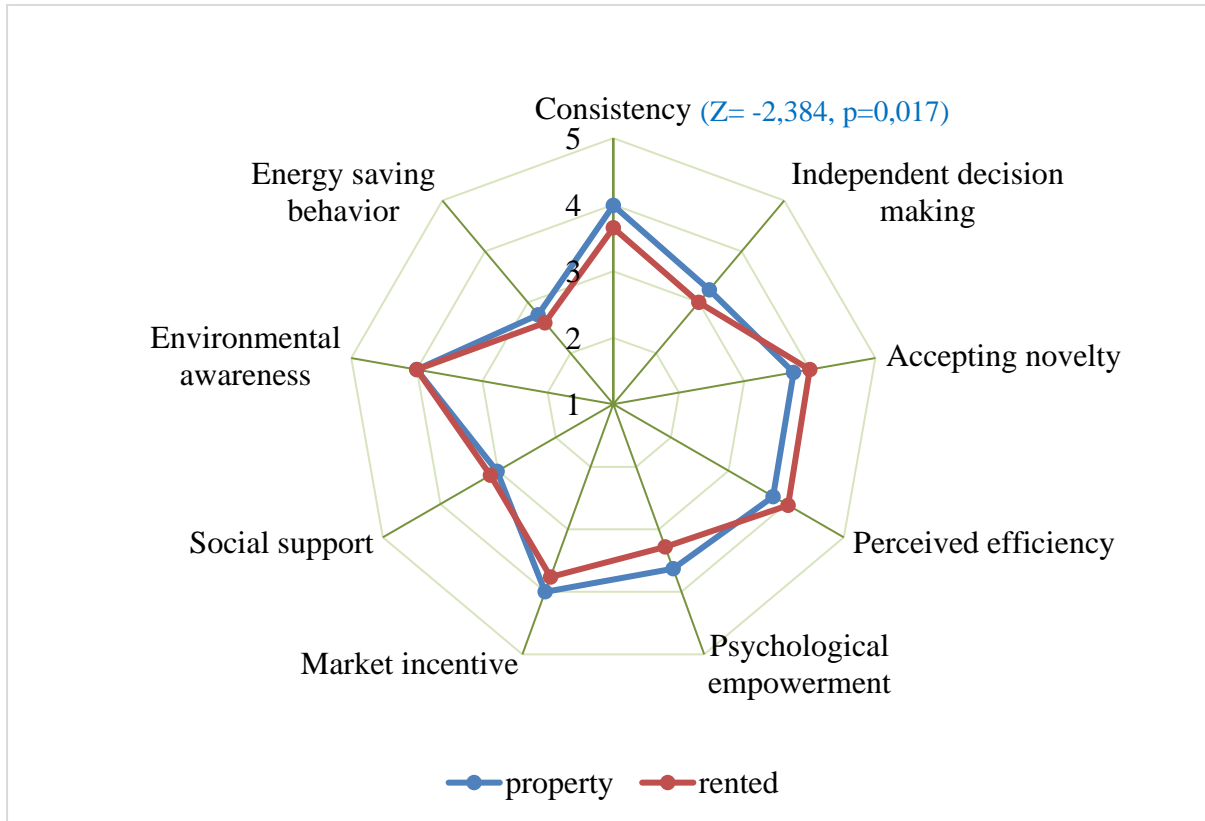
Source: Own survey, n = 602

The results obtained for the type (composition) of the household are in line with the results of the analysis of the differences between the groups according to the size of the household: one-person households have higher decision-making autonomy and the supportive effect of the direct human environment is weaker.

No significant differences could be identified between the groups formed according to the type of residential property (dwelling, terraced house, semi-detached house, detached house) in any of the survey dimensions.

Based on the results of the Mann – Whitney test, there is only a significant difference in consistency between groups formed by title to residential property ownership (own property, leased): consistency appears to be significantly stronger for property owners than for tenants (Figure 11). Some studies (CURTIS et al. 1984, BRANDON - LEWIS et al. 1999) have shown that homeowners are more willing to buy energy-efficient appliances or equipment than tenants, because they tend to have more financial security over a longer period of time. they

plan and expect a higher return on energy efficiency investments. Based on my research results, no significant difference can be justified between owners and tenants in either environmental awareness or energy-saving behavior.
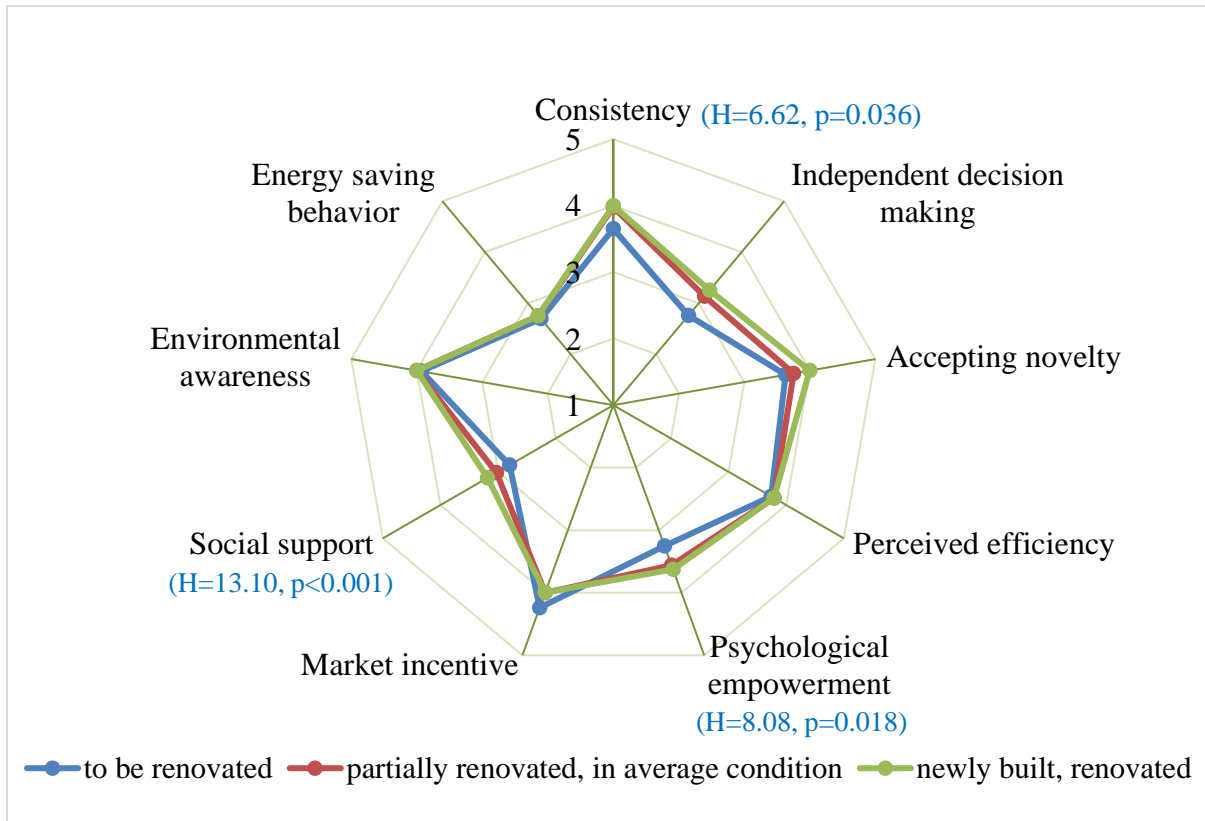

Figure 11. Examining the differences between the categories according to the title of residential real estate in the evaluation of the research dimensions

Source: Ownl survey, n = 602

In the case of the age of residential real estate (Figure 12), the inhabitants of buildings newer than five years and those aged 41-50 have significantly greater decision-making independence than the inhabitants of residential real estates aged 16-20. Residents of buildings newer than five years and those aged 5-10 are significantly more likely to receive social assistance than residents of 16-20-year-old and 31-40-year-old ones.

The energy efficiency of older buildings is generally lower than that of newer buildings, so it can be assumed that residents of older residential buildings are more likely to take energy efficiency measures than those living in newer buildings, especially if older residential buildings are physically or aesthetically poor, and renovation becomes inevitable. However, my research results did not prove a significant difference between the age groups of residential

real estate in the environmental awareness of the residents and in the energy-saving consumer behavior.

Figure 12. Examining the differences between the categories according to the condition of residential real estate in the evaluation of the research dimensions

Source: Personal survey, n = 602

The condition of residential real estate correlates negatively to consistency, support for the immediate human environment, and social support. Among the residents of the residential properties to be renovated, the mentioned research dimensions represent significantly lower levels compared to the properties in good condition. No significant differences in environmental awareness or energy-saving consumer behavior can be identified between the categories formed according to the condition of the residential property.

Summarizing the research results presented in this chapter, the significant effect of sociodemographic factors and the characteristics of residential real estate on the environmental awareness of Hungarian households and their energy-saving consumer behavior cannot be validated.

4. NEW SCIENTIFIC RESULTS

1. I have developed an integrated model based on the enumeration of attitudes and behavioral elements related to the electricity consumption of Hungarian households, as well as socio-demographic factors and the characteristics of residential real estate, which is suitable for the complex measurement of environmental awareness and energy saving behavior.

2. Based on the structural model, I have shown that the direct human environment of the respondents (family members, friends) and consistency are the strongest determinants of environmental awareness related to electricity consumption.

3. Based on the results of the large-sample empirical research, I proved a significant positive relationship between environmental awareness and energy-saving behavior among Hungarian households.

4. I found that among the socio-demographic characteristics of Hungarian household energy consumers, the size of the household and the characteristics of residential buildings have the greatest influence on the psychological elements related to environmentally conscious energy use: in the case of multi-person households and more and attitudes towards environmental awareness and elements that shape energy-saving consumer behavior.

5. CONCLUSIONS AND RECOMMENDATIONS

One of the starting hypotheses of my research was that one of the important measures of interest in the environment is the extent to which the respondent is interested in the possibilities of preserving the condition of its narrowest environment, i.e. the property it owns. I began from the premise that if the respondent attaches great importance to the protection of his / her property in terms of his / her demanding environment, this will also be true from the approach that the respondent is expected to pay more attention to the protection of his / her environment. *I have validated this assumption.*

The other group of questions in my work therefore concerned what the respondent's attitude towards his or her apartment was, how important he or she considered it, and how likely he or she was to make the decisions he or she made. To this end, I have made three statements.

In my research, all three statements received relatively high mean values. There is no doubt, however, that these variances were also associated with high standard deviations. It is noteworthy that the relative weight of the triple mean was approximately the same in terms of the degree of identification with all three statements made.

The next group of questions in my study was about the extent to which the residents of the property consider themselves independent factors, ie independent decision-makers, and the extent to which they have ideas and a definite opinion on how they would like to further develop their property.

The reactions of the respondents showed that most of them have relatively definite ideas about real estate development. This may also be explained by the fact that a relatively higher proportion of relatively young respondents with above-average qualifications were included in the sample. At the same time, it is noteworthy that the degree of freedom in their decisions was assessed as relatively low and they had less discretion than expected as to which energy systems to use.

The fourth set of questions in my research was openness to innovation. *We see a relatively heterogeneous picture in this area, as some respondents would like to try new energy-saving solutions in their household and are interested in these solutions, but the proportion of those who are open to the smart home concept was relatively low. This is probably partly due to their inexperience with the topic and partly to the fact that respondents did not have a positive experience in the initial development phase of smart houses and smart devices in many respects. Based on the analysis of this part of my work, it can be concluded that a significant proportion of respondents have a positive attitude towards adapting energy innovations, although the social acceptance of these innovations is relatively difficult due to their nature. It is unfavorable, however, that there is less interest than expected in the concept of a smart house, which can probably be explained by relative ignorance.*

A significant proportion of respondents estimated that the use of different energy-saving devices could play a significant role in reducing household spending and costs. On the positive side, in addition to reducing direct household costs, a significant proportion of respondents

agreed more than moderately with the statement that even with relatively little expenditure, the energy efficiency of a household could be greatly increased, and emissions could be reduced.

In line with the research objectives, I formulated eight research hypotheses, the first five of which relate to attitudes, social and market environment elements influencing energy awareness and energy-saving behavior. The sixth refers to the relationship between energy awareness and energy-saving behavior, and the last two to sociodemography. and the impact of residential property characteristics on environmental awareness and energy-saving behavior, as well as the attitudes and factors that influence them.

Confirming the opinion of NAGY (2021), I think it is necessary to develop a training system that describes the principles of sustainability for the given profession and discipline in all age groups and in each professional field. Those working in the technical, economic and human spheres should be educated on how to use raw materials sparingly and meaningfully, to minimize waste generation, and to explain the importance of optimizing the environmental impact of production and service processes (NAGY 2009, 2010). Several researchers have stated that the environmental attitudes measured at higher school levels are getting closer to the expert averages, so in higher education it is vital to develop attitudes and adopt an ecological way of thinking (SZANDI-VARGA 2015).

VIDA (2007) raises the question of whether we recognize the danger of deviating from the essence of an issue if its validation process involves a number of disciplines. The question is legitimate, but in my opinion an effective solution can only be achieved through an interdisciplinary approach. In my view, although scientific research reveals ample evidence of the unsustainability of the current paradigm, it cannot achieve its desired goal without widespread presentation of the results and acceptance by society. Our sense of responsibility for the environment, developed and constantly developed in our youth, leads to the consolidation of social norms.

6. SUMMARY

Examining and modelling the energy-saving behavior of households is of paramount importance for the purposeful shaping of consumer behavior that incorporates aspects of

sustainability. In developing the conceptual framework for my research, I started from Ajzen's theory of planned behavior, similar to studies of environmentally conscious consumer behavior. The model based on psychological factors was supplemented with socio-economic factors as well as characteristics of residential real estates. The final conceptual model of the research thus makes it possible to examine the energy-saving behavior of households not only from the perspective of behavioral theory, but also from a social and economic approach. In the model, I corresponded to environmental awareness as the intention to act and to energy-saving consumer behavior as the behavior.

The data required for the empirical research come from our own online questionnaire survey among Hungarian households. After data cleansing, 602 completed questionnaires were included in the data processing.

The reliability of the research dimensions of the model was examined by control factor analysis in the framework of structural equation modeling (SEM), and the internal consistency of the constructs was checked based on the Cronbach's alpha, CR and AVE indicators.

I examined the effect of psychological factors on the environmental awareness of Hungarian households and their energy-saving behavior on the basis of the structural model. Mann − Whitney and Kruskal − Wallis tests were used to detect the effects of sociodemographic factors and residential real estate.

Based on the research results of the structural model, the significant impact of psychological factors on the environmental awareness of Hungarian households and their energy-saving consumer behavior can be validated. The psychological empowerment belonging to subjective norms (the direct human environment of the respondents) and the consistency that is one of the elements of the perceived behavioral control determine the environmental awareness related to the use of electricity in Hungarian households the strongest.

The impact of socio-demographic factors and the characteristics of residential real estate on the environmental awareness of Hungarian households and their energy-saving consumer behavior cannot be validated on the basis of the research results. Only among groups trained according to household size can a significant difference be found in environmental awareness: one-person

households are less environmentally conscious than two-person households. However, the effect of the individual sociodemographic factors and the characteristics of residential real estate on the individual psychological factors can be validated. For example, the size of the household significantly influences independent decision-making, the perception of the supportive role of the immediate human environment, and the perception of the market incentive effect.

My study contributes to the development of the theoretical foundations of modeling the energy-saving behavior of households, and the research results can be used to solve the scientific and practical problems of encouraging households to save energy, and thus to increase the efficiency of energy consumption.

SCIENTIFIC PUBLICATIONS

I. Scientific journal article

a) in a foreign language published in a foreign journal

- Csegődi Tibor László ; **Naár Tamás** (2017): Some Current Issues of Energy Efficiency in the European Union. VADYBA: JOURNAL OF MANAGEMENT 31: 2 pp. 111-116., 6 p.

- Zsuzsanna, Tóth-Naár; **Tamás, Antal Naár**; Ádám, Pál Sőreg; Sergey, Vinogradov (2017): Selected reliable indicators of sustainable land management (SLM) in the European Union. VISEGRAD JOURNAL ON BIOECONOMY AND SUSTAINABLE DEVELOPMENT 6: 2 pp. 46-49., 4 p.

b) in a Hungarian journal published in Hungarian

- Naárné, Tóth Zsuzsanna; **Naár, Antal Tamás**; Sőreg, Ádám Pál; Vinogradov, Szergej (2018): A fenntartható földhasználat új lehetőségei és kihívásai. ECONOMICA (SZOLNOK) 9: 1 pp. 31-37. 7 p.

- Sőreg, Ádám Pál; **Naár, Antal Tamás**; Naárné, Tóth Zsuzsanna (2017): Regionális különbségek és árkonvergencia a visegrádi országok termőföldpiacán. STATISZTIKAI SZEMLE 95: 4 pp. 349-381., 33 p.

- Naárné, Tóth Zsuzsanna; Orlovits, Zsolt; **Naár, Antal Tamás**; Sőreg, Ádám Pál (2016): Egyes földminősítési és földpiaci tényezők összehasonlító gazdasági elemzése Németország és Franciaország példáján = Comparative economic analysis of land valuation and land market factors using the examples of Germany and France. STUDIA MUNDI - ECONOMICA 3: 2 pp. 68-79., 12 p.

- Naárné, Tóth Zsuzsanna; **Naár, Tamás** (2013): A geotermális energia hasznosításának hazai lehetőségei és a hőszivattyúk alkalmazásának egyes kérdései. HADTUDOMÁNY: A MAGYAR HADTUDOMÁNYI TÁRSASÁG FOLYÓIRATA XXIII. évfolyam Elektronikus Különszám: május pp. 378-392., 15 p.

II. Book excerpt

a) in a foreign language

- Tibor, László CSEGŐDI; Sergey, Vinogradov; Tamás, Antal NAÁR; Zsuzsanna, TÓTH-NAÁR (2021): The factors affecting energy efficiency in the European Union's residential sector. In: Zsuzsanna TÓTH-NAÁR; Emese TATÁR (Editor) (2021): Management Responses to the Twenty-First Century Economic and Social Challenges., Budapest, INFORM Publishing House, 10 p. [under appearance]

- Zsuzsanna, Tóth-Naár; Márk, Molnár; **Tamás, Naár**; Sergey, Vinogradov (2016): Capitalization of direct payments into agricultural land prices and land rents in

Hungary. In: Gyenge, Balázs; Kozma, Tímea (szerk.) Challenges in Process Management: Decision points, network systems and strategies in practice. Gyöngyös, Magyarország: Károly Róbert Kft. 152 p. pp. 140-148., 9 p.

b) in Hungarian

- Sőreg, Ádám Pál; **Naár, Antal Tamás**; Orlovits, Zsolt; Varga, Júlia; Naárné, Tóth Zsuzsanna (2018): A piaci áron alapuló földértékelés. In: Naárné, Tóth Zsuzsanna; Orlovits, Zsolt (szerk.) A piaci és hozadéki elvű földértékelés elmélete és gyakorlata nemzetközi kitekintésben. Budapest, Magyarország: Szaktudás Kiadó Ház Zrt. 118 p. pp. 60-95., 36 p.

III. Conference paper in a journal or conference volume

a) in a foreign language

- **Naár, Tamás**; Naárné, Tóth Zsuzsanna; Vinogradov, Szergej; Csegődi, Tibor László (2018): Relationship between residential electricity consumption, climate factors and energy efficiency in the case of the European Union countries. In: Illés, Bálint Csaba (szerk.) Proceedings of the International Conference "Business and Management Sciences: New Challenges in Theory and Practice" = "Gazdálkodás- és szervezéstudomány: Új kihívások az elméletben és gyakorlatban" nemzetközi tudományos konferencia tanulmánykötete, vol 2. Gödöllő, Magyarország: Szent István Egyetemi Kiadó 312 p. pp. 531-539., 9 p.

- Zsuzsanna, Tóth-Naár; Tamás, **Antal Naár**; Ádám, Pál Sőreg; Sergey, Vinogradov (2017): New opportunities and challenges for sustainable land management (SLM) in Hungary. In: Košičiarová, I.; Kádeková, Z. (szerk.) Managerial trends in the development of enterprises in globalization era. Nitra, Szlovákia: Slovak University of Agriculture in Nitra 949 p. pp. 706-717., 12 p.

- Zsuzsanna, TÓTH NAÁR; Zsolt, ORLOVITS; **Tamás, Antal NAÁR**; Pál, Ádám SŐREG; Róbert, MAGDA (2016): Possibilities of Considering some Land Assessment and Land Market Factors in Agricultural Property Evaluation. In: Rusko, M; Kollár, V (szerk.) Sustainability - Environment - Safety 2016: VI. medzinárodná vedecká konferencia, Bratislava, 06.12.2016., Zilina, Szlovákia: STRIX pp. 149-155., 7 p

- **A T, Naár**; Sz, Vinogradov; Zs, Tóth-Naár (2013): Comprehensive assessment of domestic geothermal energy and heat pump utilization. In: Magó, László; Kurják, Zoltán; Szabó, István (szerk.) Synergy 2013 - CD of Full Papers: 3rd International Conference of CIGR Hungarian National Committee and Szent István University, Faculty of Mechanical Engineering & 36th R&D Conference of Hungarian Academy of Sciences, Committee of Agricultural and Biosystem Engineering, "Engineering, Agriculture, Waste Management and Green Industry Innovation". Gödöllő, Magyarország: SZIE Gépészmérnöki Kar pp. CD-128-1-CD-128-6.

b) in Hungarian

- **Naár, Antal Tamás**; Naárné, Tóth Zsuzsanna; Vinogradov, Szergej; Csegődi, Tibor László (2019): Az éghajlati tényezők és az energiahatékonyság hatása a lakossági villamosenergia-fogyasztásra az Európai Uniós országokban. In: Horváth, Bálint; Kápolnai, Zsombor; Földi, Péter (szerk.) Közgazdász Doktoranduszok és Kutatók V. Nemzetközi Téli Konferenciája: Konferenciakötet. Gödöllő, Magyarország: Doktoranduszok Országos Szövetsége (DOSZ) 714 p. pp. 414-421., 8 p.

- Naárné, Tóth Zsuzsanna; Orlovits, Zsolt; **Naár, Antal Tamás**; Sőreg, Ádám Pál (2016): Egyes földminősítési és földpiaci tényezők figyelembe vételének lehetőségei a mezőgazdasági ingatlanértékelésben. In: Százhatvanöt éves a földadó kataszter, százhatvan éves a telekkönyv, negyvenhárom éves a magyar ingatlan nyilvántartás és húsz éves a nemzeti kataszteri program szakmai továbbképző konferencia. pp. 1-8., 8 p.

IV. Other scientific works

- **Naár, Tamás**; Csegődi, Tibor László (2018): Több, mint környezetvédelem: Az energiahatékonyság jogi és gazdasági vetületei az Európai Unióban. PRO SCIENTIA RURALIS 2: 2 pp. 39-56., 18 p.

V. Abstract

- Csegődi, Tibor László; **Naár, Tamás** (2017): Some Current Issues of Energy Efficiency in the European Union (abstract) In: Vinogradov, Szergej; Jurgita, Martinkiené (szerk.) Abstract book 12th International Scientific-Methodical-Practical Conference on Sustainable Regional Development: Economics, Management, Technology and Law Opportunities. Klaipeda, Litvánia: [s. n.] – Nemzetközi konferencia pp. 33-33., 1 p.