Department of Sustainability Management and Environmental Economics

THESIS BOOKLET

Gábor Vona

Increasing consciousness and responsibility in several fields of sustainability

related to the doctoral dissertation with the identical title

Supervisor:

Gábor Harangozó Dr. habil.

Associate Professor

Table of Contents

1. Preceding research and relevance of the topic

Most frequent streams of research are briefly listed below with selected works.

Health promotion programmes:

- identifying the impacts of such programmes on performance indicators and quantifying these impacts (*Aldana, 2001*);
- analysing the relationship between health risk factors and an aggregate variable (*Goetzel et al., 2012; Loef–Walach, 2012*);
- refining the involved determinants when assessing risks to be managed by well-being programmes.

The **nexus between corporate competitiveness, environmental protection, and digitalisation** in the circle of small and medium-sized enterprises (SMEs):

- the spread of Industry 4.0 technologies, its interaction with digitalisation, and gained experiences during implementation (*Baksa et al., 2020*);
- the effects of digitalisation on sustainability, the relationship between information and communication technology use and environmental performance;
- measuring the digital maturity; the determinants of digital transformation;
- Artificial Intelligence technologies;
- the digital entrepreneurial ecosystem;
- human resource management in the context of Industry 4.0, digitalisation, and factors hindering the innovation activity of enterprises;
- the relationship between firms' capabilities and competitiveness (*Chikán et al., 2019; Csesznák–Wimmer, 2021*).

Environmentally conscious consumer behaviour and **residential energy consumption**:

- theoretical frameworks attempting to predict and explain human behaviour e.g. the theory of planned behaviour (*Ajzen, 1991*);
- scrutinising the interrelatedness between pro-environmental behaviour/ energy consumption and selected factors (enablers or disablers), collecting stimuli and hindrances of sustainable consumption patterns (*Barbarossa–Pastore, 2015*);
- comparative studies e.g. at the level of countries or energy systems;
- carrying out financial analyses e.g. of heating and cooling systems;
- solving computational problems e.g. optimisation;
- forecasting future energy use and its drivers (*Ürge-Vorsatz et al., 2015*).

The decision-making process prior to becoming a **prosumer** in the field of **photovoltaic (PV) energy production** or having such plans in the near future:

- assessing programmes targeting PV microinstallations (*Zdonek et al., 2022*);
- recommendations for devising policies;
- inventorying enablers and disablers of the diffusion of PV prosumer systems, the role of information and professional advice (*Mularczyk et al., 2022*);
- new business models; financial aspects; avoidable environmental harms;
- national prosumer pathways; comparing private and collective prosumers;
- investigating the interactions between prosumers and consumers;
- exploring the profile of PV end users (*Hansen et al., 2022*).

Promotion of green residential routine mobility:

- individual level: e.g. socio-economic profile; environmental, convenience, financial, health, and safety aspects; social influence; political preferences; previous experiences; gender (*Echeverria et al., 2022; Herberz et al., 2020*);
- collective level: e.g. macroeconomic processes; traffic problems, infra-structural incentives; green mobility investments; the supply side and the relative strength of travel modes and business models (*Trencher et al., 2021*);
- technological background: e.g. fuels, renewable energies; battery issues, vehicle manufacturers, innovations; data science;
- corporate level: e.g. corporate shared electric/hybrid cars, ride sharing; transmitting green consumption values.

The **relevance of the topic** is underpinned by harmful, unsustainable or ongoing processes:

- the prevalence of circulatory system diseases being the leading cause of death in Hungary and the role of risk factors (*OECD–EOHSP, 2023, pp. 5, 7*);
- the digital agenda related to SMEs (*OECD, 2021a, 2021b*);
- the gap between consumption and biocapacity in Hungary (*GFN, 2023*);
- alarming forecasted sectoral impacts of changes in climate parameters in the Carpathian Basin for the 21st century (*MIT, 2020, pp. 4-5, 17-18*);
- pathway in Hungary's Act on climate protection 2020, XLIV (*NLD, 2023*);
- both Health and well-being (3. SDG) and Tackling climate change (13. SDG) are below time-proportionate requirements (*Sachs et al., 2023, pp. 36-37*);
- 6 out of 9 planetary boundaries are transgressed (*Richardson et al., 2023*);

- aggravating global warming triggers multiple climate tipping points (*McKay et al., 2022*);
- climate and further environmental challenges can engender instability and threats (e.g. political conflicts, food insecurity, migration) (*EC, 2019, p. 21*).

Integration of the research fields of the articles and research questions (RQs):
(The four RQs marked with italic font type are tightly interconnected.)

Health consciousness	1st article	**Target group**: individuals between 40 and 65 years **Year of data**: 2014–2019 **Aim**: mitigating cardiovascular risks **Findings**: creation of an easily understandable metric **Main benefits**: prolonging both life and health	RQ1: model of cardiovascular risks RQ2: calculating life expectancies RQ3: determining maximum gains
Corporate sustainability	2nd article	**Target group**: SMEs **Year of data**: 2018–2019 **Aim**: identifying best practices between company groups **Findings**: recommended measures of digital transformation and environmental protection **Main benefits**: enhancing corporate competitiveness	RQ1: map of industries and manufacturing branches RQ2: principal components of digitalisation and environmental protection RQ3: differentiating single attributes and principal components
Environmentally conscious consumer behaviour	3-5	**Target groups**: policymakers, individuals **Year of data**: 2016–2019	
	3rd article	**Aim**: clustering retail customers based on home, mobility, heating and cooling, and governance **Findings**: distinct dissimilarities between clusters **Main benefits**: profile-specific actions to elevate environmental awareness	*RQ1: levels of environmental awareness* *RQ2: social and economic characteristics*
	4th article	**Aim**: collecting motives of energy choices by mapping prosumers, customers with PV plans, and those without any plans **Findings**: distinguishing attributes of those planning or having PV installations **Main benefits**: tailored approach when promoting solar energy	*RQ1: differentiators related to PV installations and plans* RQ2: role of information channels and that of installation reasons RQ3: nexus between PV plans, energy conservation actions, and the evaluation of others' behaviour
	5th article	**Aim**: in-depth investigation of choices for environmentally friendly mobility **Findings**: potential enablers and disablers of environmentally friendly mobility **Main benefits**: improving the position of preferred travel modes	*RQ: influencing factors of preferred travel modes*

2. Methods of the applied quantitative toolkit

- Ordinary least squares (OLS) linear regression for prediction;
- binary logistic regression and probit analysis for prediction between 0 and 1;
- artificial neural network (ANN) for more sophisticated regression;
- principal component analysis (PCA) for dimension reduction;
- tests of normal distribution (Kolmogorov–Smirnov and Shapiro–Wilk);
- test of homogeneity of variances (Levene);
- tests of equality of means: the independent samples t-test, one-way analysis of variance (ANOVA), and asymptotic independent samples z-test;
- cluster analysis for creating relatively homogeneous groups;
- Pearson correlation coefficient for measuring linear correlation and its test;
- cross-tabulation analysis for testing the independence of variables and measures of association with tests;
- modelling mortality for generating probabilities.

3. Data collection

Modelling mortality:

(i) 10-year mortality rates of fatal cardiovascular diseases, (ii) population mortality rates, (iii) smoking ratios, (iv) death statistics due to cardiovascular diseases, and (v) the distribution of the population (i.e. the whole society).

Sources: European Society of Cardiology, national statistical offices (Austria, Czech Republic, and Hungary), OECD statistics

Air pollutant emission intensities:

Industries and branches of manufacturing of the national economy were evaluated by involving 12 relevant air pollutant (CO_2, N_2O, CH_4, HFC, PFC, SF_6, NO_X, SO_X, NH_3, CO, NMVOC, PM_{10}) emission intensities based on the gross value added by applying current prices.

Source: Hungarian Central Statistical Office

Firms' competitiveness:

A survey measuring the competitiveness of Hungarian firms with more than 50 employees was conducted during 2018–2019. In total, 209 entities remained in the final sample. The major industries include manufacturing (51%) and trade (24%), and ¾ of these companies are held by domestic private owners.

Source: Competitiveness Research Centre of the Corvinus University of Budapest (CUB) (*Chikán et al., 2019, p. 4*)

Individual energy choices and behaviours:

Between 2016 and 2019, a household survey was conducted with the participation of 11,265 retail customers from eleven countries (BG, DE, ES, FR, HU, IT, NO, PL, RS, UA, and UK) in order to reveal influencing factors. The survey comprised seven sections: (i) home/building characteristics and household possessions, (ii) mobility, (iii) prosumers (etymologically, a prosumer unifies the producer and the consumer in one single individual), (iv) heating and cooling, (v) electricity, (vi) governance, and (vii) social and economic characteristics.

Source: ENABLE.EU team (*ENABLE.EU team, 2019*)

3. Findings of the dissertation

3.1. Article 1: Providing new impetus to corporate well-being programmes: improving life expectancy through risk assessment

Scope: Hungary (high risk), Czech Republic (high risk), and Austria (low risk)
RQ1: How can cardiovascular risks be modelled?
Method: ANN enables the modelling of 10-year cardiovascular mortality rates.
Thesis No. 1 based on the findings: (1) The 10-year cardiovascular mortality rates can be appropriately estimated based on five variables: gender, age, smoker status (yes or no), systolic blood pressure, and total cholesterol.
The architecture of the multilayer perceptron networks is summarised below:

Architecture	High risk	Low risk
Number of hidden layers (HLs)	1	2
Number of neurons in the HLs	4	1st HL: 4, 2nd HL: 3
Activation function of the HLs	hyperbolic tangent	
Activation function of the output layer	identity	

RQ2: What are the life expectancies calculated based on the 10-year probabilities of fatal cardiovascular diseases as alternative metrics?
Method: Conventional actuarial modelling was applied for estimating country- and individual-specific (depending on the five predictors listed above) mortality rates due to any cause of death. The calculations were based on (i) 10-year mortality rates of fatal cardiovascular diseases, (ii) population mortality rates,

(iii) smoking ratios, (iv) death statistics due to cardiovascular diseases, and (v) the distribution of the population. Simplifying assumptions were made e.g. concerning smoking. In order to reproduce fact death cases, an adjustment of these probabilities with multipliers was required.

Findings: Free-to-download tables (A1-A3) (see http://www.ksh.hu/statszemle_archive/en/2021/2021_01/2021_01_017_annex.xlsx) align the life expectancies for each health status in Hungary (HU), Czechia (CZ), and Austria (AT).

RQ3: What is the estimated maximum gender- and age-specific gain in life expectancy between the two extreme cases by minimising cardiovascular risks?

Method: The differences can be determined from the free-to-download tables.

Findings: The indicated figures below are correct, the difference in the decimal place is due to rounding. The gains in life expectancy for individuals aged 40 years are:

Years	HU	CZ	AT
Females	(43.4–36.2=) 7.2	(45.8–37.8=) 8.0	(46.6–41.3=) 5.3
Males	(37.4–28.0=) 9.4	(39.7–29.7=) 10.0	(42.3–35.7=) 6.6

The gains in life expectancy for individuals aged 65 years are:

Years	HU	CZ	AT
Females	(21.2–15.6=) 5.7	(23.0–16.6=) 6.4	(23.4–19.3=) 4.1
Males	(17.1–11.3=) 5.8	(18.2–12.3=) 5.9	(20.0–16.1=) 3.9

The order of countries (HU<CZ<AT) based on the life expectancy is valid not only for the selected ages but can be also generalised to each health status.

3.2. Article 2: The outstanding role of digitalisation and environmental protection in enhancing corporate competitiveness

Scope: Hungary

RQ1: How can industries and manufacturing branches be characterised and ranked in relation to each other in terms of their air pollutant emission intensities through the example of the Hungarian economy?

Method: PCA was performed by applying 2 variants. The first one relies on 2 components and 7 molecules (N_2O, NO_X, NH_3, NMVOC, CO_2, SO_X, CO). The second one is an alteration, which keeps the 2-component structure without NO_X.

Thesis No. 2 based on the findings: (2) The critical air polluting areas are: (i) energy supply (CO_2, SO_X, NO_X, CO), (ii) agriculture, forestry, and fishing (N_2O, NO_X, NH_3, NMVOC), (iii) (a) wood and paper products and printing (NMVOC, NO_X), (b) coke and refined petroleum products (CO_2, NO_X, SO_X), (c) chemicals and chemical products (CO_2, NO_X, SO_X, NMVOC), (d) rubber and plastic products and other non-metallic mineral products (CO_2, NO_X, SO_X), (e) basic metals and fabricated metal products, except machinery and equipment (CO, SO_X).

RQ2: Which set of measures is the most apt for dimension reduction by creating the principal components of digitalisation and environmental protection?

Method: By using PCA, 52 variables were categorised into eleven components. Thereof 27 variables in six components pertain to digitalisation, while the remaining 25 variables of five components represent environmental protection.

Theses No. 3-4 based on the findings: (3) Digitalisation of most SMEs can be captured by six principal components: (i) preparedness for digitalisation, (ii) corporate level of digitalisation, (iii) digitalisation applied by leading enterprises of the industry, (iv) basic digitalisation tools, (v) advanced digitalisation tools, and (vi) technology use and change. (4) Their environmental protection can be divided into five subareas: (i) basic environmental management tools, (ii) advanced environmental management tools, (iii) environmental and social aspects of sustainability, (iv) sustainability performance compared to competitors, and (v) procurement. Tables 6 and 7 of the present study enumerate the 52 measures.

RQ3: Which of the (a) single attributes and (b) principal components in digitalisation or environmental protection can be considered differentiating in terms of competitiveness?

Methods: (a) Tests targeting normal distribution, the homogeneity of variances, and the equality of means. (b) Test of normal distribution, test for equality of variances, independent samples t-test, Pearson correlation coefficient, and non-hierarchical cluster analysis.

Theses No. 5-8 based on the findings: (5) More competitive and typically small and medium-sized Hungarian companies are more intensely impacted by a shortage of qualified workforce that impedes their innovation activities compared to less competitive firms. (6) More competitive companies outperform the less competitive ones nearly in all investigated dimensions. Exceptions are digitalisation applied by leading enterprises of the industry, instruments of advanced digitalisation, and basic environmental management. (7) Deepening

digitalisation or environmental protection (not counting procurement) promotes the competitiveness of less competitive firms. (8) Within the more competitive group, achieving better competitiveness does not necessitate a higher performance in any of the two fields (digitalisation or environmental protection).

3.3. Article 3: Analysis of retail customers in the field of environmentally conscious behaviour with respect to home, mobility, heating and cooling, and governance

Scope: Hungary, Spain, and Ukraine

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

Methods: Both hierarchical and non-hierarchical cluster analyses and asymptotic independent samples z-test.

Theses No. 9-10 based on the findings: (9) The generalisability (i.e. excellence in each field) of environmental awareness can be declined in the circle of retail customers. Even the most environmentally aware customers demonstrate a less conscious attitude in (i) the total travelled distance, (ii) opting for environmentally friendly alternatives concerning both (a) mobility and (b) household appliances, and (iii) accepting environmentally friendly measures that may cause inconvenience for them. (10) The group occupying the best environmentally friendly position in mobility underperforms in many scrutinised dimensions.

RQ2: Which socio-economic phenomena prevail in Hungary regarding environmentally conscious consumer behaviour?

Method: Asymptotic independent samples z-test.

Theses No. 11-12 based on the findings: (11) Irrespective of the cluster number, the most environmentally aware customers build the most homogeneous group that is composed of the most educated, economically active urban citizens with family (living in a household with 2.7 members on average) and stable financial background. (12) In the case of less environmentally aware clusters, a few favourable attitudes can be traced back to economic or demographic reasons, otherwise, they demonstrate significant deviations from the best performers.

3.4. Article 4: International comparative analysis of prosumers in selected fields of energy use and further customer preferences in environmental issues

Scope: Italy, Norway, Serbia, Ukraine, and the United Kingdom

RQ1: Which variables qualify as differentiators when comparing (i) prosumers with traditional customers, (ii) those having PV plans in the near future with those without such intentions, and (iii) country groups/countries with each other?

Methods: Asymptotic independent samples z-test and binary logistic regression.

Theses No. 13-16 based on the findings: (13) Comparing prosumers with traditional customers elucidates that prosumers are better educated and have a more stable financial background. They achieved a higher proportion of energy-efficient bulbs inside their homes, which are on average single-family houses

attached to building(s). These dwellings are more likely to be equipped with smart meters. They consume less energy thanks to environmentally friendly alternatives and agree more strongly with the inconvenience arising from eco-friendly measures. The same applies to the benefit of those having PV plans in the near future within the group of the traditional customers. (14) In addition, those having PV plans in the near future live in a larger family, demonstrate a higher share of men and more commitment to environmental issues, and are younger and economically more active than their counterparts without plans. (15) Without generalising but bearing in mind the restricted circle of countries, Western states have more spacious households with higher current income, are more likely to use both energy-efficient bulbs and smart meters, to consume less energy for both mobility and household appliances, and are more inclined to accept the inconvenience coupled with environmentally friendly measures than Eastern ones. (16) Furthermore, the comparison between Norway (NO) and Italy (IT) (Western countries) pointed to significant country specificities regarding (i) the weekly total travelled distance (longer distance: NO), (ii) opting for environmentally friendly mobility (more inclined: IT), (iii) supporting government actions affecting the transport system (more supportive: IT), and (iv) estimating the severity of traffic problems (more tolerant: NO).

RQ2: Which conclusions can be drawn with regard to the role of information channels and that of installation reasons when making decisions about PV systems?

Method: Asymptotic independent samples z-test.

Theses No. 17-18 based on the findings: (17) Prosumers give priority to formal information channels (one-sided p-value: 6.01%) when acquiring information about PV systems. (18) Both in the circle of prosumers and those with PV plans in the near future, the ascending order of motivating drivers of installation is: 1. technological, 2. environmental, and 3. other (e.g. financial) motives being the most important.

RQ3: What kind of interrelationships can be identified amongst having PV plans in the near future, the routines for own energy conservation actions, and the evaluation of factors detaining other people from saving electricity?
Methods: Cross-tabulation analysis or chi-square test of independence, measures of association (both symmetric and directional ones if the latter type was rational) and their tests, and asymptotic independent samples z-test.
Thesis No. 19 based on the findings: (19) The reasonable trio of interrelationships amongst having PV plans in the near future, the routines for own energy conservation actions, and the evaluation of factors detaining other people from saving electricity cannot be underpinned through the example of Serbia and the United Kingdom.

3.5. Article 5: Common practices and dissimilarities in greening residential routine mobility in selected countries of Europe, based on a comparative analysis

Scope: Hungary, Italy, Norway, Poland, and Spain

RQ: Based on the experiences gained in Hungary, Italy, Norway, Poland, and Spain, and the timeshare of preferred travel modes, what are the main influencing factors of residential routine mobility choices promoting public transport, electromobility, mobility sharing business models, biking, walking, and further environmentally friendly mobility solutions?

Methods: OLS linear regression, probit analysis, binary logistic regression, ANN, and asymptotic independent samples z-test.

Theses No. 20-24 based on the findings: (20) The influencing factors can be country-independent or country-specific. (21) Uniform enablers are (i) lower travel fares (decision based on cost), (ii) occupying a more supportive stance on government actions affecting the transport system, (iii) being more satisfied with transport facilities, (iv) consuming less energy thanks to environmentally friendly alternatives, (v) being economically less active, (vi) female, and (vii) member of younger age groups, (viii) considering CO_2 emissions, (ix) dwelling in urban areas, (x) assessing positively infrastructure development, (xi) possessing four-wheel electric and (xii) two-wheel traditional vehicles, and (xiii) facing financial difficulties (as they shift people towards less air polluting modes). (22) Uniform disablers are (i) owning four-wheel traditional vehicles, (ii) less flexibility of preferred travel modes, and (iii) considering traffic problems more seriously. (23) Conflicting effects are demonstrated by (i) the safety, (ii) availability, and (iii) reputation of travel methods, (iv) travel time, and (v) occupying a supportive position regarding environmental issues. (24) Without indicating the direction, further common factors are (i) purchasing cars or motors from public means and (ii) making use of bike-sharing.

4. Summary of the conclusions and theses

First article: Good health greatly depends on the lifestyle of citizens, but applying a positive approach in the argumentation targeting mitigating behavioural risks may prove to be more effective in preserving and prolonging their health than the use of probabilities. Albeit the geographical scope is Hungary, Czechia (both countries at high cardiovascular risk), and Austria (country at low risk), the results can be taken over. Probabilities for the occurrence of fatal cardiovascular events within 10 years can be appropriately estimated based on gender, age, smoker status, systolic blood pressure, and total cholesterol (No. 1), then, life expectancies – as a new proposed positive approach for raising health consciousness – can be calculated by relying on them. Preceding akin research was not found. From a broader perspective, the study can be assigned to the category of articles analysing the relationship between health risk factors and an aggregate variable such as health-related costs, all-cause mortality or productivity (here in specific life expectancy).

Second article: Spurring firms lagging behind on the digital pathway combined with deploying environmental management enhances their competitiveness. The findings bear relevance with particular reference to Hungary. Accelerating the spread of green(er) technologies in the most polluting industries (No. 2) could substantially abate air pollution and harm to societies. Theses No. 3-4 deal with the subareas of digitalisation and environmental protection of the scrutinised SMEs. By virtue of theses No. 5-8, the study contributes to the research fields (i)

investigating the relationship between firms' capabilities and competitiveness and (ii) identifying the factors hindering the innovation activity of enterprises.

Third article: People demonstrating a higher degree of environmental consciousness (e.g. due to being apprehensive of future generations and nature) began to make use of more sustainable alternatives except for particular facets of mobility and governance. Heightening awareness in the circle of less conscious customers is indispensable so that these solutions can become mainstream practices. Again, the findings bear relevance for Hungary. The hypothesis of generalisability of environmental consciousness can be declined (No. 9-10). Further theses shed light on attributes related to the most environmentally aware customers and their less conscious counterparts (No. 11-12). Environmentally conscious consumer behaviour is a frequently analysed and profoundly explored research area. The present scrutiny joins the numerous analogous antecedents unifying the attributes of two grouping themes represented by (i) comparative studies (along the level of consciousness) and (ii) influencers of sustainable consumption patterns. The aim was to classify consumers along environmental consciousness and collect their cluster-specific characteristics. The peculiarity lies in the feature of enabling stakeholders to conceive targeted actions when raising awareness.

Fourth article: Applying a tailored approach may promote the spread of prosumers. With regard to modifiable circumstances, a prosumer pathway can be outlined in the course of unfolding environmental awareness. It starts with being

a traditional customer without PV plans in the near future, then shifts towards having PV plans, and finally, the customer becomes a prosumer. The validity of the findings below may vary depending on the respective subset consisting of the countries Italy, Norway, Serbia, Ukraine, and the United Kingdom. The theses relate to dissimilarities along the stages of the three-stage prosumer pathway and to specificities at the level of country groups/countries (No. 13-16), to the role of information channels and that of installation reasons (No. 17-18), and to the nexus amongst having PV plans in the near future, the routines for own energy conservation actions, and the evaluation of factors detaining other people from saving electricity (No. 19). The article can be placed not only amongst the studies revealing the enablers and disablers of the diffusion of PV technology, but it explores consumer profiles as well.

Fifth article: Numerous alternatives enable us to promote environmentally friendly mobility (e.g. public transport, individual electromobility, mobility sharing business models, biking, and walking). A plethora of influencing factors are analysed from three viewpoints: whether they are (i) country-independent or -specific, (ii) enablers or disablers, and (iii) unidirectional or ambivalent (No. 20-24). The article widens the series of studies addressing determinants of green residential routine mobility by putting the research field in a broad international comparative analysis. By dividing arbitrarily corresponding preceding research into four dimensions, the collective and individual levels are affected, while the dimension of the technological background and the corporate level are left out.

5. Main references

AJZEN, I. (1991): The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. Vol. 50. No. 2. pp. 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

ALDANA, S. (2001): Financial impact of health promotion programs: A comprehensive review of the literature. *American Journal of Health Promotion*. Vol. 15. No. 5. pp. 296-320. https://doi.org/10.4278/0890-1171-15.5.296

BAKSA, M.–DEMETER, K.–DIÓFÁSI-KOVÁCS, O.–FREUND, A.–JÁMBOR, ZS.–LOSONCI, D.–MARCINIAK, R.–MATYUSZ, ZS.–MÓRICZ, P.–NAGY, J.–PISTRUI, B. (2020): Industry 4.0 Through the Lenses of Technology, Strategy, and Organization: A Compilation of Case Study Evidence. *Budapest Management Review*. Vol. 51. No. 11. pp. 14-25. https://doi.org/10.14267/VEZTUD.2020.11.02

BARBAROSSA, C.–PASTORE, A. (2015): Why environmentally conscious consumers do not purchase green products: A cognitive mapping approach. *Qualitative Market Research*. Vol. 18. No. 2. pp. 188-209. https://doi.org/10.1108/QMR-06-2012-0030

CHIKÁN, A.–CZAKÓ, E.–KISS-DOBRONYI, B.–LOSONCI, D. (Editors) (2019): *On the brink of the 4th Industrial Revolution – Quick report on the results of the 2019 questionnaire survey.* Competitiveness Research Centre of CUB. Budapest. http://unipub.lib.uni-corvinus.hu/4328/1/Gyorsjelentes_2019_Versenykepesseg.pdf

CSESZNÁK, A.–WIMMER, Á. (2021): *The competitiveness characteristics of domestic companies during the Fourth Industrial Revolution*. Alinea – Competitiveness Research Centre of CUB. Budapest. http://unipub.lib.uni-corvinus.hu/6609/1/Wimmer_Csesznak_Vallalatok_2021.pdf

EC (EUROPEAN COMMISSION) (2019): *The European Green Deal*. https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF

ECHEVERRIA, L.–GIMENEZ-NADAL, J. I.–MOLINA, J. A. (2022): Who uses green mobility? Exploring profiles in developed countries. *Transport Research Part A*. Vol. 163. pp. 247-265. https://doi.org/10.1016/j.tra.2022.07.008

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

GFN (GLOBAL FOOTPRINT NETWORK) (2023): *Country overshoot days 2023*. https://www.overshootday.org/newsroom/country-overshoot-days/dates/

GOETZEL, R.–PEI, X.–TABRIZI, M.–HENKE, R.–KOWLESSAR, N.–NELSON, C.–METZ, R. (2012): Ten modifiable health risk factors are linked to more than one-fifth of employer-employee health care spending. *Health Affairs*. Vol. 31. No. 11. pp. 2474-2484. https://doi.org/10.1377/hlthaff.2011.0819

HANSEN, A.–JACOBSEN, M.–GRAM-HANSSEN, K. (2022): Characterizing the Danish energy prosumer: Who buys solar PV systems and why do they buy them? *Ecological Economics*. Vol. 193. pp. 1-10. https://doi.org/10.1016/j.ecolecon.2021.107333

HERBERZ, M.–HAHNEL, U.–BROSCH, T. (2020): The importance of consumer motives for green mobility: A multi-modal perspective. *Transport Research Part A*. Vol. 139. pp. 102-118. https://doi.org/10.1016/j.tra.2020.06.021

LOEF, M.–WALACH, H. (2012): The combined effects of healthy lifestyle behaviors on all cause mortality: A systematic review and meta-analysis. *Preventive Medicine*. Vol. 55. No. 3. pp. 163-170. https://doi.org/10.1016/j.ypmed.2012.06.017

MCKAY, D. I. A.–STAAL, A.–ABRAMS, J. F.–WINKELMANN, R.–SAKSCHEWSKI, B.–LORIANI, S.–FETZER, I.–CORNELL, S. E.–ROCKSTRÖM, J.–LENTON, T. M. (2022): Exceeding 1.5°C global warming could trigger multiple climate tipping points. *Science*. Vol. 377. Issue 6611. pp. 1-10. https://doi.org/10.1126/science.abn7950

MIT (MINISTRY FOR INNOVATION AND TECHNOLOGY) (2020): *Report on the scientific assessment of the possible effects of climate change on the Carpathian Basin.* https://banyasz.hu/images/klimapolitika/Jelent%C3%A9s%20az%20%C3%A9ghajlatv%C3%A1ltoz%C3%A1s%20K%C3%A1rp%C3%A1t-medenc%C3%A9re%20gyakorolt%20esetleges%20hat%C3%A1sainak%20tudom%C3%A1nyos%20%C3%A9rt%C3%A9kel%C3%A9s%C3%A9r%C5%91l.pdf

MULARCZYK, A.–ZDONEK, I.–TUREK, M.–TOKARSKI, S. (2022): Intentions to Use Prosumer Photovoltaic Technology in Poland. *Energies*. Vol. 15. No. 17. pp. 1-15. https://doi.org/10.3390/en15176300

NLD (NATIONAL LEGISLATION DATABASE) (2023): *Act on climate protection 2020, XLIV*. https://njt.hu/jogszabaly/2020-44-00-00

OECD (ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT) (2021a): *The Digital Transformation of SMEs, OECD Studies on SMEs and Entrepreneurship*. OECD Publishing. Paris. https://doi.org/10.1787/bdb9256a-en

OECD (2021b): *OECD SME and Entrepreneurship Outlook 2021*. OECD Publishing. Paris. https://doi.org/10.1787/97a5bbfe-en

OECD–EOHSP (EUROPEAN OBSERVATORY ON HEALTH SYSTEMS AND POLICIES) (2023): *Hungary: Country Health Profile 2023, State of Health in the EU*. OECD Publishing. Paris. https://doi.org/10.1787/8d398062-en

RICHARDSON, K.–STEFFEN, W.–LUCHT, W.–BENDTSEN, J.–CORNELL, S. E.–DONGES, J. F.–DRÜKE, M.–FETZER, I.–BALA, G.–VON BLOH, W.–FEULNER, G.–FIEDLER, S.–GERTEN, D.–GLEESON, T.–HOFMANN, M.–HUISKAMP, W.–KUMMU, M.–MOHAN, C.–NOGUÉS-BRAVO, D.–PETRI, S.–PORKKA, M.–RAHMSTORF, S.–SCHAPHOFF, S.–THONICKE, K.–TOBIAN, A.–VIRKKI, V.–WANG-ERLANDSSON, L.–WEBER, L.–ROCKSTRÖM, J. (2023): Earth beyond six of nine planetary boundaries. *Science Advances*. Vol. 9. No. 37. pp. 1-16. http://doi.org/10.1126/sciadv.adh2458

SACHS, J.–LAFORTUNE, G.–FULLER, G.–DRUMM, E. (2023). *Implementing the SDG Stimulus. Sustainable Development Report 2023*. Dublin University Press. Dublin. https://doi.org/10.25546/102924

TRENCHER, G.–TRUONG, N.–TEMOCIN, P.–DUYGAN, M. (2021): Top-down sustainability transitions in action: How do incumbent actors drive electric mobility diffusion in China, Japan, and California? *Energy Research & Social Science*. Vol. 79. pp. 1-28. https://doi.org/10.1016/j.erss.2021.102184

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*. Vol. 41. pp. 85-98. https://doi.org/10.1016/j.rser.2014.08.039

ZDONEK, I.–TOKARSKI, S.–MULARCZYK, A.–TUREK, M. (2022): Evaluation of the Program Subsidizing Prosumer Photovoltaic Sources in Poland. *Energies*. Vol. 15. No. 3. pp. 1-23. https://doi.org/10.3390/en15030846

6. Relevant publications of the author related to the topic

Articles forming part of the doctoral dissertation:

VONA, G. (2021): Providing new impetus to corporate well-being programmes: improving life expectancy through risk assessment. *Hungarian Statistical Review*. Vol. 4. No. 1. pp. 17-50. DOI: 10.35618/hsr2021.01.en017. https://www.ksh.hu/statszemle_archive/en/2021/2021_01/2021_01_017.pdf

VONA, G. (2022): The outstanding role of digitalisation and environmental protection in enhancing corporate competitiveness. *Hungarian Statistical Review*. Vol. 5. No. 2. pp. 30-53. DOI: 10.35618/hsr2022.02.en030. https://www.ksh.hu/statszemle_archive/en/2022/2022_02/2022_02_030.pdf

VONA, G. (2023): Analysis of retail customers in the field of environmentally conscious behaviour with respect to home, mobility, heating and cooling, and governance. *Regional Statistics*. Vol. 13. No. 5. pp. 925-950. DOI: 10.15196/RS130506. https://www.ksh.hu/statszemle_archive/regstat/2023/2023_05/rs130506.pdf

VONA, G. (2023): International comparative analysis of prosumers in selected fields of energy use and further customer preferences in environmental issues. *Hungarian Statistical Review*. Vol. 6. No. 1. pp. 3-31. DOI: 10.35618/HSR2023.01.en003. https://www.ksh.hu/statszemle_archive/en/2023/2023_01/2023_01_003.pdf

VONA, G. (2023): Common practices and dissimilarities in greening residential routine mobility in selected countries of Europe, based on a comparative analysis. *Hungarian Statistical Review*. Vol. 6. No. 2. pp. 37-74. DOI: 10.35618/HSR2023.02.en037. https://www.ksh.hu/statszemle_archive/en/2023/2023_02/2023_02_037.pdf

Further article:

VONA, G. (2020): Boosting gains in healthy life expectancy through excelling in achieving SDGs. *Review of Economic Theory and Policy*. Vol. 15. No. 2. pp. 96-107. DOI: 10.14267/RETP2020.02.14. https://unipub.lib.uni-corvinus.hu/5935/1/Gabor_Vona.pdf