#ENVECON8

Book of Proceedings
Economics of Natural Resources and the Environment
8th Conference, 2 – 3 December 2022
HYBRID

Co-organized by:
Laboratory of Operations Research, UTH.
&
Research Unit of Environmental Communication and Education, UNIWA.

❑ SCOPE

Main issues that concern the Economics of Natural Resources and the Environment with emphasis on the various environmental problems and their management and solution policies.

❑ AIM

Highlight the interdisciplinary nature of environmental research through the exchange of views and experiences of researchers from different scientific fields and the finding of common components of research approaches.

- Sustainability
- R.E.S.
- Environmental Education
- Natural Hazards & Risks
- Mitigation & Adaptation
- Circular Economy

Co-organization of the Conference

Laboratory of Operations Research
School of Economics and Business

Department of Economics
University of Thessaly

Research Unit of Environmental Communication and Education
School of Public Health

Department of Public and Community Health
University of West Attica

WELCOME

Dear,

Invited guests, Colleagues, and Students.

On behalf of the Scientific and Organizing Committee I welcome you at the:
8th Conference on "**Economics of Natural Resources and the Environment**".

The 8th ENVECON Conference was organized on 2 – 3 December 2022 by the Laboratory of Operations Research of the Department of Economics, University of Thessaly and the Research Unit of Environmental Communication and Education of the Department of Public and Community Health of University of West Attica. The 8th ENVECON theme: "Environmental Research Activities: Progress and Trends".

The conference aims to present the main issues that concern the Economics of Natural Resources and the Environment and the recent scientific research on the field. The main focus will be given on sustainability and effective environmental management, while research on the environmental and social impacts of the recent COVID-19 pandemic will also be presented. The conference aims to promote the exchange of views and experiences of researchers from different scientific fields and the finding of common components of research approaches, since the environment is governed from interdisciplinarity.

I would also like to wholeheartedly thank the keynote speakers of the conference: Professor ***Phoebe Kountouri,*** Dr. ***Panagiotis Grammelis***, Professor ***Shunsuke Managi***, and Professor ***Chrysi Laspidou*** who accepted the invitation to present their long-term remarkable research experience on topics relevant to the conference.

I would also like to thank the participants, not only of the current conference but of the previous ones as well. Their support to this scientific effort is significantly important and fosters even more our efforts to contribute to the development of Economics of Natural Resources and the Environment. Personally, I promise to continue the conference at the highest possible level at a time, continuing to promote important research findings regarding sustainable development, environmental protection and natural resources management, at both theoretical and applied levels.

I hope that all academics, researchers, and students, who participate in the Conference and who either present their research results or learn and value the work of other researchers, have a pleasant and constructive experience of the attendance of the Conference.

Conference Scientific Coordinator
Professor George E. Halkos
Laboratory of Operations Research
Department of Economics
School of Economics and Business
University of Thessaly, Volos, Greece

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Concise Conference Programme

Time (Greek Time)	Sessions-Topics
	Day 1 – Friday 2/12/2022
9:30-9:45	OPENING – WELCOME
9:45-11:30	Session 1: Research on rural development in Global South
11:30-12:00	Keynote Speaker Professor Phoebe Kountouri
12:00-14:00	Session 2: Environmental statistical challenges and applications
14:00-14:30	Break
14:30-16:15	Session 3: Energy Issues and Policies
16:15-16:45	Keynote Speaker Dr Panagiotis Grammelis
16:45-17:00	Break
17:00-18:45	Session 4: Natural Resources Conservation
18:45-20:45	Session 5: Education for Sustainability and the Environment
	Day 2 - Saturday 3/12/2022
09:00-09:30	Keynote Speaker Professor Shunsuke Managi
09:30-11:30	Session 6: Environmental performance
09:30-11:30	Session 7: Corporate Social Responsibility
11:30-11:45	Break
11:45-13:05	Session 8: Circular economy
11:45-13:05	Session 9: Sustainable Transport
13:05-13:30	Break
13:30-14:00	Keynote Speaker Professor Chrysi Laspidou
14:00-15:40	Session 10: Environmental Pollution Modelling
15:40-16:00	Break
16:00-18:00	Session 11: Sustainable Tourism
16:00-18:00	Session 12: Environmental Education
18:00-18:10	CLOSING & FINAL GIVEAWAYS

Keynote Speakers

Decision Making under Deep Uncertainty:
A central challenge for Economic theory and Applications

Professor Phoebe Koundouri

President of the European Association of Environmental and Resource Economists (EAERE), Athens University of Economics and Business, Director of ReSEES, Athens, Greece.

Sustainable pathways using Biofuels and Renewable Gases under a circular economy approach

Dr. Panagiotis Grammelis

Director of Research at Chemical Process & Energy Resources Institute (CPERI)
Centre for Research & Technology (CERTH).

Inclusive Wealth Footprint: Cross-border Movement of Natural, Human and Produced Capital

Professor Shunsuke Managi

Director of Urban Institute, Urban Engineering & Economics Laboratory.
Department of Civil Engineering, School of Engineering, Kyushu University.

Climate-resilient regions through systemic solutions and innovations: theARSINOE project

Professor Chrysi Laspidou

Civil Engineering Department, University of Thessaly, Greece.
Vice-President of Research and Technology Water Europe, Brussels.

Conference Schedule

Friday 02 December 2022

Opening – Welcome **09:30-09:45**

1st Session **09:45-11:30**

Topic: **Research on rural development in global South**

Chairperson: **Assc Professor Trung Thanh Nguyen**

09:45-10:05	*Indebtedness and child well-being: Empirical evidence from Vietnam* Duy Linh Nguyen, Thanh Tung Nguyen, Trung Thanh Nguyen, Grote Ulrike
10:05-10:25	*Land Rental Markets as a Poverty Reduction Strategy: Evidence from Southeast Asia* Eva Seewald, Samantha Baerthel & Trung Thnah Nguyen
10:25-10:45	*Local infrastructure, households' resilience capacity, and vulnerability to poverty:Evidence from panel data for Southeast Asia* Tim Hartwig & Manh Hung Do
10:45-11:05	*Resilience against shocks and poverty in developing countries: Evidence from paneldata for rural Southeast Asia* Manh Hung Do
11:05-11:25	*Trade-offs between remittance and agricultural productivity: Evidence fromsmallholder farming systems in Nepal* Gokul P. Paudel, Trung Thanh Nguyen, Ulrike Grote

Keynote Speaker **11:30-12:00**

Topic: "Decision Making under Deep Uncertainty:
A central challenge for Economic theory and Applications"
Professor Phoebe Koundouri

President of the European Association of
Environmental and Resource Economists (EAERE)
Athens University of Economics and Business,
Director of ReSEES, Athens, Greece

2nd Session 12:00-14:40

Topic: **Environmental statistical challenges and applications**

Chairperson: **Assc Professor Teresa Oliveira and Asst Professor Amílcar Oliveira**

12:00-12:20	*Statistical and Probability Models for Environmental Risk AnalysisGreece* C. P. Kitsos & C.S. A. Nisiotis
12:20-12:40	*Estimating parameters in Extreme Value Theory: Application to environmental data* Dora Prata Gomes & Manuela Neves
12:40-13:00	*Analysis of Waste Management on Portuguese Subsurface Ships: A Possible Approach* M. Filomena Teodoro, Suzana P. Lampreia & Tomás Neves
13:00-13:20	*Multilevel modeling techniques to study the impact of environmental changes onhuman face development* Mónica Amorim, Joana Godinho & Teresa Oliveira
13:20-13:40	*Hazard Function of $N(\mu, \sigma^2;\gamma)$ Distribution for Environmental Pollutants* Christos P. Kitsos & Paula Camelia Trandafir
13:40-14:00	*Big Data Analytics in Control of Water* Amílcar Oliveira

3rd Session 14:30-16:15

Topic: **Energy Issues and Policies**

Chairperson: **Professor George Halkos**

14:30-14:50	*Energy poverty persistence and transition effects: Empirical evidence from Greekhouseholds* George Halkos & Ioannis Kostakis
14:50-15:10	*Regulatory Framework for the Participation of Demand Response in the newelectricity markets* Angeliki Mourtzikou, Angeliki Anastopoulou & Athanasios Volikas
15:10-15:30	*Development of RES is the answer to the current energy cricis: The economic benefitsfrom both RES and CHP support scheme and competitive procedures for RES via eAuctions in Greece."* Dionysios Papachristou
15:30-15:50	*Legal and Regulatory Framework for Storing Energy in Greece* George Loizos, Dionysios Spyropoulos
15:50-16:10	*Estimating the energy requirements of the Greek economy by the sraffian multiplier* Theodore Mariolis & Christos Tsirimokos

Keynote Speaker 16:15-16:45

Topic: "Sustainable pathways using Biofuels and Renewable Gases under a circulareconomy approach"
Dr. Panagiotis Grammelis

Director of Research at Chemical Process & Energy Resources Institute (CPERI)
Centre for Research & Technology (CERTH)

Topic: **Natural Resources Conservation**

Chairperson: **Professor G. Arabatzis and Assc Professor G. Papaspyropoulos**

17:00-17:20	*Dams and climate change: Socioeconomic approaches* Nikolaos Liagkouas, Georgios Kolkos, Garyfallos Arabatzis & Efthimios Zervas
17:20-17:40	*Assessment of the socio-economic impacts of the ForestLife Project on the governanceof Natura 2000 Forests* Marina-Vasiliki Andreadou, Victoria Datsi, Giorgos Amaslidis, Petros Kakouros &Konstantinos G. Papaspyropoulos
17:40-18:00	*Fishing cultural heritage, local identity, and implications for maritime spatialplanning* Mavra Stithou & Aris Tsantiropoulos
18:00-18:20	*Value Chain Finance in Agriculture: Empirical Evidence from Greece* Nikolaos Lathiras, Paraskevi Boufounou, Kanellos Toudas, & Chrisovalantis Malesios
18:20-18:40	*Ecosystem services supply by Agriculture: Using Choice Experiments to estimatetrade-offs between monetary and non-monetary incentives* L. Madureira, A.F. Fonseca & C. P. Marques

5th Session **18:45-20:45**

Topic: **Education for Sustainability and the Environment**

Chairperson: **Professor Steriani Matsiori**

18:45-19:05	*Smart city as a strategic improvement of the living conditions of citizens: UrbanForests* Elisavet Iannidou, Sofoklis Dritsas, Steriani Matsiori & Stavros Sakellariou
19:05-19:25	*Media and Environmental Information* Dorothea Kolindrini, Dritsas Sofoklis, Stefanos Paraskevopoulos, & Steriani Matsiori
19:25-19:45	*Public Awareness of Nature and the Environment During the COVID 19 Crisis* Pasintelis Kariofillis-Panagiotis, Georgios Meletiadis, Dritsas Sofoklis & SterianiMatsiori
19:45-20:05	*The role of environmental knowledge and environmental values in citizens' beliefs andconsumer behaviour* Ilektra Skarpa, Dritsas Sofoklis & Steriani Matsiori
20:05-20:25	*Investigation of environmental literacy in a sample of primary school teachers* Chrysovalantis Kalessopoulos, Anastasia Gkargkavouzi & Steriani Matsiori
20:25-20:45	*Citizen Science and its use in Environmental Education/Education for Sustainability* Dimitrios S. Prampromis

Saturday 3 December

Keynote Speaker **09:00-09:30**

Topic: "Inclusive Wealth Footprint: Cross-border Movement of Natural, Human andProduced Capital"

Professor Shunsuke Managi

Director of Urban Institute, Urban Engineering & Economics Laboratory.
Department of Civil Engineering, School of Engineering, Kyushu University.

6th Session **09:30-11:30 Lecture Room A**

Topic: **Environmental Performance**

Chairperson: **Professor Kostas Tsekouras and Assc Professor Kostas Kounetas**

09:30-09:50	*Innovation, Productive Performance and Undesirable Outputs across EuropeanRegions: Are there any missing links?* Eirini Stergiou, Kostas Kounetas & Kostas Tsekouras
09:50-10:10	*European firms' productivity growth and environmental regulation. Re-examining thePorter Hypothesis* Rigas Nikolaos, Tsekouras Konstantinos, Kounetas Konstantinos & Capasso Salvatore
10:10-10:30	*Environmental performance – Economic performance nexus in LCDs Agriculture; Anempirical study* Eleni Zafeiriou, Athanasios Batzios, Spyros Galatsidas & Garyfallos Arabatzis
10:30-10:50	*A causal model of climate-induced psychological resilience* Anastasia Gkargkavouzi
10:50-11:10	*Environmental, Social and corporate Governance (ESG) factors in HealthcareSystems, in terms of Sustainable Finance* Fotios Rizos & Anastasios Sepetis

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Topic: **Corporate Social Responsibility**

Chairperson: **Assc Professor Kon/os Evangelinos & Asst Professor Ant. Skouloudis**

09:30-09:50	*Corporate Social Responsibility Reporting and Health & Safety Strategies in the UKconstruction sector* Stefanos Fotiadis & Konstantinos Evangelinos
09:50-10:10	*Climate change and its effects in public health* Evangelos Kehagias and Panagiota Bobori
10:10-10:30	*The hotel business through the prism of sustainable development: Initial results of theprogram GREEN INNOVATIVE VALUE SERVICES (G.I.V.S)* Panagiotis Vouros, Panagiota Lambrou, Christos Mitsokapas, Petros Dallas,Konstantinos I Evangelinos, Panagiotis Grammelis
10:30-10:50	*Corporate Social Responsibility and Disability at Work: Evaluating SustainabilityReporting in Great Britain and Germany* Georgia Papadopoulou & Konstantinos I Evangelinos
10:50-11:10	*Factors influencing recycling intention for mobile phones: Evidence from Greece* Eirini Grigoraki & Iosif Botetzagias
11:10-11:30	*Antecedents and consequences of consumer satisfaction for bio-based products:Preliminary findings from Greece using structural equation modelling* Skouloudis Antonis, Malesios Chrysovalantis & Lekkas Demetris-Francis

8th Session **11:45-13:05 Lecture Room A**

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Topic:	**Circular Economy**
Chairperson:	**Professor Christos Kitsos and Professor George Halkos**
11:45-12:05	*Do firms care about peers when choosing to go circular? Peer effect among Italianfirms in the introduction of circular innovation* Davide Antonioli, Elisa Chioatto, Susanna Mancinelli & Francesco Nicolli
12:05-12:25	*Green Growth & Sustainability Transition through information. Are the greenerbetter informed? Evidence from European SMEs* Nikos Chatzistamoulou, Emmanouil Tyllianakis
12:25-12:45	*Defining circular economy and sustainability* Vasilis Nikou, Eleni Sardianou, Konstantinos Evangelinos, & Ioannis Nikolaou
12:45-13:05	*Policy Review towards Circular Economy on Sustainable MSWM: Examining theMediterranean Europe* George Halkos & Panagiotis – Stavros Aslanidis

9th Session **11:45-13:05 Lecture Room B**

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Topic: **Sustainable Transport**

Chairperson: **Professor Vassilios Profillidis**

11:45-12:05	*The consequences of the COVID-19 pandemic on the habitual behaviors and theselection criteria of transport mode in Greece* Athanasios Galanis, Ioanna-Theodora Dioti, Christina Taso, George Botzoris &Panagiotis Lemonakis
12:05-12:25	*Micromobility as a reference element of urban sustainable mobility and environmentalsustainability* Chrysa Vizmpa & George Botzoris
12:25-12:45	*The Effect of Road Transport Electrification on Energy Demand in Greece* Konstantinos Christidis, Vassilios Profillidis, George Botzoris
12:45-13:05	*Implementation of the rail trail practice in Greece as a sustainable tourism growthfactor* Panagiotis Lemonakis, Spyridon Barkas, Athanasios Galanis & George Botzoris

Keynote Speaker **13:30-14:00**

Topic: "Climate-resilient regions through systemic solutions and innovations: The ARSINOE project"

Professor Chrysi Laspidou

Civil Engineering Department, University of Thessaly, Greece.
Vice-President of Research and Technology Water Europe, Brussels.

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Topic: **Environmental Pollution Modelling**

Chairperson: **Professor George Halkos**

14:00-14:20	*Preliminary study for the deployment of low-cost sensors-based particulate matter(PM) monitors in a few cities in Senegal* B. Tchanche, I. Fall, D. Westervelt
14:20-14:40	*A comparative critical analysis of the major EFRAG, SEC and ISSB proposals, forclimate disclosure* Benjamin Karatzoglou (PhD)
14:40-15:00	*The effects of climate change to weather-related environmental hazards: Interlinkagesof economic factors and climate risk* George Halkos and Argyro Zisiadou
15:00-15:20	*Improving collaboration of actors involved in Risk and Resilience Assessment Centersusing Serious Games* Anastasia Roukouni, Georgios Botzoris, Maria Giannopoulou, Alexandros Kokkalis &Ioannis Dokas
15:20-15:40	*Modeling counter pollution policies: Defensive or aggressive? Which one is moreeffective* George E. Halkos, George J. Papageorgiou, Emmanuel G. Halkos, Georgia G. Papageorgiou

11th Session

16:00-18:00 Lecture Room A

Topic: **Sustainable Tourism**

Chairperson: **Professor Roido Mitoula and Assc Professor Eleni Sardianou**

16:00-16:20	*Searching for degrowth potential at the interface of tourism and the environment* George Ekonomou & George Halkos
16:20-16:40	*Determining factors that secure tourist excursions to Veria* Agisilaos Economou, Georgios Karagiannis, Roido Mitoula
16:40-17:00	*Sustainable tourism development of the former Tatoi Royal Estate in Athens* Georgios Tsimpoulis, Panagiota Karametou, Eleni Theodoropoulou
17:00-17:20	*Tourism and Corporate Social Responsibility. Case study: Tourism Businesses on theisland of Lefkada.* Olga Eleni Astara, Englantina Toska, Panagiotis Kaldis, Roido Mitoula
17:20-17:40	*Barriers and drivers in implementing sustainability practices in Greek universities* Vasiliki Platitsa, Eleni Sardianou, Konstantinos Abeliotis & Roido Mitoula

12th Session **16:00-18:00 Lecture Room B**

Topic: **Environmental Education**

Chairperson: **Professor Constantina Skanavis**

16:00-16:20	*Perceptions of secondary school students about renewable energy sources* Konstantinos Kougias, Eleni Sardianou, Anna Saiti, & Konstantinos Tsagarakis
16:20-16:40	*Trash Art as an educational tool to protect the environment: The Case of SkyrosProject* Ioannis Theodoulou, Athanasios-Foivos Papathanasiou, & Constantina Skanavis
16:40-17:00	*Awareness of teachers at Primary and Secondary Schools through Trash Art intoenvironmental issues and actions* Ioannis Theodoulou, Athanasios-Foivos Papathanasiou & Constantina Skanavis
17:00-17:20	*The theoretical framework of Ecotherapy* Fotios Mylonas, Alexandros Lingos, Constantina Skanavis
17:20-17:40	*Environmental Educators' Personality Characteristics: A Psychometric Case Study atEnvironmental Educators' Academy, Skyros Island* Kalliopi Marini, Naoum Karaminas, Moriki Eirini, Charikleia Oursouzidou, &Constantina Skanavis
17:40-18:00	*Health promotion through Ecotherapy: Impact on young students* Fotios Mylonas, Constantina Skanavis

Closing **18:00-18:10**

Topic: Closing & Giveaways

Professor George Halkos

Department of Economics, School of Humanities and Social Sciences, University of Thessaly

Proceedings Summary

The **8th ENVECON Conference** program consisted of 12 sessions and 4 Keynote speakers. The 12 thematic sessions presented concerned energy issues and policies, environment and the economy, environmental behaviour and practices, sustainable transport, environmental education, environmental management and valuation, environmental polices, assessment and quantitative methods in environmental and resource economics. In total, **21 studies** were included in the conference proceedings, however, a number of papers has not been included in the book of proceedings since they have already been submitted to the conference special issues journals.

The 1st paper by *C. P. Kitsos and C.-S. Nisiotis* has as a target the application of several statistical and probability models for the evaluation of environmental risk analysis. Some important contributions of this paper is on the utilization of AR(1) approaches and it goes beyond on the analysis on the matters of probability model of Weibull and Birnbaum-Saunders.

The 2nd paper by *M. Amorim, J. Godinho, and T. Oliveira* is centered on multilevel modelling techniques regarding human face development in order to delve into the impacts of environmental changes. Furthermore, the main analysis focuses on longitudinal hierarchical linear model (MLH).

The 3rd paper by *C. P. Kitsos and P. C. Trandafir* is the application of γ-order generalized normal distribution. This specific paper specifies hazard functions for environmental pollutants in an innovative way, especially for air pollutants.

The 4th paper by *T. Mariolis and C. Tsirimokos* estimates the energy requirements of the Greek economy based on the Sraffian multiplier. More specifically, the innovative aspect of this proposed methodology can provide a helping hand policy-makers on the development of well-targeted energy strategies.

The 5th paper by *M. Stithou and A. Tsantiropoulos* elaborates state-of-the-art issues on maritime spatial planning. More specifically, it describes the fishing cultural heritage and local identity effects on maritime planning in subarea of Chalkidiki peninsula in Northern Greece.

The 6th paper by *E. Ioannidou, S. Dritsas, S. Matsiori, and S. Sakellariou* elaborates the importance of urban forests as a strategic improvement of citizens' living conditions under the scope of smart cities. This research can offer new perspectives on Agenda 2030 and it can also ameliorate citizens' well-being.

The 7th paper by *C. Kalessopoulos, A. Gkargkavouzi, and S. Matsiori* investigates the environmental literacy of 200 primary school teachers in education for sustainable development. The utilized analysis incorporates techniques like Explanatory Factor Analysis and Multiple Linear Regression.

The 8th paper by *A. Skouloudis, C. Malesios, and D.-F. Lekkas* utilises structural equation modelling. This analysis is enables stakeholders to distinguish the perceived product quality, innovation and even rik on customer satisfaction and awareness on the use of bio-products.

The 9th paper by *G. Halkos and P.-S. Aslanidis* delves into the sustainable development principles regarding municipal solid waste management (MSWM) in European Mediterranean Area. The study is based on waste prevention reports from the studied countries (Spain, France, Italy, Malta, Slovenia, Croatia, Greece, and Cyprus) and their linkages to circular economy under the institutional European framework on European Green Deal (EGD).

The 10th paper by *A. Galanis, I.-T. Dioti, C. Taso, G. Botzoris, and P. Lemonakis* focuses on the COVID-19 repercussions on habitual behaviour and transportation. The research includes a questionnaire of 250 participants via Google Forms in two periods (spring 2020 and autumn 2020 to spring 2021).

The 11th paper by *C. Vizmpa and G. Botzoris* studies micromobility as a form of urban mobility under the notion of sustainable development. This research provides a various of different transportation ways (e.g. electric scooters, rollers etc.) as solutions for achieving sustainable human-oriented cities.

The 12th paper by *K. Christidis, V. Profillidis, and G. Botzoris* investigates the road transport electrification impacts on Greece's energy demand. Forecasting and machine learning techniques are being applied in order to identify possible increase in future energy demand.

The 13th paper by *P. Lemonakis, S. Barkas, A. Galanis, and G. Botzoris* examines rail trail practices in Greece as a way of sustainable tourism growth factor. For example, the paper proposes that the preservation of old railway architectural monuments – of great historical values – can preserve the historical memory of the railway and local architecture as well.

The 14th paper by *B. Tchanche, I. Fall, and D. Westervelt* offer insights into the deployment of low-cost sensors-based particulate matter (PM) monitors that have been applied in Senegal. The impacts of PM can be detrimental to human health and sectors as these in the future might offer an alternative way of coping with this phenomenon.

The paper 15th by *G. Halkos and A. Zisiadou* delves into the interlinkages between climate risks and economic factos under the scope of weather-related environmental hazards. The analysis incorporates two indices the Climate Change Performance Index (CCPI) and the Global Climate Risk Index (CRI) via which it is possible to compare countries' performance on the basis of economic growth as a great contributor on environmental performance and climate risk.

The 16th paper by *A. Roukouni, G. Botzoris, M. Giannopoulou, A. Kokkalis and I. Dokas* utilizes serious games in order to assess the impacts of natural and technological hazards. Case study is the prefecture of Eastern Macedonia and Thrace, Greece.

The 17th paper by *A. Economou, G. Karagiannis, and R. Mitoula* explores the determining factor which can ameliorate tourism in the city of Veria, Greece. Three core tourist attractions of great – historical and religious – importance in the studied area have been taken into account: the archaeological site of Vergina, the Altar of Paul the Apostle and the Church of Panagia Soumela.

The 18th paper by *G. Tsimpoulis, P. Karametou, R. Mitoula, and E. Theodoropoulou* explores the economic, social and environmental effects of the former Tatoi Royal Estate in Athens, Greece. The analysis is based on a sample of 132 people questionnaire leading to the conclusion that Tatoi offers a plethora of positive elements on local and national identity.

The 19th paper by *O. E. Astara, E. Toska, P. Kaldis, and R. Mitoula* investigates the liaison between tourism and corporate social responsibility in Lefkada island, Greece. Having as a result, the adoption of corporate social responsibility from local businesses in order to boost the local tourism sector.

The 20th paper by *I. Theodoulou, A.-F. Papathanasiou, and C. Skanavis* examines the positive aspects of trash art as an educational form of environmental protection at the island of Skyros, Greece. The collection and transformation of waste into art can be an excellent tool for environmental art and education too.

The 21st paper by *I. Theodoulou, A.-F. Papathanasiou, and C. Skanavis* explores the awareness of teachers in schools on environmental and educational projects like the 'Trash art'. Trash art can promote environmental education and communication among stakeholders and students under the scope of ecology and sustainable development.

Conference Papers

Session 1
Research on Rural Development in Global South

Indebtedness and child well-being: Empirical evidence from Vietnam

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33

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Abstract

Over-indebtedness is an ongoing problem in emerging economies, but its effect on child wellbeing is unexplored. In this paper, we first investigate the determinants of household over-indebtedness in rural Vietnam and then examine the effect of over-indebtedness on education and growth standards of school- aged children. Our study finds that i) households with larger farmland, suffering from adult health shocks and weather shocks, and residing far from district center have a higher probability of over-indebtedness. Meanwhile, ethnic minority households and those with self-employment business have a lower probability of over-indebtedness; ii) Over-indebtedness is insignificantly associated with the probabilityof children dropping out their schools. However, it has a negative effect on children's height for age and increase the probability of stunting. The impacts are more pronounced on school girls and young children. Our findings suggest that facilitating self-employment development and promoting effective instruments to mitigate the impact of adverse shocks would prevent rural households to be over-indebted.

Keywords: *Over-indebtedness; ethnic minority; school-aged children; health conditions*

JEL Codes: O44; O53; Q15

Land Rental Markets as a Poverty Reduction Strategy: Evidence from Southeast Asia

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Abstract
Rural poor households are particularly vulnerable to climate change. Understanding the impact of land rental market as an adaptation strategy important to support households in mitigating climate change impacts. This paper examines the interlinkage between the use of land rental markets as an adaptation strategy to climate change and land rental market participation's impact on poverty in Thailand and Vietnam. The econometric analysis from logit panel regressions show that land rental markets are used as a coping strategy and help to reduce the likelihood of multidimensional poverty. In order to understand the driving factors of successful mitigation strategies to climate change further research is necessary.

Keywords: *Climate Change Mitigation; Land Rental Markets; Multidimensional Poverty; PanelRegression.*

JEL Codes: O13; O44; O53; Q15; Q54.

Local infrastructure, households' resilience capacity, and vulnerability to poverty:Evidence from panel data for Southeast Asia

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Abstract
Infrastructure development is a topic of paramount interest because of its large-scale effects on economic growth at national, regional, and local levels. In developing countries, investments in infrastructure are expanding dramatically in order to boost economic growth and reduce poverty. Less attention in theliterature has been paid to the role of infrastructure in improving households' resilience capacity. In this study, we examine the correlation of infrastructure with household's resilience capacity against shocks and the impacts of household's resilience capacity on households' consumption, poverty, and vulnerability to poverty. We use a panel data (collected in 2010, 2013, and 2016) of 1,698 households in Thailand and 1,701 households in Vietnam, the two emerging economies in Southeast Asia to address these research issues. Our results show that infrastructure in the forms of transportation and information and communication technology helps improve households' absorptive capacity in coping with shocks. Furthermore, this capacity can prevent households from reducing consumptions and falling into poverty. Therefore, we recommend that infrastructure development projects should pay more attention to increase transportation and ICTfacilities and to improve households' economic capital.

Keywords: *Infrastructure; resilience; absorptive capacity; multidimensional poverty; instrumentalvariable.*

JEL Codes: O13; O53; Q15

Resilience against shocks and poverty in developing countries: Evidence from panel data for rural Southeast Asia

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Abstract

The question "How resilient are rural households?" is becoming an important research issue, especially in the context of more frequent and severe shocks in rural areas of developing countries. The resilience ofrural households against shocks is placed at the top of the discussion agenda, along with fighting climate change, for sustainable development. In this study, we use a balanced panel data of 1698 identical households from Thailand and 1669 identical households from Vietnam collected in 2010, 2013, and 2016. We estimate the resilience capacity of rural households and examine the effects of resilience capacity on mitigating shocks' impacts and improving household welfare. We employ a generalized structural equation model (GSEM) to estimate a latent variable representing household resilience capacity. The results from theGSEM models show that households in Thailand have a higher resilience capacity than those in Vietnam. We use lagged resilience capacity to estimate their effects on shock losses in different terms, namely total losses from shocks, losses from covariate shocks, and losses from idiosyncratic shocks. The estimation results from fixed-effects, fixed-effects with control function, and fixed-effects with instrumental variable methods show that a better resilience capacity has a significant and negative effect on shock losses. This finding implies that higher resilience capacities help reduce the adverse impacts of shocks. Further, an improved resilience capacity can also prevent rural households from reducing their consumption to cope with shocks and help them to escape from poverty in absolute, relative, and multidimensional measure

Keywords: *Resilience; shock; generalized structural equation model; fixed-effects; instrumentalvariable*

JEL Codes: O13; O44; Q15

Trade-offs between remittance and agricultural productivity:Evidence from smallholder farming systems in Nepal

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Abstract

Remittance from labor out-migration plays a vital role for the upliftment of rural livelihoods in many developing economies. Yet, studies that assess the impacts of household labor out-migration on agricultural productivity, production costs, and profitability in the developing countries are scant. This study evaluates the impacts of household labor out-migration on wheat productivity, labor cost, total cost of production,farm returns, and off-farm income in smallholder's wheat-based farming systems in Nepal. We used an endogenous switching regression model to account the observed and unobserved sources of heterogeneity between labor out-migrating and non-migrating households. Our findings show that labor out-migration substantially improved the off-farm income of the labor out-migrating households, and the labor non- migrating households could have improved their income, had their any household member out- migrated. However, we also find that labor out-migrating households were paying significantly higher labor and wheat production costs with lower wheat productivity and farm profits compared to labor non- migrating households, reflecting the labor scarcity and rise in rural wages as associated issues of labor out- migration. Finally, our analysis signifies the existence of potential trade-offs between remittance and agricultural productivity and profitability that could lead to a serious problem of survival of smallholder farmers in Nepal.

Keywords: *Remittance; wheat production; endogenous switching regression; heterogeneity*

JEL Codes: O44; Q15; Q54.

Session 2
Environmental Statistical Challenges and Applications

Statistical and Probability Models for Environmental Risk Analysis

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Abstract
The target of this paper is to apply different methods so that analyze the collected data on atmospherical pollutant CO. Curve fitting techniques adopting different models and probability models are used. We gave more emphasis on AR(1) different approaches as well as to the splines and the probability model of Weibull and Birnbaum – Saunders.

Keywords: *Regression, Splines, AR(1), Weibull, Birnbaum – Saunders*

JEL Classification: C25, C22, C32, D30

1. Introduction

The Statistical Information can be estimated either adopting a probability model on a regression model as the Fisher's information is evaluated from the inverse of variance-covariance matrix. When data is tabulated in a 2×2 table describing characteristics A and B, then the conditional probability of A given B, $P(A|B)$ might be a "better" knowledge of A, as an "extra knowledge", B, is provided. This is not true. It can be

$$P(A|B) = \begin{cases} < P(A), \text{ negative information} \\ = P(A), \text{ no information} \\ > P(A), \text{ positive information} \end{cases} \qquad (1.1)$$

Results as in (1.1) can be used in different fields, when the different options are requested and provide evidence that uncertainly is always present.
The situation is even more crucial in a 2×2 table. In such a case consider two companies C, $\bar{C}$, that produce with methods A, $\bar{A}$ two products and the production is accepted B, or not, $\bar{B}$. Then the Simpson's Paradox in probabilities terms say:
Then if it considered the extra relations as "more information"

$$\begin{aligned} P(A|BC) &\geq P(A|\bar{B}C) \\ P(A|B\bar{C}) &\geq P(A|\bar{B}\bar{C}) \end{aligned} \qquad (1.2)$$

it is possible to have, Blyth (1970)

$$P(A|B) < P(A|\bar{B})$$

Therefore a skepticism might follow for the "sure-thinking" procedures and second thoughts might applied, when conclusions from gathered information is asked. Therefore uncertainty always exist, it is not only arisen from the collected data, but also for the model choice, or even more, for the decided method, Halkos and Kitsos (2018). That is why in this paper we choose different methods and different line of thought, to provide a Statistical Analysis for the collected data, considering different chemical pollutants. We shall concentrate on the atmosphere pollutant CO in this paper, although we have data for NO, NO_2, O_3, SO_2. We choose two different Statistical Methods:

1. Model fitting to the data
2. Refer to Survival Analysis and hazard function.

As far as the model fitting concern we choose three different techniques. Moreover we clarify that our target is prediction which can be approached by the two mentioned methods above. As far as model fitting we shall use the simple linear regression, the AR(1) model and cubic splines, while as the probability model 2.1, 2.2 and the hazard function for these models is applied:

1.1 Regression analysis
1.2 Time series approach
1.3 Cubic splines

while for the Survival Analysis we choose two different probability models, namely:

2.1 Weibull probability model
2.2 Birnbaum - Saunders probability model

For each case four different data sets are collected (i) for a month, (ii) for a year, (iii) for 5 years, and (iv) for 37 years.
Thus we shall refer on the Tables of the results as 1.1(i) or 2.2(ii) or 2.1(iii) etc., meaning that we are referring to method 1.1 (regression) for the data for one month, for method 2.2 (Birnbaum - Saunders probability model) for the data for one year etc.

2. Statistical Background

The linear Regression problem referred as the 1.1 case has been extensively discussed by Halkos (2019) from an Environmental point of view, while Kitsos (1999) discussed it through the Response Surface Methods (RSM). There is an extensively number of references, see Seber (1977), among others and the references cited there. For a compact review of splines see Appendix I.

The AR(1) models referred as 1.2 case above has been extensively discussed by Halkos (2019), while Kitsos (1986) in his unpublished PhD thesis faced it as a sequential design problem, and Lai and Siegmend (1983) considered it as a random walk.

Moreover if we consider a nonnegative AR(1) process $\{Y_t\}$ defined as

$$Y_t = \beta_1 Y_{t-1} + \epsilon_t \; \theta \in [0,1) \qquad (2.1)$$

For the regression estimate see Halkos (2019). We discuss two extra cases of estimators:
Bell and Smith (1986) proved that an estimator of $\beta_1$can be

$$\hat{\beta}_1 = min\left\{\frac{Y_2}{Y_1}, \frac{Y_3}{Y_2}, \cdots, \frac{Y_n}{Y_{n-1}}\right\} \quad (2.2)$$

which is a strong consistent estimation of β_1 if and only if,

$$F(d) - F(c) < 1 \quad \text{for all } 0 < c < d < \infty \quad (2.3)$$

The function $F(\cdot)$ is such that

$$F(x) = P(\epsilon_t < x), \qquad P(\epsilon_t = 0) < 1 \quad (2.4)$$

As usually the involved errors $\{\epsilon_t\}$ is a nonnegative white noise: a sequence of iid nonnegative random variables with $E(e_t^2) < \infty$.

The distribution of $\hat{\beta}_1$ was determined by Adel (1988) for e_t exponentially distributed, while Andel (1994) proved that for the estimate of β_1 at each step

$$\beta_{1n}^* = \min_{t \in I_n} \frac{x_{t-1} - x_{t+1}}{x_t}, \quad I_n = [2, n-1] \quad (2.5)$$

under (1.5) holds than β_{1n}^* tends to β_1 almost surely i.e.,

$$\beta_{1n}^* \xrightarrow{a.s.} \beta_1 \text{ as } n \to \infty \quad (2.6)$$

As far as the 1.3 model, there is a compact introduction about Splines in Appendix I. Splines were introduced by Schoenberg (1946), while for he surface approximation the B-spline system was developed by de Boor (2001). Spline functions are a nice choice of approximation considering that the data are non-periodic. Practically, the domain of the data set is divided into subintervals and over each interval a spline is a polynomial of order d is specified. We choose cubic splines i.e., $d = 3$, see Appendix I. In our days there exist a number of appropriate software for this interesting method.

3. Results from Model Fitting

Working with R the above mentioned statistical were the basis for the produced results. Data extracted from Environment And Energy Ministry's website (https://ypen.gov.gr/) and used here.

The regression model (1.1)

The assumed linear model for CO as response, for the collected data, is the simple linear regression of the form:

$$CO = \beta_0 + \beta_1 day.t + \epsilon \qquad \epsilon \sim N(0, \sigma^2) \qquad (2.7)$$

The results are tabulated with the name introduced in section 1.

Table 1. Results for 1.1 (i)

	month	C.I.
$\widehat{\boldsymbol{\beta}}_0$	1.3561 (0.4342)	(0.7636, 1.0896)
$\widehat{\boldsymbol{\beta}}_1$	0.0161 (0.0249)	(−0.0326, 0.0648)

For the estimates $\hat{\beta}_0, \hat{\beta}_1$ the standard error is referred in parentheses.

Table 2.I Results for 1.1 (iI - iv)

	1 year	5 years	37 years
$\widehat{\boldsymbol{\beta}}_0$	0.9266 (0.0832)	1.3610 (0.0401)	8.7060 (0.0522)
$\widehat{\boldsymbol{\beta}}_1$	0.0009 (0.0004)	$-0.0002\ (4.0e-5)$	$-0.0007\ (6.5e-6)$

For **Table 2.I2** it is clear that the slope parameter $\hat{\beta}_1$ is very close to zero.

The following Figures are helpful to understand the evaluated results. In Kitsos et. al. (2022) it is proved that has been there a martingale structure for the regression models as the data size $n \to \infty$. This theoretical result appears here when the data set is more than one year.

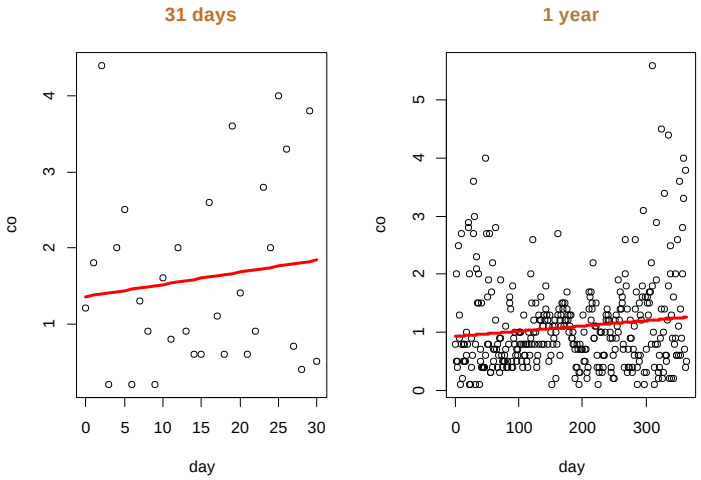

Figure 1. Estimated linear regression for 1.1(i) and 1.1(ii) models

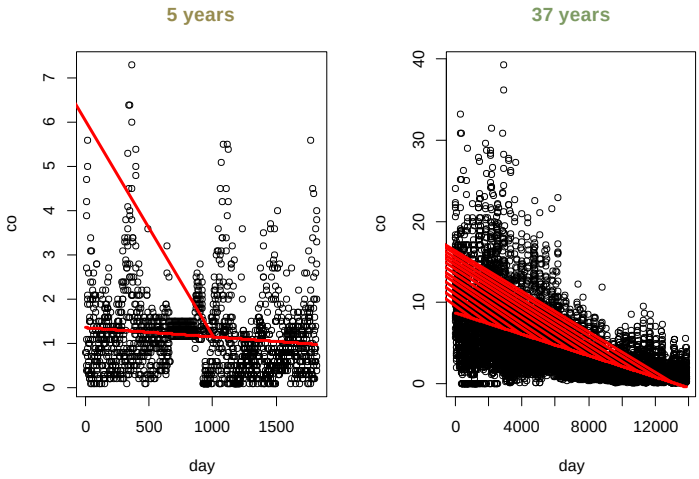

Figure 2. Estimated linear regression for 1.1(iii) and 1.1(iv) models.

The effect of time (days) is positive under the models of 31 days and last year, though it gets smaller as sample size increases. The effect turns negative for the other two, larger data samples.

The AR(1) model with constant term (1.2)

Model assumed for the CO data

$$CO_t = \beta_0 + \beta_1 CO_{t-1} + u_t \qquad u_t \sim WN(0, \sigma^2) \qquad (2.8)$$

with $WN(0, \sigma^2)$ being the very commonly-used random process, white noise. By definition, the stationary sequence of uncorrelated random variables $\{X_t\}$ is called white noise. White noise has zero mean, constant variance, σ^2, and is uncorrelated in time.

Table 3. Results for 1.2 (i)

	Month	C.I.
$\widehat{\boldsymbol{\beta}}_0$	1.602 (0.1923)	(1.225099, 1.978901)
$\widehat{\boldsymbol{\beta}}_1$	−0.122 (0.1781)	(−0.4710696, 0.2270696)

Table *4.* *Results for 1.2 (ii-iv)*

	1 year	5 years	37 years
$\widehat{\boldsymbol{\beta}}_0$	1.0904 (0.0545)	1.1729 (0.0327)	4.1423 (0.0809)
$\widehat{\boldsymbol{\beta}}_1$	0.2597 (0.0505)	0.4471 (0.0209)	0.6941 (0.0061)

The corresponding graphs are as following

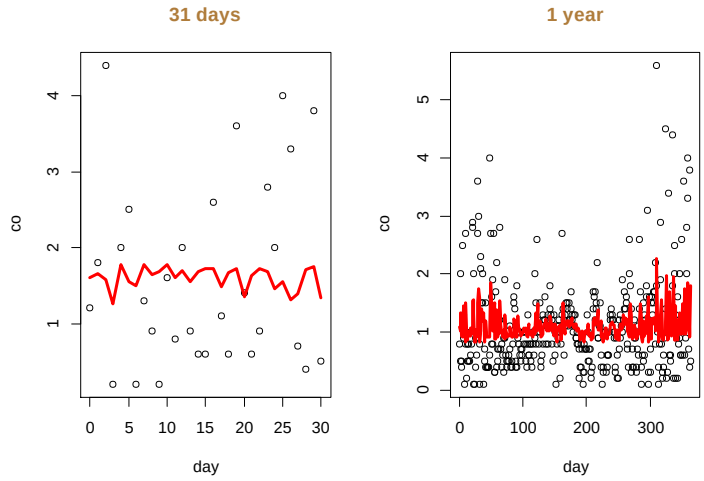

Figure 3. Estimated AR(1) response with constant term for 1.2(i) and 1.2(ii) models

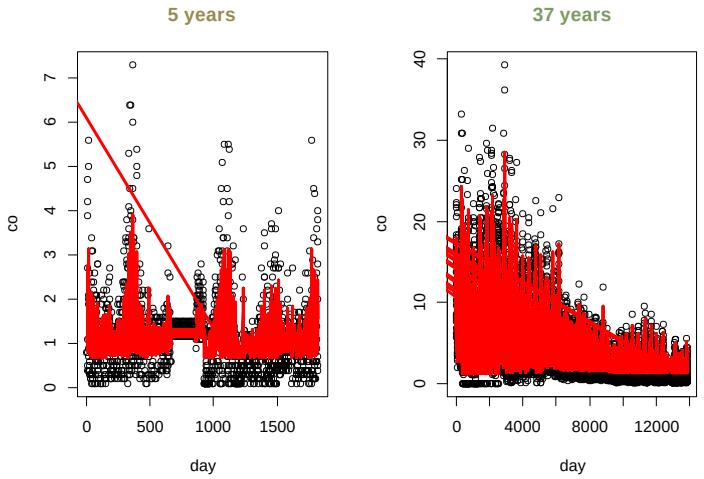

Figure 4. Estimated AR(1) response with constant term for 1.2(iii) and 1.2(iv) models

Even in this case when we are using data for more than 5 years there is a problem in prediction.

The AR(1) model without constant term (1.2)

The AR(1) Model assumed for the CO data is of the form :

$$CO_t = \beta_1 CO_{t-1} + u_t \qquad u_t \sim WN(0, \sigma^2) \qquad (2.9)$$

Table 5. Results for 1.2 (i)

	month	C.I.
$\widehat{\boldsymbol{\beta}}_1$	0.5806 (0.1409)	(0.3045, 0.8568)

Table 6. Results for 1.2 (ii-iv)

	1 year	5 years	37 years
$\widehat{\boldsymbol{\beta}}_1$	0.7401 (0.0349)	0.8053 (0.0138)	0.8507 (0.0045)

The corresponding graphs are in Figures 5, 6 bellow.

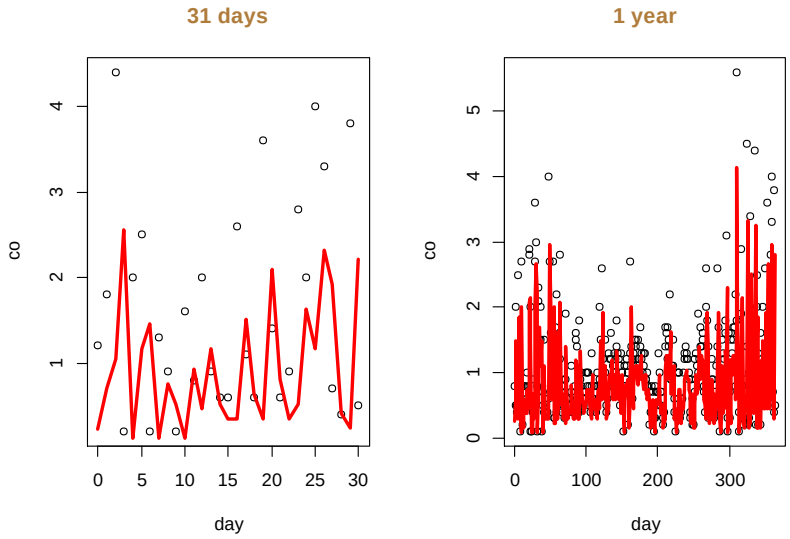

Figure 5. Estimated AR(1) response without constant term for 1.2(i) and 1.2(ii) models.

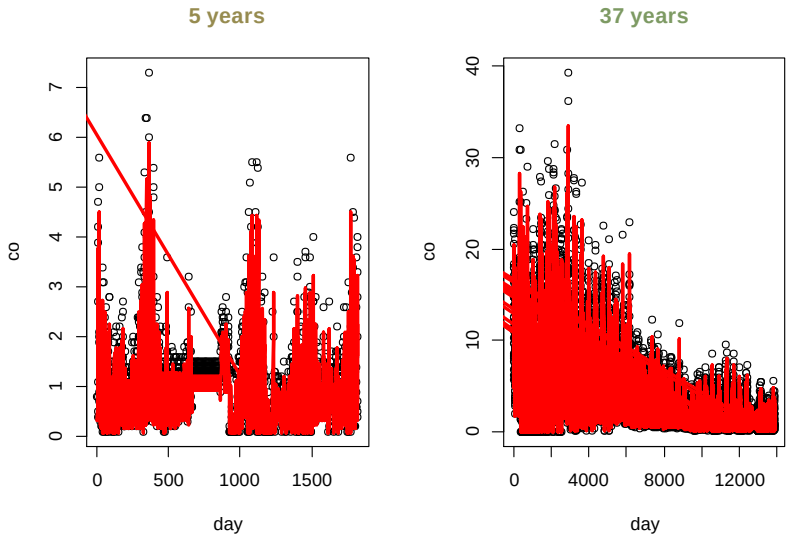

Figure 6. Estimated AR(1) response without constant term for 1.2(iii) and 1.2(iv) models.

Cubic Splines

As the cubic splines, introduced by Schoenberg (1946), are polynomials of third degree, see Appendix I for a compact introduction the estimated parameters are four, considering the same data as for the regression model (month, year, 5 years and 37 years). The results are

Table 7. Results for 1.3 (i)

	month	C.I.
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{0}}$	$-7.1e-02\ (4.262e-03)$	$(-0.0794, -0.0626)$
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{1}}$	$1.3e-03\ (5.919e-04)$	$(0.0001, 0.0025)$
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{2}}^{*}$	$2.0e-04\ (2.988e-05)$	$(0.0001, 0.0003)$
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{3}}^{*}$	$-5.0e-06\ (4.939e-07)$	$(-5.9680e-06, -4.0320e-06)$

Table 8.II Results for 1.3 (ii - iv)

	1 year	5 years	37 years
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{0}}$	$-2.0e-03\ (9.391e-05)$	$2.6e-04\ (8.921e-06)$	$-2.0e-04\ (2.743e-06)$
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{1}}$	$-1.1e-06\ (1.051e-06)$	$-1.9e-07\ (1.989e-08)$	$-1.6e-07\ (8.037e-10)$
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{2}}$*	$2.8e-08\ (4.342e-09)$	$-4.6e-10\ (1.637e-11)$	$1.5e-11\ (8.700e-14)$
$\widehat{\boldsymbol{\beta}}_{\boldsymbol{3}}$*	$-1.5e-12\ (5.918e-12)$	$2.6e-13\ (4.451e-15)$	$-3.5e-16\ (3.110e-18)$

* practically zero

From the above Tables 7 and 8 it is clear that the quadratic and cubic terms are practically zero.

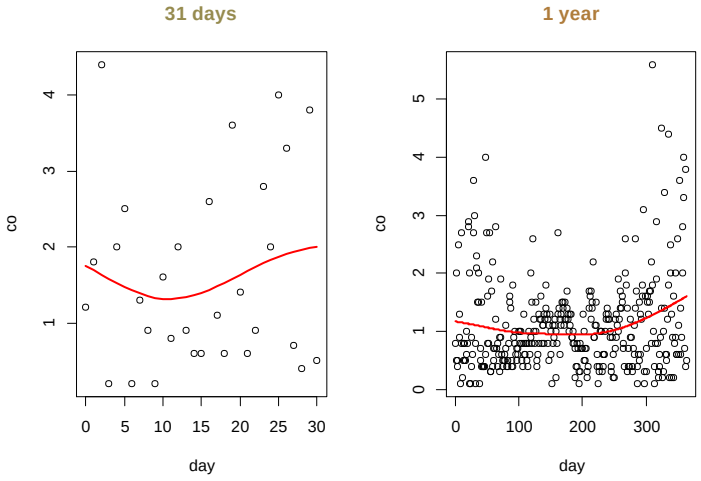

Figure 7. Estimated curves for 1.3(i) and 1.3(ii) models

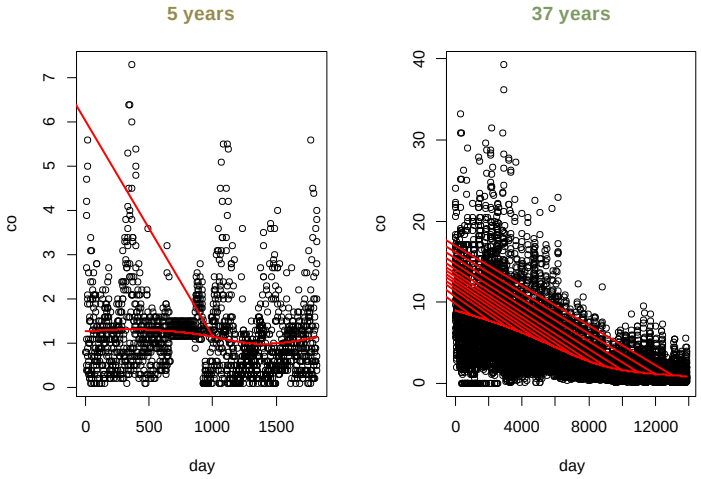

Figure 8. Estimated curve for 1.3(iii) and 1.3(iv) models.

Again, the large sample size, more than 5 years, does not contribute to the prediction problem. In the next session we discuss to probability models, applied to Survival Analysis.

4.Results from the Probability Models

Let T a random variable (r.v.) denoting **life time**. For this particular r.v. we shall consider two different probability models. The hazard function is essential to be considered for them:

Weibull $w(t)$ and **Birnbaum - Saunders $bs(t)$**

In particular

4.1 Weibull model

Recall that for the Weibull model the probability density function is

$$w(t) = w(t;\theta_1,\theta_2) = \frac{\theta_2}{\theta_1}\left(\frac{t}{\theta_1}\right)^{\theta_2-1} exp\left[-\left(\frac{t}{\theta_1}\right)^{\theta_2}\right] \qquad t \geq 0,\ \ \theta_1,\theta_2 > 0 \qquad (4.1)$$

with parameters θ_1 : scale parameter and θ_2 : shape parameter,
or equivalently

$$w(t) = w(t;\theta_1,\theta_2,\theta_0) = \frac{\theta_2}{\theta_1}\left(\frac{t-\theta_0}{\theta_1}\right)^{\theta_2-1} exp\left[-\left(\frac{t-\theta_0}{\theta_1}\right)^{\theta_2}\right] \qquad (4.2)$$

The expected value and the variance of the random variable T are coming from a Weibull distribution

$$E(T) = \theta_0 + \theta_1\Gamma\left(1 + \frac{1}{\theta_2}\right) \qquad (4.3)$$

$$Var(T) = \theta_1^2\Gamma\left(1 + \frac{2}{\theta_2}\right) - \Gamma^2\left(1 + \frac{1}{\theta_2}\right) \qquad (4.4)$$

Notice that for the special cases

$\theta_2 = 1$ we obtain the Exponential distribution, and

$\theta_2 = 2$ and $\theta_1 = \sqrt{2}\sigma$ we obtain the Rayleigh distribution

Moreover, for the failure rate θ_2 it holds

$$\begin{aligned} \theta_2 &= 1 \Rightarrow \text{constant} \\ \theta_2 &< 1 \Rightarrow \text{decreases over time} \\ \theta_2 &> 1 \Rightarrow \text{increases over time} \end{aligned} \tag{4.5}$$

The hazard function

Recall the definition of the hazard function, for a variable T, with density function $f(t)$ and cumulative distribution function $F(t)$ is

$$h(t) = \frac{f(t)}{1 - F(t)} \tag{4.6}$$

Then, the hazard function for the Weibull can be evaluated as

$$h(t) = h(t; \theta_1, \theta_2) = \frac{\theta_2}{\theta_1}\left(\frac{t}{\theta_1}\right)^{\theta_2 - 1} \tag{4.7}$$

Therefore a very useful result is

$$w(t) = h(t)\, exp\left[-\left(\frac{t}{\theta_1}\right)^{\theta_2}\right] \tag{4.8}$$

For the exponential, recall $\theta_2 = 1$ then

$$h(t; \theta_1, 1) = \frac{1}{\theta_1} \equiv \text{ const} \tag{4.9}$$

In medical statistics and Econometrics the parameter λ is sometimes very useful

$$\lambda := \theta_1^{-\theta_2}$$

Due to the above compact discussion the following results concerning CO have been evaluated

4.2 The Birnbaum - Saunders distribution

As far the Birnbaum – Saunders distribution concerns, which is not so widely used in application, it is applied for

- fatigue life distribution
- models failure times

Let T the number of cycles to failure cdf of T with cumulative distribution function F

$$F(t) = P[T \leq t] = \Phi\left(\frac{1}{\theta_2}\left[\left(\frac{t}{\theta_1}\right)^{0.5} - \left(\frac{\theta_1}{t}\right)^{0.5}\right]\right)$$

with

θ_1 : scale parameter

θ_2 : shape parameter

Φ : the usual notation for cdf of the Normal distribution.

Then, the expected value and the variance of the random variable T coming from a B-S distribution are

$$E(T) = \theta_1\left(1 + \frac{\theta_2^2}{2}\right)$$

$$Var(T) = (\theta_1\theta_2)^2\left(1 + \frac{5}{4}\theta_2^2\right)$$

Notice that for the Birnbaum – Saunders distribution ($BS(\theta_1, \theta_2)$) the following results hold

$$T \sim BS(\theta_1, \theta_2) \Rightarrow T^{-1} \sim BS(\theta_1^{-1}, \theta_2)$$

The distribution of W, a "portion" of B-S distribution as below, follows the normal distribution with variance depending on θ_2.

$$W = \frac{1}{2}\left[\left(\frac{t}{\theta_1}\right)^{0.5} - \left(\frac{\theta_1}{t}\right)^{0.5}\right] \sim N\left(0, \frac{\theta^2}{4}\right)$$

Notice that due to the above discussion, the estimation of the parameters is based on the Maximum Likelihood, therefore there is a completely different approach for the models fitted for the data set we have. Moreover the line of thought in Survival Analysis is completely different, Everitt (2003). Therefore we emphasize this fundamental difference and we believe in such cases the Covariance is a useful measure between the progress of the time and the atmosphere pollutant CO.

5. Comparing the Results - Discussion

In this section we try to compare the results presented in section 3. **Table III** summarizes the curve fitting models.

Table III *Results for comparison of curve fitting models 1.1(i), 1.2(i), 1.3(i)*

		month	1 year	5 years	37 years
Regress	$\widehat{\boldsymbol{\beta}}_0$	1.3561	0.9266	1.3610	8.7060
	$\widehat{\boldsymbol{\beta}}_1$	0.0161	0.0009	-0.0002	-0.0007
AR(1) w/ constant	$\widehat{\boldsymbol{\beta}}_0$	1.602	1.0904	1.1729	4.1423
	$\widehat{\boldsymbol{\beta}}_1$	-0.122	0.2597	0.4471	0.6941
AR(1) w/out constant	$\widehat{\boldsymbol{\beta}}_1$	0.5806	0.7401	0.8053	0.8507
Cubic splines	$\widehat{\boldsymbol{\beta}}_0$	-0.071	-0.002	0.0003	-0.00002
	$\widehat{\boldsymbol{\beta}}_1$	$1.3e-03$	$-1.1e-06$	$-1.9e-07$	$-1.6e-07$
	$\widehat{\boldsymbol{\beta}}_2$	$2.0e-04$	$2.8e-08$	$-4.6e-10$	$1.5e-11$
	$\widehat{\boldsymbol{\beta}}_3$	$-5.0e-06$	$-1.5e-12$	$2.6e-13$	$-3.5e-16$

Comparison of all extrapolation methods for 31 days

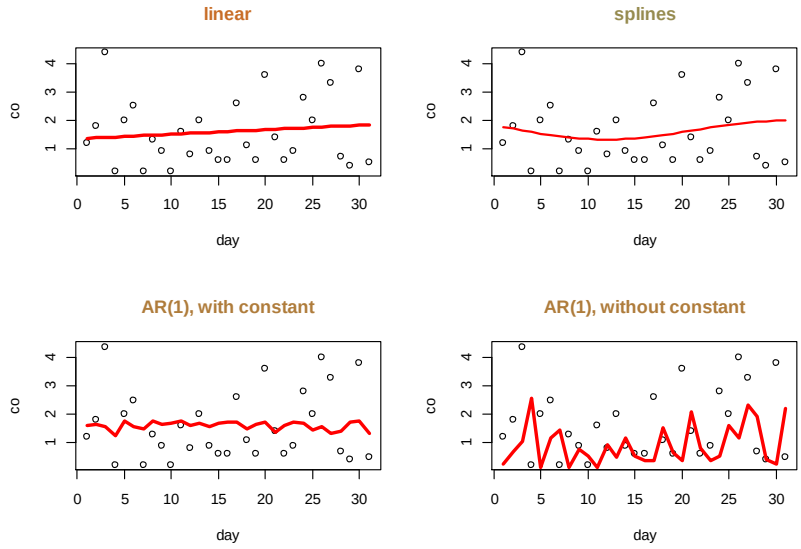

Figure 9. Comparing the curve fitting models 1.1(i), 1.2(i) (with and without constant) and 1.3(i) Notice that in 1.3(i) in

Figure 9, i.e. the third graph present a curvature due to spline structure while the linear structure of the other models do not offer such a chance to the graph.

The main points we would like to mention are:

1. It is clear that the "history of the data" does not influence significantly the predicted value. This is true due to the martingale structure of the sequentially increased regression size. Therefore:

   The 31 day models seems to offer a better approach for the presentation of the current situation so that to predict close to the "final value".

2. The cubic spline approach, is not applied in Economical models. Very often we believe it is about time to be adopted. Notice that the coefficients for the 3rd and 4th degree model are very small. Therefore there is a similarity with the Linear Regression for this particular case.
3. The hazard function is recommended for two different probability models. It can be very useful to Environmental Economical Risk (EER = hazard). It needs a special consideration, and we shall try in future work.
4. The probability models we suggested were two,
   - a rather well known in Risk Analysis (Weibull) and
   - a rather not popular one (BS), which we propose for the EER models. More investigation is needed in this area on comparing different probability models.
5. The missing data from the adopted data set were calibrated on the existed data.

Appendix I. Introduction to Splines

A cubic-spline (c-s) is constructed by piecewise 3d order polynomials for the 1-dimensional spline of the form

$$Y_i(t) = \alpha_i + \beta_i + \gamma_i t^2 + \delta_i t^3 \quad i = 0, 1, \cdots, n-1 \tag{A.I.1}$$

where for the parameter t we assume $t \in [0,1]$, and there is a set of $n+1$ points $(y_0,\ y_1, \cdots, y_n)$, and the c-s is passing through m control points. In principle the 2d derivative of each polynomial is set to be zero at the end points i.e., from (A.I.1)

$$\begin{aligned} Y_i(0) &= y_i = \alpha_i \\ Y_i(1) &= y_{i+1} = \alpha_i + \beta_i + \gamma_i + \delta_i \end{aligned} \tag{A.I.2}$$

thus

$$\begin{aligned} Y_i'(0) &= D_i = b_i \\ Y_i'(1) &= D_{i+1} = \beta_i + 2\gamma_i + 3\delta_i \end{aligned} \tag{A.I.3}$$

Therefore we obtain

$$\begin{aligned} \alpha_i &= y_i \\ \beta_i &= D_i \\ \gamma_i &= 3(y_{i+1} - y_i) - 2D_i - D_{i+1} \\ \delta_i &= 2(y_i - y_{i+1}) + D_i + D_{i+1} \end{aligned} \tag{A.I.4}$$

Under the assumption that the 2d derivatives also much at the points :

$$\begin{aligned} Y_{i-1}(1) &= y_i \\ Y_{i-1}'(1) &= Y_i'(0) \\ Y_i(0) &= y_i \\ Y_{i-1}''(1) &= Y_i''(0) \end{aligned} \tag{A.I.5}$$

for the interior points, while for the end points is required

$$Y_0(0) = y_0, \;\; Y_{n-1}(1) = y_n, \qquad \text{(A.I.6)}$$

Therefore a total of $4(n-1)+2 = 4n-2$ simultaneous equations are formed with $4n$ unknown. So to extra conditions are required, namely

$$Y_0''(0) = y_0, \;\; Y_{n-1}''(1) = 0,$$

Therefore the triangular system

$$T\, d = 3\delta(y) \qquad \text{A.I.7}$$

Is obtained, with T the triangular matrix,

$$T = \begin{bmatrix} 2 & 1 & & & & & 1 \\ 1 & 4 & 1 & & & & \\ & 1 & 4 & 1 & & & \\ & & & \ddots & & & \\ & & & & 1 & 4 & 1 \\ 1 & & & & & 1 & 4 \end{bmatrix}$$

d the vector

$$d = (D_0, D_1, \cdots, D_{n-1}, D_n)'$$

And $\delta(y)$ the vector

Now: $$\delta(y) = [(y_1 - y_n), (y_2 - y_0), (y_3 - y_1), \cdots, (y_{n-1} - y_{n-3}), (y_n - y_{n-2})]$$

Data extracted from Environment And Energy Ministry's website (https://ypen.gov.gr/) and used here, is of the form,

	Day	CO.Hr1	Day.t
1	5113	22.3	0
2	5114	21.7	1
3	5115	13.7	2
4	5116	16.3	3
5	5117	22.0	4
…	…	…	…
6205	11317	5.5	6204
6206	11318	7.8	6205
6207	11319	1.3	6206
6208	11320	2.7	6207
6209	11321	8.6	6208
6210	11322	6.1	6209

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Estimating parameters in Extreme Value Theory: Application to environmental data

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Abstract

Extreme Value Theory (EVT) aims to study and to predict the occurrence of extreme or even rare events, outside of the range of available data. These events are part of the real world but environmental extreme or rare events may have a massive impact on everyday life and may have catastrophic consequences for humanactivities. Most environmental datasets have a time-dependent variation and short-term clustering are typical phenomena for extreme value data, and it is crucial that both are properly accounted when making inferences. Here, an important parameter comes into play, the extremal index, θ, that characterizes thedegree of local dependence in the extremes of a stationary sequence. It needs to be adequately estimated,not only by itself but because its influence on other relevant parameters, such as a high quantile. Several estimators of θ have appeared in the literature. However those estimators depend on tuning parameters that need to be adequately chosen. Computational procedures have been considered and present nice results.They will be revisited and some results will be shown in this work and applied in a real data set.

Keywords: *Parameters of rare events, Extremal Index, Computacional procedures.*

JEL Codes: C13; C14; C15.

Analysis of Waste Management on Portuguese Subsurface Ships: A Possible Approach

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Abstract

Management of marine waste is an important issue for of who uses the sea: the elimination of waste disposal at sea to protect the environment and people. When we consider ships, it implies a waste management that is complex and ongoing challenge, especially during long trips with no access to land or sea implies unload materials, other possible reason is the fact that some ports do not allow the disposal of solid and liquid waste. In particular, ships produce organic and non-organic waste but its Operation and maintenance generally produce residues depending on the kind of mission. The case is more demanding when we consider a subsurface ship due their specific characteristics. The national and internationalregulations on the environment that Portuguese warships can be find in MARPOL and the environmental policy of the Portuguese Navy. This study, restricted to the pollution contemplated in Annexes I, IV and V of Marpol 73/78 (namely hydrocarbons, sewage and all types of garbage), analyzed the methods and typesof storage and disposal of ship waste to verify the existing equipment, operating conditions and on-board waste management plans.The evaluation of knowledge and cooperation of the staff on board and their contribution to the sustainability and environmental protection was also investigated.

Keywords: *Waste Management; environment protection; submarine.*

JEL Codes: C02; C13; C63; C80; D89; L99

Multilevel modeling techniques to study the impact of environmental changes on human face development

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Abstract
Environmental changes leading to different growth patterns of allergenic species, longer pollen seasons, deterioration of indoor and outdoor air quality have reportedly increased allergic rhinitis and viral infections in children which may lead to facial growth problems. The airway has a relevant role in the development of craniofacial structures, thus, in this work, we intended to model the mandibular inclination in growing individuals, considering sagittal pharyngeal characteristics and other craniofacial characteristics as predictors. Angular, linear and area measurements were performed concerning the maxilla, mandible, cranio-cervical posture and upper airway at pre-peak, peak and post-peak cephalograms, in a sample of 157 individuals with no history of orthodontic treatment. Mandibular inclination (ML/NSL) was adjusted as a function of other craniofacial variables using a longitudinal hierarchical linear model (MLH). Two relevant adjustments with random intercepts and slopes were obtained for the time variable. Modelling with MLH allowed for the estimation of fixed and random components at the individual level, the time level for ML/NSL and the influence of certain predictors on the rate of change of ML/NSL throughout growth were explored. The application of MLH is recommended to allow the incorporation of clinical and environmental variables during growth and to better clarify the role of the airway in the development of craniofacial structures.

Keywords: *Linear Hierarchical Model, Longitudinal Data, Cephalometry, Growth, Airway.*

JEL Classification: I19

Τεχνικές πολυεπίπεδης μοντελοποίησης για τη μελέτη των επιπτώσεων των περιβαλλοντικών αλλαγών στην ανάπτυξη του ανθρώπινου προσώπου

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Περίληψη

Οι περιβαλλοντικές αλλαγές που οδηγούν σε διαφορετικά μοτίβα ανάπτυξης αλλεργιογόνων ειδών, μεγαλύτερες εποχές γύρης, επιδείνωση της ποιότητας του αέρα σε εσωτερικούς και εξωτερικούς χώρους έχουν αναφερθεί ότι έχουν αυξήσει την αλλεργική ρινίτιδα και τις ιογενείς λοιμώξεις στα παιδιά που μπορεί να οδηγήσουν σε προβλήματα ανάπτυξης του προσώπου. Ο αεραγωγός έχει σχετικό ρόλο στην ανάπτυξη των κρανιοπροσωπικών δομών, επομένως, σε αυτή την εργασία, σκοπεύαμε να μοντελοποιήσουμε την κλίση της κάτω γνάθου σε αναπτυσσόμενα άτομα, λαμβάνοντας υπόψη τα οβελιαία φαρυγγικά χαρακτηριστικά και άλλα κρανιοπροσωπικά χαρακτηριστικά ως προγνωστικούς παράγοντες. Πραγματοποιήθηκαν μετρήσεις γωνίας, γραμμικής και εμβαδού της άνω γνάθου, της κάτω γνάθου, της κρανιοαυχενικής στάσης και του ανώτερου αεραγωγού σε κεφαλογράμματα προ-αιχμής, κορυφής και μετά-αιχμής, σε δείγμα 157 ατόμων χωρίς ιστορικό ορθοδοντικής θεραπείας. Η κλίση της κάτω γνάθου (ML/NSL) προσαρμόστηκε ως συνάρτηση άλλων κρανιοπροσωπικών μεταβλητών χρησιμοποιώντας ένα διαμήκη ιεραρχικό γραμμικό μοντέλο (MLH). Λήφθηκαν δύο σχετικές προσαρμογές με τυχαίες τομές και κλίσεις για τη μεταβλητή χρόνου. Η μοντελοποίηση με MLH επέτρεψε την εκτίμηση σταθερών και τυχαίων συστατικών σε μεμονωμένο επίπεδο, διερευνήθηκαν το χρονικό επίπεδο για ML/NSL και η επίδραση ορισμένων προγνωστικών παραγόντων στον ρυθμό μεταβολής του ML/NSL σε όλη την ανάπτυξη. Η εφαρμογή της MLH συνιστάται για να επιτραπεί η ενσωμάτωση κλινικών και περιβαλλοντικών μεταβλητών κατά την ανάπτυξη και να διευκρινιστεί καλύτερα ο ρόλος του αεραγωγού στην ανάπτυξη των κρανιοπροσωπικών δομών.

Λέξεις Κλειδιά: *Γραμμικό Ιεραρχικό Μοντέλο, Διαμήκη Δεδομένα, Κεφαλομετρία, Ανάπτυξη, Αεραγωγός.*

JEL Κωδικοί: I19

1. Introduction

In orthodontic data analysis it is common for the researcher to be faced with one or more dependent variables measured over several variable time instants. These may be related to other independent variables such as an orthodontic or surgical intervention or pathologies of interest, which in turn may have to be controlled by gender, age and skeletal maturation.

One of the options for longitudinal data analysis is the Analysis of Variance for Repeated Measures (RM-ANOVA). It requires, however, some assumptions that may be limiting, namely verifying sphericity and normality in real data. The use of Generalized Linear Models may overcome such limitations. With Hierarchical Linear Models (HLM) it is possible to include temporal effect on the variability between evaluated instants, as well as effects of independent variables in the various data levels, namely the instant, the individual and/or other characteristics that segregate these individuals into distinct units (Finch *et al.*, 2019).

The purpose of this paper is to outlay theoretical fundamentals for HLM and demonstrate their applicability through computational software on cephalometric data, specifically by modelling mandibular inclination (ML/SNL) over time in regard to craniofacial, pharyngeal and posture variables.

2. Literature Review

2.1 The Biologic Standpoint

Aetiology of orthodontic problems comprises three main factors: genetic, environmental, and specific. An environmental factor is considered to be the set of forces to which the face, jaws and teeth are subjected during physiological activity. These must be considered not only for diagnosis and planning, but also for the stability of orthodontic treatment (Proffit *et al.*, 2013). In this context, the role of the airway in the growth and development of craniofacial structures has been widely debated in scientific literature. Several cross-sectional and longitudinal studies support the existence of a relationship between upper airway patency and the sagittal (anteroposterior) relationship between the maxilla and the mandible (Grauer *et al.*, 2009; Ansar *et al.*, 2015; Uslu-Akcam, 2017; Chan *et al.*, 2020). The terms "adenoid facies" or "long face syndrome" have been used in the orthodontic literature for more than a century to describe patients who, in conjunction with a mouth breathing habit, often present with long, convex faces with lips parted at rest; and, when observed intraorally, they exhibit maxillary constriction and displacement of the anterior teeth (Dunn *et al.*, 1973; Proffit *et al.*, 2013). The peak of adenoid growth occurs between 4-6 years of age, followed by regression until around 10-11 years of age, and interrupted by a brief increase in volume at around 11 years of age, resuming its regression until adulthood (Linder-Aronson & Leighton, 1983). In childhood, hypertrophy of the adenoid gland and palatine tonsil are the second most frequent cause of respiratory obstruction and oral breathing, following allergic rhinitis (Bresolin *et al.*, 1983 apud Valera *et al.*, 2003). On the other hand, environmental changes leading to different growth patterns of allergenic species, longer pollen seasons, deterioration of indoor and outdoor air quality have reportedly increased allergic rhinitis and viral infections in children which may lead to facial growth problems (Wu *et al.*, 2021).

2.2 The Hierarchical Linear Model

A Hierarchical Linear Model is an extension of the Simple Linear Regression Model, the latter described by the following equation:

$$y = \beta_0 + \beta_1 x + \varepsilon \, . \qquad (1)$$

The application of Simple and Multiple Linear Regression Models is restricted by assumptions of linearity, homoscedasticity, normality, and independence of observations. If the observations are not independent, i.e. individuals can be segregated into separate clusters (school, hospital, residence area), y may take different mean values for $x = 0$ in each group. Likewise, β_1 may also take different values in each group, as well as the remaining regression coefficients (β_i) if more than one independent variable (x_i) is added to the model. As such, modelling datasets with related individuals or repeated measures, calls for the use of other techniques. HLM allows the adjustment of data structures with more than one level, also referred to as clustered data. In the general literature, level 1 of the data structure refers to the individual, while level 2 refers to a larger group of related individuals. However, when applying HLM to longitudinal data analysis, where repeated measures of the same individual are collected over time, the individual is considered a level 2 data structure, whereas the time instant is considered level 1 (Finch *et al.*, 2019).

The addition of group specific intercepts and slopes to the regression equation at the first hierarchical level can be described as follows:

$$y_{ij} = \beta_{0j} + \beta_{1j} x_1 + \beta_{2j} x_{2ij} \ldots \beta_{mj} x_m + r_{ij}, \qquad (2)$$

where $r_{ij} \sim N(0, \sigma^2)$ and r_{ij} are independent,

and the *ij* notation generally refers to the *i*-th individual in the *j*-th group, considering *m* predictor *x* variables that characterize the individual. In the specific case of longitudinal data analysis, the

notation should be interpreted as *i*-th time instant for the *j*-th individual. It is possible to model β_{0j} and distinct slopes for each group. The intercept β_{0j} can be modelled as:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}w_1 + \gamma_2 w_2 \ldots \gamma_k w_k + u_{0j}, \quad (3)$$

where $u_{0j} \sim N(0, \tau_{00})$ and u_{0j} are independent; u_{0j} are independent from r_{ij}.

As γ_{00} is common to all groups, it is referred to as a fixed effect, while u_{0j} represents a random effect, such as r_{ij} in equation (2).

As for the slope, β_{1j} can be modelled as:

$$\beta_{1j} = \gamma_{10} + \gamma_{11}w_1 + \gamma_2 w_2 \ldots \gamma_k w_k + u_{1j}, \quad (4)$$

where $u_{1j} \sim N(0, \tau_{11})$ and u_{1j} are independent; u_{1j} are independent from r_{ij}.

Equations (3) and (4) establish the level 2 model, through which individuals may be separated into different groups. In this manner, a linear hierarchical model considers that the effect of *x* on *y* may vary on a level higher than the individual.

To assure HLM validity the following assumptions must be verified: (1) the level 1 residuals, r_{ij}, present normal distribution with mean 0 and constant variance σ^2 ($r_{ij} \sim N(0, \sigma_j)$; (2) level 2 residuals, u_{0j} and u_{1j} are independent between clusters, have normal distribution with mean 0 and variances $\sigma^2{}_{00}$ and $\sigma^2{}_{11}$ respectively ($u_{0j} \sim N(0, \sigma_{00})$, $u_{1j} \sim N(0, \sigma_{11})$); (3) the covariance between level 1 residuals (r_{ij}) and u_{0j} or u_{1j} is null ($Cov(r_{ij}, u_{0j}) = Cov(r_{ij}, u_{1j}) = 0$), that is, level 1 and level 2 residuals must be independent and if otherwise, similarly to multiple linear regression, one should suspect other independent variables or relevant interaction terms better explain the variability of Y; (4) the covariance between u_{0j} and u_{1j} takes the value of σ_{01} $Cov(u_{0j}, u_{1j}) = \tau_{01}$, a value that can be non-zero (Natis, 2001; Marôco, 2018; Finch *et al.*, 2019).

3. Methods and Data

3.1 Data

Convenience sampling was performed using lateral cephalograms available through the AAOF Craniofacial Growth Legacy Collection. Inclusion criteria included patients with pre-growth peak, growth peak and post-growth peak radiographs, according to the stage of skeletal maturation assessed by the cervical vertebrae (Baccetti *et al.*, 2005). Exclusion criteria comprised undergoing orthodontic treatment, open mouth position, low quality of relevant anatomical structures or references for image calibration. A total of 157 individuals met the inclusion and exclusion criteria. Image calibration was performed according to instructions published by the AAOF (AAOF, 2020) and the digital cephalometric analysis (Facad software, version 3.12.1.1653, Ilexis AB, Sweden) was carried out previously described methodology (Solow & Tallgren, 1976; Ansar *et al.*, 2015; Uslu-Akcam, 2017; Baka & Fidanboy, 2021). The working dataset included 28 continuous variables, for which the descriptive statistics are detailed in Table 4 by time instant.

Table 4. Descriptive statistics on the overall sample. Sample mean; sd: sample standard deviation; min: minimum; max: maximum.

	Pre-growth peak		Growth peak		Post-growth peak	
	$\bar{x}$ (sd)	[min; max]	$\bar{x}$ (sd)	$\bar{x}$ (sd)	[min; max]	$\bar{x}$ (sd)
Age (y)	8.0 (0.6)	[7.0, 10.8]	11.6 (1.4)	[8.2, 15.8]	18.9 (2.5)	[16.0, 28.4]
SNA (º)	80.4 (3.3)	[73.3, 90.9]	80.8 (3.3)	[73.2, 91]	81.4 (3.6)	[73.2, 93.9]
SNB (º)	76.2 (2.9)	[69.8, 83.7]	77.2 (3.0)	[70.7, 84.7]	78.9 (3.3)	[70, 87.5]

ANB (°)	4.2 (2.0)	[-0.2, 9.6]	3.6 (2.1)	[-2.6, 8.9]	2.5 (2.5)	[-2.8, 8.8]
PP/NSL (°)	8.0 (3.1)	[0.1, 16.9]	7.6 (3.1)	[0.1, 14.6]	7.3 (3.4)	[0.3, 19.0]
OL/NSL (°)	21.9 (4.4)	[9.7, 34.3]	19.3 (4.4)	[7.4, 34.8]	15.6 (5.1)	[2.0, 26.8]
ML/NS (°)	36.8 (4.6)	[25.2, 46.6]	35.7 (4.6)	[23.7, 45.5]	33.4 (5.3)	[18.4, 46.3]
gonial_angle (°)	130.4 (5.5)	[116.6, 144.9]	128.4 (5.3)	[115.2, 143.1]	125.7 (5.7)	[110.7, 140.9]
body_length (mm)	64.3 (10.4)	[49.4, 96.9]	71.4 (11.6)	[56.6, 105.1]	81.3 (14.6)	[55.4, 125.0]
ramus_height (mm)	37.0 (6.3)	[28.4, 60.1]	41.3 (7.0)	[30.3, 62.0]	50.9 (9.3)	[29.2, 79.9]
ramus_hgt:length	0.58 (0.07)	[0.43, 0.83]	0.58 (0.06)	[0.43, 0.78]	0.63 (0.07)	[0.45, 0.84]
ANS-PNS (mm)	49.0 (8.3)	[39.8, 74.1]	52.9 (8.9)	[40.8, 76.8]	58.5 (10.5)	[40.1, 90.7]
PFH (mm)	63.7 (10.5)	[48.3, 96]	71.3 (12)	[56, 108.3]	84.6 (15.4)	[53, 133.4]
AFH (mm)	105 (17)	[87.5, 157]	114.9 (19.2)	[90.3, 175.6]	130.4 (23.7)	[85.4, 197.2]
LFH (mm)	60.2 (10.7)	[47.7, 98.1]	65.1 (11.8)	[48.9, 106.6]	74.3 (14.6)	[48.3, 123.8]
PFH:AFH	0.61 (0.04)	[0.53, 0.74]	0.62 (0.04)	[0.54, 0.72]	0.65 (0.04)	[0.55, 0.80]
LFH:AFH	0.57 (0.02)	[0.51, 0.63]	0.57 (0.02)	[0.51, 0.63]	0.57 (0.02)	[0.52, 0.63]
NAS (mm)	21.5 (5.6)	[10.8, 39.9]	24.2 (5.5)	[8.5, 42.5]	27.6 (5.6)	[16.1, 46.9]
OAS1 (mm)	10.8 (3.9)	[3.9, 28.8]	11.0 (3.6)	[2.9, 23.7]	12.2 (4.7)	[4.3, 35.3]
OAS2 (mm)	6.8 (3.0)	[2.1, 24.1]	7.0 (3.0)	[1.8, 25.0]	8.2 (3.5)	[1.8, 20.8]
AAA (mm^2)	198.4 (92.1)	[60.0, 589.8]	272.1 (124.2)	[71.4, 792.5]	419.7 (196.3)	[159.1, 1228.1]
NAA (mm^2)	518.1 (218.6)	[264.0, 1356.3]	617.3 (237.5)	[257.8, 1493.8]	790.7 (307.7)	[306.5, 1878.8]
OAA (mm^2)	421.5 (208.1)	[164.0, 1339.0]	488.4 (201.0)	[190.2, 1138.0]	692.3 (316.5)	[227.2, 2199]
AAA/NAA	0.39 (0.12)	[0.1, 0.8]	0.44 (0.12)	[0.14, 0.77]	0.53 (0.13)	[0.28, 0.84]
cHP/TVL (°)	93.4 (7.7)	[80.3, 119.9]	91.1 (7.9)	[74.4, 111.9]	90.8 (6.9)	[78.5, 111.8]
OPT/NSL (°)	98.5 (9.2)	[75.4, 133.3]	97.7 (9.8)	[75.6, 127.6]	99 (8.8)	[80.8, 126.9]
CVT/NSL (°)	101.5 (9.2)	[79.6, 132.8]	101 (9.9)	[80.2, 131.3]	104 (8.3)	[87.1, 125.8]
OPT/CVT (°)	3 (2.9)	[-5.4, 10.6]	3.3 (2.9)	[-5.8, 12]	5 (3.3)	[-2.8, 13.8]

3.2 Methods

Firstly, a null model was adjusted considering ML/NSL as the dependent variable, using the nlme package and the maximum likelihood method (R x64 4.1.1), expressed by the following equation:

$$\mathrm{ML/NSL}_{ij} = \beta_{0j} + r_{ij} \qquad (5)$$
$$\beta_{0j} = \gamma_{00} + u_{0j}$$

To confirm a level 2 effect on the data, the intra-class correlation coefficient (ICC) was then estimated considering the within-person variance (σ^2) and the between-person variance (τ_{00}) of mandibular inclination through the null model, given by the following equations:

$$ICC = \frac{\tau_{00}}{\tau_{00} + \sigma^2} \qquad (6)$$

$$\hat{\sigma}^2 = \frac{\sum_{j=1}^{C}(n_j - 1)S_j^2}{N - C} \qquad (7)$$

$$S_j^2 = \frac{\sum_{i=1}^{n_j}(y_{ij} - \bar{y}_j)}{(n_j - 1)} \qquad (8)$$

Then, a random intercept model was adjusted considering time as a level 1 predictor and a fixed slope:

$$\begin{aligned} \mathrm{ML/NSL}_{ij} &= \beta_{0j} + \beta_{1j}\mathrm{time} + r_{ij} \\ \beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} \end{aligned} \quad (9)$$

The previous adjustment was then compared (ANOVA) with a random slope fit on the data:

$$\begin{aligned} \mathrm{ML/NSL}_{ij} &= \beta_{0j} + \beta_{1j}\mathrm{time} + r_{ij} \\ \beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} + u_{1j} \end{aligned} \quad (10)$$

Following graphical error structure inspection of the level 1 fit, predictors, higher order terms and possible interactions were then iteratively searched regarding the level 2 model in a forward manner, considering clinical relevance and 5% level of significance. Adjustments were subsequently compared using ANOVA. Any terms indicating multicollinearity (Variation Inflation Factor, VIF >5) were removed (Gareth *et al.*, 2013).

Model diagnostics included level 1 and level 2 standardized residuals graphical analysis of normality and homoscedasticity. Quality of fit was determined according to Akaike's Information Criterion, AIC (Akaike, 1974); and Schwartz's Bayesian Criterion, BIC (Schwarz, 1978). Influent value analysis included fixed and random effects leverage regarding influence on predicted values; Cooks distance concerning influence on fixed effects estimates; covariance matrix ratio and covariance matrix trace for influence on fixed effects precision; and relative variance change (RVC) for variance influence analysis (Loy, 2013).

4. Empirical Results

Summary statistics for the preliminary level 1 models are detailed in Table 5. The null model $\widehat{ICC}$ suggests that approximately 72.6% of the ML/NSL variability can be explained by the between-person variance (τ_{00}), that is, mandibular inclination tends to be relatively stable over time and there are relevant differences between individuals. On the other hand, only 27.4% of the ML/NSL variability ($1-\widehat{ICC}$) is explained by the within-person variance. Considering the fixed effects component in the null model (γ_{00}), the overall mean mandibular inclination considering all individuals and all instants was 35.3º.

Table 5. Preliminary models summary for mandibular inclination variation by time.

Parameters	Null model	Fixed slope model	Random slope model
AIC	2597.123	2430.284	2371.135
BIC	2609.587	2446.904	2396.064
logLik	-1295.561	-1211.142	-1179.567
Random effects			
StdDev – Residual (σ)	2.628118	4.391268	4.3600089
StdDev – Intercept ($\sqrt{\tau_{00}}$)	4.280849	2.008558	1.3697296
Fixed effects			
γ_{00} Intercept	35.28089	36.9758	36.65987
Std Error	0.362861	0.3805939	0.3597831
γ_{10} Intercept	-	-1.6949	-0.82739

Std Error	-	0.1135909	0.0665738
ICC	0.7262674	0.8269841	0.9101707

A random slope model was deemed more appropriate after graphical analysis (Figure 10), allowing for ML/NSL rate variation between individuals. Predictive variables were centered prior to adjustment and proportions were multiplied by 100, in favor of their interpretation. A quadratic term for time was initially explored although it ceased to be significant after the introduction of level 2 predictors.

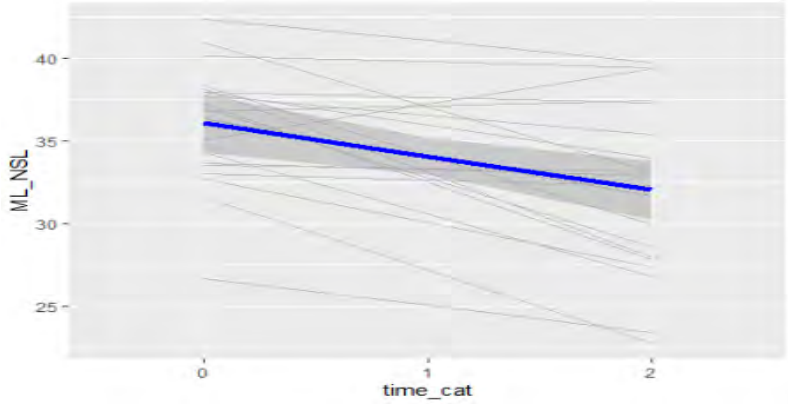

Figure 10. *Line graph of observed ML/NSL values per time instant (n=20 subset).*

The iterative selection of level 2 predictors accompanied by the search for possible interactions produced two relevant adjustments for ML/NSL, which are presented below:

$$\begin{aligned} \text{ML/NSL}_{ij} &= \beta_{0j} + \beta_{1j}\text{time} + r_{ij} \\ \beta_{0j} &= \gamma_{00} + \gamma_{01}ANB_j + \gamma_{02}PP/NSL_j + \gamma_{03}OPT/NSL_j + \gamma_{04}OAS1_j + \\ &\quad + \gamma_{05}\,gonial\_angle + \gamma_{06}\,PFH{:}AFH_j + u_{0ij} \\ \beta_{1j} &= \gamma_{10} + u_{1ij} \end{aligned} \tag{11}$$

$$\begin{aligned} \text{ML/NSL}_{ij} &= \beta_{0j} + \beta_{1j}\text{time} + r_{ij} \\ \beta_{0j} &= \gamma_{00} + \gamma_{01}SNB_j + \gamma_{02}\,PFH{:}AFH_j + \gamma_{03}\,ramus\_height{:}length_j + u_{0ij} \\ \beta_{1j} &= \gamma_{10} + \gamma_{11}SNB_j + \gamma_{12}\,ramus\_height{:}length_j + u_{1ij} \end{aligned} \tag{12}$$

Table 6. Summary statistics for mod1 (Equation 11) and mod2 (Equation 12). [1]Wald Test

		mod1			***mod2***		
Coefficient	**Parameter**	**Estimate**	**S. Error**	***P*** [1]	**Estimate**	**S. Error**	***P*** [1]
$\boldsymbol{\beta_{0j}}$	γ_{00}	34.796	0.151	< 0.001	34.860	0.135	< 0.001
	γ_{01}	0.106	0.038	0.005	-0.110	0.035	0.002
	γ_{02}	0.183	0.028	< 0.001	-1.131	0.028	< 0.001
	γ_{03}	0.030	0.008	0.0004	0.190	0.014	< 0.001
	γ_{04}	-0.058	0.020	0.0034	-	-	-
	γ_{05}	0.162	0.019	< 0.001	-	-	-
	γ_{06}	-0.757	0.024	< 0.001	-	-	-
$\boldsymbol{\beta_{1j}}$	γ_{10}	0.485	0.082	< 0.001	0.479	0.061	< 0.001
	γ_{11}	-	-	-	-0.037	0.015	0.014
	γ_{12}	-	-	-	-0.014	0.007	0.037

	σ	0.694	-	-	0.595	-	-
	$\sqrt{\tau_{00}}$	1.622	-	-	1.490	-	-
	$\sqrt{\tau_{11}}$	0.546	-	-	0.384	-	-

The comparison between the adjustments (Table 6) favored *mod2* fit (Equation 12), which explains the variability of β_{0j} of the level 1 model through the predictor variables SNB (sagittal position of the mandible relative to the skull base); PFH:AFH (ratio between posterior facial height and anterior facial height); and ramus_height:length, (the proportion between the height of the ramus and the length of the mandibular body). The *mod2* fit also explains the variability of the slope β_{1j} by the presence of significant interaction between two predictor variables and time: SNB and ramus_height:length. It should be noted that the addition of any pharyngeal and postural variables in mf2, as well as gender, were not significant to explain the variability of β_{0j} or β_{1j}.

5. Conclusions

Adjustment with MLH distinguishes fixed and random components of the variation in mandibular inclination during growth. Two distinct adjustments were obtained, the first illustrating the relationship between ML/NSL and predictors ANB, PP/NSL, OPT/NSL, OAS1, gonial angle, and posterior/anterior facial height over time; and the second adjustment, with superior quality indicators, demonstrated a relationship with posterior/anterior facial height, SNB and mandibular height/length predictors.

Apart from OAS1/OAS2, no other linear pharyngeal variable was found to be a significant predictor of ML/NSL change during growth. Although it has a reduced effect on the outcome, it may eventually reflect a relationship between the mandibular position and the soft palate, the tissues at the base of the tongue and the hyoid bone. No significant relationship was found between the ratio of free respiratory area/nasopharyngeal area and mandibular inclination.

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Hazard Functions, Nγ(μ, σ2) distribution, for Environmental Pollutants

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Abstract

The target of this paper is to apply the γ-order Generalized Normal distribution, based on three parameters: location (mean) μ, scale (variance) $\sigma^2$and shape γ. When the shape parameter is γ=2, the classical Normal distribution is obtained. The hazard function is crucial to evaluate the relevant Risk. We are comparing the hazard function of the N(μ, σ^2; γ) with the hazard function of a rather simple distribution, but so useful in practice, the triangular distribution. Both the distributions are discussed and interpreted, while their hazard functions provide evidence and criteria, to which we can adopt, it depends on the nature of the application. Data sets for a number of air pollutants were adopted for the application, comparing the Normal distribution, as well as the "fat tail" distributions obtained with different than 2 for the shape parameter γ.

Keywords: *Triangular distribution; Generalized Normal Distribution; Laplace Distribution; air pollutants.*

JEL Classification: C25; C22; C32; D30.

1. Introduction

In principle we would define as the environment of human A, the set of A^C, i.e. the complementary set of A. But this is not the case for a city X, as it is difficult to define what is exactly X. Such definition involves logical and philosophical discussion, Wittgenstein (1921), and it is beyond the target of this paper. Different approaches have been developed to face environmental influence on different target groups: children and women.

As far as children concern-typical example of a vital influence is the Chernobyl accident- the UN in General Assembly Special Session on the children decided on 1992: "to give any assistance to protect children and minimize the impact of natural disasters and *environmental degradation* on them".

As far as the influence on the women some fundamental results (see UNIFEM (2005), WEDO (2007)) are:

i) The bigger the environmental disaster, the bigger the influence on their expected life time, while

ii) The bigger the social-economical level of the woman the smaller the influence on their expected life time.

Typical example is the cyclone of 1991 at Bangladesh which caused the death of 138 000 people, most of them women over 40. The Indonesian tsunami (Bada Aceh) caused the death of many people on the villages of this area-55-70% of them were women. Although these statistics need a theorical improvement, such as discrimination analysis, and more careful statistical consideration, still integrate that there is a particular problem on genre, as far as environmental disaster concerns and more statistical studies are need.

The Human Development Report of UN defines the safety of human beings as "safety from chronic threats such as hunger disease and repression as well as protection from sudden and harmful disruptions in the patterns of daily life whether in homes, in jobs or in communities." Therefore, a healthy Environment is required and qualitative methods are need to measure the environmental risk in the Earth-Water-Air. There is a number of publications and guidelines on these subjects. We only refer to WHO (1999), IARC (2002), US EPA (1992).

This paper provides studies on the quality of the Air, measuring the risk of a number of pollutants through the statistical analysis and in particular survival analysis.

2. Background of the Survival Analysis

Let T presents time, we define as the survival time, usually denoted by S(t),

$$S(t) = P(T > t) \tag{1}$$

If T comes from a cumulative distribution function F(t), it is easy to see that

$$S(t) = 1 - F(t) \tag{2}$$

The hazard function, h(t) can be defined in two ways:

i. Through the cumulative distribution function F(t) and the probability density function of the survival time f(t) as

$$h(t) = \frac{f(t)}{1-F(t)} \tag{3}$$

ii. As the probability that an individual experience a risky event is a very small given time interval, s, given that the individual has survived up to the origin of this interval, i.e.

$$\lim_{s\to 0} \frac{P(event\ in\ [t,t+s])}{s} := \mathrm{h(t)} \tag{4}$$

Following the line of thought as in (ii) we can have the equivalence of (3) and (4):

$$\mathrm{h(t)} = \lim_{\Delta t\to 0} \frac{P[t \le T \le t+\Delta t | T \ge t)}{\Delta t} = \frac{f(t)}{S(t)} = \frac{f(t)}{1-F(t)}$$

Therefore,

$$S(t) = \exp\left(-\int_0^t h(x)dx\right) \quad (5)$$

$$f(t) = -\frac{dS(t)}{dt} = h(t)\exp\left(-\int_0^t h(x)dx\right) \quad (6)$$

We are applying the previous definitions with the Makeham´s law.

Let hazard function to be:

$$h(t) = \theta_0 + \theta_1 \exp(\theta_2 t), \theta_0, \theta_1 \in ; \ \theta_2 \neq 0$$

Then the survival function is:

$$S(t) = \exp\{-[\theta_0 t + \left(\frac{\theta_1}{\theta_2}\right)(e^{-\theta_2 t} - 1)]\}$$

and the relation between them is the following:

$$f(t) = h(t)\exp\left\{-\left[\theta_0 t + \left(\frac{\theta_1}{\theta_2}\right)(e^{-\theta_2 t} - 1)\right]\right\} = h(t)S(t), t \geq 0.$$

See for details Tan (1991).

Finally, the cumulative hazard function is the accumulated hazard up to time t:

$$H(t) = \int_0^t h(s)ds. \quad (7)$$

This cumulative hazard function can be thought of as providing the total accumulated risk of experiencing the event of interest that has been gained by progressing to time t. While the instantaneous hazard rate (h(t)) can increase or decrease with time, the cumulative hazard rate can only increase or remain the same.

Notice that the cumulative hazard, survival and pdf are related as following:

$$H(t) = -\log S(t)$$
$$S(t) = exp(-H(t))$$
$$f(t) = h(t)\, exp(-H(t))$$

2.1. Triangular distribution

It is a distribution for continuous variables that describes the probability of occurrence or value of an event between a minimum, most probable value and maximum value. For triangular distribution (a, m, b), a minimum, be maximum y m mode, pdf will be:

$$f(x) = \begin{cases} \frac{2}{b-a} \cdot \frac{x-a}{m-a}, & a \leq x \leq m \\ \frac{2}{b-a} \cdot \frac{b-x}{b-m}, & m \leq x \leq b \end{cases} \quad (8)$$

cdf has the following form:

$$F(x) = \begin{cases} \frac{(x-a)^2}{(b-a)(m-a)}, & a \le x \le m \\ 1 - \frac{(b-x)^2}{(b-a)(m-a)}, & m \le x \le b. \end{cases} \quad (9)$$

and hazard function is given by:

$$h(x) = \begin{cases} \frac{2(x-a)}{(b-a)(m-a)-(x-a)^2}, & a \le x \le m \\ \frac{2}{b-x}, & m \le x \le b. \end{cases} \quad (10)$$

2.2 Generalized Normal Distribution

Definition 1. The p-variate random variable X follows the γ-order Generalized Normal distribution ($\gamma - GND$), i.e. $X \sim N_\gamma^p(\mu, \Sigma)$, with location parameter vector $\mu \in \mathbb{R}^p$, shape parameter $\gamma \in \mathbb{R} \setminus [0,1]$ and positive definite scale parameter matrix $\Sigma \in \mathbb{R}^{pxp}$, when the density function f_γ of X is of the form:

$$f_\gamma(x) = c\ exp\left\{-\frac{\gamma-1}{\gamma}[Q(x)]^{\frac{\gamma}{2(\gamma-1)}}\right\} \quad (11)$$

where Q is a p-quadratic form $Q(x) = (x-\mu)\Sigma^{-1}(x-\mu)^T, x \in \mathbb{R}^p$, while the normalizing c factor is defined as

$$c = c(\Sigma, \gamma, p) = \frac{\Gamma\left(\frac{p}{2}+1\right)}{\pi^{p/2}\Gamma\left(p\frac{\gamma-1}{\gamma}+1\right)\sqrt{|\Sigma|}}\left(\frac{\gamma-1}{\gamma}\right)^{p\frac{\gamma-1}{\gamma}} \quad (12)$$

where |A|=det A denotes the determinant of any $A \in \mathbb{R}^{pxp}$.

We denote $X \sim N_\gamma^p(\mu, \Sigma)$. Notice that, for γ=2, $N_\gamma^2(\mu, \Sigma)$ is the well-known multivariate normal distribution.

From now on we will consider p=1.

Definition 2. The cumulative distribution of GND is:

$$\Phi_\gamma(x) = 1 - \frac{\Gamma(\gamma_0, \gamma_0 z^{1/\gamma_0})}{2\Gamma(\gamma_0)}\ ;\ \gamma_0 = \frac{\gamma-1}{\gamma}, z = \frac{x-\mu}{\sigma}. \quad (13)$$

Proposition 1. (Kitsos, Vassialidis and Toulias(2014)) The hazard function of a univariate γ-order normally distributed, $X \sim N_\gamma(\mu, \sigma^2)$, is given by:

$$h_\gamma(x) = \frac{\gamma_0^{\gamma_0-1} exp(-\gamma_0|z|^{1/\gamma_0})}{\sigma\Gamma(\gamma_0,\gamma_0 z^{1/\gamma_0})} \quad (14)$$

Proposition 2. (Toulias and Kitsos(2018)) The cumulative hazard function for of a univariate γ-order normally distributed, $X \sim N_\gamma(\mu, \sigma^2)$, is given by:

$$H_\gamma(x) = \begin{cases} -log\left\{1 - \frac{\Psi(z)}{2}\right\}, & x \le \mu \\ -log\frac{\Psi(z)}{2}, & x > \mu \end{cases} \quad (16)$$

$with\ \Psi(z) = \frac{\Gamma(\gamma_0,\ \gamma_0 z^{1/\gamma_0})}{\Gamma(\gamma_0)}, z = \frac{x-\mu}{\sigma}.$

2.3 Special cases

The following two example are showing that the hazard function of the Laplace, Uniform and multivariate Normal distribution can be provided due to the Proposition 1 and 2.

Proposition 3. For the Laplace distribution of r.v. $N_\gamma(\mu, \sigma^2)$=L(μ, σ) for $\gamma \to \pm\infty$, $\gamma_0 \to 1^+$ the hazard function can be written as:

$$h_L(x) = \begin{cases} \frac{1}{\sigma} exp(2z), & x \le \mu \\ \frac{1}{\sigma}, & x > \mu \end{cases} \quad (17)$$

And the corresponding cumulative hazard function is:

$$H_L(x) = \begin{cases} -log\left\{1 - \frac{1}{2} exp(z)\right\}, & x \le \mu \\ log2 + z, & x > \mu \end{cases} \quad (18)$$

with $z = \frac{x-\mu}{\sigma}$.

Proposition 4. For the U(a,b) distributed r.v. can be obtained from the $\gamma - GND$:

$$X \sim N_1(\mu, \sigma^2) = \lim_{\gamma \to 1^+} N_\gamma(\mu, \sigma^2) = U(a, b), \text{where } \mu = \frac{a+b}{2}, \sigma = \frac{b-a}{2}$$

Therefore, $\gamma \to 1^+, \gamma_0 \to 0^+, x \in [\mu - \sigma, \mu + \sigma]$, the pdf will be $f_\gamma(x) = 1/(2\sigma)$

and the cdf $F_\gamma(x) = 1 - \frac{1}{2}(1 - z)$.

Consequently, for $x \in [a, b]$, pdf and cdf are given by $f_u(x) = f_{\gamma \to 1^+}(x) = 1/(b-a)$ and $F_u(x)$=$F_{\gamma \to 1^+}(x) = \frac{x-a}{b-a}$, the hazard and cumulative hazard function will be:

$$h_u(x)=h_{\gamma \to 1^+}(x)=\frac{f_u(x)}{1-F_u(x)}=\frac{1}{b-x}$$
$$H_u(x)=H_{\gamma \to 1^+}(x)=-log(1-F_u(x))=-log\left(\frac{b-x}{b-a}\right) \quad (19)$$

Proposition 5. The multivariate normal distribution $X \sim N_2(\mu, \sigma^2)$ it is special case of the $\gamma - GND$, therefore:

$$h_N(x)=\frac{\varphi(x)}{1-\Phi(x)}$$
$$H_N(x)=-log(1-\Phi(x)) \quad (20)$$

3. Empirical Results

In order to prove the empirically propositions 3-5 we are using simulated data.

In the first case the 1000 data are obtained from a Laplace(10,50). This distribution is compared with $X\sim N_{100}(10,50)$. There were plotted the PDF, the hazard function and the cumulative hazard function for γ=100, as can be seen in the **Figure 1.**

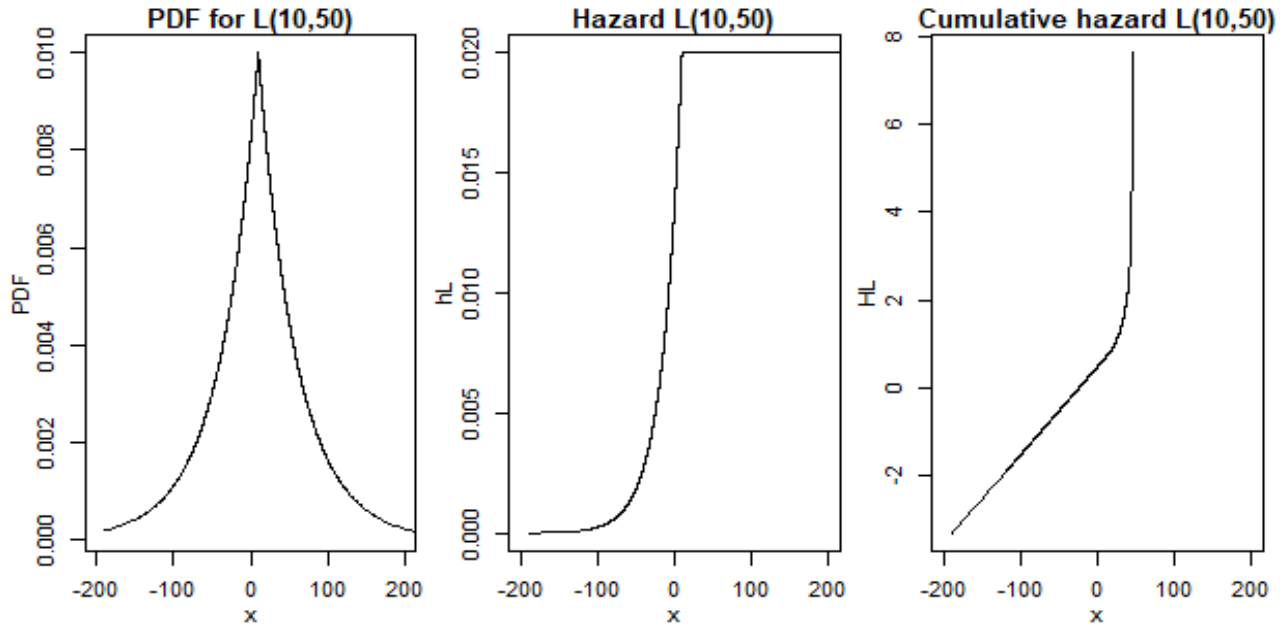
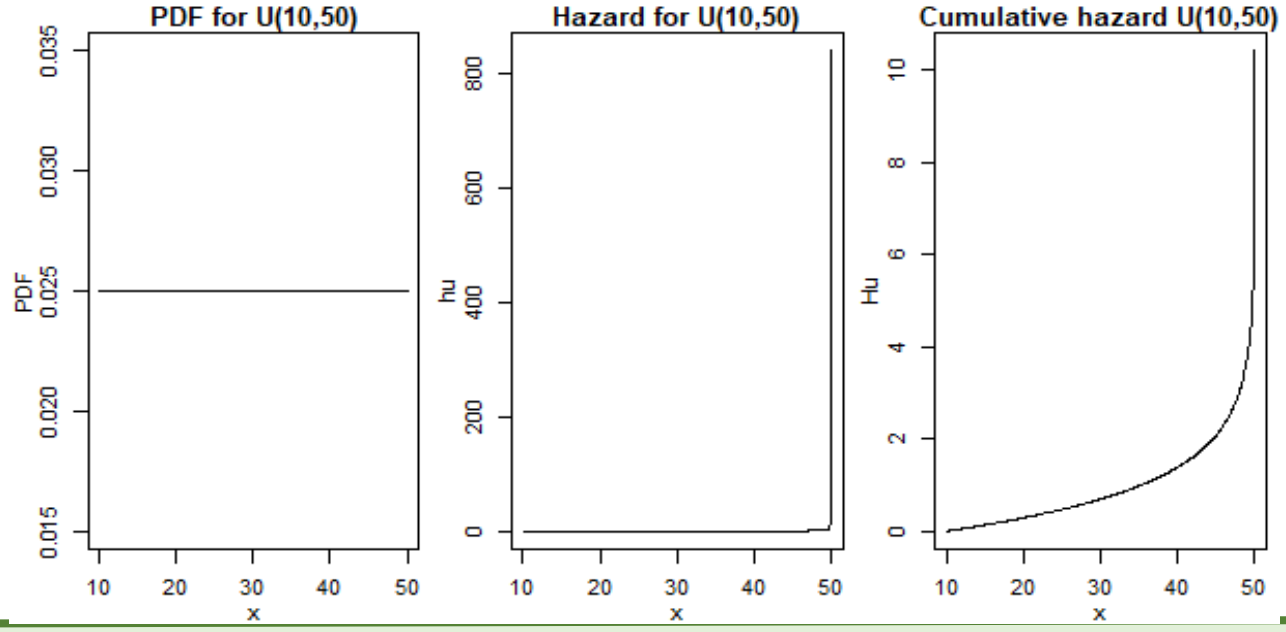


Figure 1. Plotting $\boldsymbol{X\sim N_{100}(10,50)=L(10,50)}$

In the second case the 1000 data are simulated from a Uniform distribution cu a=10 and b=50. Therefore μ=30 and σ=20 and the comparation is done with $X\sim N_{1.001}(30,20)$. There were plotted



the PDF, the hazard function and the cumulative hazard function for γ=1.001, as can be seen in the **Figure 2**.

Figure 2. Plotting $\boldsymbol{X \sim N_{1.001}(30, 20) = U(10, 50)}$

In the last case the 1000 data are randomly obtained from a Normal multivariate distribution μ=10 and σ=1 and the comparation is completed with $X \sim N_2(10,1)$. There were plotted the PDF, the hazard function and the cumulative hazard function for γ=2, as can be seen in the **Figure 2**.

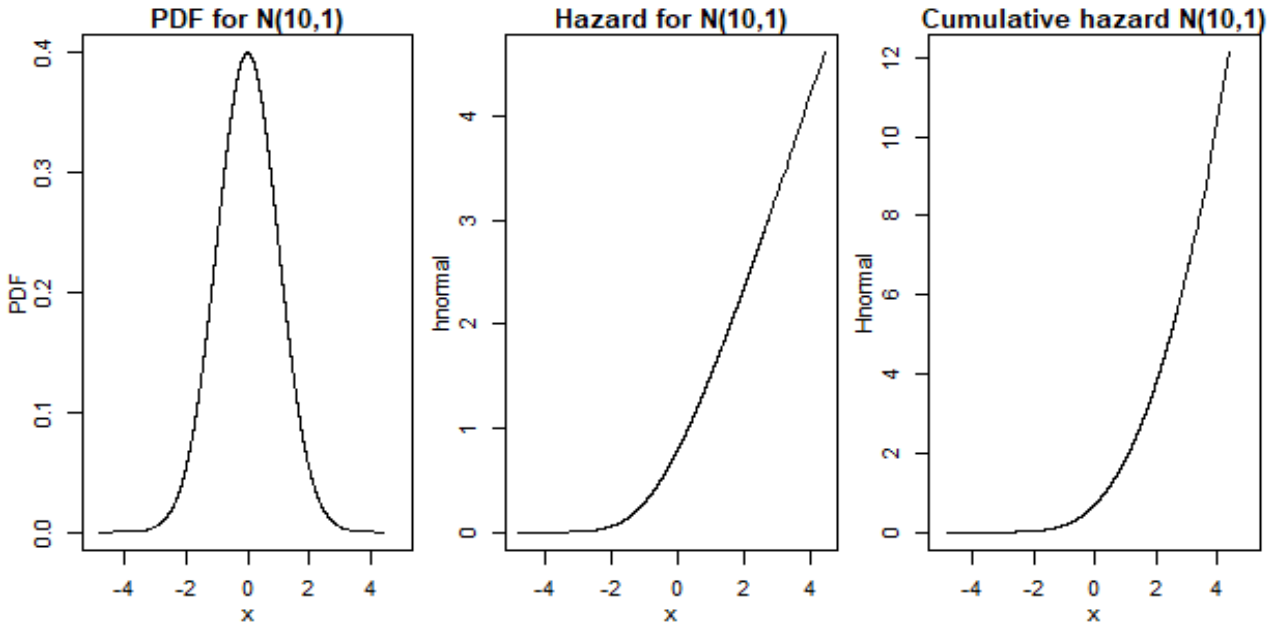


Figure 3. Plotting $\boldsymbol{X \sim N_2(10, 1) = N(10, 1, \gamma = 2)}$

4. Application to the environmental data

4.1 Data

The data include the daily average concentrations of Carbon monoxide (CO,1g) collected in Poland in the biggest cities (Warsaw, Krakow, Lodz and Poznan) and its suburbs in 2018, before Covid-2019 in order to have the real image of the pollution level. The initial data were composed by 8765 measurements and in this word has been used 365 measurement, aggreged date by city and day. Being large urban agglomeration, each city has more than one monitoring station and the data are collected hourly.

4.2 Analysis

In the **Table 1** can be seen the minimum, maximum and mode need it in order to calculate the hazard and cumulative hazard function through the triangular distribution. In this case we are interested in the extreme points and the middle point. This distribution is easy to use and give good results as can be seen in the **Figure 4-7.**

Table 1. Descriptive statistics for the pollutant CO 2018 by city

City	Min	Max	Median	Mean	Mode
Warsaw	0.2	1.5	0.6	0.59	0.8
Krakow	0.2	2.55	0.6	0.68	1.38
Lodz	0	1.03	0.43	0.47	0.52
Poznan	0.1	1.2	0.4	0.46	0.65

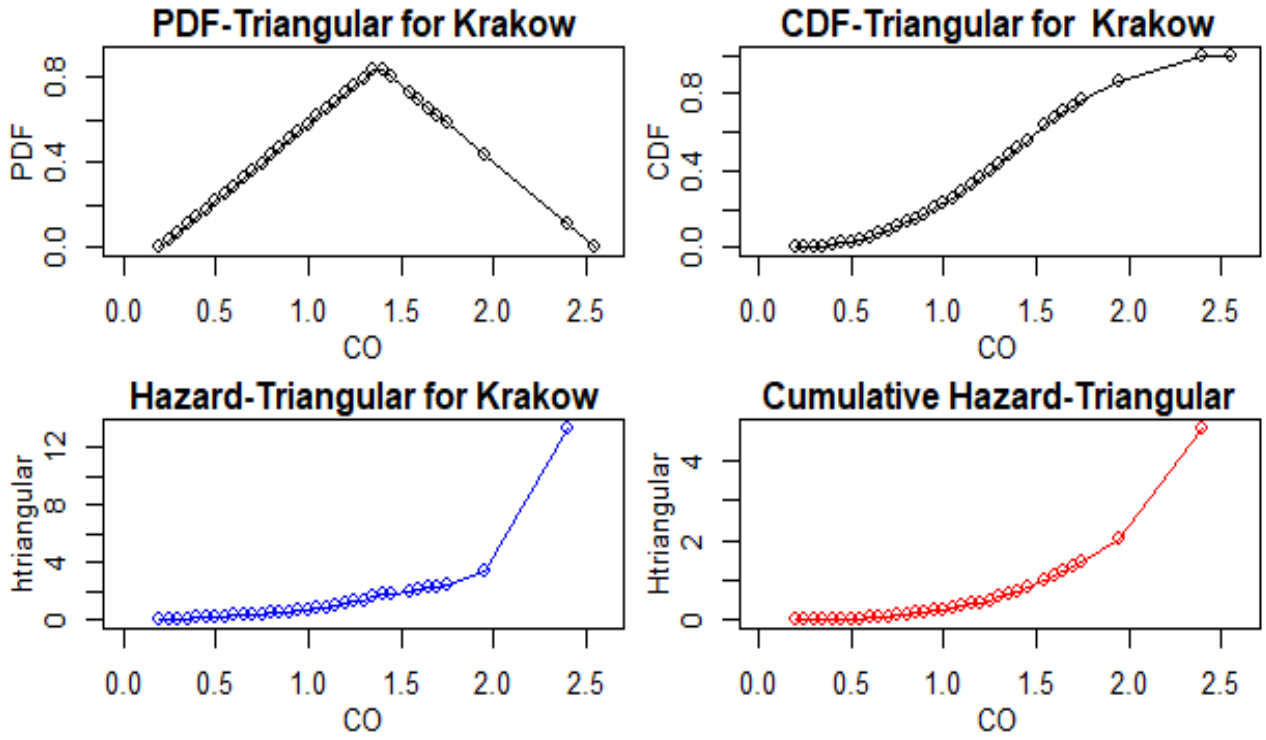


Figure 4. Warsaw Pollutant CO 2018

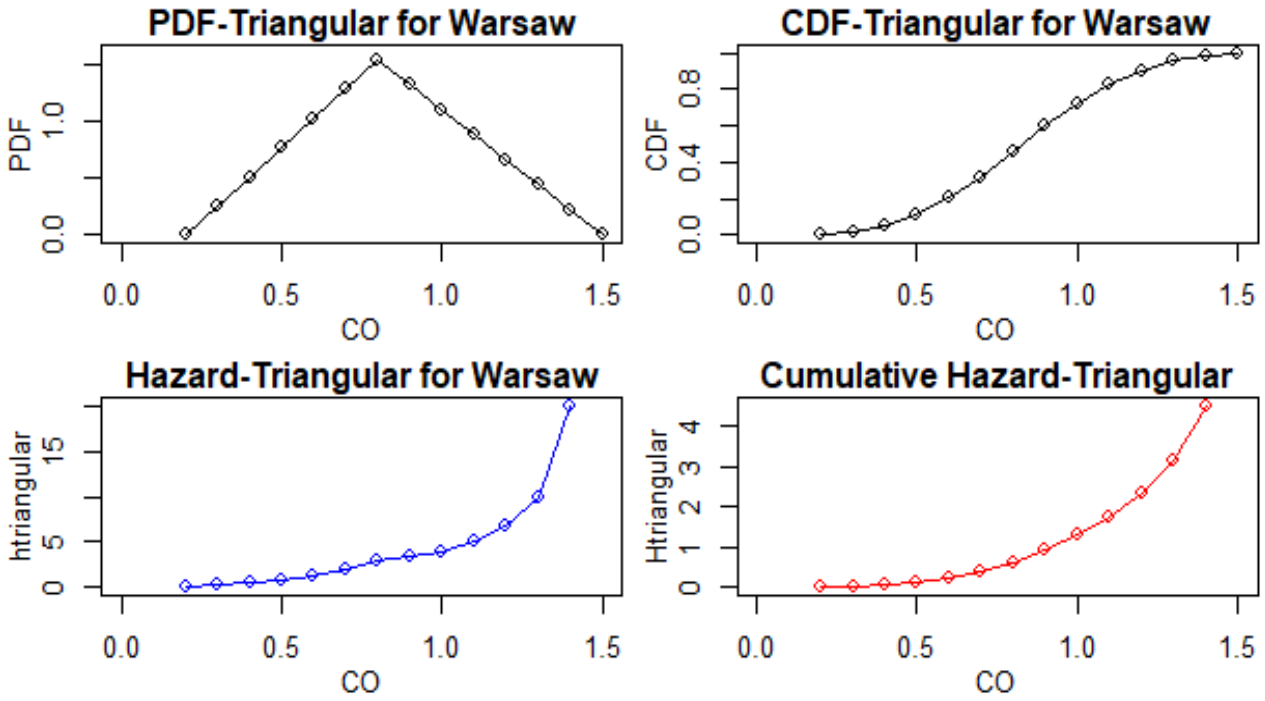


Figure 5. Krakow Pollutant CO 2018

Warsaw and Krakow have triangular distribution, the minimum is the same, but the maximum in the case of Krakow is one point bigger. Thus, the mode of Krakow is almost double as the mode of Warsaw. But the values of the hazard and cumulative hazard has similar values.

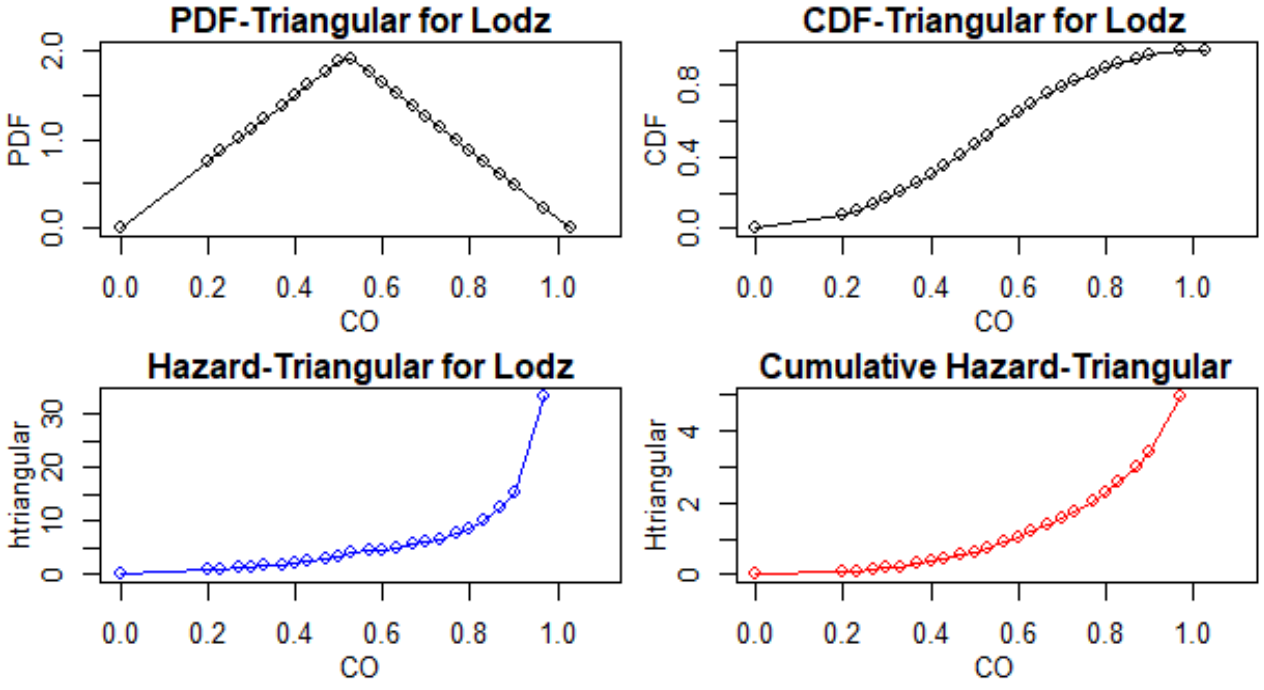


Figure 6. Lodz Pollutant CO 2018

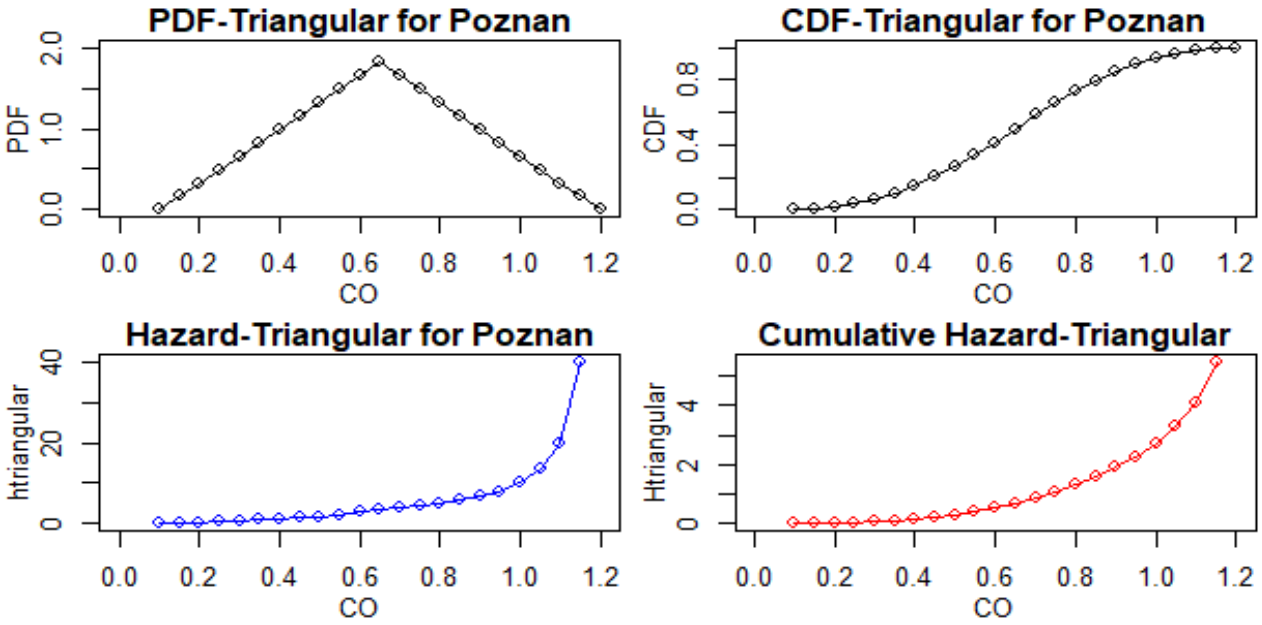


Figure 7. Poznan Pollutant CO 2018

In the case of Lodz and Poznan the minimum, maximum and mode are approximately the same and only the hazard for Poznan has lightly bigger values.

5. Conclusions

The special case of the $\gamma - GND$ are having the same comportment as the Laplace, Uniform and Normal distribution. We are presenting, the theoretical and also one empirical demonstration of this affirmation.

The use of triangular distribution is working properly in the case of the polish pollutant data. We tried to present the two extreme statistical cases: a complicated one, and a rather easy to handle distribution. So that we believe we provide evidence that both can be adopted, for the Environmental Statistical Analysis.

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Big Data Analytics in Control of Water

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Abstract
This work to approach the theme of analytics of large amounts of data (Big Data), its applicability in the universe of water management in a city, in the context of the Smart Cities paradigm and to present the appropriate tools for the process of analytics of large amounts of data. After a brief description of some important statistical concepts, the Big Data paradigm will be approached, as well as the concept of smartcity (Smart City) in a perspective of use for the sustainability of a city as well as of life itself: urban water management. The concept of Big Data Analytics and some tools used are also introduced. Finally, the relationship of the technology most used by data analysts with a Big Data system is explained.

Keywords:: *Statistics; Big Data; Water; Smart Cities.*

JEL Codes: C1; Q25; Q55

Session 3
Energy Issues and Policies

Energy poverty persistence and transition effects: Empirical evidence from Greek households

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Abstract
The present paper uses four rounds of household panel data to investigate the persistence of poverty in Greece. Employing dynamic Probit random effects and Wooldridge Conditional Maximum Likelihood (WCML) estimators, we find evidence of genuine state dependence effects in consensual-based energy poverty among Greek households. Poverty persistence is around 10- 12%, while transition effects are also evident in our data. Socioeconomic, demographic market, household, and climatic characteristics are essential predictors of energy poverty. Around 9% ofthe households are chronically energy poor, while education, income level, dwelling characteristics, migration background, and employment status affect the chances of suffering and exiting from energy poverty. Empirical results have significant policy implications that can reduce residential energy poverty.

Keywords: *Energy poverty; Dynamic Probit; WCML; Persistence;Transition*

JEL Codes: Q40; Q48; D63.

Regulatory Framework for the Participation of Demand Response in the new electricity markets

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Abstract

According to the Energy Efficiency Directive (2012/27/EU) and the EU Regulations (943/2019 and 944/2019), Member States shall promote access to and participation of demand response alongside supply within the wholesale, balancing, capacity markets and ancillary services to improve energy and cost efficiency and enhance system's adequacy. Therefore, all customer groups (industrial, commercial and households) should have access to the electricity markets to trade their flexibility and self-generated electricity. Market participants engaged in aggregation are likely to play an important role as intermediaries between customer groups and the market. Member States should be free to choose the appropriate implementation model and approachto governance for independent aggregation while respecting the general principles set out in this Directive. To this aim, national regulatory authorities have a central role in developing the regulatory framework and defining the technical modalities as well as the contractual arrangements to encourage consumers' participation in electricity markets by offering their demand flexibility whether alone or through aggregation. In this context, the Regulatory Authority for Energy (RAE) will present the main developments within the last one year as well as the elements of the recently approved regulatory framework regarding the rules and procedures for demand response participation in the electricity marketsin Greece. Several entities have been licensed by RAE to operate in the market as demand response aggregators and all the provisions regarding their participation in the electricity balancing market have been activated.

Keywords: *Demand response; electricity markets; regulatory framework, energy; EuropeanUnion.*

JEL Codes: N74; Q41; Q43

Development of RES is the answer to the current energy crisis: The economic benefits from both RES and CHP support scheme and competitive procedures for RES via eAuctions in Greece

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Abstract
The development of RES is the answer to the current energy crisis in Greece as it leads to a gradual de- dependance on Russian natural gas. The RES and CHP support scheme in Greece has been approved by the European Commission (EE[C(2016)7272final–SA44666 based on a sliding feed-in-premium concept for the majority of RES projects, where the premium is provided through competitive auctions, that can be technology-specific or neutral, national or regional. According to a Ministerial Decision, published in July 2022, a cumulative capacity of about 4000 MW will be auctioned in Greece for wind and PV power plants within the years 2022 to 2024, in order to achieve the RES deployment and CO2 reduction targets of the country for the next decade, while increasing the competition and reducing the cost of renewable energy for the consumers. This paper will describe and analyze the economic benefits of the development of RES to the consumers. More specifically the results of the first period (2016-2021) of RES auctions implemented in Greece and the design of the RES auctions the next period 2022-2024 will be presented. The Hellenic Regulatory Authority for Energy (RAE) has successfully introduced in the Greek market since 2016, innovative Competitive Procedures for Renewable Energy Sources (RES): tenders with the use of customized e-auctions. Seeking an efficient solution to facilitate the extremely complex process within limited time and great outcome, a number of 17 energy eAuctions have been conducted up currently, featuring as the most transparent and competent tool under the approval of SA 48143 of EU; their undisputable success has contributed to the smooth award of 1629,34MW solar and 1426,73MW wind plants, with significant low prices to the benefit of both the consumers and national economy. The implementation of RES support scheme drives to a great economic benefit to the consumers and it is estimated that a total amount of about 1,5 billion euro up to September 2022 returned to the consumers from the RES Special Account via the Energy Transition Fund.

Keywords: *Energy crisis; RES; eAuctions; CHP support schemes*

Legal and Regulatory Framework for Storing Energy in Greece

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Abstract

This paper presents the latest advances of the legal and regulatory framework for storing energy in Greece. It gives a review of the licensing regime for storage, the new grid connection priority rules, the electricity market, the system operation, as well as the grid technical requirements codes highlighting the gaps and challenges to assist a potential investor, understand the case in Greece and take decisions.

Keywords: *Legislation; Regulatory framework; Storage.*

Estimating the energy requirements of the Greek economy by the sraffian multiplier

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82

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Abstract

This research estimates the energy requirements of the Greek economy based on data from the National Symmetric Input-Output Table and the Environmental Accounts for the year 2014. Starting from an open linear single production model and based on the concept of sraffian multiplier, the total (direct and indirect) changes in energy use due to one unit change in (i) the autonomous final demand and (ii) the direct energy use of the commodities are estimated. Empirical findings can provide the basis for the development of a well-targeted energy policy program.

Keywords: *Energy policy; input-output analysis; sraffian theory, energy multipliers; Greek economy.*

JEL Codes: C67; E11; Q43; Q48.

Session 4
Natural Resources Conservation

Dams and climate change: Socioeconomic approaches

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Abstract

Dams are important structures for managing increasing water needs due to climate change and global population growth, while they have an important role in flood regulation, clean energy and balancing the energy system. Nevertheless, their role is disputed, due to their strong environmental footprint and social impact. Many new projects are often delayed or canceled due to severe social backlash. While the issue of social acceptance is widely discussed, the research on the social attitude of citizens around the construction and operation of dams is not enough. However, the social attitude of the citizens, their opinion, the role the dams have in the economy and the social balance of the local society can be a crucial aspect in maximizing their benefits. The aim of this research is to specify the social attitudes of the citizens of an area affected by the construction of a dam, in our case the Regional Unit of Arta, and explore the issues that concern its citizens such as security, the connection of economy with the operation of the dam, the water use, the protection against climate change, the residents' role in the decision-making process, and the acceptance of hydroelectric projects by the local community.

Keywords: *dams; climate change; acceptance; conflicts; local community*

JEL Codes: O44; O52; Q25; Q40; Q56; R11.

Assessment of the socio-economic impacts of the Forest Life Projecton the governance of Natura 2000 Forests

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Abstract

This research aims to assess the socio-economic impacts of the LIFE ForestLife project, which aimed to strengthen forest governance in the Natura 2000 network areas and was completed in 2022. These impacts were grouped into three categories: a) capacity building of the staff of the competent services for the management of the forests that benefited from the project, b) improving the governance of the forest sector and c) increasing its contribution to the local economy or reducing the cost of forest management in Natura 2000 areas. The method of focus groups and in-depth interviews was used in a sample of stakeholders- experts and the above socio-economic benefits were assessed. Participants rated ForestLife's contribution to capacity building and governance positively. However, in terms of the contribution to the economy, they believe that more effort is needed and that despite the potentially positive contribution, this requires further analysis in the coming years to be quantified.

Keywords: *Natura 2000, ForestLife, capacity building, focus groups, in-depth interviews, Forestry*

JEL Codes: Q00, Q23, Z13

Fishing cultural heritage, local identity, and implications for maritime spatial planning

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86

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Abstract

In maritime spatial planning, an informative and 'fair' representation of marine activities requires that sociocultural aspects have to be included along with economic considerations, in the battle of claiming marine space. This will allow for activities of sociocultural importance to become visible. Marine commercial fisheries in contemporary Greece offer an insight. Ethnographic research, in the subarea of Chalkidiki peninsula in Northern Greece, indicates that fishing shapes a strong individual and shared identity, which means that fishing is more than an economic activity. The paper will focus on fishing cultural heritage of the area and the need for its consideration in maritime spatial planning process and related plans.

Keywords: *Fisheries; culture; heritage; identity; maritime spatial planning*

JEL Codes: Z10; Z13; Z19; Q22; Q28. O20

Funding: This research is co-financed by Greece and the European Union (European Social Fund- ESF) through the Operational Programme «Human Resources Development, Education and Lifelong Learning» in the context of the project "Reinforcement of Postdoctoral Researchers - 2nd Cycle" (MIS-5033021), implemented by the State Scholarships Foundation (IKY).

Αλιευτική πολιτιστική κληρονομιά, τοπική ταυτότητα και η σημασία τους για τον θαλάσσιο χωροταξικό σχεδιασμό

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Περίληψη

Στον θαλάσσιο χωροταξικό σχεδιασμό, μια πλήρης και «δίκαιη» αναπαράσταση των θαλάσσιων δραστηριοτήτων απαιτεί να συμπεριληφθούν, εκτός των οικονομικών, κοινωνικές και πολιτιστικές οπτικές των δραστηριοτήτων αυτών, στον αγώνα διεκδίκησης του θαλάσσιου χώρου. Αυτό θα επιτρέψει να γίνουν ορατές δραστηριότητες κοινωνικοπολιτιστικής σημασίας. Η εμπορική αλιεία στη σύγχρονη Ελλάδα αποτελεί μια τέτοια περίπτωση και προσφέρει τη δυνατότητα συμπερίληψης των παραπάνω οπτικών. Εθνογραφική έρευνα, στην Ανατολική Χαλκιδική, στη Βόρεια Ελλάδα, αποκαλύπτει ότι η αλιεία διαμορφώνει μια ισχυρή ατομική και συλλογική ταυτότητα, το οποίο σημαίνει ότι αποτελεί κάτι περισσότερο από μια οικονομική δραστηριότητα. Η εργασία αυτή εστιάζει στην αλιευτική πολιτιστική κληρονομιά της περιοχής και στην ανάγκη συνεκτίμησής της στη διαδικασία θαλάσσιου χωροταξικού σχεδιασμού και στην παραγωγή των σχετικών σχεδίων.

Λέξεις Κλειδιά: *Αλιεία; πολιτιστική κληρονομιά; ταυτότητα; θαλάσσιος χωροταξικός σχεδιασμός.*

JEL Κωδικοί: Z10; Z13; Z19; Q22; Q28; O20.

1. Introduction

Greek fisheries are primarily characterized as Small-Scale Fisheries (SSFs)[1] (Tzanatos et al., 2020; Mantziaris et al., 2020), that typically use different gear adapted to diverse target species (Pardalou and Tsikliras, 2015). The overwhelming majority of SSFs employ wooden boats (Kapantagakis, 2014). Most small-scale fishers are owners, fishing is their main occupation, and they are from 40 years old and above (Mantziaris et al., 2020).

The contribution of SSFs to the national economy is relatively small, when measured through conventional economic indicators. However, their role is critical to the economic and social integrity of several coastal and insular communities of the country (Tzanatos et al., 2020). SSFs are also linked to a range of cultural ecosystem services, such as cultural heritage and identity, sense of place, inspiration for arts, contribution to tourism (e.g., Reed et al., 2013; Urquhart and Acott, 2013; 2014; Acott and Urquhart, 2014; Ropars-Collet et al., 2017; Koutrakis et al., 2019) etc.

[1] Small-scale coastal fishing is conducted by vessels below 12 meters, not using towed fishing gear (EU, 2014).

However, the study of the sociocultural values of fisheries has rarely been at the center of fisheries research (Ignatius and Haapasaari, 2018) and such evidence has been poorly documented (Garcia et al., 2014)[2]. Furthermore, fisheries management has been focused until recently mainly on provisioning services (Garcia and Cochrane, 2005). Despite the historical connection of Greeks with fishing (Dimitropoulos and Olympitou, 2010), the study of the social, and especially of the cultural dimension of fishing has been very limited (e.g., Zachariou-Mamaliga, 1986; Olympitou, 2014; Mylona et al., 2021), in contrast to agriculture and livestock farming (Koutrakis et al., 2019). Therefore, there is increasing need to address these knowledge gaps not only for fisheries management, but also for other related policy frameworks, such as Marine Spatial Planning (MSP).

The paper initially presents the case study area and the employed methodology. Then, it offers an overview of the area's fishing cultural heritage, while exploring its contribution to shaping a local identity. The significance of fishing activity and its connection to personal identity follows. Finally, before summing up the main conclusions, implications are discussed regarding the implementation of MSP.

2. The case study area

The case study area is in Eastern Chalkidiki, Northern Greece. It has a population of 7.110 people in 2011 Census, covers a geographical area of 131 km^2 and includes the area of Aristotle Municipality that falls within the Fisheries Local Action Group (FLAG) of Chalkidiki. The FLAG area is characterized by the highest concentration of fishing activity, mainly family run SSFs, on a small geographical scale compared to other parts of Chalkidiki Prefecture, while in certain municipal communities, such as Ammouliani island, fishing employs approximately half of the local population (ANETXA SA, 2017). There are about 125 small-scale vessels and 450-500 people employed at Municipal scale (interview with key informant). Although, fishing activity is in decline, it is the most important activity of the primary sector. Furthermore, fishing in communities such as Ierissos is dated back to 5th century B.C, as demonstrated by depictions of specific species (i.e., 'orkini') on ancient coins (Varvaressou, 2019). Following local narrations, another important historical fact is the link of fishing to the arrival of refugee fishing populations from coastal Asia Minor after 1922. Some settlements were inhabited for the first time after their arrival, while innovative changes in fishing techniques, especially in open sea fishing, were brought along (Lilimbaki – Spyropoulou, 2002).

Apart from fisheries, modern professions related to tourism have emerged since the '70s, and today tourism has dynamic and dominant presence. Furthermore, there is a considerable touristic demand for the Mount Athos monastic community (religious tourism). Overall, tourism differs from the model of mass tourism that characterizes the rest of the Prefecture. Furthermore, regarding both sectors, there are differences in their importance and degree of dependence from place to place within the study area. Finally, the identity of the wider area is also composed of the long presence of mines, the extensive coastline, the rich natural resources, as well as the significant historical and archaeological sites.

[2] Stithou et al. (2023) present different conceptual frameworks and methods employed to explore the sociocultural importance of SSFs and their integration into marine management and planning.

3. Methods

Ethnographic research was carried out between 2020 and 2022, including interviews and collection of other informative data (e.g., photographic material, video, on-site personal observations etc.). In total, 34 in-depth semi-structured interviews were conducted[3]. Participants included fishers, fishers' organizations, tourism related stakeholders (employees, employers and tourism organization representatives), cultural associations representatives and their members, local authorities, shipbuilders and fishmongers. The locations of the interviews were Ierissos, Nea Roda, Ouranoupoli and Ammouliani. Participants were recruited using snowball method (Breweton and Millward, 2001) and interviews ranged from 1 to 2 1/2 hours in duration. It is noted that, due to Covid-19 pandemic restrictions, both telephone and on-site interviews took place. Ethical approval was obtained by the Research Ethics Committee of the University of Crete. Interviews were recorded following permission of participants and subsequently transcribed, organized and coded using NVivo12 software. To preserve anonymity of participants, pseudonyms have been used.

4. Results

4.1 Fishing cultural heritage and social identity

There are several tangible and intangible elements that compose the fishing cultural heritage of the case study area. Specifically, boats, ports, traditional shipyards, buildings (e.g., old shipyard 'arsanas' in Ammouliani) are indicative of material characteristics. Stakeholders' perceptions about the area and its specific characteristics, including tangible elements such as boats (Images 1-4), shape a specific identity and sense of place (Urquhart and Acott, 2013; Acott and Urquhart, 2014; Khakzad and Griffith, 2016).

'*[boats] are part of our everyday life, like the ports and overall fishing …and you can see them [the boats] that come and go, and it is fantastic scenery, just fantastic*!' *(Eleni, Municipality)*

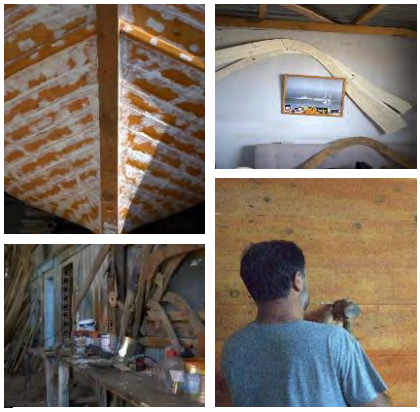
Images 1-4. Boats in the ports of the case study area (Photos by M. Stithou).

Traditional vessels are often used as symbols of the identity of a country or a region, such as in the case of the Maltese colorful 'luzzu' (Said, 2017). Traditional boats also create a connection to the past and history embedded in some communities' identity. Such is the case of 'santala', which was one of the boat types used by Asia Minor refugees to arrive in Ammouliani, also supporting settlement's livelihood afterwards (Hatziioannou, 1997; Lilibaki – Spyropoulou, 2002). Furthermore, boats and SSFs are interlinked to traditional shipyards that construct wooden boats (Tzanatos et al., 2020).

[3] Considering the case-study approach, the focus is on the wealth and depth of the qualitative data and results are meant to be indicative of the importance of fishing cultural heritage in the case study area.

'those two [activities] go together…if one dies, the other will die too… The best customers of shipbuilders are fishers, specifically the poor fishers [laughing]… Plastic boats are more expensive than wooden, and poor fishers prefer wooden ones' (Thanassis, Ierissos)

There are only few traditional shipyards left in the country, where knowledge passes on from generation to generation, and two of them are in Ierissos (Images 5-9). Informants refer to them with a sense of pride, underlining their uniqueness and presence through time[4] that mark the identity of the region and maintain Ierissos' reputation throughout Greece. The intangible art of shipbuilding[5] is also associated with other intangible elements such as social practices and celebrations (e.g., related to designing, naming, and launching a boat), traditions and expressions (e.g., use of vernacular language) (Cheilari and Vasilaki, 2010; Damianidis, 2013) etc.



Images 5-9: Scenes from a traditional shipyard (Photos by M. Stithou)

Other aspects of intangible cultural heritage, mostly acquired through apprenticeship, included skills related to ways of fishing and use of gear, navigation and seamanship, as well as the local gastronomy and fish processing techniques. The long-term use of traditional knowledge, local practices and skills (Kaltenborn et al., 2017), as well as a common dietary culture also contribute to identity (Chakraborty and Gasparatos, 2019). In the area, there is a wide variety of local recipes also linked to the dietary habits of Athos monastic community and the refugees' cuisine. Overall, fish is big part of the residents' diet as Giannis from Ierissos asserts: '*fish is 60-70% of our food*', while others emphasise on the quality of fish and its reputation due to Ierissos' origin. Furthermore, local species 'orkini' is a trademark of Ierissos and is linked culturally and dietarily till today to the town, to such extent that locals are nicknamed 'orkinades' after that fish. The sculpture of the fisherman fishing 'orkinia' on the pier in Ierissos is also exemplary of this strong connection (Image 10).

Image 10: Sculpture 'Orkinas' by B. Pavlis (Photo by M. Stithou)

'*it is the best dish in the region. In Ierissos everyone knows how to prepare salted orkini...and remember, you will not find it anywhere else!' (Andreas, Ierissos)*

In addition, a processing technique called 'pastoma' is related to the presence of this fish, used for its preservation. The species also brings memories of a traditional way of fishing, called 'daliani'

[4] It is noted that official registration of professional shipbuilders (in total 10) is found in the electoral rolls of Ierissos in 1914. https://www.xalkidikipolitiki.com/2019/05/22/oi-protoi-eklogikoi-katalogoi-tis-ierissoy-1914/?amp (Accessed 20/04/2022).

[5] Inscribed on the National Inventory of Intangible Cultural Heritage of Greece in 2013 https://ayla.culture.gr/en/xilonaupigiki_wooden_shipbuilding/ (Accessed 30/12/2022).

(Karabatakis and Mertzimekis, 2010), which has died out. Nevertheless, memories of fishers and residents shape their perceptions and identity, demonstrating the tight connection to the sea and fishing[6]. In our study area, other memories, apart from those already mentioned, were related to informants' childhood (e.g., fishing with friends, with father, grandfather), social practices that do not exist anymore (e.g., 'agiathodoria' described by Koumaros (2015)), as well as words and scenes from past fishing life etc.

Religious practices (e.g., fishers participating in St Nicholas' celebrations) and festivals (e.g., sardine festival in Nea Roda, fishers' festival in Ammouliani, fishing competition in Stratoni, gastronomic festival 'KOUZINA' across the municipality), are additional demonstrations of a rich intangible cultural heritage. The same holds for oral traditions, folk sayings and stories, as seen elsewhere (Goubili et al., 2021). Manifestations of personal and social identity related to fishing are also encountered as expressions of art and crafts. For example, during our research, it became evident that fishing has inspired sculpture, music, painting, photography and even embroidery made of scales (Image 11).

Image 11: Embroidery (Photo by M. Stithou)

Overall, informants, including fishers, emphasized that fishing was intertwined with the character, the life and the identity of the area, the society itself and each community described their place as *'a fishing village'*. Fishing was also perceived as connecting informants to heir past and roots and was even paralleled by Zoi in Ierissos to '*DNA that goes from generation to generation'*. Finally, its contributing role to social cohesion was underlined, as also asserted by Brookfield et al. (2005, p. 56): '*For fisheries dependent communities, fishing is the glue that holds the community together*'.

'[Fishing] is the pillar around which everything else is centred ... tourism is also good but ... [fishing] is the epicentre around which all the rest is based' (Giorgos, Ammouliani)

4.2 Personal, occupational identity

Fishers demonstrate a strong occupational identity related to their passion for their work (Bakker et al., 2019). During our interviews with fishers (a total of 13), we witnessed this strong identity, reflected through a deep emotional connection with the sea and expressed with emotions of love, thrill, freedom, independence, and mindfulness.

'I have a relationship of dependence, affection, love, I am married to the sea [he laughs] the sea ... how can I put it? It connects, at any time you can go anywhere. It's freedom, we have it in us...' (Takis, Nea Roda)

Working at sea was also experienced by Takis as creating a sense of unity by transferring as he noted: '*money, emotions, products, people, news…everything!'*. He also emphasised that working at

[6] See also Tsantiropoulos and Mylona (2021) for the case of Kavala city area.

sea away from home impacts on the mentality and psyche of people '*making them more open*' compared to people of mountainous areas.

Many fishers also noted that even if they retire, they plan to go fishing for leisure, confirming this tight bond to the sea, as also seen in other study areas that exhibit a strong fishing/nautical identity (Alexakis, 2010). Fishers also demonstrated a special connection to their boat, referring to it as *'part of my life', 'family member', 'my home'*. Boats were also decorating, in a prominent position, house walls demonstrating the pride and importance attached to them (Image 12). Overall, fishers, regardless of the hardships of their profession, value highly their work at sea, while the strong occupational identity makes it difficult for some of them to change their profession, as also seen in other studies (Alexakis, 2019; Winchenbach et al., 2022). Furthermore, part of their appreciation is also attributed to their profession's capacity to demonstrate resilience during crisis (e.g., recent pandemic, wartime).

Image 12: Photo of a boat in a home dining room (Photo by M. Stithou)

An expression of fishers' identity is also captured in the 'ethics of fishing'[7], following French ethnologist Serge Collet, perceived as behavioral rules and actions. Collet in the fishing villages of Southern Italy and Sicily traces these 'ethics' on participating in common habits and customs, in using common spaces for rest or entertainment, in forms of labor solidarity, in gender division of labor, in celebrations and ceremonies in honor of patron saints (Collet, 1998). Similar manifestations of collective identity were identified in our study area. Apart from participating in St Nicholas celebrations, other actions included solidarity between fishers but also altruistic behavior towards other members of the community. Our informants attributed these behaviors mainly to the nature of their work that makes it easier for them to relate to common risks, anxieties, and overall hardships.

'there are certain unwritten laws in the sea … even if your worst enemy is in danger … you will drop what you are doing and go to rescue him' (Andreas, Ierissos)

'anyone who goes to the bow of the boat, even if he does not need food, will be given fish...[fishers] are like this because they have this saying 'give [fish], and God may give you'. That's the philosophy. Fishers and seafarers are…altruistic, they sympathize more easily with others' pain and needs' (Takis, Nea Roda)

Nevertheless, less positive collective attitudes were also mentioned by some informants (e.g., difficulty in coming together to achieve common targets, that was also expressed through the saying '*fishers and hares do not flock*'), while changes through time in collective behaviours were also noted (e.g., in terms of companionship) due to the increased competition in the sea, the way society functions and the decreased number of fishers, as they explained.

[7] Serge Collet uses the Greek word '*ethics*'.

5. Discussion

MSP aims, among others, at the sustainable development of marine space, while considering environmental, economic and social aspects (EC, 2014). However, cultural components have been rarely factored into planning (McKinley et al., 2019). In marine policy frameworks and practices, underestimating social and cultural elements could lead to less informative outputs (Said and Trouillet, 2020), raise equity and justice issues (Bennett et al., 2022), and impact on the legitimacy and acceptability of decisions (Ignatius et al., 2019).

Identity is a fundamental element of wellbeing that should be recognized in SSFs' governance and policy design (Weeratunge et al., 2014). Furthermore, one could also think of identity as being based on '*habitus*'[8] (or 'Hexis'). Fishing creates a close relationship not only with place, but it also offers another perspective on the way we connect to the sea and the marine environment. At the same time, cultural identity and collective memory are dynamic, in response to a changing environment (Hall, 1990; Halbwachs, 1992), and the transformation of the identity of the region seems inevitable[9]. Considering these, what does it mean in terms of ocean literacy and marine citizenship (Mokos et al., 2020; Buchan, 2021), if the 'last hunters' disappear? Will this affect our connection to the sea and the degree of taking responsibility for the sustainable management of marine resources? What is the role of MSP in terms of enhancing public engagement and impacting on socially created '*marine habitus*"?

6. Conclusions

Although a declining fishing activity coexists with a dynamic tourism sector, a strong fishing identity is still present in the study area. Evidence from our ethnographic study shows that fishing is more than an economic activity. In fishing communities, the presence of tangible and intangible cultural elements of marine fisheries and specifically of SSFs, shape social identity. Such elements include, for example, boats and the art of shipbuilding, the presence of specific species, local gastronomy, fish processing techniques etc. Furthermore, the activity is more than a job from fishers' perspective, forging a strong personal identity.

MSP should integrate the cultural and social dimensions of fishing into its process and plans, since those are related to human wellbeing, but also to the effectiveness of MSP in meeting its minimum requirements and being an inclusive and acceptable process. Furthermore, one should consider that the way in which marine governance policies are implemented, may shape the identity of the plan area, perhaps to irreversible extent, potentially also impacting the way we relate and react to issues that concern the sustainability of the marine environment and resources.

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[8] We use the term following sociologist Bourdieu (2006).
[9] Forthcoming work will present opportunities and challenges related to the future of the case study area.

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Value Chain Finance in Agriculture: Empirical Evidence from Greece

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Abstract

The primary sector is particularly important for the Greek economy, especially in light of the country's current financialcrisis, which has lasted since 2010. The purpose of this research is to investigate the current state of agricultural financing across the value chain, as well as to investigate the potential of Contractual Agriculture and its needs and potential for expansion. The study presents the findings of a survey of 222 agricultural sector producers, some of whomhad used the Contractual Agriculture financing tool. The main findings are that financed farmers are more positive than non-financed farmers about the importance and contribution of value chain finance in covering the cost of production, ensuring uninterrupted supply of agricultural inputs, improving the possibility of negotiating the purchase price of pesticides, achieving more satisfactory bank terms and conditions for agricultural product financing, as well as the possibility of negotiating the purchase price of pesticides. Finally, in line with previous research, the study found that younger age groups are more hesitant to use this innovative financial tool, whereas producers with a higher level of education are more likely to use it. The study's findings have significant practical and theoretical ramifications for how Contractual Agriculture will continue to contribute to the growth of Greece's primary sector.

Keywords: *Value-Chain Finance; Contractual Agriculture; Economic Development; Primary Sector;Greece*

JEL Codes: Q14; Q10; Q13

Ecosystem services supply by Agriculture: Using Choice Experiments to estimate trade-offs between monetary and non-monetary incentives

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CETRAD (Centre for Transdiciplinary Development Studies), Portugal

Abstract

Payments for ecosystems services (ES) have been used worldwide to incentivize land managers to adopt more sustainable land uses and management practices. However, recent empirical evidence shows that land managers preferences towards monetary payments are probably overrated. Public funded access to farm advisory services (knowledge services) appear to be highly valued by farmers because the adoption of more sustainable land management practices to be successful requires intensive knowledge services. Climate change adds complexity to decision-making, due to trade-offs between ES. Hence, land managers, and farmers in particular, need knowledge to support their decisions. Non-market valuation methods, such as Choice Experiments (CE) have been applied to estimate farmers, and other type of land managers, willingness to accept (WTA) monetary compensation to adopt sustainable land managing practices, including conservation agriculture. This paper shows how this method can be used to assess trade-offs between the WTA monetary compensation and the public funded supply of advisory services, accounting additionally for subjective socio-psychologic variables, such as perceptions or emotions. Hence, the paper goals are twofold. It aims at showing that CE can be useful to measure trade-offs between different type of policy incentives and to identify the ones or the mix showing more effective to influence land managers decision-making towards sustainability transitions. Another goal is to provide empirical evidence for policy recommendations on European eco-schemes intended to enhance farmer's supply of ES. The survey was conducted in the Mediterranean Uplands in Portugal. These landscapes are extremely vulnerable to climate change entailing trade-offs between the supply of different ES. A questionnaire was designed to implement CE collecting also farmer's perceptions (latent variables). A total of 253 valid questionnaires were obtained. Data analysis showed farmers are willing to exchange monetary compensations for knowledge services, in particular when more demanding soil conservation practices ate atstage. Results also show farmer's perception of higher knowledge needs increases WTA, and that being socially acknowledged reduces WTA. Fire risk perception increases WTA and the perception of collective effort to reduce firerisk at landscape level reduces WTA. The results enable to produce recommendation on more effective incentives mixes beyond simpler ES payments.

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Session 5
Education for Sustainability and the Environment

Smart city as a strategic improvement of the living conditions of citizens: Urban Forests

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Abstract

This paper attempts to present the dimensions, factors, and elements of people's quality of life that lead to well-being. The research focuses on the quality of life in cities and through specific indicators, with special reference to environmental indicators. To investigate the contribution of a smart city to the improvement of people's quality of life, its components are to be presented, as well as the complexity, and the need for an interdisciplinary approach based on participation and technology. This paper focuses on the relationship of the city with green spaces and urban forests highlighting the necessity of integrating urban forests and green spaces in smart city planning. The impact of urban greenery on improving living standards and its social role, its influence on the anthropogenic environment, and its interactivity with the city constructions and climatic conditions of the urban landscape are analyzed. The importance of the morphology and diversity of the urban forest for the maximum environmental and economic upgrading of the city is presented. To conclude, with the projection of the Goals of the 2030 Agenda for Sustainable Development, the contribution of urban and peri-urban forests to sustainable urbanization and restoration of degraded ecosystems is confirmed. The methodological part of the paper aims to highlight the environmental and ecological dimensions of the city of Trikala, in the context of interaction with the Forest of *Panagia* in Valtino, Trikala, focusing on interventions that promote the utilization of ecosystem services in the urban population.

Keywords: *Smart city, Urban forests, Citizen well-being, Agenda 2030*

JELClassification: Q01, Q23, Q51, Q53, Q54, Q56

1. Introduction

Rapid urbanization has caused a number of impacts on the natural environment as cities have spread at the expense of agroforestry ecosystems. Urban expansion has, in several cases, spread to local habitats and degraded ecosystems. The necessity of the present research is due to the fact that while urban development "intelligently" assimilates technology, it neglects its relationship with the natural environment, resulting in the loss and limitation of ecosystem services. The main purpose of the paper is to study the interaction and coexistence of urban and forest ecosystem, the necessity of new policy making, regulatory policy formulation and the understanding of coordination situation to ensure ecosystem service provision and ecological restoration.

This paper attempts to highlight the contribution of ecosystem provision and specifically the significance of urban forests to human well-being. In the first place, reference is made to the concept of the quality of life in cities, followed by the presentation of the structural elements that make up the smart city with reference to the city of Trikala. Then the interdependence of citizens with urban forests is analyzed, as an element of the "smart city", while the importance of proper planning of an urban forest is presented so that the city and its citizens as a whole to reap the maximum benefits. The methodology concerns the mapping and utilization of actions and infrastructure in the peri-urban Forest of *Panagia* in Valtino of the Municipality of Trikala and aims to highlight the recreational, educational, and environmental benefits of citizens, through their interaction with it. The benefits are expected to be strengthened in various ways such as the development of cultivation projects; fire prevention actions; the promotion of the Forest as a Theme Park of flora and fauna to strengthen environmental education; the construction of a bicycle lane to connect the city with the Forest; the installation of informative signal lights, etc. The above will upgrade the local natural environment, will be a pole of attraction for environmental education, information and utilization, and will highlight the valuable natural features as a place for tourism and recreation.

2. Theoretical background

2.1 Quality of life

Various attempts have been made to find a common definition of quality of life. To define the concept, one could first use the analytical scheme of Allardt (1976, 1981), who makes a distinction between objective and subjective living conditions and, in particular, takes into account four different dimensions: cultural, economic and social level, as well as trust. Specifically: the standard of living concerns the so-called material needs in terms of health, nutrition, employment, income, etc.; the quality of life concerns the intangible living conditions, mainly in terms of the quality of human relationships, social and cultural integration and the quality of environment; *satisfaction* refers to the subjective view of the level of living conditions, and *happiness* refers to the subjective view of the quality of life.

2.2 Quality of life in smart cities

The quality of life in cities cannot be analyzed only based on the characteristics of their structure, and this is because cities have a strong and complex relationship with their surrounding areas. For this reason, reliable and revealing indicators related to the socio-economic status of the population are taken into account, such as gainful employment, unemployment rate, income and home ownership. Quality indicators include available services such as trade, education, culture,

entertainment, hotels and restaurants, and health care. Also, the utilization of data, access and use of Information and Communication Technologies (ICT) in all social sectors, as well as the shift of needs, the quality of the natural environment and the economic attractiveness that entails the supply and demand are considered to be factors that indicate quality.

Smart cities are derived from the concept of the city of information, (Leeetal., 2014), and the six dimensions they include are smart economy, smart mobility, smart environment, smart people, smart living and smart governance. Smart cities support holistic and sustainable development in their core elements which are technology (as hardware and software infrastructure), education, governance and policy institutions, and the participation of creative and diverse people (Caragliuetal., 2011, Nam&Pardo, 2011). Anthopoulos&Vakali (2012), Caragliu et al. (2011), Dameri et al. (2019), Desdemoustieretal.(2019), and Lazaroiu&Roscia(2012), define smart cities as hubs for the use of limited economic resources, promoting sustainable economic development and high quality of life with the conservative management of natural resources through participatory governance, analyzing thus the financial aspect of smart cities. People interact with technology and information and create a high quality of life through a sustainable, green and innovative city within a smart city when limited resources are intelligently coordinated according to Barionuevoetal.(2012). The transformation of the smart city is done through four steps (Kumar et al., 2020). The first step is the designing stage, the second is the development of physical infrastructure, followed by the ICT infrastructure, and finally the development of smart solutions.

2.3 Smart cities with urban green spaces, Urban forestry

To highlight the role of urban green spaces, we define their benefits in the lives of citizens. The most important factor that characterizes a healthy urban environment is greenery in the form of park vegetation, tree rows, safety islands. The presence of greenery in the city improves the quality of life of citizens in a variety of ways. First, it positively changes the local climate, offers oxygen, cools the hot summer days with the transpiration of the trees, and improves the quality of the atmospheric composition (Kassios, 2005). Furthermore, it filters floating solid particles and dust, helps to reduce noise and aesthetically upgrades the environment. The role of urban green space based on functions could be categorized into Ecological, Social and Economic.

In order to understand the position of public green space we refer to the following definitions. We call a smart urban forest the gathering of trees and related vegetation within a city with the aim of enhancing forest benefits by self-regulation and automation using digital technologies such as free and big data, sensors, artificial intelligence, robotics, augmented and virtual reality and social media. Therefore, a smart urban forest management is the planning, installation, monitoring and management of urban trees and vegetation through the use of digital technologies, with the common goal of improving the urban environment with the participation of all relevant sectors.

2.3.1 The importance of forest city planning

Population growth and economic development lead to the uncontrolled emission of carbon dioxide on the one hand, and the reduction of usable natural resources on the other. The ways to solve the reduction of carbon emissions are aimed at a sustainable natural environment for urban development and the development of ecological balance.

An effective way to mitigate the warming of the atmospheric environment as a negative impact of reckless carbon emission is the forest city. The research results of Shao, (2019), show that the economic development and the construction of forest cities promote each other. Expanding forest areas and improving accessibility to urban forests is the most immediate and effective way to achieve

a reduction in direct emissions. Based on the four important categories that include ecology, economy, industry, and culture, technical support must be given to the design and construction of the forest city.

Shao's (2019) quantitative and qualitative analysis concerns the basic planning and construction stages of forest cities and is based on the principle of low carbon effect providing the basis for forest construction of cities with the designation "sustainable city". His analysis proved that the driving factors of change and reduction of carbon emissions are both natural and anthropogenic. Population growth and urbanization can to some extent promote the construction of forest cities, expand forest area and improve accessibility in urban forests. The above make the most direct and effective ways to achieve immediate reduction of the emissions and the forest city's aim.

The system's design for the construction of urban forests includes the main functions which are firstly the direct reduction of emissions, secondly the indirect reduction and thirdly the increase of the ecological footprint.

2.3.2 Treesincities – Sustainable Development Goals

The decade 2021-2030 was declared by the General Assembly of the United Nations as the decade for the protection and restoration of degraded ecosystems with participation in global actions. One of the main drivers of ecosystem degradation is unsustainable urbanization. Based on the above, cities will play an important role in the decade. The end of the decade is the deadline for meeting the 2030 Agenda for Sustainable Development (SDGs). The contribution of urban and peri-urban trees in a series of Goals (SDGs, are significant and presented below (UNECE, 2022) :

Goal 1, Zero Poverty. By creating employment, reducing damage costs caused by natural hazards and boosting the local economy, urban and peri-urban trees and forests can help confront urban poverty.

Goal 2, Zero Hunger. Urban and peri-urban forests are a source of instantly available food with nutrients.

Goal 3, Good Health and Well-Being. The presence of forests and urban greenery can enhance physical and mental health.

Goal 6, Clean Water and Sanitation. Urban and peri-urban forests filter drinking water, reduce the risk of flooding and help capture and store underground water.

Goal 11, Sustainable cities and communities. Through their contribution to a wide range of Goals, urban trees and forests help create more sustainable cities and communities.

Goal 13, Climate Action. Planting more trees in and around cities has proven to be one of the fastest, most cost-effective ways to mitigate the effect of urban heat-island.

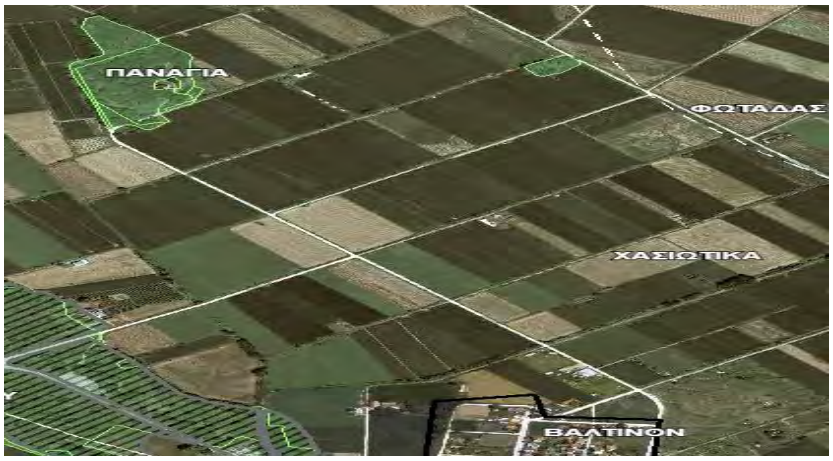
Goal 15, Life on land. By hosting a wide variety of flora and fauna, urban and peri-urban trees and forests can help restore the biodiversity crisis.

3. Methodology for Mapping and Utilization of *Panagia* Forest Works and Infrastructure in Valtino, Trikala.

3.1 Intended purpose and Recipients of the Exploitation of Works

The purpose of the research concerns the recording of works concerning fire protection, cultivation and the improvement of the infrastructure of recreational places in the *Panagia* Forest (Local Community of Valtino - Municipal Unit of Kallidendros) of the Municipality of Trikala (Picture 1), and its connection with the bicycle lane of the Municipality of Trikala. After the on-site visit and based on the needs, the following maintenance works are proposed in brief: i) path cleaning works, vegetation cleaning, cutting and removal of dry, malformed, double-headed trees, existing vegetation treatments, ii) installation of new seating (benches), iii) installation of waste bins, iv) fire

hydrant maintenance, v) installation of road signs, perimeter marking of forest boundaries (especially on the eastern side), vi) installation of bee and bird watering holes, installation of an insect hotel, installation of bird effigies with information signs, etc.



Picture 1. Excerpt of a certified Forestry map of the area studied. Source: National Cadastre Certified Forest Maps-Hellenic Cadastre, 2022.

Through our interventions on the aesthetic, recreational and environmental upgrading of the Forest of *Panagia* in Valtino Trikala, the residents of the Municipal Unit of Trikala, Kallidendros, Faloreia and Koziakas and the Municipal Unit of Pialia of the Municipality of Pyli can benefit mainly, due to their proximity.

3.2 Proposed Interventions

Concerning the Forest of *Panagia*, actions are being proposed that aim to strengthen its functions as a special habitat, one for species of flora and fauna, to protect the water balance of the area under consideration, to inform and raise environmental awareness among citizens, to strengthen touristic function and recreation of the natural resources, and to contribute to its fire protection, without its functions being violated as a Preserved Natural Monument.

3.2.1 Monitoring-Delimitation-Overpumping-Nitropollution

The natural resource can be highlighted and improved with corrective interventions when deemed necessary through a continuous monitoring process by the Municipality of Trikala through "smart city" applications. The resource must be self-sustaining and self-regulating by design. The local community of Valtinos actively supports of the Forest of *Panagia*, and this continuous activeness is essential. The demarcation and perimeter marking of the Forest, mainly on its eastern side, would limit clearing and encroachment to create areas for agricultural cultivation. It would minimize the 'pressure' on boundary trees (forest trees bordering properties), and prevent illegal logging and pruning due to the shading they cause on adjacent crops. Over-extraction affects the hydrological regime of the area, the amount of surface and groundwater, the fluctuation of the groundwater level with an impact on wetland vegetation, the creation of habitats and the support of food webs. Land improvement works give a significant boost to the economic development of acre yields as long as they are carried out through Local Land Improvement Organizations preferably, and not through private drilling as is the case in the area under consideration. The presence of increased concentrations of nitrogenous and phosphorous compounds (nitrite pollution) in surface waters, due to the

agricultural activities bordering the Forest of *Panagia*, is enhanced by the presence of solar radiation resulting in the development of aquatic vegetation and plant microorganisms in the water (phytoplankton) creating the phenomenon of eutrophication (Kougolos, 2007). However, the accumulation of nitrates also makes the water unsuitable for drinking in underground waters as well. Harmonization with the nitrate's pollution concentration limit in mg/l requires the regular review of the status of surface and groundwater.

3.2.2 Fire protection

The risk of fire could be reduced by the following preventive measures. Outdoor recreation sites must be defined in order to define the points of collection and disposal of garbage as well, which are often the causes of fire. The signs will inform visitors which activities and actions are permitted such as the burning of garbage and dry grass and branches in the summer months, using outdoor grills in the summer, throwing cigarettes, etc. The connection of the fire hydrant to the water supply network must be checked and maintained annually following the instructions of the Fire Service. It is proposed to open a path around the forest to provide multi-use accessibility. One of them is to act as a firewall. A forest monitoring system to detect and assess fires at an early stage could be implemented in the study area. Its implementation would be an extension of the SFEDA system, the multinational program that detects fires through optical systems and the use of drones (TCG, 2022).

3.2.3 Environmental Education- Emergence and Regeneration of the Forest

The location of the Forest of *Panagia* and its geographical features, since it is located in an area without large land slopes (0-10%), and with the condition of improving the existing infrastructure, it can become a pole of attraction for the development of gentle sightseeing, recreation and environmental education for students of every spectrum, even special schools. The students, in collaboration with their teachers and their chaperones, based on the needs of each group, can get to know the ecosystem of the area and perceive its value. Thus, understanding the factors and effects of the reduction of biodiversity due to human interventions would lead to propose ways to deal with the risks that threaten biodiversity. The Forest of *Panagia* can be transformed into a Theme Park of Flora and Fauna and provide the urban population with a wide range of recreational and educational services. Informative signs can be incorporated into the game of tree-watching and bird-watching, with important forest vegetation features and bird figurines.

The placement of bird and bee watering holes will enrich the Forest of *Panagia* with infrastructure and materials that are consistent with the character of the area and integrated into its natural environment, while enhancing the educational activities.

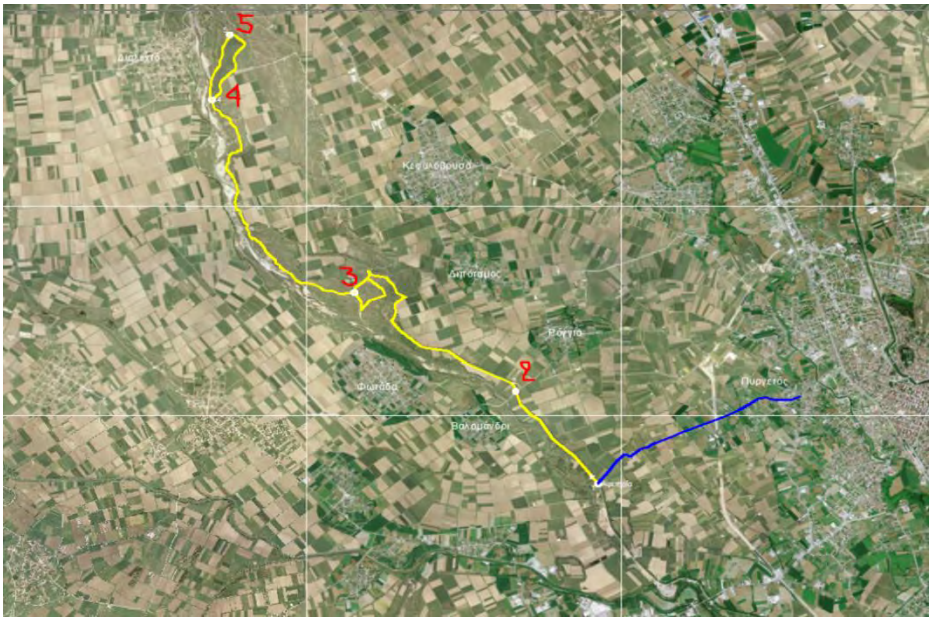
In order to give prominence to the area and regenerate it, it is deemed necessary to clean the understory in certain parts of the Forest, while the natural regeneration and evolution of the understory will be enhanced by minimizing windfall (thinning of the forest), and by cracking down on illegal logging for fuel material and stakes by taking forestry measures and removing trees that are scattered within the forest and are considered dangerous.

3.2.4 Peri-urban cycling route in the Forest

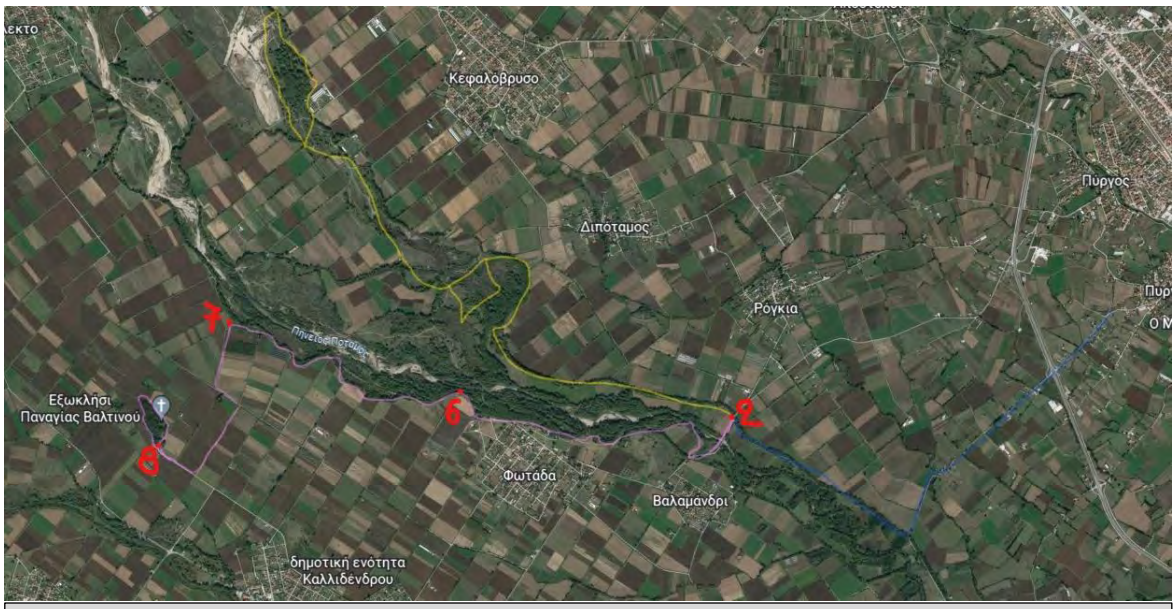
The combination of cycling, walking and public transport, supports the concept of sustainable mobility (Sdoukopoulos, et.al., 2017) and aims at the existence of sustainable freight transport and movements in the urban and peri-urban environment (BoozandCompany, 2012). The bicycle as a non-polluting means, with little space occupation, flexible and with little risk, finds its place in a larger public space due to the urban renewals that have developed in recent years (Jain 2009, Vlastos et al. 2007). The Forest of *Panagia* can be included in the strategic plan of the "smart city" of the

Municipality of Trikala, and specifically be an extension of the program "Periastic Cycling Route in the Municipal Units of Faloreia and Kallidendros of the Municipality of Trikala" (Picture 2). The lowland rural area of the Municipal Units of Kallidendros and Faloreia of the Municipality of Trikala, is not particularly developed for tourism, and the purpose of that work is to increase visitors and tourist traffic, without disturbing the rural landscape of the area.

The work includes a 12 kilometer cycling route that starts from Trikala and reaches the Dialechtos forest through the Fotada forest. The route specifically starts from the borders of Rogion and Pyrgenos and after 4 kilometers it reaches the Fotada forest. It moves for 2 kilometers outside the forest and after 6 kilometers it reaches the Dialechtos forest. The movement next to the banks of Pinios takes place on a 4-meter-wide embankment that has been shaped with the appropriate materials. For the cyclist's relaxation and recreation, there have been placed wooden seating areas and table seats in 4 places (2,3,4,5) as can be seen in the general topographical map that follows. This work can be expanded as mentioned above by incorporating the *Panagia* Forest into the peri-urban cycling route. Through this, additional opportunities are created for mild sports activities, outdoor recreation, environmental education and aesthetic upgrading, while all the natural beauty of the Forest is offered to cyclists, wooden seating and table seats in positions 6,7,8, installation of masts with solar panels for the lighting of the route and markings with informative signs at key points - stops (Picture 3,4).



Picture 2. General Topographical, Peri-urban Cycling Route in the Municipal Units of Faloreia and Kallidendros, with a kiosk of 2,3,4,5 seats. Source: Directorate of Technical Services of the Municipality of Trikala - Department of Studies, 2015, Authors' editing.



Picture 3. General Topography, New Peri-urban Cycling Route in the Municipal Units of Valamandri, Fotada and Valtino, with a kiosk of places 6,7,8. Authors' editing.

Picture 4. Design proposal of a peri-urban cycling route with a kiosk. Authors' editing.

3.2.5 Electric Bicycle charging station

With the approval of the Forestry Service, it is proposed to place an electric bicycle charger in the forecourt of the Church in the form of a sturdy post made of anodized aluminum that is driven into the ground (Picture 5). The electric bike charger will be able to have up to two sockets for

charging up to 22KW each. It will have built-in cables of 4 meters long each, it will be able to operate at low and high temperatures, it will be water and dust proof and shock/damage resistant and will have protection against leakage currents meeting all standards and regulations.

Picture 5. Design proposal for the placement of an electric bicycle charger and configuration of a bicycle parking area. Authors' editing.

4. Conclusions

The "smart city" contributes to the achievement of a quality of life, and urban and peri-urban greenery defines the "smart city" as "green". Embedded in the urban landscape, it leads the effort to bring balance between urban expansion and the natural environment, while forest design maximizes the efficiency of absorbing air pollution particles in cities.

The interventions in the Forest of *Panagia* utilize the ecosystem services in the urban population through coordination works. The Forest is upgraded, environmental education is strengthened, it becomes a pole of attraction, while the new peri-urban cycling route connects the city of Trikala and the surrounding areas with the Forest, enhancing sustainable mobility. The energy footprint is reduced by installing an electric bicycle charging station.

We conclude that the key to healthy and sustainable living is to strengthen the citizens' connection with the natural environment.

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Media and Environmental Information

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Abstract

The object of our work is the Environmental information and the Citizens' Media, instead of the "Mass Media". Let me modify the acronym, because in every other case we adopt, as individuals, the role of a unit that together with the rest is a mass, a role that is by no means honorable and worthy of research. Environmental information is emerging as an escalating need today more than ever. Rapid climate change, rising weather, normal weather events, floods, tsunamis, fires, rising sea levels, pollution, melting ice, global warming, greenhouse effects, dioxin addiction, eutrophication, Acid rain, smog are some of the phenomena and events that overwhelm us either in the form of news or experiential. Therefore, the catalytic role of the citizen's media is as means of awareness, reflection, protection, and mainly information. Because the properly informed citizen is also the one who can contribute to the alleviation of any problems. The purpose of the research is to examine, through indexing of publications of the electronic local press in the depth of three years, the factors, causes, and in general the parameters that influence the channelling of environmental information to the public in the appropriate way for the same subject matter.

Keywords: *Information, Electronic and print media, Environmental Awareness, Objectivity of Information, Public Opinion, Political Situation, Customer System*

JEL Codes: Q01, Q51, Q54, Q56

Public Awareness of Nature and the Environment During the COVID 19 Crisis

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Abstract
The health crisis during the outbreak of the disease COVID-19 became the beginning of the awareness ofthe behavior of the public towards nature and the management of the environment. The present survey ware investigated the relationship of the public with the environment and nature as well as the practical environmental awareness during the period of the COVID-19 crisis in Greece. The survey was conducted using a self-administered questionnaire, which was distributed in a convenience sample, to 222 citizens.The examined questions concerned the public's contact with nature and the awakening of environmental interest alongside practical environmental awareness during the pandemic period. The analysis of the data was done in three parts: a) the analysis of the demographic characteristics of the sample, b) the analysis of the impact of the COVID-19 pandemic on contact with nature, and c) environmental awakening and practical environmental awareness. The results were obtained by analyzing the data through Descriptive and Inductive Statistics, highlighting a stronger feeling of personal environmental responsibility through themanifestation of ecological behaviors for most of the sample. The research subject should in the futuretarget behavioural processes in sustainable contexts at the public level.

Keywords: *Awareness, Public, Nature, Environment, Pandemic, COVID-19, Health crisis.*

JEL Codes: C40, O44, Q01, Q51, Q54, Q56

The role of environmental knowledge and environmental values in citizens' beliefsand consumer behaviour citizens' beliefs and consumer behaviour

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Abstract

Without a doubt, climate change is the most central challenge that humanity will face in the rest of the 21st century. This problem has been highlighted for decades and we now seem to have entered the main phase of the crisis. In this context, it is imperative to take action to address climate change. The objective of the present survey was to explore the relationship between environmentally friendly consumption choices with environmental values and environmental knowledge. To examine these relationships, three relevant self- report questionnaires were administered. The measurements were carried out on a sample of 120 participants from the general population. A positive and statistically significant association between environmental knowledge and pro-environmental consumption choices was found in this study. Therefore, the higher the relevant knowledge, the higher the relevant choices. In contrast, no statistically significant correlation was found between environmental values and pro-environmental consumption choices. The concluding proposition of this research is to further enhance knowledge of environmental and climate change issues in impact the related consumer behaviour.

Keywords: *Consumer behaviour; climate change; environment; environmental knowledge;environmental values*

JEL Codes: Q01, Q51, Q54, Q56

Investigation of environmental literacy in a sample of primary school teachers

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Abstract

Core aim of Education for Sustainable Development is to foster pro-environmental behavior among students. Teachers are mainly responsible for promoting environmental attitudes, and they must have the necessary to qualifications support their students to adopt a more sustainable lifestyle. The purpose of this work is to study the multiple dimensions of environmental literacy and their interrelationships in a sample of primary school teachers. A total of 200 teachers completed an online questionnaire. Data analyses included Exploratory Factor Analysis and Multiple Linear Regression. The main findings suggest that teachers were moderately environmentally literate. Finally, it was shown that environmental behavior can predict environmental skills of teachers. These results may underpin the efforts of the Pedagogical Departments of Universities to substantially cultivate environmental literacy in their students, who will be called upon in the future to pass on these ideals to the student population.

Keywords: *Environmental literacy; environmental behavior; environmental skills; causal relationships; primary school teachers.*

JEL Codes: I20; C31; Q54.

1. Introduction

Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability IPCC (2022). Coping with climate change requires broad behavioral change and cultivating an informed global citizenry (Radzi et al., 2022). Education for sustainable development (ESD) is crucial to promote climate action and a critical agent in addressing the issue of climate change. It aims to address the impacts of the climate crisis by empowering future generations with the knowledge, skills, values, and attitudes needed to act as agents of change.

Teachers play a key role in imparting ESD and global citizenship, and thus it is highly important to have the necessary to qualifications, motivations, and skills to teach sustainability issues effectively, and instill in students the knowledge, competencies, values, and attitudes that will enable them to address global challenges and forge sustainable living through individual and collective action at local and global levels (UNESCO, 2021).

In Greece, the studies on environmental literacy of teachers are particularly few. In addition, the present study fills an important research gap, as environmental skills of the educational community have never been assessed. Finally, in the international literature, all five dimensions of teachers' environmental literacy have never been investigated concurrently, a gap that this work aims to fill.

The rest of the paper is structured as follows: Section 2 includes the literature review, section 3 contains the methods of the study, section 4 presents the main results, and section 5 includes discussion of the findings.

2. Literature Review

The concept of environmental literacy has been introduced by Roth (1968). According to Hollweg et al. (2011), environmental literacy is defined as the outcome of interplaying cognitive, affective, and behavioral components and as a continuum of developmental capacities.

The acquisition of environmental literacy is considered the primary and most important goal set by the curricula of Environmental Education (Duerden & Witt, 2010). Teachers are mainly responsible for promoting environmental attitudes, and they must have the necessary qualifications to lead their students and achieve a broader societal shift towards sustainability (Esa, 2010). The existence of environmentally literate teachers in schools maximizes the chances of creating environmentally literate students, as well as future citizens (Tuncer et al., 2009). More recently, research focuses on climate literacy which is viewed as an intersection of climate science and environmental education approaches and strategies (Radzi et al., 2022).

Environmental literacy has been conceptualized in five basic dimensions (Maurer & Bogner, 2020). The first dimension is environmental knowledge, which, according to Otto and Pensini (2017) is defined as an "intellectual prerequisite to performing ecological behavior". Environmental attitudes, the second dimension, are defined as "a psychological tendency expressed by evaluating the natural environment with some degree of favor or disfavor" (Milfont, 2007). The third dimension, values, represents general goals that people strive for in life, and specifically environmental values represent egoistic, altruistic, and biospheric orientations (De Groot and Steg, 2007, Bouman et al.,

2018). Environmental behavior, the fourth dimension, is described as "any behavior intended by the individual to have a positive impact on the environment" (Alisat & Riemer, 2015). Two broad types of behavior are observed, personal practices and civic actions (Gkargkavouzi et al. 2019a,b). Last, environmental skills illustrate the process of evaluating issues and problems related to the environment, based on personal values and evidence available from the individual (Glomo-Narzoles, 2013).

Many studies have turned their interest to how individual dimensions of environmental literacy are related. However, findings are often considered to be contradictory. According to Sahin et al. (2020), environmental knowledge was significantly correlated to individual behavior, while results from Liu et al. (2015) did not provide support for this relationship. They also concluded that the relationship between attitudes and behavior in the private, as well as the public sphere, was significant. In addition, Esa (2010) reported a high correlation between environmental knowledge and attitudes, but low correlation between these two dimensions regarding the adoption of pro-environmental behavior. Alkaher and Goldman (2017) found positive relationships between environmental knowledge, attitudes, and behaviors.

Karpudewan et al. (2011) identified a positive interrelationship between environmental values and behavior. Sahin et al. (2020) concluded that environmental values predicted pro-environmental behavior. Additionally, according to the same researchers, environmental knowledge was directly related to the dimension of environmental values. Liu et al. (2015), also found a strong relationship between environmental skills and behavior, a conclusion that was also reached by Cheng and So (2015). Nayan et al. (2020) confirmed that environmental skills are correlated to environmental behavior.

The main purpose of this study is to investigate the dimensions of environmental literacy in a sample of primary school teachers. Secondary objectives are i. to explore the correlations among dimensions of environmental literacy, and ii. investigate the predictive power of different types of Environmental Behavior on environmental skills.

3. Methods and Data

3.1. Sample & data collection

A total of 200 teachers completed an online questionnaire distributed via the internet (Google Forms) from September to October 2021, applying snowball sampling (Etikan et al., 2016).

3.2. Measures

The questionnaire consisted of eight scales derived from previous research (i.e. Liobikienė & Poškus, 2019; Gu et al., 2020; Carmona et al., 2021; Vuong et al., 2021). To investigate environmental knowledge, the "Action-related environmental knowledge" scale by Frick et al. (2004) (5 items; 4-point Likert scale) was adopted. Environmental attitudes were measured via the "Environmental Attitudes Inventory" by Milfont et al. (2010) (24 items; 7-point Likert scale) and the "New Ecological Paradigm" by Dunlap et al. (2000) (15 items; 5-point Likert scale). Measures of Environmental values included the "Two Major Environmental Value" by Bogner and Wiseman (2006) (21 items; 5-point Likert scale) and the "Portrait Value Questionnaire" by Bouman et al. (2018) (17 items; 7-point Likert scale). Two scales were used to assess environmental behavior, the "Private-sphere Pro-Environmental Behavior" by Tam and Chan (2017) (6 items; 4-point Likert scale) and the "Environmental Action Scale" by Alisat and Riemer (2015) (18 items; 5-point Likert scale).

Environmental skills were investigated through the "Competences in Sustainable Development Teaching" scale, adopted by Filho et al. (2020) (52 items; 5-point Likert scale).

3.3. Data analysis method

For data analysis, the SPSS software version 26.0 was used. Data screening involved the detection of missing values and potential univariate outliers based on standardized scores (z values), while we assessed normality through skewness and kurtosis values (Field, 2013). Also, negatively worded items were reversed before data analysis.

Following previous research on the field (Bogner et al, 2015; Andrade et al, 2021), Exploratory Factor Analysis (EFA) with Principal Axis Factoring (PAF) and Oblimin rotation was applied to uncover the underlying factor structure of the constructs. Additionally, we calculated the sampling adequacy index (KMO) (Kaiser, 1974), Bartlett's test of sphericity (Norusis, 2011), corresponding eigenvalues (>1; Sharma, 1996), total variance, and internal consistency of the factors using Cronbach's alpha (Fabrigar & Wegener, 2012). New variables resulted from the extracted factors based on the mean scores method and then tested for normality using the Kolmogorov–Smirnov test.

Finally, multiple linear regression analysis was conducted to estimate the effects of different types of environmental behavior on specific environmental skills. Before performing the analysis, we assessed underlying assumptions: i. residuals must be normally distributed (Normal P-P Plot), ii. data should have homoscedasticity (standardized residual plots against the unstandardized predicted values), iii. linear relationships (partial regression plots), iv. absence of multicollinearity (Variance Inflation Factor (VIF) & Tolerance index).

4. Empirical Results

All items were normally distributed, as all skewness and kurtosis values fell within the range of |2|, while inspection of z scores (< 3.29) suggested the absence of univariate outliers Field, 2013). A moderate level of environmental knowledge (M = 2.86, SD = .72), positive environmental attitudes (M = 4.93, SD = 1.35 on the 7-point scale and M = 3.79, SD = .91 on the 5-point scale), and a relatively high level of environmental skills (M = 3.89, SD = .95) were indicated. Also, a moderate level of private behavior (M = 2.75, SD = .87) and a very low level of public behavior (M = 1.18, SD = 1.14) were detected, while environmental appreciation values (M = 3.64, SD = .96), biospheric values (M = 5.93, SD = 1) and egoistic values (M = 4.40, SD = 1.56) were found to be enhanced. The Spearman rho correlation coefficients indicated that environmental knowledge is significantly correlated to private behavior (rho =.18; $p < .05$), while participatory behavior is significantly correlated to environmental attitudes (rho = .36; $p < .05$). Moreover, environmental skills are significantly correlated with private behavior (rho = .61; $p < .01$). Additionally, environmental appreciation values are significantly correlated to all three types of environmental behavior (rho = .48; $p < .05$), as are biospheric values (rho = .37; $p < .05$). Finally, egoistic values demonstrate a significant correlation only with private behavior (rho = .30; $p < .01$) and leadership behavior (rho = .18; $p < .05$). Table 1 shows the sociodemographic profile of responders.

Table 7. Sociodemographic profile of participants.

Sample profile (n=200)				
Variables	n	%	SD	Mean
Sex				
Women	145	72.5		
Men	55	27.5		
Age	200	100	10.36	36.41
Marital Status				
Married	95	47.5		
Unmarried	93	46.5		
Other	12	6		
Years of Service	200	100	9.53	9.49
Personal Income/ month (€)	155	100	278.31	946.45

Note. Elementary School teachers = 147 (73.5%), Kindergarten teachers = 30 (15%); Level of education: University

For the environmental skills scale "Competences in Sustainable Development Teaching", five factors were extracted accounting for 66.22% of total variance: Learning to know and be, Learning to be, Learning to know – Cognitive background, Learning to do, and Learning to live together. EFA for the public sphere environmental behavior scale, "Environmental Action Scale", resulted in two factors, "Leadership behavior" and "Participatory behavior", explaining 58.72% of total variance. Results from Factor Analysis, including Bartlett's test of sphericity K.M.O., communalities, and factor loadings are shown in Table 2. Cronbach's alpha values for all factors ranged from 0.75 to .91 and advocated for internal consistency (Table 2).

Table 8. Exploratory Factor Analysis Results.

Factors	Items	Mean (SD)	Loadings	η^2	Eigenvalues	Cronbach's alpha
Learning to know and be	Problem-solving method	4.12 (.74)	.43	.39	9.72	.91
	Experiential learning	4.01 (.93)	.47	.58		
	Promoting student autonomy	3.86 (.99)	.64	.62		
	Testing new learner-centered strategies	4.06 (.77)	.53	.54		
	Preparing for challenges of the future	3.77 (1.24)	.65	.70		
	Improving other people's lives locally	3.65 (1.03)	.62	.74		
	Improving other people's lives globally	3.53 (1.18)	.67	.73		

	Challenging unsustainable practices	3.39 (1.25)	.61	.53		
Learning to be	Positive relationships with students	4.62 (.53)	.61	.48	2.36	.77
	Receptive to the feelings of others	4.30 (.73)	.68	.59		
	Promoting collaborative relationships	4.50 (.59)	.77	.65		
Learning to know – Cognitive background	Ecological issues	3.96 (.75)	.54	.39	2.07	.75
	Imposing growth limits	3.90 (.86)	.85	.68		
	Excessive consumption and poverty	3.88 (.94)	.64	.47		
	Development based on scientific evidence	3.81 (.93)	.43	.23		
	Conceptual change of sustainable development	3.83 (.82)	.46	.34		
Learning to do	Impact assessment	3.68 (1.14)	.53	.72	1.34	.90
	Anticipation prevention	4.30 (.73)	.46	.50		
	Different perspectives on teaching topics	3.89 (1.10)	.57	.58		
	Responsible change factor	3.59 (1.20)	.61	.75		
	Actual events as learning contexts	3.98 (1.01)	.55	.58		
	Responding to changes	4.02 (.95)	.57	.55		
	Utilization of past experiences	3.95 (1.12)	.74	.67		
Learning to live together	Cooperation with other classes	4.27 (.67)	.86	.78	1.06	.87
	Cooperation with other people at school	4.19 (.79)	.88	.83		
Bartlett's test of sphericity $\chi^2 - 2998.65$; df – 300; p – .00; K.M.O – .90; 58.45% total variance						
Leadership behavior	Organization of educational activity	.82 (1.14)	.54	.31	5.27	.91
	Using traditional methods	.95 (1.17)	.62	.40		
	Letter to a political dignitary	.48 (.90)	.81	.68		
	Organizing a demonstration	.37 (.82)	.91	.80		
	Organizing a boycott	.43 (.88)	.92	.82		
	Organization of resolution	.44 (.90)	.92	.83		
	Organizing a local environmental event	.54 (1.02)	.86	.74		
Participatory behavior	Search for information about the environment	2.30 (1.13)	.62	.42	2	.76
	Discussion of environmental problems	2.81 (.96)	.77	.58		
	Financial support of an environmental cause	1.64 (1.41)	.55	.41		
	Participation in the protection of nature	1.77 (1.46)	.58	.48		
Bartlett's test of sphericity $\chi^2 - 1442.34$; df – 55; p – .00; K.M.O – .86; 58.72% total variance						

Note. η^2 values represent items' communalities.

Concerning the multivariate regression assumptions, homoscedasticity and linearity were established, while the regression residuals were normally distributed as shown in Figure 1. VIF (<5) and tolerance values (.77 to .89) confirmed the absence of multicollinearity issues.

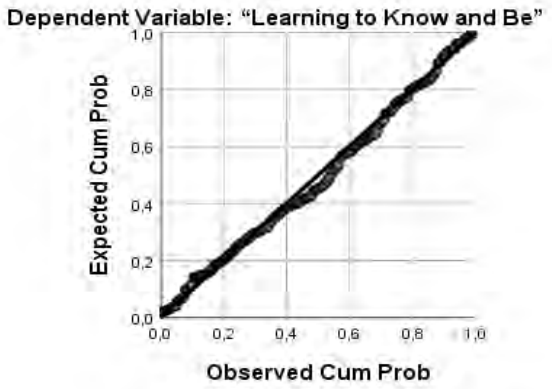

Fig. 1. Normal P-P plot of regression standardized residuals.

Multiple Regression results indicated that Environmental Behavior significantly predicted environmental skills. Specifically, "Pro-Environmental Behavior" significantly predicted the (β = .59, $p < .01$), as did "Leadership Behavior" (β = .18, $p < .01$), and "Participatory behavior" (β = -.30, $p < .01$) significantly predicted environmental skill "Learning to Know and Be". The three outcome variables explained 50% of the variance ($R^2 = .50$, (F (4, 192) = 47.93, $p < .001$).

Table 9. Model coefficients. Regression coefficients for predicting environmental skill "Learning to Know and Be". All standardized coefficients are significant at p = .05 level.

	Unstandardized Coefficients		Standardized Coefficients		
	B	Confidence interval 95%	Beta	t	p
Private-sphere Pro-Environmental Behavior	0.74	[0.60,0.88]	0.59	10.55	0.000
Environmental Leadership Behavior	0.18	[0.06,0.30]	0.18	3.06	0.003
Participatory Environmental Behavior	-0.25	[-0.34,-0.16]	-0.30	-5.50	0.000

Note. R^2adj = 0.49 (N = 197, $p = 0.000$).

5. Conclusions

The results suggest that teachers have a moderate level of environmental knowledge (Liu et al., 2015), hold positive environmental attitudes (Cobar-Garcia & Garcia, 2019), and have relatively high levels of environmental skills (Alvarez-Garcia et al., 2018). Moreover, they perform pro-environmental behaviors in their daily lives but rarely engage in public sphere actions (Tibola da Rocha et al., 2020). Teachers also showed enhanced environmental values (Oerke & Bogner, 2010). The research confirms that environmental literacy dimensions are related to each other in various ways. Specifically, environmental knowledge is linked to the adoption of private sphere behaviors

(Cobar-Garcia & Garcia, 2019), and participatory behavior is associated with environmental attitudes (Tibola da Rocha et al., 2020). Environmental values and environmental skills are related to environmental behavior, as well as egoistic values to private and leadership behaviors (Sahin et al., 2020). Additionally, environmental behavior is a significant predictor of environmental learning skills, a finding which is also supported by other researchers (Hsu & Roth, 1999; Liu et al., 2015). Finally, teachers who demonstrate a high level of environmental behavior in the private sphere, as well as in the public sphere through leadership actions, tend to be more capable of "Learning to Know and Be". On the contrary, participatory behavior negatively affected environmental learning skills.

5.1. Strengths and possible implications

In Greece, previous studies on environmental literacy of citizens are scarce, and even fewer focus on primary education teachers. Considering climate change adaptation emergency and the call for more effective ESD (UNESCO, 2021), the present work provides further evidence on the critical issue of teachers' environmental literacy. In addition, this study covers an important research gap, as environmental skills of the educational community have never been studied.

The findings of the present study can support the efforts of the Pedagogical Departments of Universities, so that they in turn focus on enhancing environmental literacy of future teachers through climate-oriented training programs, as they will be called upon to transmit sustainability ideals to the student population during the immediate future.

5.2. Limitations and future research

Regarding the limitations arising from the present research, we must point out the use of non-probability convenience sampling. Therefore, the conclusions cannot be generalized to the corresponding population. In addition, the survey relied on a self-administered questionnaire for data collection, and social desirability bias may have influenced teachers' responses.

Finally, future research should further investigate teachers' environmental literacy and explore causal relationships between the corresponding dimensions, while the implementation of the present research in other sociocultural contexts is recommended.

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Citizen Science and its use in Environmental Education/ Education for Sustainability

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Abstract

The question "progress and development at any cost?" is answered by Environmental and Economical Policy which deals with the study of the interaction of the economy and the natural environment. The basic parameter is the optimal use of natural resources of the environment, which, if well managed, will not be diminished. Nature will not be burdened by any human activity and the future of the area that hosts us will not be in danger. Unfortunately, the absence of the adjective 'excellent' and its meaning haw the exact opposite effect: natural resources are diminishing, the environment is deteriorating, the planet is unable to cope and is seeking … allies.". Citizen Science attempts to give the planet the allies it needs. After all, its rapid growth shows that the planet's communication with its inhabitants, especially the younger generation has been... restored. Every citizen should take action, become a researcher, observe and record the changes around him/her. Once a citizen changes his or her behavior, he/she becomes environmentally conscious.The first step in protecting the planet has already been taken.

Keywords: *Citizen science; school-classroom, Greece/European Union/USA; environment, environmental policy, environmental movement.*

JEL Codes: Q3; Q30; Q31; Q35; Q36 Q39 O13; O44; F64.

Session 6
Environmental Performance

Innovation, Productive Performance and Undesirable Outputs across EuropeanRegions: Are there any missing links?

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127

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Abstract

Technological innovation has become a main driver of economic growth and plays an important role in regional development. It has also been recognized as an efficient way of addressing environmental problems. The present paper introduces an analytical methodological framework that links the efficiency of knowledge generation with the efficiency of economic activities and their environmental impact for 199 European regions in period 2000-2018, using a chain DDF approach. The results indicate a definite relationship between knowledge generation efficiency and productive performance while the overall efficiency is mainly driven by innovation activities. Therefore, European regions that exhibit high innovation efficiency exhibit higher overall performance. Moreover, the examination of convergence dynamics discloses high complexity patterns for both knowledge generation and production process and hence a steady state convergence is not confirmed.

Keywords: *Regional Innovation; Environment; Undesirable outputs; Convergence; Two-stageDDF*

JEL Codes: O13; O30; O44; Q55; C44

European firms' productivity growth and environmental regulation. Re-examining thePorter Hypothesis

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128

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Abstract

The current energy crisis offsets governments' efforts to achieve carbon neutrality removing significant degrees of freedom in terms of firm's competitiveness and put significant pressure on European industries regarding their environmental performance and productivity growth. We use a detailed dataset derived from the European Pollutant Releases and Transfer Register (E-PRTR), consisting of 1610 European firms belonging to various industrial sectors in order to compute environmental productivity and its components and how it is affected from various economic indexes. We focus on three available pollutant groups (Greenhouse gases, heavy metals and other gases) for the period 2011-2017 and compute the regulatory costs of each firm based on comparison between an unregulated and a regulated scenario that holds as policy implementation. We also reveal the Total Factor Productivity (TFP) and its components having considered the existence of emissions using a meta-technology regime. Our results point out that industrial environmental productivity on average has deteriorated across Europe with best practice change being the main contributor. Moreover, the empirical evidence, robust to different specifications and estimation methods, supports the presence of win–win opportunities.

Keywords: *Carbon emissions; decomposition analysis; growth; energy; European Union;Porter's Hypothesis.*

JEL Codes: O44; O47; O52; Q43; Q56.

Environmental performance – Economic performance nexus in LCDs Agriculture; An Empirical Study

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Abstract

The environmental performance of agriculture has allured scientific interest within the last decade. That is because agriculture is a major source of environmental degradation. The carbon emissions of different activities in agriculture have become a novel strand of literature in terms of empirical studies through different econometric techniques. The present work focuses on least developed countries (LCDs}. Giventhat the LDCs are primarily agricultural economies with nearly 70% of the population engaged in agriculture these activities constitute the major source of income while food security alleviation is a requirement in those countries. With the assistance of three different methodologies namely FMOLS, DOLS, and ARDL/PMG models we tried to quantify the association of environmental degradation caused by energy, fertilizers, and enteric fermentation with per capita income with value-added generated by agriculture to be used as a proxy. Different results were derived by different estimation models. For the short-term coefficients and more specifically for the case of carbon emissions generated by the energy the impact on agricultural income seems to be decreasing with a diminishing trend validating the little effort made by farmers to limit carbon emissions along with the limited efficacy of the implementing policy. As far as pesticide use is concerned seems to be affected by energy use and more specifically renewable energy adoption in LCD agriculture can mitigate the effect of pesticide use on GHG emissions. Last but not leastthe achievement of sustainable development goals s limited.

Keywords: *Energy fertilizers, Kuznets, livestock, Energy, Least Developed Countries, DOLS, FMOLS*

JEL Codes: O44; O47; Q4; Q18; Q56.

A causal model of climate-induced psychological resilience

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Abstract

This study presents a causal model of psychological resilience to climate change that incorporates several intrapersonal constructs, including coping strategies, eco-emotions, well-being dimensions, mindfulness, self-efficacy, and perceived restorativeness of nature. Online- questionnaires were administered in a cross- sectional survey of Greek residents. Structural Equation Modeling (SEM) was used to test the proposed conceptual model. Data analysis also included tests for common method bias (CMB) using the Common Latent Factor (CLF) technique, and evaluation of reliability and construct validity indices. The findings showed an adequate overall fit for the measurement and structural models, while all latent variablesestablished reliability and construct validity. The results suggest that dispositional mindfulness and self- efficacy beliefs positively affect climate – induced resilience, but perceived restorativeness has a non- significant influence on resilience. Perceived climate resilience has a significant positive influence on coping appraisals, life satisfaction and positive affects, but a negative impact on eco-emotions. Future research is essential to further investigate the strength and direction of the proposed psychological model of climate resilience. The study provides useful insights to policymakers for the design and implementation of informed interventions and programs aimed to increase psychological resilience, improve well-being, and eventually support climate crisis battle.

Keywords: *Climate Change, Psychological Resilience, Mindfulness, Eco-emotions, StructuralEquation Modeling.*

JEL Codes: A14; C38; Q00; Q51; Q56; Q59.

Environmental, Social and corporate Governance (ESG) factors in Healthcare Systems, in terms of Sustainable Finance

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Abstract

Sustainable development is considered to be a main strategic issue for the entire business world, including the Healthcare sector. In addition, the concept of Sustainable Finance and the Environmental, Social and corporate Governance (ESG) factors is directly related to the theory of Sustainable Development Goals.This paper aims to present the current situation of the ESG factors in Healthcare Systems and the connection as well as the correlation with Sustainable Finance. More specific, ESG factors that concern healthcare sector with the respective proposed evaluation tools, are categorized and presented. Suggested key points and factors are demonstrated for the development of a model tool for the classification, evaluation, presentation and communication of the results of ESG factors, oriented to the particularities of Health Systems and the various stakeholders. Finally, a specialized methodology for the holistic approachto ESG is presented in conjunction with the specific actions for implementation, monitoring, measurement, evaluation and benchmarking in order to achieve a Sustainable Healthcare System.

Keywords: *Sustainable Development, ESG factors; Sustainable finance in healthcare; CorporateGovernance*

JEL Codes: Q01; I18; G30

Session 7
Corporate Social Responsibility

Corporate Social Responsibility Reporting and Health & Safety Strategiesin the UK construction sector

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133

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Abstract

Constructions are among industries with high- risk for employees and severe working conditions, which in turn are addressed through a series of Occupational Health and Safety (OHS) accidents and work-related ill- health incidents. Managing and moderating such workplace risks in the construction industry is a top priority every day. As a result, because of the nature of their activities, the number of constructions that adopt with OHS tools or strategies are increasing. Further, the continuous rising focus on OHS topics, isalso supported by the quantity and the quality of information disclosed in many CSR reports. Taking into account the poor safety record of the construction industry, this paper aims to assess the disclosure behavior regarding OHS issues by extracting information from CSR reports of UK construction companies. Abenchmarking technique was designed by using the Global Reporting Initiative (GRI) Standards guidelines to detect and assess the OHS information in CSR Reports. Findings show that the sample demonstrate quite poor performance in relation to OHS issues.

Keywords: *OHS disclosures, sustainability; compliance; accountability; construction*

JEL Codes: J81; J89; Q01; M14.

Climate change and its effects in public health

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Abstract

One of the key variables of the environment is climate which affects our decisions, the food we eat, the air we breath and our all aspects of our health. The chaos theory dictates that non-linear dynamic systems are sensitive to even small changes in the initial conditions. One such system is climate; the current way of life results in changes leading to extreme weather events, a rise in the global temperatures, a reduction in air and water quality and overall degradation of the environment. This research aims to examine these directand indirect impacts and attempts to identity the dependence of public health on climate change. If changes in the way of our life are changing climate the focus should be on changing back some habits. There is evidence that societies most affected by climate change are those least responsible.

Keywords: *Climate Change; Public Health; Dependent Indexes; Raise of Temperature*

JEL Κωδικοί: Q01, Q54, I18, M14

The hotel business through the prism of sustainable development: Initial results of theprogram GREEN INNOVATIVE VALUE SERVICES (G.I.V.S)

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Abstract

The hotel industry can significantly contribute to economic, social and environmental goals. The sector makes a particularly significant contribution to economic development, employment and investment in Greece. It produces a stream of revenue some of which is reinvested in infrastructure and facilities used by visitors and inhabitants alike which in turn promotes the quality of touristic services in Greece. The PRAKSIS project, funded by the Regional Operational Program of Central Macedonia 2014-2020, promotes the benefits available fr om the adoption of Sustainable Development in the hotel sector. The aim of the project is to support entrepreneurship in the sector based on green strategies, sustainable tourist products and effective safeguarding of the sector from a variety of risks. The objectives are to provide circular economy strategies in the hotel industry and the development of a risk digital application. The initial results of the project are very promising with significant improvements in waste management andthe implementation of strategies towards a circular economy model in the hotel industry.

Keywords: *Sustainable Tourism; Circular Economy; Green Hotel;zero waste, zero emissions*

JEL Codes: Q01, Q54, M14, Q53

Corporate Social Responsibility and Disability at Work: Evaluating Sustainability Reporting in Great Britain and Germany

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Abstract

People with disability are considered the largest minority in the world and face challenges in the workplace. Research on how disability considerations are integrated in Corporate Social Responsibility (CSR) strategies is very recent and rather limited. This research aims to explore how disability issues in the workplace are dealt with through CSR strategies in the UK and Germany. All 338 CSR reports available in the GRI database for UK and German companies with a reference year of 2018 were evaluated through content analysis on the basis of selected indexes. Results demonstrate that most of the reports from both countries made references to disability. However, there were significant differences both in relation to the type of disability referred to (primarily mental health issues in Great Britain and significant disability in Germany) and also in relation to the indexes focused on (commitment to non-discrimination and reasonable adjustments in the UK and number of employees with disability and participation of disabled employees in managerial positions in Germany.) These results highlight that CSR reporting is in line with the command and control requirements in each of the countries and confirm prior research that legislative requirements formulate CSR strategies for disability in the workplace.

Keywords: *Corporate Social Responsibility; CSR reporting and disability*

JEL Codes: Q01, I18, M14

Factors influencing recycling intention for mobile phones:Evidence from Greece

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Abstract

Improper management of waste electrical and electronic equipment (WEEE) entails serious risks for the environment and human health, while the constantly growing production of new electronic devices increases the demand for raw materials, making WEEE recycling imperative. The present study, recognizing the role played by the users, attempts to determine the habits of the Greek public in relation to the consumption and disposal of WEEE through the example of mobile phones. Furthermore, using the theoretical framework of the Theory of Planned Behavior (TPB), it seeks to understand the main factors thatdetermine mobile phones recycling intention. Through the analysis of a sample of 361 people, data are presented on the number of mobile phones used per person, the average time and the reasons of replacement, as well as on how mobile phones are disposed of at the end of their life cycle. Individuals' attitude towards recycling, their subjective norms and their perceived behavioral control have a positive effect on the intention to recycle, while among these three factors, the effect of subjective norms appears to be the least strong. The results demonstrate the need of appropriate measures in order to strengthen the recycling of e-waste and achieve the goals that have been set at European level.

Keywords: *E-waste recycling; mobile phones; Theory of Planned Behavior (TPB), Greece.*

JEL Codes: D19; Q01; Q53; Q59.

Antecedents and consequences of consumer satisfaction for bio-based products: Preliminary findings from Greece using structural equation modelling

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Abstract
This study investigates structural linkages of perceived product quality, value, price, innovation, quality, risk, brand image, marketing awareness and labelling on customer satisfaction and loyalty towards bio- based products usage. The study employs the structural equation modelling technique for data analysis across a sample of 100 Greek consumers and in terms of three products: (i) bio-based interior wall paint/colour, (ii) bio-based household cleaning detergent and (iii) a kitchen chair/furniture made from biocomposite (wood fibres). The analysis reveals that consumers' perceived product value followed by perceived quality affected customer satisfaction derived from all three bio-based products. Moreover, in all three sub-studies consumer (green) satisfaction has a significant positive association with customer loyalty (i.e. repeated repurchase intention of the product). The study demonstrates the importance of key antecedents in shaping consumer satisfaction and inducing repurchase likelihood (loyalty). It provide insights for effective marketing strategies that widen domestic marketers' understanding of consumer behaviour toward bio-based products with regard to their satisfaction and loyalty levels. Based on the SEM results, we offer academic contributions to the existing body of knowledge of consumer (green) behaviour with regard to potential structural linkages describing bio-based product usage in Greece.

Keywords: *Bio-based products, consumer satisfaction, customer loyalty, structural equationmodelling, Greece.*

JEL Codes: D19; Q01; Q57; Q59.

1. Introduction

Since the 1990s the concept of consumer satisfaction, the pleasurable degree of consumption-related fulfillment (Oliver, 1996; Paulssen & Birk, 2007), has a profound impact on management thinking and has emerged as a critical source of competitive advantages within a highly competitive market of fast-moving consumer goods and durables. Through a better understanding of how to meet and anticipate consumer expectations and needs companies refine their priority-setting processes and redefine existing practices and production plans. To this regard, numerous national and sector-specific consumer satisfaction indicators have been devised (e.g. Fornell, 1992; Fornell et al., 1996; Andreassen & Lindestad, 1998; Martensen et al., 2000; O'Loughlin & Coenders, 2004). Such indices pertain to structural models of cause-and-effect relationships between parameters affecting consumer satisfaction and the desired outcomes-results of obtaining it, i.e. customer loyalty in terms of repurchasing and/or recommending the product to others. According to Fornell, (1992), such models are "*expected to be an important complement to traditional measures of economic performance, providing useful information not only to the firms themselves, but also to shareholders and investors, government regulators, and buyers*" (p.6). This realization of their importance has led to a proliferation of related market(ing) research endeavours and for satisfaction to emerge as an essential aspect of for-profit activities. Relevant studies offer fruitful as well as actionable insights about consumer needs, shed light on factors that drive satisfaction, facilitate benchmarking and give room to simulation modelling.

Literature suggests that antecedents of customer satisfaction can be perceived value, perceived quality, brand image and marketing awareness. Perceived value signifies an overall evaluation that consumers make for a product in terms of their gains and the amount they paid for (Zeithaml, 1988). Perceived quality (consumers' subjective judgement on the superiority-reliability of a product - Zeithaml, 1988), perceived price (an overall feeling that consumers have about the selling price of a product - Bruce and Abhijit 2002), perceived risk (uncertainty consumer may have on the outcomes of a certain purchase - Lim, 2003), perceived innovation (technological novelties describing a product and/or its manufacturing processes) along with product labelling (information disclosed by the producer on the product's label – Amacher et al., 2004) have been found to shape perceived value (Tam, 2004; Tsai et al., 2010). Likewise, brand image (a set of consumer perceptions about a brand name reflected through associations they get from a company - Andreassen and Lindestad, 1998; Russo Spena et al., 2012; Millar et al., 2012) and marketing awareness (companies' marketing messages to convey the high efficiency and extra benefits of products - Zhu and Sarkis, 2016) have been identified as predictors of both satisfaction and loyalty (Martensen et al., 2000; Grigoroudis and Siskos, 2003; Chang & Tu, 2005; Martenson, 2007; Chang & Fong, 2010). Marketing awareness is reported to decrease perceived risk, while, together with perceived innovation, have been found have a positive effect on perceived price (Kotler & Armstrong, 2008; Leonidou et al., 2012). Several studies also suggest a strong influence of consumer satisfaction on consumer loyalty (Chang & Fong 2010; Tee et al. 2012; Norazah, 2013).

The emergence of eco-friendly, 'green', products gave room to models assessing consumers' satisfaction for products of this segment. Chen (2010) defines 'green satisfaction' as "*a pleasurable level of consumption-related fulfilment to satisfy a customer's environmental desires, sustainable expectations, and green needs*" (p.309). Employing such analytical lenses firms can improve the

performance of eco-friendly they produce, increase customers' (green) satisfaction and, ultimately, boost sales (Chen and Chang, 2013). In this study we examine consumer satisfaction for three bio-based products: (i) interior wall paint, (ii) household cleaning detergent and (iii) kitchen chair/furniture. Products characterized as bio-based are derived from renewable biomass materials, i.e., plants, trees, or animals and our research motivation stems from the fact that the bio-based industry is one of the fastest-growing sectors (Grand View Research, 2022). The European Commission invested €3.8 billion during 2014–2020 in endorsing bio-based industrial processes and related innovation systems (European Commission, 2013). While their actual environmental footprint and impact remains a much-debated issue (Hottle et al., 2013; Bachmann et al., 2022), the attributes of bio-based products are continuously improving and considerable growth is expected over the following decade (European Commission, 2022). Despite the increased interest in the use of bio-based materials, ingredients, and/or additives, no study has, so far, focused on the (expected) consumer satisfaction in relation to such products. Our knowledge of what may explain consumer satisfaction for such products and whether it may lead to loyalty patterns remains sparse and this is where the following analysis seeks to contribute.

2. Methods

2.1 Identification of items and hypothesized model

The relevant empirical research on consumer satisfaction (e.g. Chen, 2010; Wu & Chen, 2014; Lam et al., 2016; Mohd Suki, 2015; 2017; Shih, 2018) indicates that consumer (green) satisfaction is affected by a series of mediating and moderating variables, described in the following table (Table 1).

Table 1. Conceptual items/factors affecting customer (green) satisfaction

Perceived Value	An overall evaluation consumers make of a product based on gains they have from consuming it compared to what they paid for it	+
Perceived Risk	Consumers' uncertainty on the outcomes of an individual purchase or use	-
Perceived Price	A feeling that consumers have about the selling price of a product	-
Perceived Quality	Consumers' overall judgment on the 'superiority'-reliability of a product	+
Perceived Innovation	Novelties describing the production processes of a product	+
Brand Image	A set of consumer perceptions about a brand name reflected through associations they get from a business entity	+
Marketing Awareness	Companies' marketing messages to convey the high efficiency and extra benefits of products they offer	+
Product Labelling	Information disclosures by the producer on the product's label	+

The above factors are realized through the combination of observed items obtained from a quantitative survey and the utilization of a structured questionnaire.

Literature also suggests that consumer satisfaction is a strong predictor of consumer loyalty (i.e. sustaining an affiliation with a producer via repeated product purchases), which is graphically described by the following diagram (Figure 1).

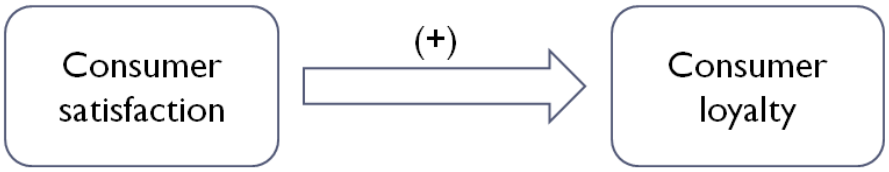


Figure 1. Hypothesized association between consumer satisfaction and consumer loyalty

These two theoretical factors were also devised by a combination of suitable observed items as identified from the relevant literature.

The current study attempts to examine associations between the conceptual factors of Table 1 and consumer (green) satisfaction, as well as the effect of the latter to consumer loyalty. In doing this, a quantitative research design is applied by distributing a self-administered questionnaire among Greek consumers (convenience/snowball sampling). The research pertains to three sub-studies, conducted for a diverse set of bio-based products:

a. bio-based wall paint (1lt)

b. bio-based household cleaning detergent (500ml)

c. kitchen chair made from biocomposite (wood fibres)

2.2 Testing the hypothesized model through structural equation modelling

The hypothesized associations between the various latent factors of the theoretical model are tested through the use of Structural Equation Modelling (SEM), also known as path analysis (Bollen, 1989). The theoretical model is tested for each one of the three bio-products. Each of the three fitted SEM models is based upon a sample of 100 respondents.

The application of path analysis allows the testing of hypotheses for simultaneous effects at different levels and gives indications of the degree/strength of each effect. Structural equation modelling also allows the integration of factors (i.e. not directly measurable structures) or variables to capture mediation effects. It is a general case (and unifying framework) of many other statistical techniques, such as regression, generalized linear models (GLM), confirmatory factor analysis.

Statistical and econometric analysis was performed using the SPSS 21.0 statistical package (SPSS, 1999) for conducting descriptive statistical analysis and performing reliability/validity tests whereas the AMOS package was utilized for the fit, estimation and inference through SEM modelling (Arbuckle, 2006). Specifically, the following steps were followed for conducting SEM analysis:

- Initially, we chose the method of estimating the parameters of three SEM models. For Likert data we choose the weighted least squares method (WLS) since it is the suitable estimation and inference method for this type of data.
- After a number of iterations, the final model is estimated, and parameter estimates are presented typically with the help of a path diagram, where the numbers on the arrows express the loadings of the factors on the observed variables, and the loadings for the relationship between the factors.
- Finally, using the goodness of fit indices we check the fit of the model we have assumed (e.g. root mean square error of approximation, goodness-of-fit index etc.).

The theoretical latent factor structure tested is presented in Figure 2.

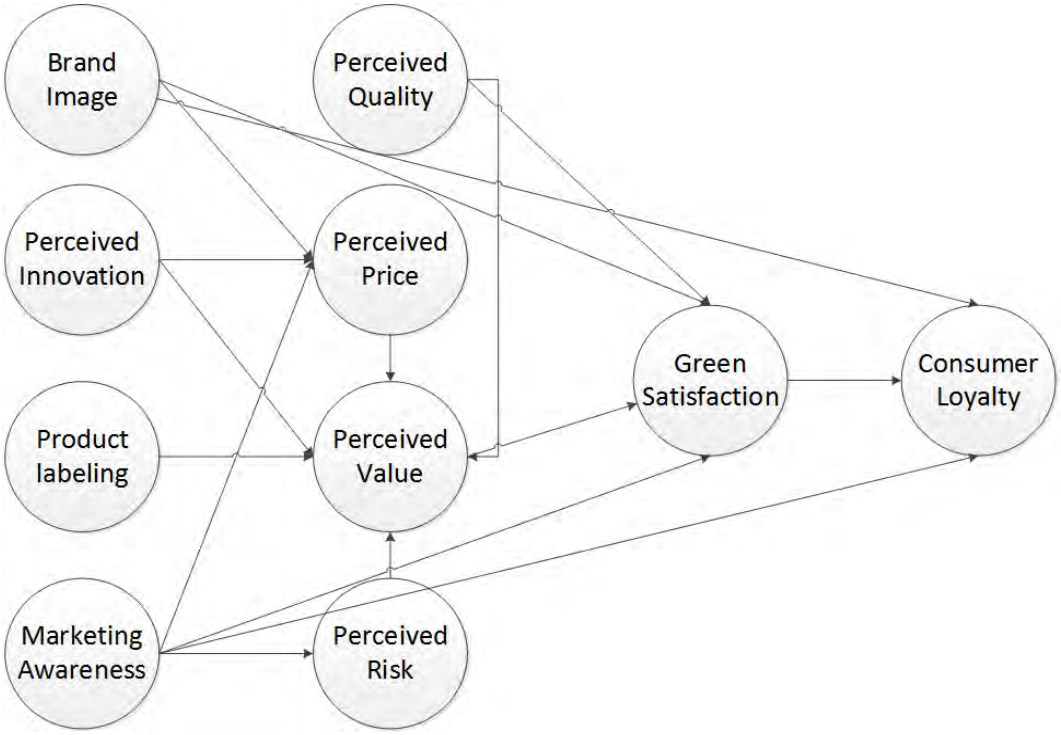


Figure 2. Path diagram of the hypothesized model

3. Findings

In the current section, the main results of quantitative analysis in terms of preliminary statistical analysis associated with testing the validity and reliability of the latent constructs utilized for SEM analysis and SEM analysis results are presented in detail.

3.1 Testing validity/reliability

Prior to utilization of the latent constructs of the conceptual model, the 10 factors were tested for validity and reliability, since these are prerequisites for obtaining valid inferences through the use of structural equation modelling.

In doing this, Cronbach's alpha values along with the percentage of variance of the observed group of items explained by the factors are calculated with the use of SPSS statistical package. The obtained results are presented in the following table (Table 2).

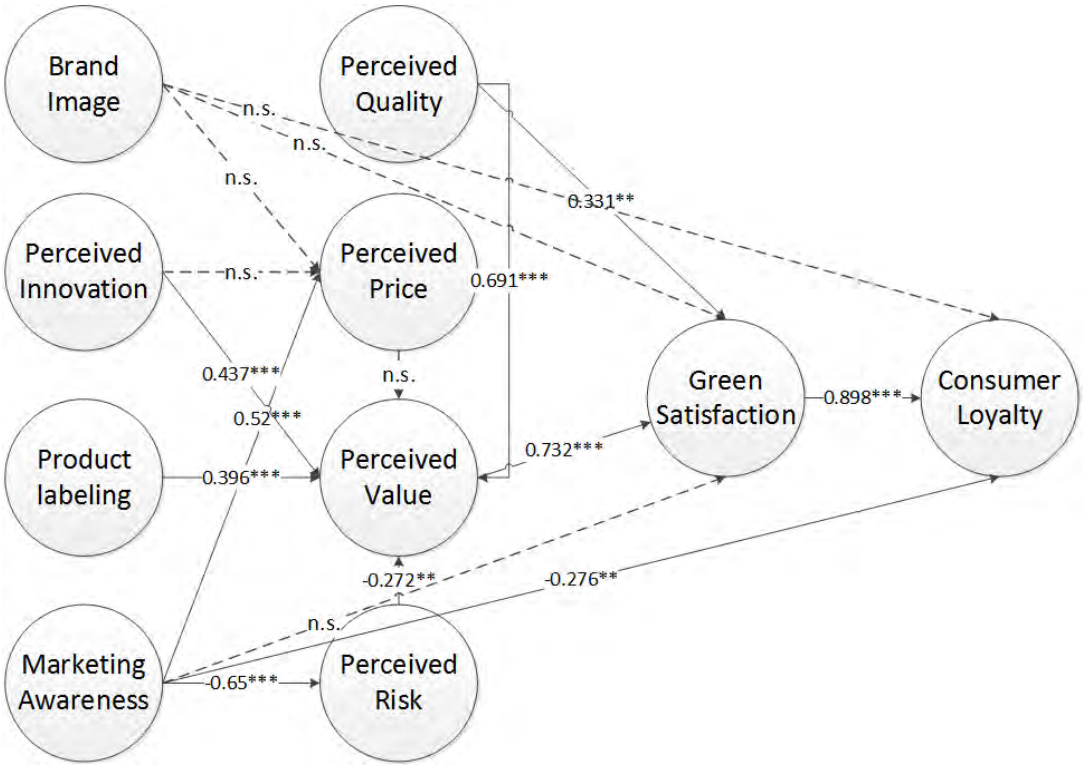
Table 2. Cronbach's alpha values and % of variance explained by the latent factors.

Factor	Paint		Detergents		Furniture	
	Cronbach's alpha	% of variance	Cronbach's alpha	% of variance	Cronbach's alpha	% of variance
Perceived Risk	0.884	68.727	0.905	72.520	0.878	68.442
Brand Image	0.940	77.122	0.949	79.665	0.951	80.430
Marketing Awareness	0.948	73.597	0.963	79.556	0.974	84.948
Perceived Price	0.857	67.301	0.851	77.243	0.924	86.857
Perceived Value	0.897	76.704	0.887	74.755	0.912	79.243
Perceived Quality	0.906	84.416	0.909	84.836	0.908	84.467
Perceived Innovation	0.807	72.345	0.919	80.690	0.926	81.944
Product Labeling	0.859	65.734	0.922	76.559	0.950	83.645
Green Satisfaction	0.896	76.335	0.904	77.723	0.937	84.152
Consumer Loyalty	0.873	79.901	0.889	82.164	0.919	86.340

Results of reliability and validity preliminary analysis (in terms of Cronbach's alpha and % of variance explained by the factors) showed that the factors utilized for SEM modelling are suitable for deriving valid inferences and estimation of parameters, since that alpha values are generally higher than the acceptable limit of 0.8-0.9, whereas the percentage of variance in all cases is well beyond the acceptable lower limit of 50%.

3.2 Structural equation modelling results

In this sub-section, the derived estimation results from structural equation modelling for the three sub-studies are presented in detail. Hence, regarding the estimation of the SEM model associated with the survey on the bio-based interior wall paint and relative perceptions of respondents, the estimated standardized path coefficients are shown in the following path diagram (Figure 3). In the diagram, statistically significant coefficients are shown through solid lines whereas non-significance is shown using dashed lines.



*: significant at 10%; **: significant at 5%; ***: significant at 1%; n.s.: non-significant.

Figure 3. SEM model for wall paint.

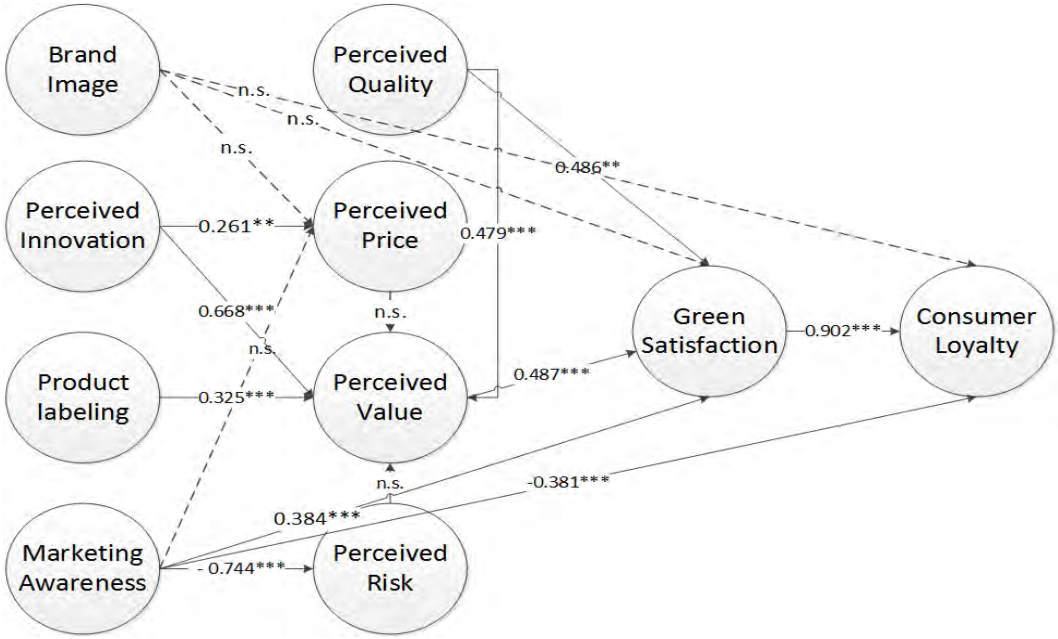
As identified by the inspection of the path diagram, the most significant positive associations between the various latent structures are those between Green satisfaction and Consumer loyalty (beta = 0.898; p-value<0.01), Perceived Value and Green satisfaction (beta = 0.732; p-value<0.01) and Perceived quality and Perceived value (0.691; p-value<0.01).

On the other hand, the most significant negative association is the one between Marketing Awareness and Perceived Risk (beta = -0.65; p-value<0.01).

Other important connections are those between Marketing Awareness and Perceived Price (beta = 0.52; p-value<0.01), Perceived Innovation and Perceived Value (beta = 0.437; p-value<0.01) and Product Labeling and Perceived Value (beta = 0.396; p-value<0.01).

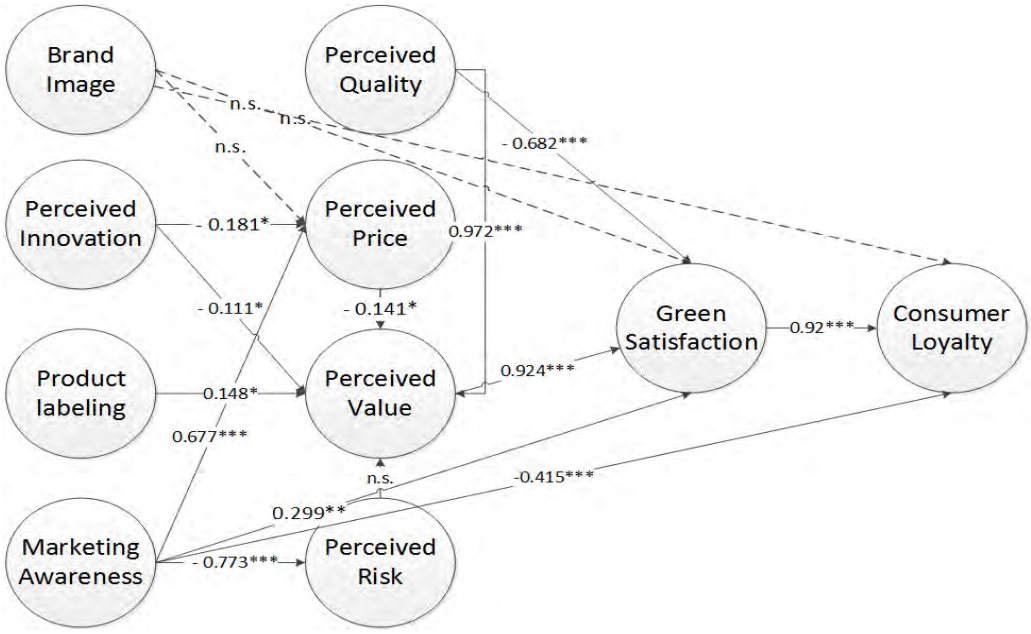
Next path diagram (Figure 4) presents the corresponding estimate results for the SEM model related to the detergents bio-products survey. Here, most positive and significant relations are identified for the effects of Green Satisfaction on the Consumer Loyalty (beta = 0.902; p-value<0.01)

and the effects of Perceived Innovation on the Perceived Value (beta = 0.668; p-value<0.01). A high and negative effect of Marketing Awareness on Perceived Risk is also observed (beta = -0.774; p-value<0.01).



*: significant at 10%; **: significant at 5%; ***: significant at 1%; n.s.: non-significant.

Figure 4. SEM model for detergents.



*: significant at 10%; **: significant at 5%; ***: significant at 1%; n.s.: non-significant.

Figure 5. SEM model for furniture

Finally, the corresponding SEM analysis results for the furniture bio-product survey are shown in path diagram above (Figure 5). These results are somewhat different in comparison to the previous two models, especially when considering the effect of Perceived Quality on the construct of Green Satisfaction which now appears to be negative (beta = -0.682; p-value<0.01). However, the positive and significant effect of Green Satisfaction on Consumer Loyalty is also observed as in previous sub-studies (beta = 0.92; p-value<0.01). Also, Perceived Value positively affects Green Satisfaction (beta = 0.924; p-value<0.01) and Perceived Quality positively affects Perceived Value (beta = 0.972; p-value<0.01). The analysis also identified a negative and highly significant effect of the Marketing Awareness factor on the Perceived Risk factor (beta = -0.773; p-value<0.01). The above results are summarized for the three distinct models in Table 3.

Table 3. Parameter estimates (standardized coefficients) along with statistical significance (p-value), for the three SEM models

ASSOCIATION	**PAINT**		**DETERGENTS**		**FURNITURE**	
	Estimate	p-value	Estimate	p-value	Estimate	p-value
PERCEIVED_INNOVATION--->PERCEIVED_PRICE	-0.166	n.s.	0.261	**	-0.181	*
MARKETING_AWARENESS--->PERCEIVED_RISK	-0.65	***	-0.744	***	-0.773	***
MARKETING_AWARENESS--->PERCEIVED_PRICE	0.52	***	0.04	n.s.	0.677	***
BRAND_IMAGE--->PERCEIVED_PRICE	0.119	n.s.	0.137	n.s.	0.065	n.s.
PRODUCT_LABELING--->PERCEIVED_VALUE	0.396	***	0.325	***	0.148	*
PERCEIVED_INNOVATION--->PERCEIVED_VALUE	0.437	***	0.668	***	-0.111	*
PERCEIVED_RISK--->PERCEIVED_VALUE	-0.272	**	-0.067	n.s.	0.003	n.s.
PERCEIVED_PRICE--->PERCEIVED_VALUE	-0.079	n.s.	0.073	n.s.	-0.141	*
PERCEIVED_QUALITY--->PERCEIVED_VALUE	0.691	***	0.479	***	0.972	***
MARKETING_AWARENESS--->GREEN_SATISFACTION	-0.065	n.s.	0.384	***	0.299	**
BRAND_IMAGE--->GREEN_SATISFACTION	-0.029	n.s.	-0.117	n.s.	0.026	n.s.

PERCEIVED_VALUE--->GREEN_SATISFACTION	0.732	***	0.487	***	0.924	***
PERCEIVED_QUALITY--->GREEN_SATISFACTION	0.331	**	0.486	***	-0.682	***
MARKETING_AWARENESS--->CONSUMER_LOYALTY	-0.276	**	-0.381	***	-0.415	***
BRAND_IMAGE--->CONSUMER_LOYALTY	-0054	n.s.	-0.076	n.s.	-0.097	n.s.
GREEN_SATISFACTION--->CONSUMER_LOYALTY	0.898	***	0.902	***	0.92	***

*: significant at 10%; **: significant at 5%; ***: significant at 1%; n.s.: non-significant

Finally, goodness-of-fit (GoF) measures that are suitable for structural equation models are presented in Table 4.

Table 4. Goodness-of-fit measures for the three SEM models (bio-based wall paint; bio-based cleaning detergent; kitchen chair made from biocomposite)

Goodness-of-fit statistic	**Wall paint SEM model**	**Detergents SEM model**	**Furniture SEM model**
RMSEA	<0.01	<0.01	<0.01
GFI	0.909	0.899	0.891
AGFI	0.865	0.882	0.845
PGFI	0.847	0.809	0.831

Goodness-of-fit indices values for the three fitted SEM models are acceptable for indication of a good fit. Worst fit is seen for the Furniture SEM model. The GoF values are generally within the acceptable rule of thumb limits for a good fit.

4. Concluding remarks

Our empirical study advances marketers' and policy-makers' understanding of the identification of consumer satisfaction as a mediator in the relationship between bio-based characteristics of products and consumer loyalty as inspected in Greek context. Results from the three sub-studies are to a certain degree consistent with previous findings of empirical studies in the pertinent consumer behaviour research domain (e.g. Chen, 2010; Wu & Chen, 2014; Lam et al., 2016; Mohd Suki, 2015; 2017; Shih, 2018) and demonstrate the relative importance of key antecedents in shaping consumer

satisfaction and inducing repurchase intention (i.e. loyalty) for the bio-based products we opted for. Expanding such modelling considerations to other bio-based product categories will give room to fruitful insights for effective marketing-promotional strategies that can widen practitioners' realization of consumer behaviour in selecting bio-based materials (with regard to pertinent satisfaction and loyalty levels). Based on the SEM results, we offer academic contributions to the existing body of knowledge of consumer (green) behaviour with regard to potential structural linkages describing bio-based product consumption in Greece.

To this regard, as this (ongoing) study relies on cross-sectional data, the dynamic change of consumer attitudes, satisfaction and loyalty for bio-based products can be explored using longitudinal data and as the market share for such products increases over time. Likewise, as the preliminary results outlined here cannot be generalized, future studies can focus on the purchase experience of other bio-based product types and/or in other national settings and compare with this study, leading to cross-comparisons and verify-refine the relationship model suggested. Future research can also segment consumer groups accordingly in order to further investigate possible differences in attitudes, purchase intentions, satisfaction and loyalty for bio-based products and suggest suitable marketing strategies for each group. Lastly, key demographics can be added in the model as control variables to identify relevant effects of such consumer characteristics on the considered factors.

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Session 8
Circular Economy

Do firms care about peers when choosing to go circular? Peer effect among Italian firms in the introduction of circular innovation

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Abstract

The challenges posed by the achievement of the circular economy require the adoption of new innovative practices that are not simply green but specifically related to closing, narrowing, and extending resources cycles (Bocken et al., 2016). Understanding the relationship between eco-innovation and circular innovation and what factors favour their implementation is, therefore, pivotal. This paper offers new pieces of evidence on the role of social norms in increasing firms' propensity to adopt circular innovation. In doing this we will try to move a step further the analysis on traditional market-pull and regulatory push-pull effect that might contribute to the adoption of innovation. Drawing upon the literature corpus confirming the influence of the social context on firms' decision to innovate and enriching this analysis with recent evidence on the effect of peers in firm decision-making, the present study relies on panel data from 2.305 Italian Small and Medium Enterprises, observed for the biennium 2017-2018 and 2019-2020. The analysis will examine whetherconsidering peers having increased their investments in CI is a driving factor for CI adoption. These results, therefore, offer a relevant starting point for the design of policy guidelines and organisational strategies in favour of the circular economy. Social norm information and comparison can be indeed complementarytools to the traditional market and regulatory levers for circular innovation adoption.

Keywords: *Circular Economy; Circular Innovation; Eco-Innovation,Peer Effect; Social norm.*

JEL Codes: Q5; O31; O36; D91

Green Growth & Sustainability Transition through information. Are the greener better informed? Evidence from European SMEs

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Abstract

The European Green Deal along with directives promoting Circular Economy support sustainability transition and foster green growth through developing appropriate funding. However, information on how to access such funding affects firms' decision to expand their business strategy. This paper investigates the effect of information about financing tools on the adoption of Circular Economy business activities by exploring whether the better-informed firms are 'greener' and what influences such decision through a switching endogenous regressor model to account for endogeneity and selectivity bias. Data on European SMEs is combined with country-specific characteristics and econometric results indicate that better informed firms are by 65 percentage points more likely to adopt an activity promoting Circular Economy, highlighting that awareness about funding tools is crucial for sustainability transition. Evidence advocates for mainstreaming information regarding funding sources to pave the way towards green growth. A rebound effect regarding the use of renewables is observed whilst evidence points towards the rejection of Porter Hypothesis. Policy makers should target in fostering a greener business environment for the firms that engage in Circular Economy practices through increased information on funding options. Findings are also pertinent to the ongoing discussion and policy agenda around acceleration of the transition to agreener European Economy.

Keywords: *Green Growth, Circular Economy, European Green Deal, Awareness & Information,Switching with binary endogenous regressors*

JEL Codes: B41, C13, C51, C54, D22, D83, M21, Q56

Defining circular economy and sustainability

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Abstract
The concept of Circular Economy (CE) blossomed in recent years in response to the development pressures, economic concerns and energy deficits. From the very beginning, the CE has appeared to be a great opportunity to foster economic growth without being mortgaged the ability to fulfill the needs of future generations (WCED, 1987).The improvident use of scarce resources, the destruction of biosphere and the failure to comply with the ecological laws are some of the reasons that deepen the need for the immediate adoption and implementation of a self-sustaining process. Therefore, it is necessary to consider the earth as a circular-flow system in which both the environment and the economy will not be defined by linear interconnections but by a circular relationship (Boulding, 1966). The present study aims to provide acomprehensive overview of research efforts documented by entities and researchers in CE through indexing
136 definitions. Specifically, a thematic and content analysis is performed employing Leximancer™ software in order to delineate the relationships emerged among concepts. The goal is to present the possible ways of adopting the CE principles reflecting the targets laid down in Union legislative acts.

Keywords: *Circular economy, sustainable development, content analysis.*

JEL Codes: Q01; Q53; Q56.

Policy Review on Sustainable Municipal Solid Waste Management. Case Study: Mediterranean Europe.

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Abstract

The present study is targeted on the liaisons between circular economy (CE) and municipal solid waste management (MSWM) under the principles of sustainable development in Mediterranean European countries. The studied countries are: Spain, France, Italy, Malta, Slovenia, Croatia, Greece, and Cyprus. A discussion of the waste hierarchy barriers would be supplemented with the provision of best management practices (BMPs) in the studied cases. In short, the sustainable MSWM might be an integral part of the European Green Deal (EGD) under the Agenda 2030.

Keywords: *waste hierarchy; best management practices; sustainable development goal 12; European green deal.*

JEL Codes: O01; Q53; Q56.

1. Introduction

The linear Fordic model is the reason why a bulk of waste has been created, thus it is imperative to adopt a circular economy (CE) model in order to achieve sustainable development (Halkos and Aslanidis, 2023). CE contains the aim to minimize – material and energy – loops especially when adopting R-strategies (e.g. repair, reuse, recycling) (Geissdoerfer *et al.*, 2017). In essence, sustainable waste management (SWM) has two central CE principles (i) the reduction of waste volumes and (the creation of energy from waste (EMAF, 2013).

The European framework on sustainable waste management is centered on the Directive 2008/98/EC and Directive 2018/851, which give prominence on the MSWM (EC, 2008; EU, 2018). The European Mediterranean countries strive to adopt 'dematerialization' techniques (Pires and Martinho, 2019). Nevertheless, there are problems when dealing with waste negative externalities towards environment (Van Ewijk and Stegemann, 2016). Some reasons are the feeble policies on achieving 'dematerialization' and the inability of measuring the environmental footprint of MSWM.

Important is the incorporation of sustainable development goals (SDGs) in MSWM in order to align policies and strategies towards CE. More specifically, SDG 12 includes plenty of sub-targets that focus on MSWM (e.g. 12.1.1., 12.2.2., 12.7.1. και 12.8.1.) (UN, 2016, 2022). The aforementioned sub-targets aim to evaluate the integral values of products via the reduction of negative externalities (EC, 2019). However, is this policy possible and robust? The answer to this problem is the expansion of best management practices (BMPs), which incorporate CE principles.

2. Materials and Methods

Eight reports from the European Environment Agency (EEA) have been compared based on their pathways to align CE principles with MSWM. The studied countries are shown in Figure 1: Spain, Malta, Italy, Croatia, Slovenia, Greece, Cyprus, and France (EEA, 2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g, 2021h). All the studied reports are focusing on BMPs from several EU Mediterranean countries.

Figure 1. The studied are of the study.

3. Results and Discussion

The linkages between the European waste prevention programmes in the Mediterranean present an alignment with sustainable development under CE policies. In table 1, the seven main factors are presented.

Table 1. Connection of waste prevention programmes with circular economy in European Mediterranean countries.

	Eco-design	RRM	Recycling	Economic Incentives	CBMs	Eco-innovation	GSK
	▲	▲	▲	▲	▲	▼	▲
	▲	▲	▲	▲	▼	▼	▼
	▲	▲	▲	▲	▲	▲	▲
	▼	▲	▲	▲	▼	▼	▲
	▲	▲	▼	▲	▲	▼	▲
	▲	▲	▲	▲	▲	▲	▲
	▲	▲	▲	▲	▲	▼	▲
	▲	▲	▲	▲	▼	▲	▼

Sources: EEA (2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g, 2021h). Authors' edit.

The seven main factors in Table 1 are: (i) eco-design; (ii) RRM that presents the repair, refurbishment, and manufacture; (iii) recycling; economic and financial incentives; CBMs: circular business models; GSK: governance, skills, and knowledge. RRM and economic incentives are wholly covered by the European Mediterranean countries, on the contrary, the factor of eco-innovation is not being effectively targeted in these programmes. It should be noted that the non-incorporation of a factor refers only to the specific reports, the omission of these factors might be covered by other reports or national strategies.

Table 2. Best management practices (BMPs) in the studied countries.

	**Zero Waste Alliance**: Reduce waste generation in landfills and incineration.
	**Repairability index** for WEEE with 10-tier categorization of materials.
	**ReMade** (NGO) checks one product regarding the included recycled materials.
	**Don't waste waste**: educational Campaign via business support – green initiatives & practices.
	**Reuse Centre Ltd**, since 2012 aims to solve environmental and social problems.
	**City of Prelog**: within 5 years has tripled the percentage of its separately collected waste.
	**2 repair cafés** in Lefkada and Patras, volunteers are gathered in these cafes in order to repair different equipment or materials (e.g. clothing, furniture, bicycles etc).
	**Let's make Cyprus green** (NGO) raises public awareness over negative anthropogenic impacts.

The table has been created by authors based on data from EEA (2021a, 2021b, 2021c, 2021d, 2021e, 2021f, 2021g, 2021h).

In table 2 there is a presentation of specific BMPs that have been operated in the European Mediterranean regional economic development, most of which are highly interlinked with CE strategies for effective MSWM. BMPs are necessary as they provide positive elements such as: promotion of sustainable consumption and production, educational programmes, and the stimulation of public opinion for environmental issues. In Spain, France, Slovenia, and Croatia there are general BMPs that cover material needs and the promotion of an eco-friendly attitude.

Additionally, the non-governmental organizations (NGOs) can be also a leverage of achieving effective MSWM as the BMPs in Italy and Cyprus. Even more, it is imperative to educate people on how to become more eco-responsible as the BMPs in Malta and Greece.

The aforementioned BMPs are under a multidisciplinary cooperation and might be a robust framework for the transition towards CE. Putting these BMPs under an institutional framework can be attained by the European green deal (EGD). The EGD is centered on the dealing with waste generation in MSWM by incorporating CE strategies under sustainable development (EC, 2019).

4. Conclusions

MSWM is important as the waste crisis is a matter of great importance nowadays. It is the long-term design that can establish a robust framework for waste prevention and treatment. Furthermore, CE principles and strategies are necessary, as they offer alternatives on the copying with waste management, but it is a great hiatus in waste management that should be covered.

To conclude, the European Mediterranean countries have included SDG 12 and its elements in their waste prevention programmes. Prevention is central to sustainable waste management and EGD is the most central institutional framework on the transition from the Fordic to CE model.

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Session 9
Sustainable Transport

The consequences of the COVID-19 pandemic on the habitual behaviors and the selection criteria of transport mode in Greece

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Abstract

This study examines the possible effects and changes in the transport habits of citizens in Greece, due to the COVID-19 pandemic, through a questionnaire survey with 250 participants. The questionnaire is divided into six sections and was distributed electronically in spring 2021 using Google Forms. The research focuses on the transport habits, the frequency and the reasons of citizens' trips with specific transport modes before the pandemic, as well as on the change of citizens' transport conditions for two time periods (1st period: spring 2020, and 2nd period: autumn 2020 to spring 2021) after the start of the pandemic. Additionally, this research focuses on the use, effectiveness and impact of tele-education on students and teleworking on employees. The results of this research mainly indicate a significant change in the transport habits of citizens before and after the COVID-19 pandemic. Particularly, with the start of the pandemic, a significant increase in walking and decrease in public transport use were observed, while tele-education and teleworking were implemented to a large extent.

Keywords: *Transportation, Transport habits, COVID-19, Greece.*

JEL Codes: L91, O18, R41.

Οι συνέπειες της πανδημίας COVID-19 στις διαμορφωμένες συνήθειες μετακίνησης και τα κριτήρια επιλογής μεταφορικού μέσου στην Ελλάδα

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Περίληψη

Η εργασία διερευνά τις ενδεχόμενες επιπτώσεις και αλλαγές στις συνήθειες μετακίνησης των πολιτών στην Ελλάδα, εξαιτίας της πανδημίας COVID-19, μέσω μιας έρευνας ερωτηματολογίου στην οποία συμμετείχαν 250 άτομα. Το ερωτηματολόγιο χωρίζεται σε έξι ενότητες και η διανομή του έγινε κατά τη διάρκεια της Άνοιξη του έτους 2021 σε ηλεκτρονική μορφή με τη χρήση του Google Forms. Η έρευνα εστιάζει στις προτιμήσεις, τον τρόπο και τη συχνότητα των μετακινήσεων των πολιτών πριν την εμφάνιση της πανδημίας, καθώς και στη μεταβολή των συνθηκών μετακίνησης των πολιτών για δυο χρονικές περιόδους (1η περίοδος: άνοιξη 2020, και 2η περίοδος: φθινόπωρο 2020 έως άνοιξη 2021) μετά την εμφάνιση της πανδημίας. Επιπλέον, η έρευνα εστιάζει στη χρήση, την αποτελεσματικότητα και την επίδραση της τηλεκπαίδευσης σε φοιτητές/μαθητές, καθώς και της τηλεργασίας στους εργαζόμενους. Τα αποτελέσματα της έρευνας δείχνουν μια σημαντική αλλαγή στις μετακινήσεις των πολιτών πριν και μετά την έναρξη της πανδημίας COVID-19. Συγκεκριμένα, με την έναρξη της πανδημίας παρατηρήθηκε σημαντική αύξηση της μετακίνησης πεζή και μείωση της μετακίνησης με Μέσα Μαζικής Μεταφοράς, ενώ εφαρμόστηκε σε μεγάλο βαθμό η τηλεκπαίδευση και η τηλεργασία.

Λέξεις Κλειδιά: *Μεταφορές, Συνήθειες μετακίνησης, COVID-19, Ελλάδα.*

'JEL Κωδικοί: L91, O18, R41.

1. Introduction

The COVID-19 pandemic has been a situation that affected seriously the life of people worldwide. The outbreak was identified in December 2019, in Wuhan, China (Wikipedia) and World Health Organization (WHO) recognized it as a pandemic in 11 March 2020 (WHO, 2020).

The COVID-19 pandemic has affected mobility of passengers and freights in local, national and global scale. The COVID-19 pandemic restrictive measures that implemented in Greece affected peoples' life into a new reality (Government of Greece, 2020).

The COVID-19 pandemic affected seriously the global economy and the attention is turning to the long-run impact of the shock on productivity. Long-term output losses are estimated in the order of 3% of global GDP (Bartholomew & Diggle, 2021). Furthermore, the COVID-19 pandemic could affect the supply side of the economy through several channels and thus lead to a permanently lower level of potential output (Martín Fuentes & Moder, 2021).

Digital transformation evolution took place during the COVID-19 pandemic (Zeitelhack, 2020) and digital transformation can be the key to revival after the pandemic (Tse, 2020). The study "Jobs in green and healthy transport" (2020) compares a "business-as-usual" approach with scenario-based projections that run up to 2030. The study finds that 10 million additional jobs could be created worldwide [2.9 million in the "United Nations Economic Commission for Europe" (UNECE) region] if 50% of all vehicles manufactured were electric. Additionally, almost 5 million new jobs could be created worldwide (2.5 million in the UNECE region) if UNECE countries doubled investment in public transport.

During the lockdown period, teleworking and tele-education were based on digital transformation and development of new software tools and skills from daily users. This transition came quickly and its benefits shaped a new world in the areas of work and education. In a study from Botzoris et al. (2016), is mentioned that many citizens can telework from their residence using new technological tools, and they were willing to increase teleworking in order to save time and transport cost, and work more conveniently and efficiently.

During the years 2020 and 2021 the lockdowns and restrictive measures have affected all passenger transport. Urban trips have decreased but not equally for all transport modes. The COVID-19 pandemic poses

a great challenge for contemporary public transportation worldwide (Tirachini & Cats, 2020). Transmission of SARS-CoV-2 is very possible in public transport vehicles because people are in close contact with each other, comparing to private vehicles. A study from Awad-Núñez et al. (2021) resulted that some measures, such as the increase of supply and vehicle disinfection, result in a greater willingness to use public transport in post-COVID-19 times. Use of sustainable transport modes, especially public transport, should not be reduced in favor of private vehicles. Especially in Greece that suffered economic depression in previous years, people were willing to increase use of sustainable transport modes in order to reduce the transport cost (Galanis et al., 2017).

2. Methodology and Data Collection

This study examines the possible effects and changes in the transport habits of citizens in Greece, due to the COVID-19 pandemic, through a questionnaire survey. The study was conducted during the spring of the year 2021 on a sample of 250 individuals. Participants in this survey answered the questions anonymously and clarifications, if requested, could be given through contact details (emails).

The questionnaire was divided in six parts and was distributed electronically using Google Forms. The research focuses on the transport habits, the frequency and the reasons of citizens' trips with specific transport modes before the pandemic, as well as on the change of citizens' transport conditions for two time periods (1st period: spring 2020, and 2nd period: autumn 2020 to spring 2021) after the start of the pandemic. Additionally, this research focuses on the use, effectiveness and impact of tele-education on students and teleworking on employees.

After the data collection was completed, followed the data analysis and export of results and conclusions. The data were analysed with the use of Microsoft Excel and the analysis was based on descriptive statistics.

3. Results

The survey results are presented in the following Figures 1-11. In Figure 1 are presented the demographic characteristics of the participants (gender, age, education and profession).

In Figure 2, are presented the participants' answers regarding to the transport mode mainly used before the COVID-19 pandemic whereas in Figure 3 and 4 are illustrated the answers regarding to the usage frequency of various motorized and non-motorized transport modes before the pandemic.

In Figure 5, are presented the participants' answers regarding to the change of daily trips due to the pandemic, comparing normal conditions and 1st pandemic period, and between 1st and 2nd examined pandemic periods.

Furthermore, in Figure 6 are presented the participants' answers regarding to the transport mode mainly used during the 1st and 2nd pandemic periods, whereas in Figure 7 is presented the safeness evaluation of public transport during the 1st and the 2nd pandemic periods.

The participants' answers regarding to use of tele-education (e-learning) and teleworking, and the necessary used equipment during the pandemic are presented in Figure 8.

In Figure 9 the easiness to use the methods of tele-education and teleworking are illustrated. Furthermore, in Figure 10 are presented the participants' answers regarding to the encountered problems during tele-education and teleworking.

Finally, in Figure 11 are presented the participants answers regarding to their willingness to continue tele-education (e-learning) and teleworking during and after the end of the pandemic COVID-19.

4. Conclusions

This study examines the possible effects and changes in the transport habits of people in Greece, due to the COVID-19 pandemic, through a questionnaire survey. The main conclusions are the following:

- Daily trips decreased significantly 79.9% (comparison between normal conditions and 1st pandemic period), and 33.2% (comparison between 1st and 2nd pandemic period).

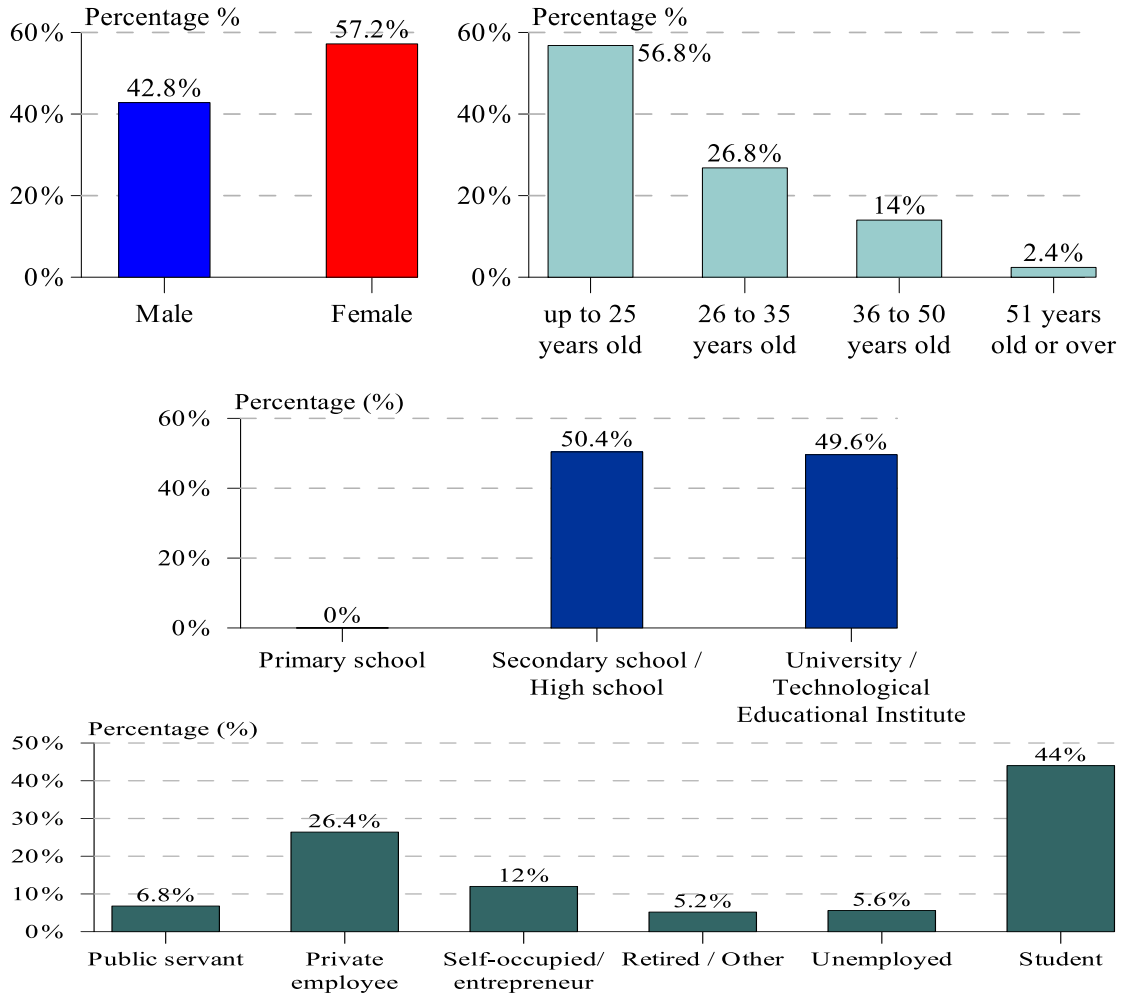

Figure 1. Demographic characteristics of participants.

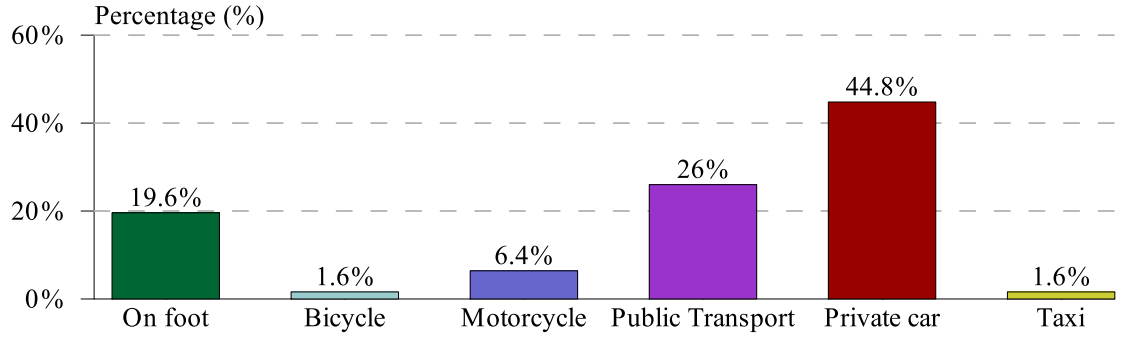

Figure 2. Transport mode mainly used before the COVID-19 pandemic.

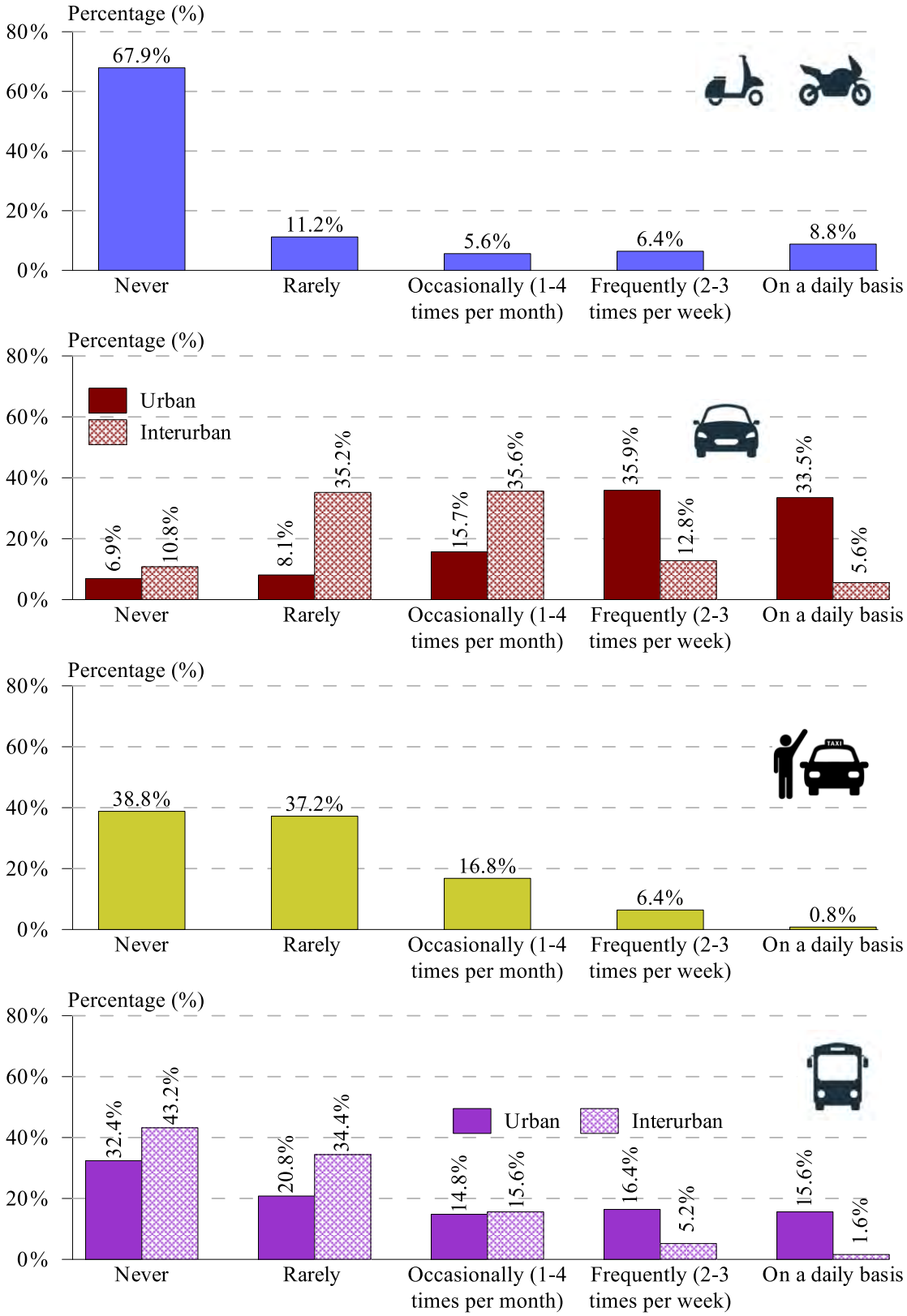

Figure 3. Usage frequency of various motorized transport modes before the COVID-19 pandemic.

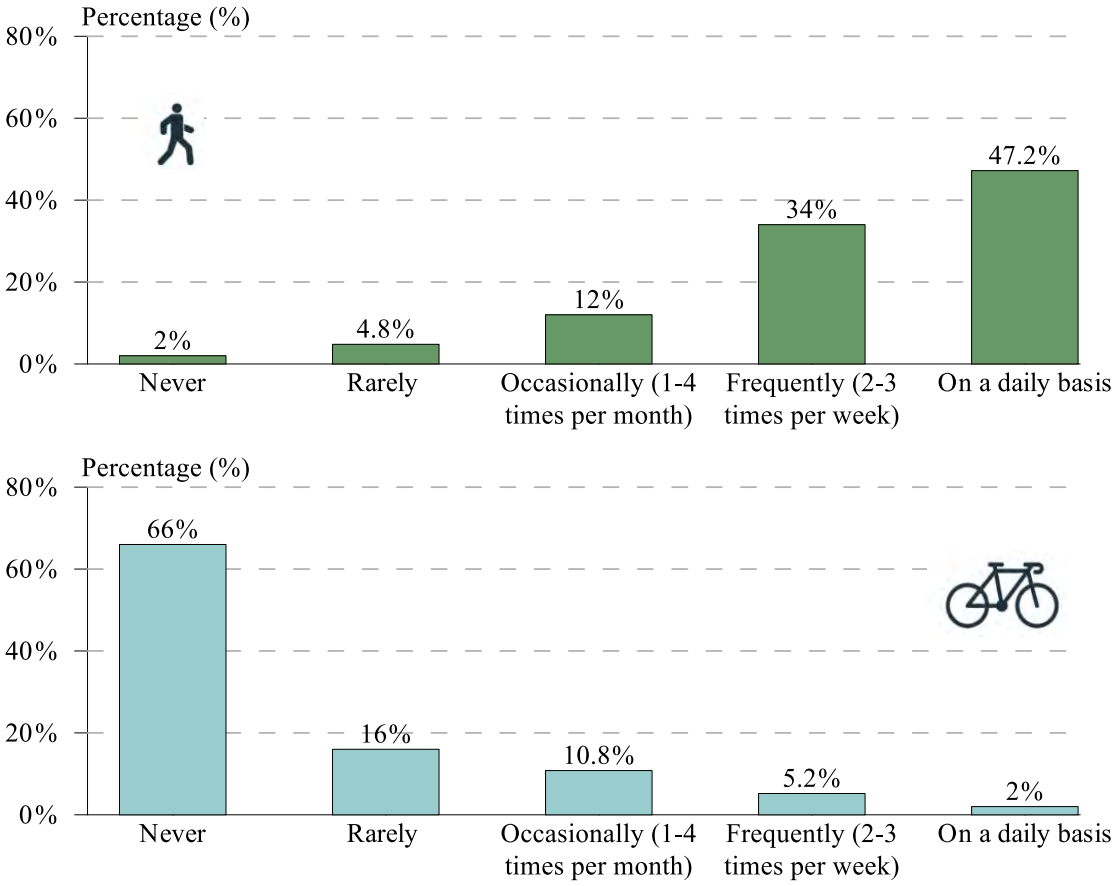

Figure 4. Usage frequency of various non-motorized transport modes before the COVID-19 pandemic.

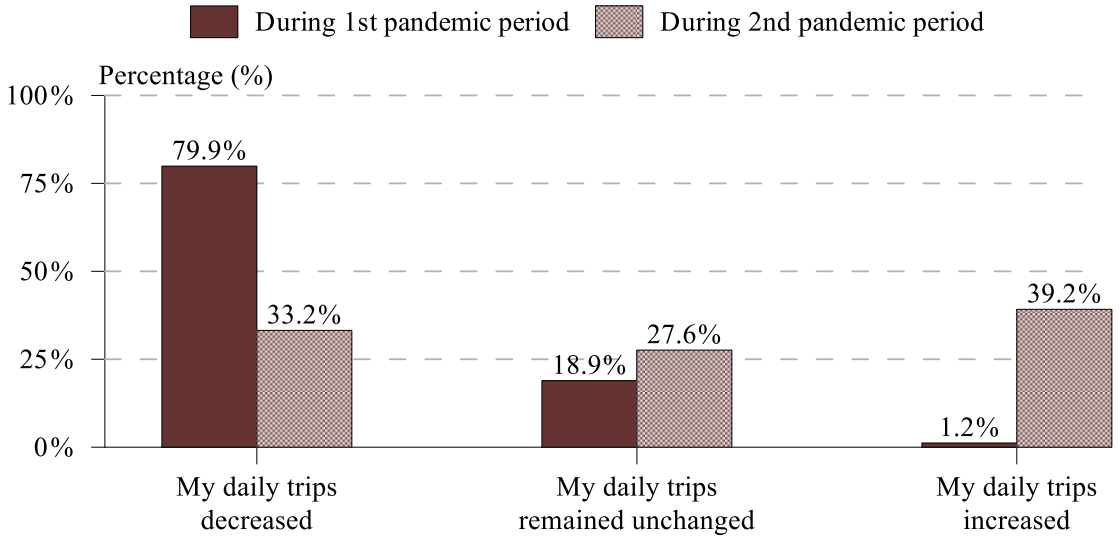

Figure 5. Change of daily trips due to the COVID-19 pandemic (comparison between normal conditions and 1st pandemic period, and between 1st pandemic period and 2nd pandemic period).

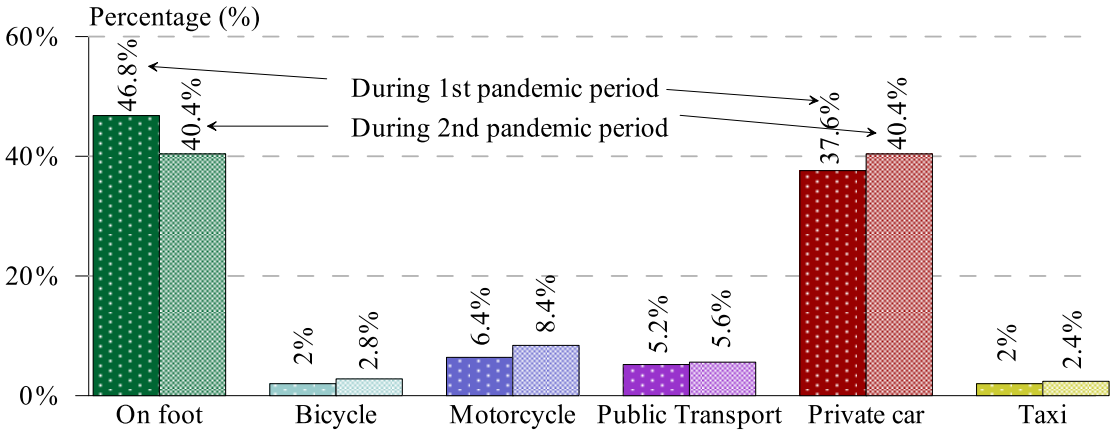

Figure 6. Transport mode mainly used during the 1st and the 2nd pandemic period.

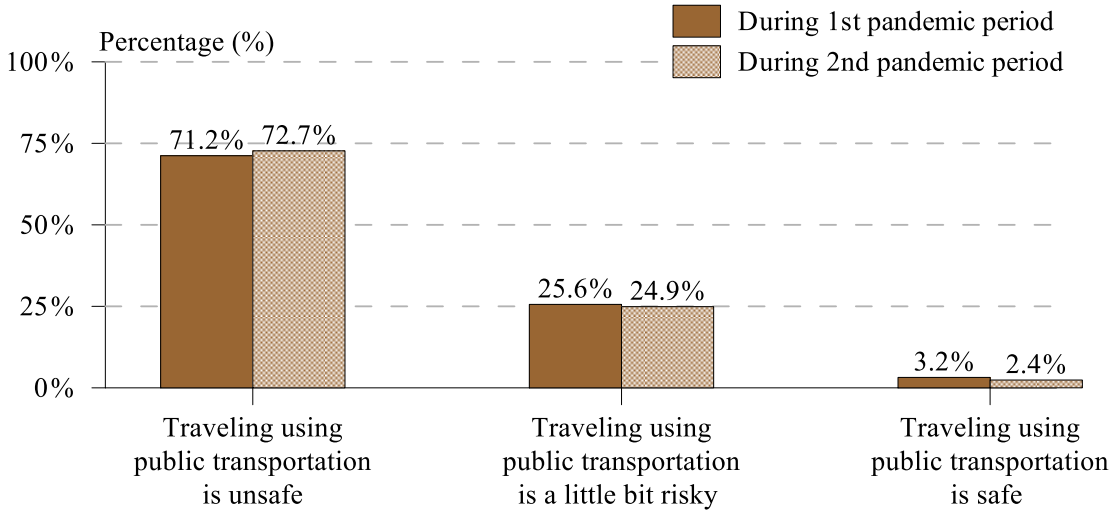

Figure 7. Safeness evaluation of public transport during the 1st and the 2nd pandemic period.

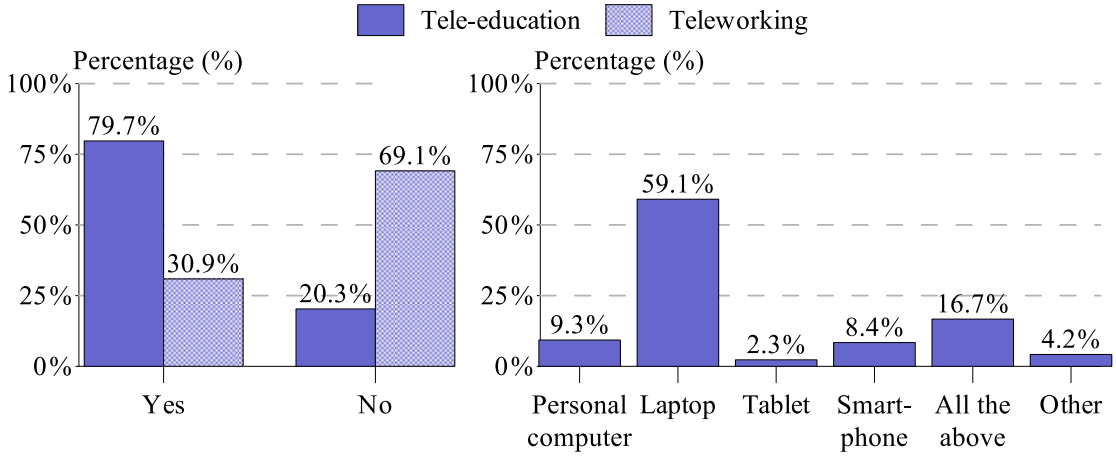

Figure 8. Tele-education (e-learning) and teleworking during the COVID-19 pandemic and used equipment.

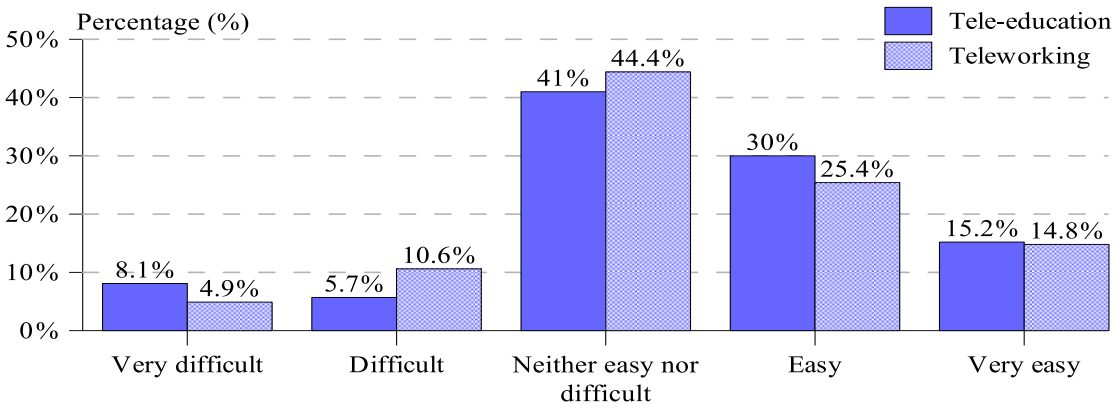

Figure 9. Easiness to use the method of tele-education (e-learning) and teleworking.

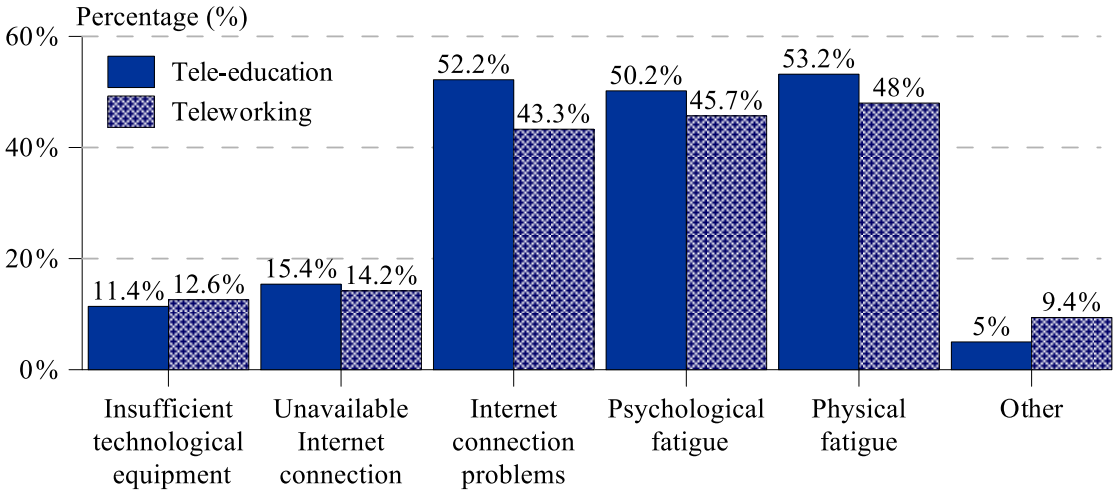

Figure 10. Encountered problems of tele-education (e-learning) and teleworking.

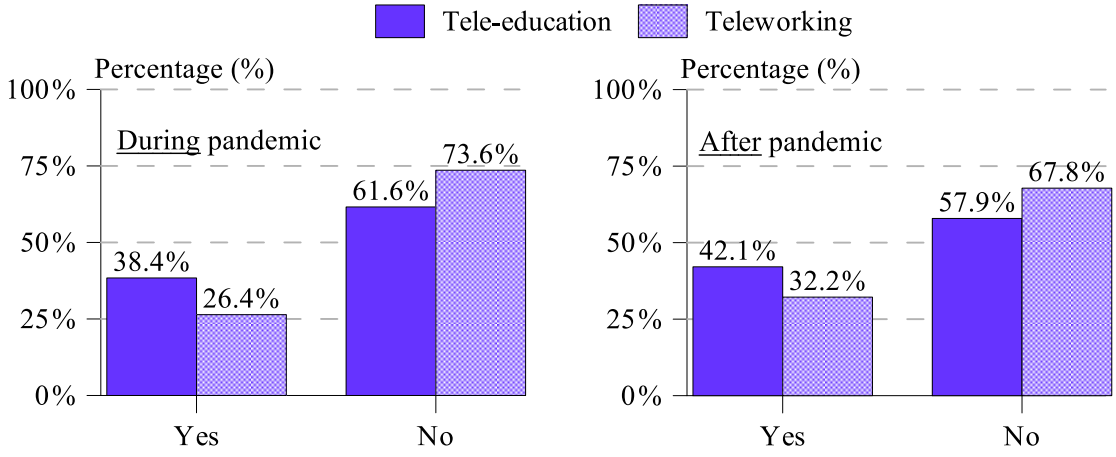

Figure 11. Continuation of tele-education (e-learning) and teleworking during the pandemic period and after the end of pandemic period.

- Walking (as a main transport mode) increased significantly comparing normal conditions before the pandemic (19.6%), and the 1st period (46.8%) and 2nd period (40.4%) during the pandemic.
- Private cars use (as a main transport mode) slightly decreased comparing normal conditions before the pandemic (44.8%), and the 1st period (37.6%) and 2nd period (40.4%) during the pandemic.

- Public transport use (as a main transport mode) decreased severely comparing normal conditions before the pandemic (26%), and the 1st period (5.2%) and 2nd period (5.6%) during the pandemic.
- Furthermore, the respondents stated that use of public transport was unsafe during the 1st (71.2%) and the 2nd (72.7%) examined pandemic periods.
- Finally, the respondents stated that implemented tele-education (79.7%) and teleworking methods (30.9%) during the pandemic, and they were willing to continue tele-education (42.1%) and teleworking (32.2%) after the pandemic.
- Internet connections problems, psychological and physical fatigue were the main reported problems of tele-education and teleworking.

The results of this study clearly indicate a significant change in the transport habits of people before and after the start of COVID-19 pandemic. Specifically, with the start of the pandemic, a significant increase in walking and decrease in public transport use were observed, while tele-education and teleworking were extensively implemented. Further research is proposed in order to examine the effects of the pandemic in peoples' transport habits and the transport sector.

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Micromobility as a reference element of urban sustainable mobility and environmental sustainability

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Abstract
Achieving a sustainable urban transportation system has been of interest for several years at European and international transport policy. The ultimate goal is to achieve an integrated and well-connected transportation network that promotes seamless travel, facilitates non-motorized travel, reducing at the same time traffic congestion, noise and air pollution. Despite the thorough planning and implementation of such relative policies, the development and rapid spread of micro-mobility vehicles (electric scooters, electric bicycles, rollers, skateboards, etc.) is unexpectedly the latest successful achievement in the transportation urban sector. Millions of users worldwide enjoy using shared micro mobility options with electric scooters and bicycles being the most popular of them. The present paper investigates the prospects of the rapid spread and increasing use of these vehicles, their effects on accelerating the transition to more sustainable and human-oriented cities, the expected benefits in improving the quality of life and the protection and maintenance of urban environment.

Keywords: Micromobility, urban planning, sustainable development, 15-minutes city

JEL Codes: O39, R41

Η μικροκινητικότητα ως στοιχείο αναφοράς στην αστική βιώσιμη κινητικότητα και περιβαλλοντική αειφορία

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Περίληψη
Η επίτευξη ενός βιώσιμου συστήματος αστικών μεταφορών έχει τεθεί για χρόνια στο επίκεντρο της ευρωπαϊκής και διεθνούς πολιτικής μεταφορών. Απώτερος στόχος, η επίτευξη ενός ενιαίου και καλά συνδεδεμένου δικτύου μεταφορών που να προωθεί τις απρόσκοπτες μετακινήσεις για τους χρήστες του, να διευκολύνει τις μη μηχανοκίνητες μετακινήσεις και ταυτόχρονα να μειώνει την κυκλοφοριακή συμφόρηση, τον θόρυβο και την ατμοσφαιρική ρύπανση. Παρά τον ενδελεχή σχεδιασμό και την υλοποίηση πολιτικών προς την κατεύθυνση αυτή, η ανάπτυξη και ραγδαία εξάπλωση της χρήσης οχημάτων μικροκινητικότητας (ηλεκτρικά πατίνια, ηλεκτρικά ποδήλατα, τροχοπέδιλα, τροχοσανίδες, κ.α.) αποτελεί ένα απρόβλεπτα επιτυχημένο επίτευγμα των τελευταίων ετών στον τομέα των αστικών μεταφορών. Εκατομμύρια χρηστών παγκοσμίως απολαμβάνουν τη χρήση των παρεχόμενων κοινόχρηστων επιλογών μικροκινητικότητας με πιο διαδεδομένη αυτή των ηλεκτρικών πατινιών και ποδηλάτων. Η παρούσα εργασία διερευνά τις προοπτικές της ραγδαίας εξάπλωσης και ολοένα αυξανόμενης χρήσης των οχημάτων αυτών, τις επιπτώσεις τους στην

επιτάχυνση της μετάβασης προς περισσότερο βιώσιμες και ανθρωποκεντρικές πόλεις, τα αναμενόμενα οφέλη στη βελτίωση της ποιότητας ζωής και φυσικά στην προστασία και διατήρηση του αστικού περιβάλλοντος.

Λέξεις Κλειδιά: Μικροκινητικότητα, αστικός σχεδιασμός, βιώσιμη ανάπτυξη, πόλη των 15 λεπτών

JEL Κωδικοί: O39, R41

1. Micromobility: a new form of urban mobility with many perspectives

Urban mobility has entered a period of substantial changes as new transport technologies, facilitated by developments in electrification, automation, internet and real-time transactions, provide new mobility options (Fitt, 2020). In this context, micro-mobility plays an important role.

Micromobility is a relatively recent concept. According to the Federal Highway Administration (FHWA), a micromobility vehicle is defined as any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric assist bicycles, electric scooters, and other small, light wheeled vehicles. Other definitions describe micromobility devices as partially or fully motorized, low speed (typically less than 48 km/h), and small sized (typically less than 230 kg and less than 1 meter wide) (FHWA, 2021). In another definition included in a report of the International Transport Forum (ITF), micromobility is defined as the use of micro-vehicles with a weight of up to 350 kg and a maximum speed of up to 45 km/h. This definition includes vehicles powered by human or electric power, as well as assisted vehicles (ITF, 2020b), private or shared (Shaheen et al., 2020).

As far as shared micromobility is concerned, this refers to the shared use of micromobility vehicles, it is an innovative strategy for transport that allows the user short-term access to a transport mode according to his needs. Shared micromobility includes various service models and modes of transport that meet the different needs of commuters, such as shared bikes, a bike that can be picked up and returned at any station, as well as the sharing of dockless bikes, scooters, etc. (Shaheen et al., 2020).

The rapid rise in popularity of micro-mobility vehicles in recent years was unexpected. More and more micromobility companies are operating around the world and are spreading globally, from the largest urban centers to the smallest urban areas. According to literature review, shared bike systems worldwide have experienced rapid growth within a few years, from 17 shared bike programs in 2005 to over 2900 programs in 2019 (Gelatoulas et al., 2020), with more and more electric bikes being today available. A significant increase was also shown in the use of electronic scooters, which annually records millions of trips in Europe, but also at a global level (ITF, 2020b).

The first wave of shared micromobility can be traced back to the first half of the first decade of the 21st century, it was public, with specific stations (docked), connected and planned. It was initiated by local government, through public procurement or public-private partnerships. Bicycles were found and returned only at specific and predetermined stations. Stations were often planned alongside the design and construction of the city's cycling network. These early shared bike systems were very successful. The number of people using bicycles increased significantly and made it clear that cycling is a sustainable mode of urban mobility. Shared fleets began to include electric bikes as well

Around 2015, the second wave of shared micromobility began, defined by various smartphone applications. The user, having a smart phone, could install the appropriate application on his mobile phone so that he could look for and locate an available bicycle anywhere close to him or at a point of his choice. These bicycles could, apparently, be located anywhere, as they were no longer fixed to predetermined stations. The app was also used to remotely unlock the bike as well as lock it at the end of the ride.

The third wave of shared micromobility evolving today is similar to the previous one, it is private, dockless and unplanned, that means it is not limited by the city's cycling network. However, there are some differences while comparing to the previous ones: bicycles are no longer exclusive, as many, if not most, operators also use electric scooters. Many fleets are fully electric. The operating companies are now looking

for the support of public authorities. Two years after starting their e-scooter businesses in California (between June and September 2017), Lime and Bird had already entered the market of more than 100 cities worldwide, reaching almost every continent. It took Lime only one year to reach 6 million rides on its shared scooters and bikes, and another two months to double that size, while Bird became the fastest-growing startup (Vancluysen, 2019).

2. New forms of urban planning: the 15 min city

2.1 Smart City and Covid-19 Pandemic

Aiming at transforming urban areas for improving their sustainability and resilience, many urban planning models have been proposed and evolved over the years as a result of their application in different contexts and geographical areas. The most recent of these, the concept of Smart City, although progressive was nevertheless found to have significant shortcomings (Moreno et al., 2021). From a theoretical point of view, the Smart City perspective has the potential and conditions to help cities achieve all these sustainability and resilience goals, however this potential is limited by the business orientations and financial constraints of technology providers, who are often inspired and driven solely by the profit margins this model can bring. According to literature, the size of the global smart cities market will increase from 410.8 billion. USD in 2020, to 820.7 billion. USD by 2025, with a compound annual growth rate (CAGR) of 14.8% during the period under consideration (Research and Market, 2020). As a result of this mainstream and economically driven pursuit, urban areas transformed into smart neighborhoods are too expensive for most city dwellers, ultimately creating inequalities in housing but also access to technological innovations (Pandey, 2018), (Konstantinou et al., 2020).

These design weaknesses of many urban planning models, including the concept of Smart Cities, were exposed and reinforced when the COVID-19 pandemic emerged, necessitating the introduction of strict health protocols and readjustment due to the growing socio-economic issues the pandemic brought. So as restriction measures, social distancing, traffic restrictions and other health protocols had to be imposed, it became apparent that the need for proximity to most basic amenities in cities became paramount as most city dwellers had to face economic and social challenges due to inability to access basic needs, despite the availability of advanced smart city technologies.

With these experiences in mind, it emerged that most cities will need to be restructured to ensure that future essential services will be available within accessible distances, and cycling and walking will play a catalytic role, as they facilitate healthy trips in compliance with health protocols that will be followed in a sustainable manner (Research and Market, 2020).

2.2 Introduction to the 15 min city concept

The 15-minute city was proposed in 2016 by the French-Colombian scientist and professor Carlos Moreno. This concept gives a new perspective to chrono-urbanism, adding to the existing smart city theme of rebuilding more humane urban tissues, and the dimension of rebuilding safer, more resilient and more sustainable urban environments, as it is outlined in the United Nations Development Goal 11 (Moreno et al., 2021). According to the United Nations, only 50% of the world's population living in urban centers has adequate access to public transport, based on 2019 data from 610 cities in a total of 95 countries (United Nations, 2022). Adequate access for a resident is considered to be within walking distance of up to 500 meters from a bus or tram stop (low-capacity transport system), and within a walking distance of up to 1000 meters from a railway or ferry station.

The 15-minute city concept is based on chrono-urbanism, according to which the quality of urban life is inversely proportional to the time spent on transport, especially those trips carried out by car. Moreno's 15-minute city refers to an urban area where residents can access, fulfilling all their basic needs, at distances that do not require more than 15 minutes on foot or by bike. Moreno argues that in the 15-minute city, residents will be able to enjoy a higher quality of life and be able to effectively fulfill six basic functions in order to

maintain a decent standard of urban life: living, working, commerce, health care, education and entertainment (Moreno et al., 2021). In today's era, where the world is experiencing the fourth industrial revolution characterized by the presence of Information and Communication Technology (ICT), the idea of the 15-minute city is considered more relevant than ever. This is true as ICTs offer a range of solutions to many urban challenges (Allam, 2020).

The four identified components that could be incorporated into Moreno's already existing proposed structure are as follows:

- Density: density is considered in people per square kilometer. Here it is about the optimal number of people for a city to be sustainable. This city should be able to comfortably support its residents both in terms of service provision and resource consumption. Therefore, emphasis is placed on optimal density that ultimately allows the achievement of sustainability goals in economic, social and environmental terms.
- Proximity: proximity is both a temporal and a spatial component. That is, within 15 minutes, through rapidly accessible radial hubs, residents can easily access essential services. This component is critical not only because it helps cities reduce time spent on commuting, but also because it is about reducing the environmental and economic impact of such an activity.
- Diversity: in the context of the 15-minute city, diversity refers to the need for mixed-use neighborhoods that are paramount to providing a healthy mix of residential, commercial and recreational activities, and diversity in culture and people.
- Digitalization: a very important component to ensure the realization of the other three components, closely aligned with the Smart City concept from which the 15-minute city can be said that is inspired. For example, in the context of the Smart City concept, factors such as inclusiveness, resident participation and real-time service provision are encouraged through various platforms, including digital, just as in Moreno's proposed concept (Moreno et al., 2021).

The above four dimensions were redefined after observing the challenges faced by different cities around the world during the peak of the COVID-19 pandemic, as well as the subsequent health measures and protocols that followed with the aim of mitigating its spread (Moreno et al., 2021). In this light, certain aspects supported in the concept of the 15-minute city gained particular weight during the pandemic, despite the fact that this model had already been proposed by 2016.

2.3 The 15-minute city responding to the challenges of the pandemic

According to Appleyard (1980), neighborhoods need to be redefined as livable places, with history, green spaces, suitable for recreation. Neighborhoods should be protected but not to the point of exclusion. The criteria for a protected neighborhood depend on acceptable speeds, traffic loads, noise levels, accident reduction and pedestrian rights (Appleyard, 1980). The emergence of the COVID-19 pandemic has exposed the vulnerability of cities in their current state and the need for a radical rethink, where innovative measures must be adapted to ensure that city dwellers are able to cope and continue their core activities, including cultural ones, and that cities will remain resilient and sustainable in both the short- and long-term future (Moreno et al., 2021). In the above context, policy makers tried to find ways to satisfy the fulfillment of the basic needs of city dwellers within a close distance from their residence, thus the idea of the 15-minute city was more relevant than ever.

During the same period and in order to achieve a reduction in car use, bicycles provided the solution. Encouraging people to cycle had multiple positive effects on their health and well-being but has also significantly helped to maintain social interactions while meeting health protocols and sustainability goals (De Vos, 2020). New bike lanes appeared, initially as temporary infrastructure, in an attempt to facilitate commuting beyond the crowded public transport and the restrictions imposed on the use of car. But in addition to mobility infrastructure and other services linked to public spaces, parks and cultural services and amenities that were often overlooked in the past, they have seen their popularity and demand increase during the pandemic. Such temporary infrastructure is just one idea among many that could be implemented in pursuit of

the 15-minute city (C40, 2020). In addition, the adoption of the 15-minute city concept will encourage additional digital innovations in the field of mobility (Gehl et al., 2013).

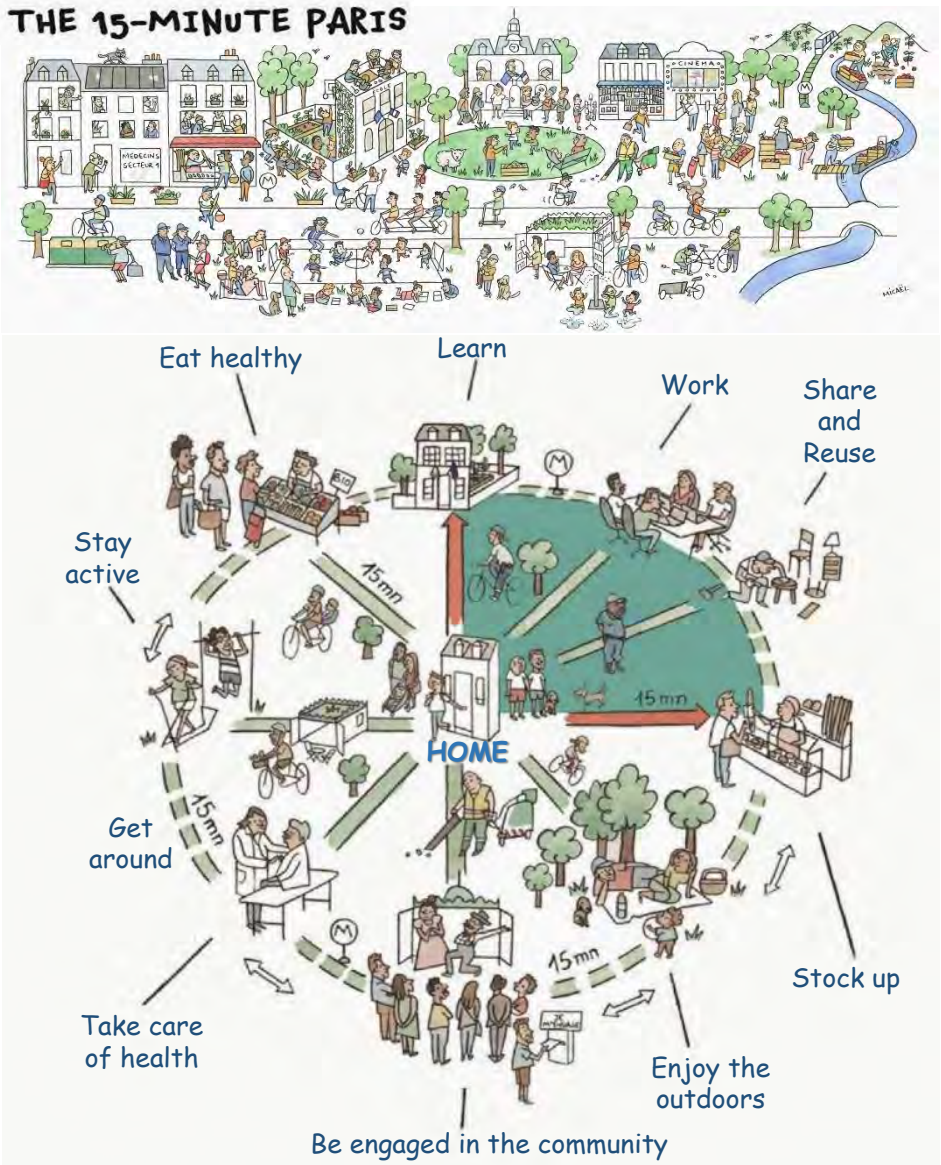

Figure 1. The vision of the evolution of Paris to a 15-minute city (Crook, 2021).

Trying to imagine a post-pandemic world and living under the constraints of COVID-19, the neighborhood came into focus as the only place to fulfill basic activities. Leading agencies and municipalities around the world have embraced the concept of the 15-minute city, where most residents will be able to fulfill their daily needs and activities within 15 minutes of walking or cycling from their residence (Pozoukidou and Chatziyiannaki, 2021). Perhaps the main difference from other neighborhood-centric approaches is that 15-minute cities are looking to bring activities to neighborhoods rather than people to activities, bringing back the urban concept of proximity. Proximity, or even better geographical proximity, i.e. the location of people, services and activities close to each other, is a key element for people's access to spatially distributed opportunities in the urban environment. Recently (2021) the concept of inclusiveness was also formulated and defined, which refers to access to basic urban services and amenities that include quality, affordable housing, mobility infrastructure for different ages and users, affordable transportation options, equal opportunities in

employment and education, as well as the right and possibility for a healthy life (Pozoukidou and Chatziyiannaki, 2021).

Paris was the first city to be transformed into a 15-minute city (Figure 1), with Madrid, Ottawa and Seattle following the same approach. Similar, at the level of central idea and basic aims, forms of urban planning are the superblocks of Barcelona, the 20-minute neighborhoods in Portland, the areas for walking in Houston (walkable places), the 20-minute city of Shanghai, the Singapore's 45-minute city, Melbourne's 20-minute neighborhoods, etc., (Stanley et al., 2015), (Pozoukidou and Chatziyiannaki, 2021).

3. An extended approach of the 15-minute city

3.1 The extended 15-minute city

The 15-minute city concept emphasizes to proximity-based planning, while the urban neighborhood is designed to accommodate an optimal density of people who will have access to essential services within walking distance. Residents will enjoy a higher quality of life as they will travel less to access essential facilities such as public spaces, structures and services of health and education, work, etc., and thus they will have increased remaining time and opportunities to interact with other members of the community in which they live, in order to achieve additional social functions, which were missing from other models of urban planning.

Emphasis on accessibility and proximity, particularly through walking or cycling, is paramount, as these modes have numerous benefits on a social, economic and environmental scale. For example, cities benefit from reduced congestion, reduced pollution (noise, emissions, etc.) and increased green spaces, resulting to health and economic benefits. They also benefit from increased time and opportunities for exercise and socializing. Economically, this model has the potential to unlock many potential positive outcomes such as employment, new technologies and innovations, as well as helping to reduce overhead costs resulting from fuel costs, road maintenance, pollution and other related costs (Moreno et al., 2021).

In modern, large urban centers as designed, shaped and operated today, the 15-minute city could have a wider- extensive approach. In this approach, the dimension of time is preserved and thus the travel time remains 15 minutes, but the spatial dimension is extended, since the travel radius from the place of residence increases as much as one could reach within the same time, combining walking, cycling, public transport and micromobility. The role of micromobility here can be that of the first and last mile connection of a route (internationally the term 'first and last mile mobility' is used to describe the different mobility options on the first and last leg of a major route) which is combined with public transport, or independently as part of an exclusive route with one of the micromobility vehicles, or combined with walking (Mohiuddin, 2021), (Kåresdotter et al., 2022).

In this extended approach, the components of Moreno's idea of access to basic amenities and services in order to maintain a better and higher standard of life are maintained, but the spatial radius is expanded and so are the options, while maintaining the socio-economic and environmental components of mobility. Moreno's six basic social functions (living, working, commerce, health care, education and entertainment) are also preserved, but in this case the options for citizens are more since they are not limited by the small radius around their residence. Trips will now be part of an integrated and multimodal network, combining additionally public transport and micromobility options. Global trends show that shared and private micromobility vehicles contribute to intermodal transport and have an important effect in the first and last mile of a trip (Heineke et al., 2019).

3.2 The positive impact of micromobility in the 15-minute city approach

A key role in this extended approach, can be played by electric scooters, which, being cost-effective especially for commuters between 0.8 and 3.2 km, make them a particularly attractive alternative to private cars (McKenzie, 2020). Surveys in US modal choice suggest that e-scooters can also replace up to 1% of trips by taxi in central urban areas. By bridging this mobility gap, these vehicles have the potential to reduce car

use but due to their higher relative cost for longer journeys (beyond 3.2 km), they would likely not lead to a significant displacement of citizens from the public transport (Zagorskas and Burinskienė, 2020).

From research in 2019 it emerged that the available shared electronic scooters and bicycles are particularly suitable in urban areas for short trips. The typical scooter user or bike share pass holder travels 11-12 minutes and 1-3 kilometers on an average trip in major cities in the United States (NACTO, 2019). The same trend is observed in European cities. Micromobility has also the potential to replace short car journeys and thus contribute to reducing traffic congestion and vehicle emissions. Study revealed that 48% of all car trips in the 25 most congested US cities are less than three miles (Reed, 2019).

Data from various surveys in six North American cities found that approximately 45% of micromobility trips replace car trips (NACTO, 2019). From data collected by the International Transport Forum the substitution rate in US cities is lower: about 15% of private car trips (ITF, 2020a). In New Zealand, 24% of micromobility trips replace car travel, while 50% of e-scooter trips replace walking (ITF, 2020a). Also, the availability of micromobility can also affect car ownership. In Oslo, Norway, in a survey of shared e-scooter users, 2% of respondents confirmed that they replaced their cars due to the use of e-scooters, while 8% said they would do the same in the future. In the same survey, 46% of respondents said they use taxis less often because of electric scooters (ITF, 2021). Similarly, bike sharing has been linked to an observed decline in motor vehicle use in cities across Europe and the USA (Fishman et al., 2014).

The economics of shared micromobility are largely favorable for businesses in the sector, as it is much easier and cost-effective for them to increase micromobility components (e.g., the number of e-bikes available for shared use) compared to shared options of car-based usage. For example, the current cost of acquiring an electric scooter is about $400, much less certainly than what is required in order to buy a car. Thus, while today's car-sharing solutions take several years to become financially viable, the cost of purchasing an e-scooter could even pay for itself in less than four months (Heineke, 2019).

The key dynamic of micromobility in the urban network lies in the fact that it can solve the problem of first and last mile trips, by improving access to public transport, while increasing and improving accessibility in services and opportunities and contributing to changes in mobility patterns and thus to less car-centric transport systems (Møller et al., 2020). The integration of these new means and vehicles in public transport systems could lead to a shift of the modal share from private-car use to these forms, in favor of sustainable development (Ostermeijer, 2019), (Oeschger et al., 2020).

However, the integration of micromobility into the existing transport systems is not a simple process and requires very good planning by the the local authorities, excellent cooperation with the operators and in general all the agencies that provide transportation services. The issues that have to be solved are many and presuppose the existence of the appropriate legislative framework in order to determine the rules and regulate the issues concerning the new vehicles, their coexistence, integration and interaction in the urban transportation network, the required infrastructures, security issues, etc.

In Greece, Law 4784/2021 regulates the issue of Light Personnel Electric Vehicles (EPHO) as they are defined, on streets and areas where the Road Traffic Code applies. Matters related to their categorization, as well the traffic rules of these vehicles (speed limits, classification of offenses and imposed fines, rules for the drivers, age criteria, equipment, supervision) (Law 4784/2021, 2021).

3.3 Micromobility and public transport integration

Micromobility is a growing trend for short trips especially at younger ages. However, it has given rise to a number of new challenges, some of which need to be resolved, such as operational issues related to traffic, safety, the use of public space, the coexistence of micro-mobility vehicles with pedestrians and other conventional vehicles, the management of traffic, parking, integration and cooperation with the city's urban transport network. As micro-mobility can solve important issues of urban mobility, it should be integrated as part of the urban planning of cities and thus become an integral part of the extended 15-minute city.

In some cities where public transport already has capacity issues, micromobility services could absorb some of the shorter journeys such as those that would require one or two metro stops. They could additionally

help bus passengers are waiting for several time at a stop or could combine their movement with other forms of mobility in order to achieve the best service in the least possible time Vancluysen, 2019).

Today consumers buy mobility services (buses, shared bikes, scooters, taxis, etc.) separately from different providers. The commuter is obliged to organize each leg of a multimodal journey separately and take particular care of his transfers. The demand was therefore and remains an integrated service where individual movements will become easier, simpler and seamless, as they will have been integrated into a single system. Mobility as a Service (MaaS) is the next major step in transportation and mobility worldwide. MaaS is actually the digitization of operations and the aggregation of providers and users on a single platform. According to research published by BIS Research, titled "Mobility as a Service Market Analysis and Forecast, 2018–2028", this market is forecast to reach $1759.83 billion globally by 2028 (Fleetnews, 2018). Maas promotes innovative means and mobility services as well as micro-mobility which is integrated into all transport services in a unified way. However, the issues that remain to be regulated are multiple and concern both the end users and the companies providing the transport systems.

4. Conclusions

The contemporary challenges of urban mobility have highlighted urban planning models that could address them in order to achieve the goals of sustainability, resilience and improving the quality of life of urban residents. Some of them existed for years, but emerged during the Covid-19 pandemic when travel restrictions and strict health protocols were imposed. One of the most popular urban planning models formulated was the 15-minute city, which is based on proximity and characterizes a city where the fulfillment of the basic needs of its residents takes place within 15 minutes of their home on foot or by bicycle. This model of urban planning supports the improvement of the quality of life of the inhabitants of a city in the reduced commuting time and thus in the increased remaining time for the satisfaction of individual, social, professional and other needs. Quickly, the principles of the model began to be applied in cities around the world, adapting in this way the daily life of transportation.

The model could in a more extended approach be applied in a modern city with high urban densities and a developed public transportation network. In this approach, the dimension of time is preserved and thus the travel time remains 15 minutes, but the spatial dimension is extended, since the radius of travel from the place of residence increases as far as one could reach by combining walking, bicycle, public transport and micromobility.

A number of issues should be considered in order for its implementation to be successful. These issues mainly concern the integration of the micromobility system with the public transport system as well as the other modes that may coexist (micromobility, demand-responsive services, flexible transport, walking, etc.). The issues of this integration should be properly regulated through the appropriate institutional framework and address all aspects of systems integration (infrastructure, regulatory framework, security, users, technology and innovation).

A critical issue in this whole project of the 15-minute extended city is the cooperation between the local authorities and micromobility operators as well as other transport modes which is catalytic as will determine the success or failure of the project, as well as the correct information of the residents.

Easier access to public transport is one of the determining factors for choosing between a car journey or public transport (Holmgren, 2020). Micromobility can increase the influence area of public transport. It provides a faster journey to/from public transport or increases the distance people are willing to travel to/from home and public transport, compared to walking.

Some micromobility trips may replace public transport trips. In Brussels, about 30% of users stated that e-scooter replaced some trips previously made by public transport (Moreau et al., 2020). However, a large proportion of both shared bike and e-scooter trips are part of longer and intermodal trips, thus increasing the area of influence of public transport (Shaheen et al., 2016). In Paris, 15% of trips with electric scooter and 18%

of bicycle trips are combined with public transport. In Oslo, 57% of electric scooter users combined their journeys with public transport (ITF, 2021).

Widespread availability of micromobility services, particularly for first- and last-mile connections, would increase access to 35% more jobs for residents of the city of Seattle, while reducing commute time and car dependency (Stewart, 2019). In Zurich, dockless e-scooters and bicycles are mostly used in the city center where there are parking spaces at the main public transport stations suggesting that the integration of bicycle and scooter sharing with public transport can increase the number of multimodal trips (ITF, 2021).

The rapid development of micromobility has been based on the fulfillment of important goals of sustainable development and its components of economic, environmental and social sustainability. Research and studies on these vehicles, as well as their effects and benefits will surely intensify in the upcoming years, as their integration into the mobility systems of modern cities has already began. With the application of the appropriate regulatory framework, the inclusion of micromobility in modern urban planning models, and especially in the 15-minute city model examined in this paper, can only be beneficial.

Micromobility, in the context of the extended 15-minute city can be a reliable transportation solution especially as part of a single and public transport route, in which it will play the role of the first and last mile connection, enabling its residents to more spatial options within a limited time in order to fulfill their basic needs to maintain a good standard of living. Although the first steps have already been taken to utilize it both in Europe and in Greece, it is still not the most popular way of moving, due to the lack of infrastructure organization and functionality. Ensuring the above conditions and the organized inclusion of micro-mobility in transport systems and urban planning will accelerate, as is evident, in the coming years.

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The Effect of Road Transport Electrification on Energy Demand in Greece

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Abstract

Governments within the European Union push for the electrification of road transport as a means to reduce road-transport-related greenhouse gas emissions. This means that the energy required for road transport shifts from the gas pump to the plug and hydrogen. Forecasting the energy demand of the shifting vehicle fleet is important in planning the power generation system of tomorrow. The case of Greece is examined with the use of previously developed forecasting models using machine learning techniques and projected regulatory changes to identify the increase in electricity and hydrogen demand in the near, medium, and long term. It is found that this future demand is strongly correlated with macroeconomic conditions and that in scenarios that lead to strength growth of the EV sector may necessitate a significant expansion of electricity and hydrogen production.

Keywords: Road Transport, Electrification, Forecasting, Machine Learning
JEL Codes: R41, R48, Q41, Q42, Q47

Επιρροή του Εξηλεκτρισμού των Οδικών Μεταφορών στη Ζήτηση για Ενέργεια στην Ελλάδα

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Περίληψη

Οι Κυβερνήσεις την Ευρωπαϊκή Ένωση προωθούν τον εξηλεκτρισμό των οδικών μεταφορών ως ένα μέσο μείωσης των εκπομπών αερίων του θερμοκηπίου. Αυτό σημαίνει ότι η ζήτηση ενέργειας από τις οδικές μεταφορές μεταφέρεται από την αντλία βενζίνης στην πρίζα και το υδρογόνο. Η πρόβλεψη της ενεργειακής ζήτησης από το μεταβαλλόμενο στόλο οχημάτων είναι σημαντική για το σχεδιασμό του μελλοντικού συστήματος παραγωγής ενέργειας. Η περίπτωση της Ελλάδας εξετάζεται με τη χρήση ήδη εξελιγμένων υποδειγμάτων πρόβλεψης που χρησιμοποιούν τεχνικές μηχανικής μάθησης και προβλεπόμενων κανονιστικών μεταβολών ώστε να αναγνωρισθεί η αύξηση σε ζήτηση ηλεκτρισμού και υδρογόνου στο βραχύ, μέσο, και μακρύ χρονικό ορίζοντα. Βρίσκεται ότι η μελλοντική ζήτηση εξαρτάται ισχυρά από τις μακροοικονομικές συνθήκες και ότι σε σενάρια που οδηγούν σε ισχυρή ανάπτυξη του κλάδου των ηλεκτρικών οχημάτων μπορεί να κάνει αναγκαία μία σημαντικά αύξηση της παραγωγής ηλεκτρισμού και υδρογόνου.

Λέξεις Κλειδιά: Οδικές Μεταφορές, Εξηλεκτρισμός, Πρόβλεψη, Μηχανική Μάθηση
JEL Κωδικοί: R41, R48, Q41, Q42, Q47

1. Introduction

The electrification of the road transport sector is seen as a means to mitigate some of its environmental impact and limit reliance on fossil fuels, which are often imported from hostile or oppressive regimes. The Greek Government's plan for Energy and the Climate, (Hellenic Ministry for the Environment and Energy, 2019) and the legislation for the advancement of electric-powered mobility, (Hellenic Republic, 2020), target an electric passenger car market penetration of 30% by 2030.

2. Materials and Methods

The authors presented aggregate passenger car demand models in (Christidis, et al., 2021), whereas discreet choice models were presented in (Christidis, et al., 2022). It was found in both cases that machine learning techniques performed better than their conventional counterparts. Data for the development of the models was collected from the Hellenic Statistical Authority (Hellenic Statistical Authority, 2022), IOBE (Foundation for Economic and Industrial Research, 2022), Eurostat (Eurostat, 2022), and dedicated consumer surveys.

3. Forecasting Scenarios

3.1. Aggregate Demand

Based on (Christidis, et al., 2021), passenger car aggregate demand is driven by GDP per capita, the unemployment rate, consumer confidence, the harmonized consumer price index, and whether used car imports are favorably taxed or not. Three different scenarios are considered:

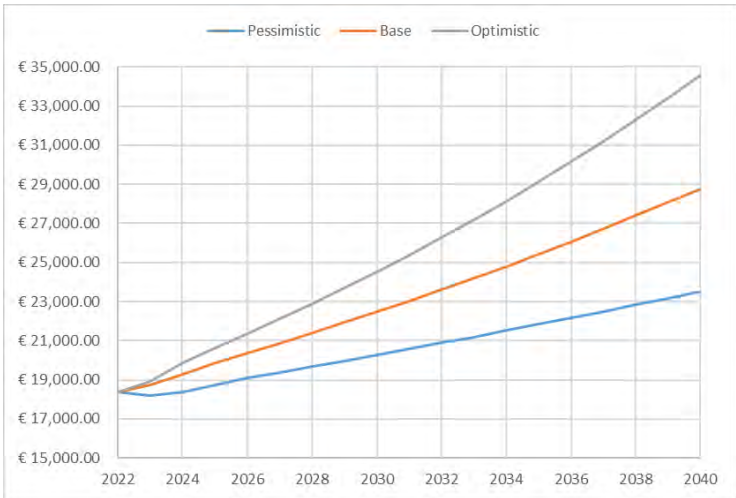


Figure 11. GDP per Capita Forecast Scenarios (2015 Euros).

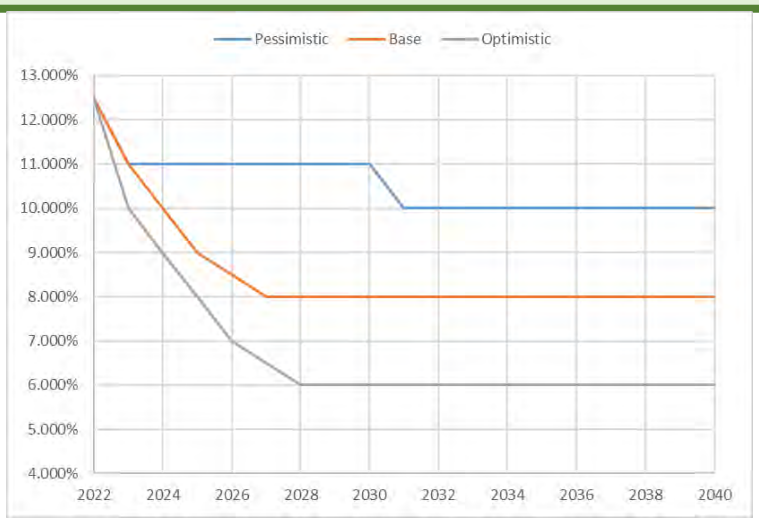


Figure 12. Unemployment Rate Forecast Scenarios.

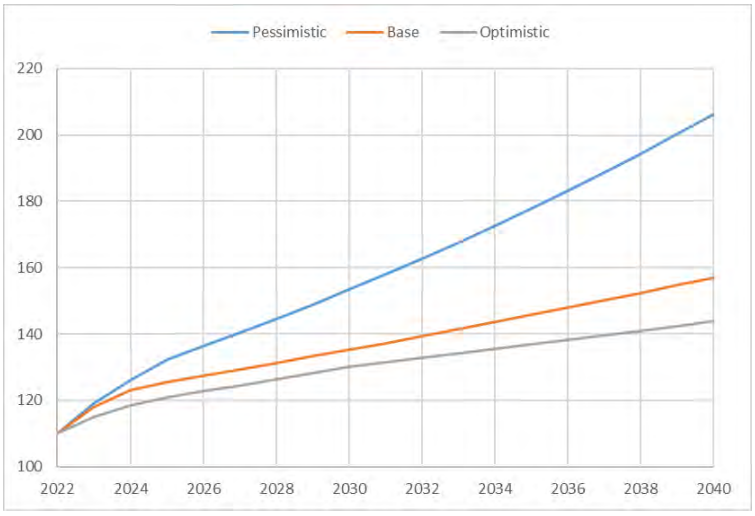


Figure 13. Harmonized Consumer Price Index Forecast Scenarios (2021 = 100).

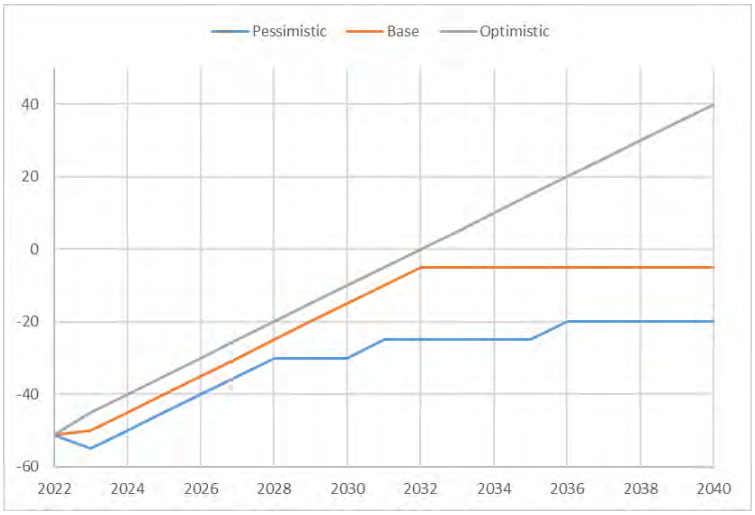


Figure 14. Consumer Confidence Forecast Scenarios.

The pessimistic scenario is unlikely; a combination of economic stagnation and high inflation within the Euro currency regime would need to be realized in a continent-wide level coupled with a change in the European Central Bank's policies that would allow for a high inflation environment. Nevertheless, such a scenario is not impossible and as such it is examined as an extreme if unlikely case.

3.2. Demand Split

The Greek Government has publicly committed that from 2030 onwards the sale of new internal combustion engine (ICE) cars will be banned. It is thus necessary to differentiate between before and after this.

3.2.1. Prior to New Internal Combustion Engine Car Sales Restrictions

Distribution of public perceptions regarding different types of passenger cars will evolve over time such that alternative motor unit vehicles become more popular. As illustrated in (Christidis, et al., 2022), perceptions of cost and technology state drive the demand split. These are expressed by two composite explanatory variables whose value falls in the range [1, 5], with 1 representing a very unfavorable perception of the vehicle type in question, and 5 an unequivocally positive one. Forecast scenarios start with the perception split recorded in March 2022 for the aforementioned research, and evolve in time as described, see examples below for cost perceptions regarding plug-in hybrid vehicles:

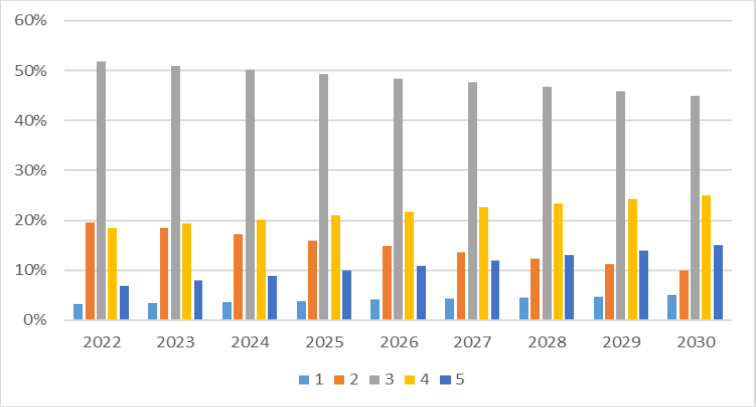


Figure 15. Base Forecasting Scenario Evolution of Cost Perceptions of Plug-In Hybrid Passenger Cars (1 = Definitely Unfavorable, 5 = Definitely Favorable).

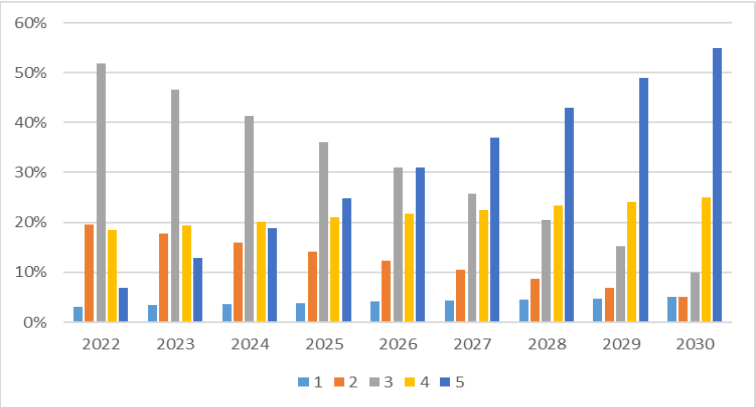


Figure 16. Optimistic Forecasting Scenario Evolution of Cost Perceptions of Plug-In Hybrid Passenger Cars (1 = Definitely Unfavorable, 5 = Definitely Favorable).

Similar evolutions were considered for other vehicle types and perceptions used as explanatory variables.

3.2.2. After New Internal Combustion Engine Car Sales Restrictions

After the introduction of ICE care sales restrictions, it is assumed that the split between different types of cars will remain proportional to the split recorded for the year 2030, minus the ICE cars. A discreet choice model based on current data of such a fundamentally different market, where certain options are no longer available, would not be realistic.

3.3. Passenger Car Energy Requirements

Energy requirements of the electrified passenger car fleet depend on the amount of kilometers travelled per vehicle per year, the average mass of the vehicles, the type of traffic vehicles are used in, driving patterns etc.. According to (International Energy Agency, 2022), car and light truck energy consumption in Greece for the year 2018 was 101.4PJ, which corresponds to 3,024,518,284lt of gasoline. For a vehicle fleet of 5,282,695 passenger cars, (Hellenic Statistical Authority, 2022), this means that on average each passenger car in Greece consumed 19.2GJ of energy per annum or the equivalent of approximately 573lt of gasoline. Given that electric vehicles are on average heavier than their ICE equivalents, and that the reduced cost of energy for such cars will lead to longer distances travelled through the phenomenon of induced demand, a value of 20GJ or 600lt of gasoline per annum will be used.

The projected gasoline demand for the vehicle fleet based on the above consumption is then converted to kilo-Joules, and then based on the efficiency of different motive units (~20% for ICE cars, ~30% for hydrogen electric, and~73% for battery electric vehicles, for more details see (Martins, et al., 2013)) and (Volkswagen A.G., 2019), in kWh required to be generated to charge batteries and create the necessary amount of hydrogen through electrolysis..

4. Calculation

4.1. Aggregate Demand Forecasts

Based on the aforementioned scenarios, the forecasted aggregate demand for new cars is given in the following figure:

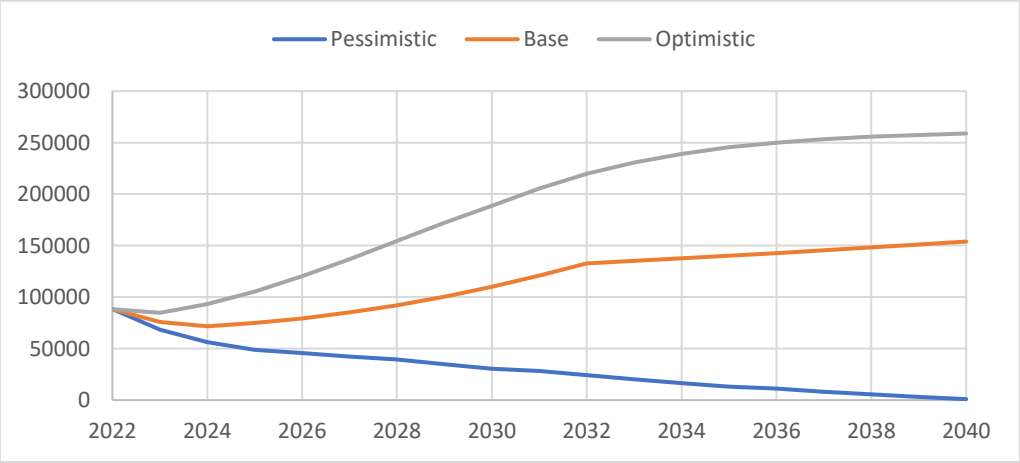


Figure 17. Forecasted New Vehicle Registrations per Annum.

It should be noted that the pessimistic scenario, which describes a stagnating economy with high unemployment rates and inflation, foresees a significant drop of new car registrations, whereas used car registrations, i.e. of old ICE cars imported from other EU countries, dominate the market.

4.2. Demand Split Forecasts

Using the discrete choice model from (Christidis, et al., 2022) and the forecasting scenarios:

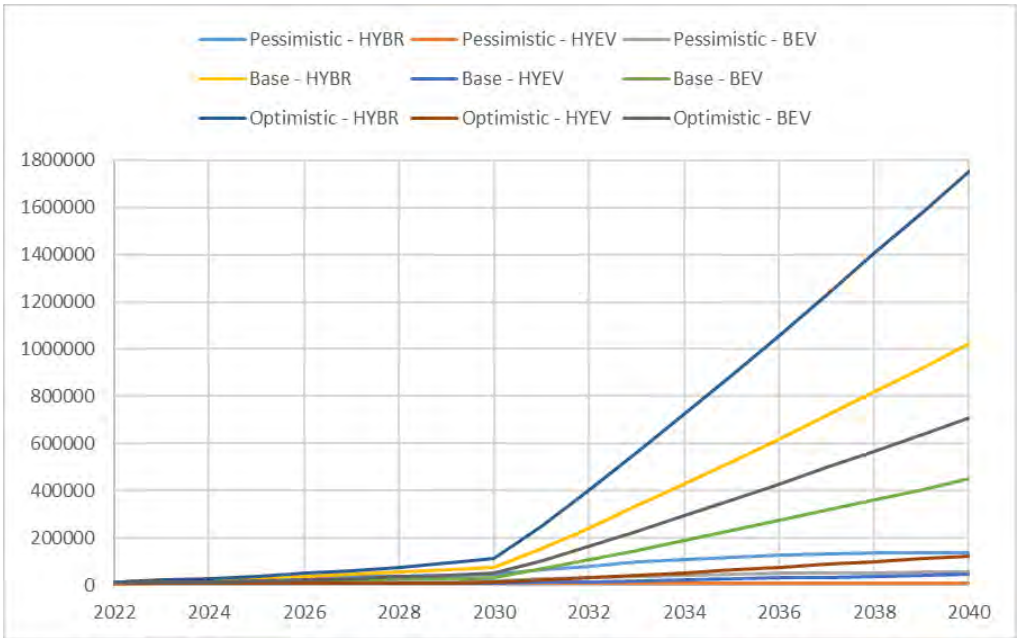


Figure 18. Forecasted Vehicle Demand Split per Annum.

4.3. Passenger Car Fleet Composition

Based on the previously developed models and the scenarios for the evolution of the explanatory variables, the following fleets of alternative motor unit cars is forecasted:

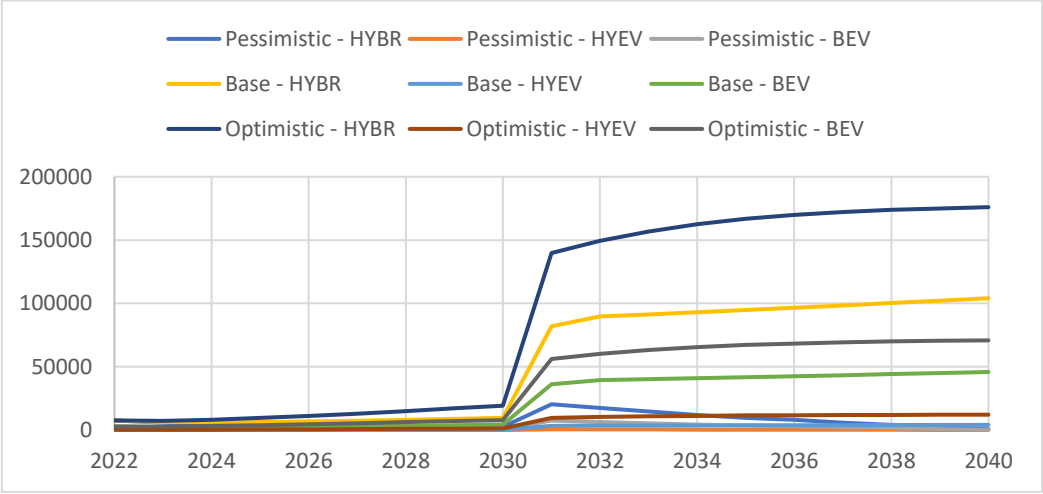
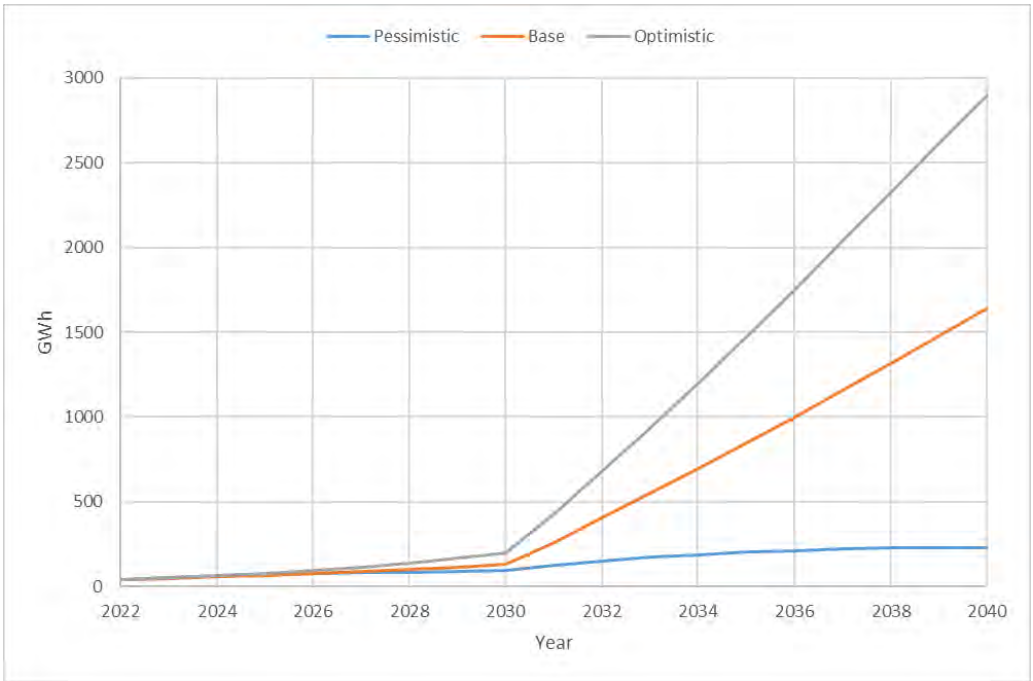


Figure 19. Forecasted Alternative Motive Unit Fleet per Annum.

4.4. Energy Demand for the Projected Fleet Composition

Based on the above forecasts and the approach presented in Section 3.3, the following energy demand per year is calculated for the different scenarios.

Figure 20. Forecasted Energy Demand in GWh.



The above energy consumption corresponds to a wind power generating capacity, which has a capacity utilization factor of ~36%, (University of Michigan - Center for Sustainable Systems, 2022), of approximately 0.5GW to 1.0GW, based on whether the base or optimistic scenario materializes. In the case of the pessimistic forecasting scenario where a combination of high unemployment, stagnation of GDP per Capita and high inflation rates leads to very low new passenger car demand, electricity demand does not escalate.

5. Results and Discussion

Previously developed forecasting models using machine learning (artificial neural networks) were used to forecast registrations of new plug-in hybrid, hydrogen electric, and battery electric vehicles to the year 2030 and beyond. The forecasted electrified passenger car fleet's requirements were then used to estimate its electricity demand taking into account historical data on energy demand per vehicle in Greece and efficiency differences between alternative motive units.

According to (Hellenic Ministry for the Environment and Energy, 2019), electricity production in Greece for 2030 will reach 57.93TWh generated from an installed production capacity of 25.94GW, 19.03GW of which will regard to renewable sources. The projected additional demand resulting from the electrification of road transport means that electricity production will need to increase by 1.5TWh to 3.0TWh over a decade-long period which corresponds to additional production capacity between 0.5GW to 1.0GW. This is a significant amount that will need to be accounted for in medium and long-term plans for electricity generation in Greece as it corresponds to approximately a 5% increase of installed capacity from 2030 to 2040 and represents a significant investment effort as the cost of this kind of investment could be from 1.0 to upwards of 2.0 billion Euros.

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Implementation of the rail trail practice in Greece as a sustainable tourism growth factor

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Abstract

One of the basic transport infrastructures of any country is the railway.However, the new specifications and technological development lead to the abandonment of older lines if they are deemed incompatible. While keeping sustainability as well as environmental protection in mind, it is proposed to exploit the abandoned railway tracks through "rail trails". Due to their physical characteristics, abandoned railway tracks are the preferred types of infrastructure for the implementation of rail trails. This conversion grants access exclusively to non-motorized users, thus contributing to the sustainable infrastructure but also to the tourist attractiveness of an area. They are friendly to people with reduced mobility. Physical activities in nature adds an extra dimension to the visitor's experience, which often evokes a sense of well-being. The most important factor in the success of a rail trail is its environmental sustainability. In addition, it is possible to preserve old railway architectural monuments, such as infrastructure and auxiliary buildings, elements of great historical value, that can help preserve the historical memory of the railway. This article will describe the methodology of implementing the rail trails standards of other countries in Greece and will identify the obstacles in the implementation process, but also mention examples from urban areas in Greece.

Keywords: *Railway;Sustainability; Rail trail;Tourism; Trails.*

JEL Codes: O0, O52,R42, Q56.

Σιδηροδρομικά μονοπάτια: μετασχηματισμός μεταφορικών υποδομών με όρους αειφόρου τουριστικής ανάπτυξης

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Περίληψη

Ο σιδηρόδρομος είναι μια από τις βασικές υποδομές μιας χώρας, ωστόσο οι νέες προδιαγραφές οδηγούν στην κατάργηση των παλαιότερων γραμμών εάν κριθούν ασύμβατες. Με παράμετρο τη βιωσιμότητα αλλά και την προστασία του περιβάλλοντος, προτείνεται η εκμετάλλευση τωνκατηργημένων τμημάτων μέσω των «Σιδηροδρομικών Μονοπατιών»(railtrails).Εξαιτίας των φυσικών τους χαρακτηριστικών, οι αχρησιμοποίητες σιδηροδρομικές γραμμές αποτελούν τα προτιμώμενα είδη υποδομής για την υλοποίηση των railtrails. Με την εν λόγω μετατροπή επιτρέπεται η πρόσβαση αποκλειστικάσε μη μηχανοκίνητους χρήστες, συμβάλλοντας έτσι στις πράσινες υποδομές ενός τόπου, αλλά και στην τουριστική ελκυστικότητα μιας περιοχής. Είναι φιλικοί προς πεζούς, ποδηλάτες, καθώς και άτομα με μειωμένη κινητικότητα. Επίσης, η ενασχόληση στο φυσικό τοπίομέσω μιας ενεργητικής δραστηριότητας, προσθέτει μια επιπλέον διάσταση στην εμπειρία του επισκέπτη, η οποία συχνά προκαλεί μια αίσθηση ευεξίας. Ο βασικότερος παράγοντας της επιτυχίας ενός railtrail είναι η περιβαλλοντική του βιωσιμότητα, επιπλέον, είναι δυνατό να διατηρηθούν παλιά σιδηροδρομικά αρχιτεκτονικά μνημεία, όπως έργα υποδομής και βοηθητικά κτίρια, στοιχεία μεγάλης ιστορικής αξίας που μπορούν να βοηθήσουν στη διατήρηση της ιστορικής μνήμης του σιδηροδρόμου. Στην παρούσα εργασία θα περιγραφεί η μέθοδος εφαρμογής των προτύπων railtrails άλλων χωρών, στην Ελλάδα και θα εντοπιστούν τα εμπόδια υλοποίησης αλλά θα αναφερθούν και παραδείγματα προσπαθειών σε αστικά κέντρα.

Λέξεις Κλειδιά: Σιδηρόδρομος, Βιωσιμότητα, Railtrail, Περιβάλλον, Τουρισμός, Μονοπάτια

JEL Κωδικοί: O0, O52,R42, Q56.

1. Introduction

Railroads played a central role in transportation worldwide from the second half of the 19th century, aiding regional development through changes in land uses. During their period of dominance, up to 1950, they were the key to the development of transport networks, however the rapid development of road networks was an inhibiting factor in their further development, leading to a decrease in their attractiveness and as a result many railway sections were decommissioned (Martí-Henneberg, 2017). Recently, however, the usefulness of the railway begins to increase, resulting in the creation of new lines, in accordance with the new technological data and speed requirements as well as the layout, and the abandonment of the older lines.

In the context of sustainability and environmental development, the removal of lines does not necessarily imply their abandonment, but their conversion through the rail trail practice. The term rail trail refers to the creation of multi-use paths, such as transportation and recreation, that run along decommissioned railway lines or parallel to an active railway (Moore&Graefe, 1994). The utilization of railways as a rail trail has already been implemented in many countries, such as the USA (Rails-to-TrailsConservancy, 2014) and Australia (Beeton, 2009). Rail trail conversion ought to be a point of interest and further research as a tourist product since its benefits lead to sustainability (Reis&Jellum, 2012), (Reisetal., 2014).

Rail trails can have multiple purposes. In many cases they can help with the daily commute of citizens if they are in urban centers (Merometal, 2003). Also, the longer paths have become an important recreation pole not only for locals but also for tourists (Reis&Jellum, 2012). These trails usually have unique features related to the location, landscape, cultural heritage and history of each place, which attract a significant number of tourists (Reis&Jellum, 2012). Modern environmental demands are linked to the creation of "green" infrastructure, as such infrastructure improves the quality of life of citizens, a fact supported by research that links the well-being of citizens to the accessibility of said infrastructure (Lachowyczetal, 2013) a matter in which (Prideaux, 2002) also agreed in his research. Health benefits come from exposure to green spaces and interaction with nature.However, the evidence for the existence of "green" infrastructure shows mixed findings. Trail accessibility is a key factor in footfall as evidenced by research conducted in Belgium (Dumontetal., 2005), where the majority of visitors to the Demerbroeken forest came from areas up to ten kilometers away. Other investigations (Schipperijnetal., 2017) also showed that the number of parks located within a radius of one kilometer is associated with an increase in the physical activity of citizens.

Trails are also an important tourism product for each region, so the process of expanding their application will be helped by studies of the importance of their services as tourism goods (Leiper, 2004). The area traversed by a rail route may not have enough or no attractions, in this case it is recommended to create tourist attractions in conjunction with advertising campaigns that will attract new visitors (Sharpley, 2007).

Therefore, the selection of a decommissioned railway section for its reuse as a rail trail is a complex process that depends on many factors, beyond the existence of the decommissioned railway, as the lack of infrastructure or tourist attractions can negatively affect the viability of the project and therefore to his success. Furthermore, the implementation of the rail trail can be realized where there are removed sections of railway tracks with adequate hospitality or recreation infrastructure for visitors (Kołodziejczyk, 2021).

The decommissioned lines in Greece can be used to create rail trails, as according to OSE data, the country's railway network has a total length of 2,773 km, of which 2,265 km correspond to active lines, 321 km to a network under suspension and 187 km on a decommissioned network (Tsiotas, 2016). This prospect can bring significant benefits to the areas where the rail trails extend,

increasing their touristic appeal, thus helping regional development. However, the benefits extend to the state level, as the economy will be boosted and a new opportunity to spread history and tradition will be provided. However, this prospect, as mentioned above, requires the cooperation of both state and private entities as well as the cooperation of citizens, in order to ensure the sustainability of the project.

2. Benefits of rail trails

2.1. Rail trail as a tourism product

The appeal of rail trails is high due to the universal accessibility of non-motorized users, due to gentle gradients, fairly wide corridors and stable surfaces. These characteristics are a consequence of the structure of the railways and the limitations of the tracks, thus providing an ideal environment for the organization of recreational activities that attract a wide range of visitors. (Moore&Graefe, 1994; Beeton, 2009). The rail trail's ideal infrastructure and landscapes combined with the promotion of non-motorized use make for a tourism product that is rapidly growing in popularity.

Prohibiting motorized users along a rail trail promotes environmental protection through low-carbon emission activities, thus contributing to the sustainability of the project.This feature attracts environmentally conscious tourists and enhances the quality of the product as a sustainable tourism option. Also, actively engaging with the landscape adds another dimension to the visitor's experience, which often evokes a sense of well-being and health enhanced by the safety of the route due to the lack of motorized vehicles.

The amenities of a location where a rail trail is located affect its attractiveness. Its spatial positioning often crosses forests and generally areas of natural beauty. As national parks are in many cases tourist attractions, a denser network of routes or more infrastructure along the rail trail enhances the attractiveness of the route (Kołodziejczyk, 2021). Infrastructure may take the form of catering facilities or stop and rest areas. The existence of these factors is a criterion for the selection of visitors.

2.2. Rail trail as a mean of wellbeing for citizens

The existence of parks and generally "green" infrastructure positively affects the health and well-being of citizens. Growing research in the category of "green exercise" examines the physical and psychological benefits that can accrue to those who exercise in "natural" environments, but what constitutes a "natural" environment varies from study to study (Bambergetal., 2018). However, evidence shows a positive association between parks and physical activity as well as other health-related outcomes, but the results are unclear and difficult to compare directly due to the wide range of measures and methods used to determine park access. and the type of physical activity carried out in them (Schipperijnetal., 2017).

A well-designed park can motivate users to adopt a more active lifestyle, especially if it is combined with the natural landscape, as in the case of the rail trail. The rhythms of life in modern urban centers lead to people's distance from nature, resulting in the deterioration of their mental and physical health, through the increase of daily stress. Engaging in physical activities in nature helps reduce stress (Sugiyama, 2018). The type and duration of the exercise vary depending on the physical or mental state of the visitor.

Evidence supporting the health benefits of green infrastructure users is growing. However, the recreational and sports areas in a city are predetermined and often disproportionate to the population. Adding new recreational spaces to the layout of the built environment is difficult to accomplish in

existing neighborhoods. In contrast, existing railways are considered relatively easy to modify as they often run through an urban network.

The number of parks within one kilometer in urban areas had consistent associations with the presence of physical activity (Dumontetal., 2005). Therefore, the conversion of a railway line can improve the health of citizens in urban centers as well. Therefore, the creation of a rail trail on lines that are part of an urban network can enhance the mobility of citizens and encourage transport in more environmentally friendly ways. This benefit results from the earlier use of the railway as a means of transport of all types, as well as its spatial placement in points of interest in the urban center.

These routes should be addressed to all age groups. Attendance at young ages seems to be greatly influenced by the reputation of the route among their peers (Riveraetal., 2021). The reputation of a rail trail is also based on factors such as proximity to permanent residence, as the transportation of these groups is mainly on foot, but also on the connection the trail has with nature and its cleanliness. Physical exercise at these ages is not a primary reason for visiting. Therefore, in order to ensure visits from these ages, the organizational authorities of the route should invest in the view of the route.

Older adults also agree that the view and maintenance of the trail play a large role in their choice (Chang, 2020). The distance parameter doesn't seem to affect them, as proximity to a path expands as a term. The benefits derived from exercise help prevent health problems associated with age and a sedentary lifestyle.

3. Factors that affect rail trail success

The most important factor in the success of a rail trail is its environmental sustainability. Although the flora and fauna may have been disturbed to create the railway line, there were no restoration processes and consequently their local population could not repopulate the area. Thus during the conversion of the railway it is possible to restore migratory routes for animals, as well as to create protection reserves for the preservation of wildlife and plants. Several rail routes around the world have used this feature as an incentive for support from governmental and non-governmental agencies and organizations. This fact highlights the sustainability of railways as a rail trail, as it promotes the preservation of infrastructure by creating a green corridor that might otherwise continue to further disrupt the environment.

The length of a rail trail is also a determining factor in selecting a line segment for conversion, as length can influence visitor choice based on the length of their visit. Visitors prefer longer routes so length is a critical aspect to consider when classifying a rail trail as a tourism product. Some paths in the USA are an example. less than 1 km long, which, while attracting visitors every day as connecting passages, do not at the same time have power as tourist products (Rails-to-Trails-Conservancy, 2014).Because of their physical characteristics, disused railway lines are the preferred types of infrastructure for the implementation of rail trails. Abandoned railways are almost completely separated from road networks with a reduced number of crossings, they have gentle longitudinal gradients, no steep elevations and relatively wide and long corridors. Thus, it is ideal for the construction of paths, even for the most vulnerable users such as children, the elderly and people with reduced mobility (Beeton, 2009).

The accessibility of a rail trail is a factor in its success, but for its attractiveness “Gateways” must also be created (Reis&Jellum, 2012). Gateways are defined as the starting or ending points of the route, where visitors are provided with information about the route, the place, the history and even

information about accommodation and bicycle rental. In many cases the gates can develop into an independent tourist attraction due to their size and the amenities they may offer, thus enhancing the appeal of the rail trail.

Visitors to a rail trail can be native or non-native, but this fact is independent of whether they revisit the trail. In order to achieve the repeated visit, the gates and the paths that will be created, have the task of highlighting the particularities of the paths, so as to encourage the visitors both to visit the place again, and to recommend it to others (Leiper, 2003). The particularities to be highlighted can consist of many factors, such as the rich nature along the route, the accessibility of the walkways for disabled people (due to the small gradients), the tradition of the area and the activities that are possible in the area.

The success of a rail trail, being a tourist product, is mainly based on the attractiveness of a place and the particularities that visitors will encounter so that they visit this place again. In this case, a big role is played by the local and state administration, which may undertake the promotion and information campaign as well as the operation and maintenance costs of the route. However, the support of the state alone is not enough for the sustainability of the project, as residents and businesses should be involved so that the visitor has a pleasant experience.

Along a rail trail it is a common phenomenon that there are tourist attractions such as archaeological monuments, museums, natural habitats, etc., which need to be highlighted. However, new attractions can also be created in the form of events, such as the organization of cycling races or a celebration of local products, which encourage a visitor's choice. Establishing events of this scale requires the cooperation of local government and citizens to play a supporting role in raising financial resources for the maintenance of the trails.

The sustainability of this project as mentioned above is mainly based on the proper management of the product that is created and for this it is proposed to create rail trail management bodies that can come from the local government or cooperative bodies. They are vital to the success of the rail trail as they contribute to the development, funding, maintenance and promotion of the trails. In many cases there are cooperative agreements between local governments, non-profit organizations and state agencies responsible for parks and recreation to manage rail trails, which has already happened in countries with active rail trails, such as in Australia (Beeton, 2009).

Finally, one of the main factors affecting the visitor's experience, and thus the likelihood of returning or recommending the rail trail, is the condition of the trail. The maintenance of the path has a serious impact, both on the sustainability of the rail trail and on the environment, while the existence of rest infrastructure or sanitary facilities help to manage pollution more smoothly and contribute to the overall positive impression of the visitor. The provision of water supply and drainage along the entire length of the route is also considered necessary. In general, infrastructure is necessary for the attractiveness of a rail trail, as the use of rail trails can vary depending on the activities that take place on it.

4. Retrofitting themethods implementedinforeigncountries to Greece

4.1 Implementation methods in foreign countries

The utilization of railways as a rail trail has already been implemented in many countries, such as the USA. (Rails-to-Trails-Conservancy, 2014) and Australia (Beeton, 2009), as the existence of unused railway tracks is a consequence of technological development. The methods used, although

they differ slightly per country mainly due to geographical differences, agree in several aspects of the study stage.

During the selection of the appropriate lines for their transformation into a rail trail, spatial analysis methods were used in many cases, depending on land uses, through "Geographic Information Systems" (GIS) software. GIS software has been helpful in selecting suitable segments thanks to the ability to combine information on many parameters, such as investment opportunities, the existence of monuments, the length of the line, proximity to urban centers, accessibility of the line, land uses, and even information on the attractiveness of the landscape.

In a second stage, the investigation of attractiveness was carried out through questionnaire surveys, and finally advertising campaigns followed to inform visitors, native and non-native, in order to increase the traffic of the route. As part of the campaign, the mass media and social media were used to promote the product. In the case of Australia, the appeal of the rail trail was studied, focusing on visitors who were cyclists or pedestrians within a 5 km radius of the line. The purpose of the study was to encourage visitors through the promotion of entertainment and health. The results showed a great acceptance of the rail trail as a new means of recreation.

The appeal of a rail trail can be increased through the use of advanced marketing techniques, which can be undertaken by the state or the associations responsible for the line. As part of the advertising, websites and brochures can be created to inform visitors about the benefits and activities provided along the route. Trail websites can provide prospective visitors with all the necessary visit planning information, such as route maps, attractions and history of the area along the rail trail, events being held, and contact information for lodging and tourism. businesses.

The lack of consistent funding for the maintenance and cleanliness of an attraction has been identified as an ongoing concern (Hughes & Carlsen, 2010). Reliable sources of funding are essential for the development and ongoing management of rail trails. Therefore, the viability of a rail trail is linked to the existence of financial resources that can be allocated to the maintenance and development of the rail trail as a tourism product. It is worth noting that the lack of financial resources sufficient for the sustainability of the rail trail stands out as a problem even in successful rail trails around the world, such as the one in Otago, New Zealand (CentralOtagoDistrictCouncil, 2012).

4.2. Method implementation in Greece

Greece has a railway network of 2,773 km, of which 187 km are abandoned (Tsiotas, 2016), (Figure 1). Decommissioned sections of railway often pass through areas rich in history and tradition which help to select a section to be converted into a rail trail. The choice of a rail trail should initially be based on its proximity to urban centers or more generally to areas with accessibility through other transport networks that facilitate the visitor, as was the case with the rail trail from Lilydale to Warburton in Australia (Beeton, 2009), as its accessibility alone has established it as an attraction. As all the decommissioned railway tracks of the Greek network are close to an urban center, they are in principle considered capable of conversion. This selection can be accelerated through the use of GIS programs, after detecting the suitable part of the line to convert.

Reliable sources of funding are essential for the development and ongoing management of rail trails.Many of the decommissioned railway tracks in Greece may need initial capital to convert them into a rail trail, which may negatively affect the viability of the project. These modifications vary depending on the terrain of the railway, for example bridged areas need to be covered to provide a single layer of traffic and safety side protection added to the edges of the bridge to prevent falls.

The width of on the decommissioned tracks in Greece rangesbetween two types: a) metric and b) normal, hence the provisions of the Official Government Gazette of the Hellenic Republic 206/B/30-1-2017 on the subject “Definition of technical specifications for the marking, construction and maintenance of hiking trails” can be applied to them, to ensure the passage of pedestrian users as, depending on the width of the line, accessibility for people with reduced mobility will also be defined. The lengths of decommissioned railway tracks in Greece vary, however the selection of a suitable section is possible. Long routes, i.e., longer than one kilometer, are the easiest candidates for conversion, but shorter ones can also be converted as they can also be used as passageways to access long routes if they intersect with them, or if they are in urban areas. centers enhancing the mobility of citizens.

Figure 1. Railway network of abandoned and active railwaytracks of Greece (Railway Hero, 2022).

The history of ancient and modern Greece is a key factor for its tourism and thus the success of a rail trail is based on the choice of that route that will be able to promote it. This promotion can be carried out in many ways, such as drawing such routes to show the special points of interest of each region or the organization of sports events or various cultural events that are covered by the mass media and social media.

The creation of gateways and intermediates along the length of the route can stimulate visits to areas, thereby boosting the local economy. In many areas in Greece, the railway was the only means of communication for small communities before the development of the road network. The railway stations of these areas can be used as rail trail gateways, thus promoting their history and tradition.

Information about the new rail trails that will be created can take place on various television and radio stations as well as on social media. The advertising of the routes will also give space to the advertising of the involved bodies, therefore also to the revenues that will be used to cover the costs of operation and maintenance of the route.

Finally, an important role will be determined by the authorities responsible for the route, as they will also be responsible for the smooth operation and maintenance of the rail trail, as well as its further development and promotion as a tourist product.

4.3. Construction regulations

Accordingtothe Official Government Gazette of the Hellenic Republic(OGG 206/B/30-1-2017), a path is defined as a narrow non-motorized road intended for the passage of mainly pedestrians and animals. Mountain hiking trails are routes intended for hiking, mountain climbing and pedestrian access to natural environments, attractions and in general the acquaintance and contact of man with the nature, history and culture of each place. In addition, they are used to serve communication and facilitate access to mountainous forest areas or points, traditional settlements and difficult, inaccessible low-altitude areas. Motorized vehicles are prohibited on the hiking trails. According to the Official Government Gazette of the Hellenic Republic (OGG 206/B/30-1-2017), long-distance paths must be passable and be a combination of individual paths and existing paths and forest roads that are established with special markings. As for the dimensions of hiking trails, they vary depending on the intensity of use of the trail and its category. More specifically, on large slopes (from 25% and above) and altitudes (from 1,000m and above) the width of the climbing path is suggested to vary up to 1.20m, on moderate slopes (from 10%to 25%) between 0.80 and 1.60m, and on gentle slopes (under 10%) from 1.20 to 2.40m.

In order to classify the path that will be created along the decommissioned railway line according to what is mentioned in the Official Government Gazette of the Hellenic Republic (OGG 206/B/30-1-2017), the following categories of paths related to the longitudinal slope of the track should be taken into account:

a) easy (ideal for disabled access) with slopes of 0 to 10%,
b) moderate with slopes of 10% to 15% and
c) difficult with slopes of 15% to 25%.

The minimum width of a walking path varies between 85 cm and 1 m. An exception is the case of people in wheelchairs, in which case the minimum width is set at 1.5 m, while every 100 m a widening of a total width of 2.2 m and a length of 5 m should be done. It is noted that on the decommissioned railway lines the gauges are of two categories: a) metric (1 m) and b) normal (about 1.5 m). In Figure 2, an example of a typical standard gauge railway line is shown.

On mountain paths, hard pavements are allowed either in exceptional cases, such as in permanently slippery or slippery soils that become muddy and it is not possible to improve the passability with drainage works, or in cases of preservation of cultural heritage (OGG206/B/30-1 - 2017). As walkers prefer more natural terrain, it is recommended to cover the lines with dirt or gravel on medium and high difficulty routes (Kolodziejczyk, 2021).In the paths that run through urban fabrics according to the feasibility study in the greater Milwaukee area (Milwaukee) it appears that for an urbanized area, asphalt and concrete are ideal types of surfaces (Rails-to-Trails-Conservancy, 2020).

Vegetation of the decommissioned railway will vary, given the topography, so the clearing and excavation procedures will also vary as the case may be, as the vegetation that has grown on the sides of the railway may cause potential difficulty in bringing in construction equipment for maintenance(OGG 206/B/30-1-2017).

Figure 2: Railway line with conventional bearing(Pirgidis, 2015).

The configuration of rest areas can be done in natural gaps or artificial expansions, which can be located close to the primary paths or approached by secondary paths and appropriate markings. There it is allowed to make micro-leveling, to clear the vegetation, to place prefabricated wooden tables or benches or to construct such installations from natural materials. The choice of rest areas is ideal to be combined with the presence of water (natural springs) or to build water pumping, water transport from close distances and a tap. A similar combination can be made at viewpoints or other points of special interest (OGG 206/B/30-1-2017).

5. Conclusions

All over the world after 1950 the importance of railways declined, with a significant proportion of the networks being phased out. From the 1990s onwards, the rise of high-speed rail led to the phasing out of old railway lines and their replacement by new ones with different gauge requirements. Unused railways can now be converted into paths dedicated to pedestrians, cyclists and people with reduced mobility, to be used both for leisure and tourism and for daily commuting if located in urban centers.

In addition, through the conversion of unused railways into rail trails, it is possible to preserve old railway architectural monuments such as bridges, tunnels, stations and auxiliary buildings, elements of great value that can provide cultural experience to visitors and help preserve historical memory of the railway to the younger generations.

Growing interest and demand for rail trails as tourism products is often hindered by a lack of financial resources and management by local and state authorities. Greece being a country with favorable conditions for the conversion of decommissioned lines for tourism, could benefit from such utilization. This fact creates the need to provide stakeholders and stakeholders with tools to assist the decision-making process and to evaluate as better as possible the benefits and costs of implementing such a perspective.

The purpose of this paper is to attempt a bibliographic review of the methods and benefits in the conversion of decommissioned railways into rail trails and to propose methods of their application in Greece. The selection of a section of abandoned railway for conversion to a rail trail is influenced by many factors, which makes the choice and decision complex. However, the rich history of Greek railways and the unique locations of some decommissioned railway sections create favorable conditions for further investigation. In any case, the benefits of reusing decommissioned railway sections should not only be sought at an economic level, but also at a social and environmental level.

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Session 10
Environmental Pollution Modelling

Preliminary study for the deployment of low-cost sensors-based particulate matter (PM) monitors in a few cities in Senegal

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Abstract
As Africa develops, more Africans are living in populated areas, where atmospheric pollution reaches high levels and put their lives at risk. Exposure to air pollution can lead to a wide range of diseases, which includes headaches, stroke, lung cancers, etc. More generally, chronic exposure can affect every part of the body. Particulate matter ($PM_{2.5}$) has been recognized as a leading cause of cancer. Atmospheric pollution not only impacts health but has a high economic cost. However, data on atmospheric pollution are still scarce in African cities due to lack of monitors, one of the reasons being the high upfront cost of high-grade monitors. Low-cost sensors-based monitors owing to their features are bringing hope. In the study, we evaluated the conditions for the deployment of low-cost monitors in Senegal. A cost analysis led us to the conclusion that hybrid networks made up of one reference monitor and a few low-cost monitors could be the cost-effective configuration to get air quality data. A couple of low-cost monitors available on the market were compared, and devices powered by solar panel and operating on cellular communication appeared to be well suited to the Senegalese context. Airqo devices were acquired and tested but failed to provide the expected performance. In particular, the calibration model couldn't be established because of the mismatch between data generated from the station and that obtained with the Airqo sensor.

Keywords: *African cities; air sensors; calibration; air quality.*

JEL Classification: I15; O29; R00

Προκαταρκτική μελέτη για την ανάπτυξη οθονών χαμηλού κόστους με βάση αισθητήρες σωματιδίων (PM) σε μερικές πόλεις της Σενεγάλης

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Περίληψη
Καθώς η Αφρική αναπτύσσεται, περισσότεροι Αφρικανοί ζουν σε κατοικημένες περιοχές, όπου η ατμοσφαιρική ρύπανση φτάνει σε υψηλά επίπεδα και θέτουν τη ζωή τους σε κίνδυνο. Η έκθεση στην

ατμοσφαιρική ρύπανση μπορεί να οδηγήσει σε ένα ευρύ φάσμα ασθενειών, οι οποίες περιλαμβάνουν πονοκεφάλους, εγκεφαλικά επεισόδια, καρκίνους του πνεύμονα κ.λπ. Γενικότερα, η χρόνια έκθεση μπορεί να επηρεάσει κάθε μέρος του σώματος. Τα σωματίδια (PM2,5) έχουν αναγνωριστεί ως η κύρια αιτία καρκίνου. Η ατμοσφαιρική ρύπανση δεν επηρεάζει μόνο την υγεία αλλά έχει υψηλό οικονομικό κόστος. Ωστόσο, τα δεδομένα για την ατμοσφαιρική ρύπανση εξακολουθούν να είναι σπάνια στις αφρικανικές πόλεις λόγω έλλειψης οθονών, ένας από τους λόγους είναι το υψηλό αρχικό κόστος των οθονών υψηλής ποιότητας. Οι οθόνες χαμηλού κόστους που βασίζονται σε αισθητήρες λόγω των χαρακτηριστικών τους φέρνουν ελπίδα. Στη μελέτη, αξιολογήσαμε τις συνθήκες για την ανάπτυξη οθονών χαμηλού κόστους στη Σενεγάλη. Μια ανάλυση κόστους μας οδήγησε στο συμπέρασμα ότι τα υβριδικά δίκτυα που αποτελούνται από μία οθόνη αναφοράς και μερικές οθόνες χαμηλού κόστους θα μπορούσαν να είναι η οικονομικά αποδοτική διαμόρφωση για τη λήψη δεδομένων ποιότητας αέρα. Συγκρίθηκαν μερικές οθόνες χαμηλού κόστους που διατίθενται στην αγορά και οι συσκευές που τροφοδοτούνται από ηλιακό πάνελ και λειτουργούν σε κυψελώδες επικοινωνίες φάνηκαν να ταιριάζουν καλά στο πλαίσιο της Σενεγάλης. Οι συσκευές Airqo αποκτήθηκαν και δοκιμάστηκαν αλλά απέτυχαν να παρέχουν την αναμενόμενη απόδοση. Συγκεκριμένα, το μοντέλο βαθμονόμησης δεν ήταν δυνατό να καθοριστεί λόγω της αναντιστοιχίας μεταξύ των δεδομένων που παράγονται από το σταθμό και εκείνων που προέρχονται από τον αισθητήρα Airqo.

Λέξεις Κλειδιά: Αφρικανικές πόλεις; αισθητήρες αέρα; βαθμονόμηση; ποιότητα αέρα.

JEL Κωδικοί: I15; O29; R00

1. Introduction

Africa is experiencing a rapid demographic growth; from around 1,4 billion inhabitants today, the African population is projected to reach 2,5 billion by 2050. This rapid growth comes with several challenges and issues: pressure on natural resources, increasing demand for electricity and water, as well as in the education sector; high rate of urbanization is followed by crowded cities and rising demand in real estate. In parallel, we are witnessing a deterioration of the air quality accentuated by poor road infrastructure, old car fleet, low quality fuels, unregulated emissions in the industrial sector, poor management of solid municipal wastes, and uncontrolled mining activities. More broadly, air pollutants may have a natural, anthropogenic, or mixed origin. Natural and anthropogenic origin include burning of fossil fuels in transports, cooking activities (households, restaurants…), industrial processes (electricity generation, cement factories, etc.), open burning of solid waste, natural sources (volcanic eruption, Sahara dust storm, etc.), agricultural activities and bush fires, mining activities and construction work(Agbo et al., 2021; Alvarez et al., 2020).

Key primary pollutants are found in the form of particulate matter (PM: 1; 2.5; 10), black carbon (BC), sulphur dioxide (SO_2), nitrogen oxides (NO_X), ammonia (NH_3), carbon monoxide (CO), methane (CH_4), and volatile organic compounds (VOCs). More Africans are living in populated cities, where atmospheric pollution reaches high levels and put their lives at risk. Exposure to air pollution can lead to a wide range of diseases, which includes headaches, stroke, lung cancers, chronic obstructive pulmonary disease, dementia, asthma, type 2 diabetes, and respiratory infections(European Environment Agency, 2020; Health Effects Institute, 2022; Katoto et al., 2019). More generally, chronic exposure can affect every organ in the body: eyes, brain, lungs, heart, stomach, liver, bones, and even the reproduction. $PM_{2.5}$, has been recognized as a leading cause of cancer. The health effects of the PM depend on health condition, sex, and age. Long-term exposure of children to air pollution affects their cognitive faculty while that of pregnant women can lead to

low weight and premature birth(Rees et al., 2019). Atmospheric pollution also bears a high social, economic and environment cost. Fisher et al. evaluated the lost in economic growth due to air pollution, and ~1% of GDP lost by African countries each year(Fisher et al., 2021).

Air quality data are scarce in Africa, and this is due to the lack of air quality monitors. Africa does not show up in any air quality maps – see for instance Fig. 1. Governments lack information and financial resources to acquire reference monitors, from which generated data would help sustain their policy. High-grade monitors are expensive and require skilled personnel for their operation and maintenance. Low-cost sensors-based monitors are bringing hope owing to their features. They are easy to deploy, flexible and cheap. This study deals with the ongoing efforts to bridge the gap in air quality data in Senegal. The investigation is carried out in the framework of the LCS-WACA project, a project funded by the CAMS-Net to install few networks of low-cost sensors in Senegal.

Figure 1: Sensors' map generated from the IQAir platform.

2. Air Quality Monitoring in Senegal

Senegal is a country of about 17 million inhabitants, located in West-Africa. Dakar, its capital city is one of the many megacities in the region with four million inhabitants, that is 25% of the total population. The population density is quite high, with an average of 6,000 inhabitants per km^2, but can reach 10,000 in some parts of the city, like Dakar-Plateau. The population is unequally distributed, most people living in coastal cities in the West: Dakar, Saint-Louis, Ziguinchor, Thiès and Fatick. The climate is tropical, hot, and dry with a short rainy season that can last from two up to five months depending on the region. The proximity with the Sahara Desert in the East and Atlantic Ocean as border in the West, plays an important role in the distribution of the population, the climate being more tolerant in the West, than in the East where population density falls below fifty, in some areas.

Senegal has an AQM centre (Centre de Gestion de la Qualité de l'Air, CGQA) which operates under the umbrella of the Ministry of the Environment and Sustainable Development. CGQA has installed a couple of air quality monitoring (AQM) stations in Dakar, in the following areas: Bel-Air, Plateau, Pikine, Yoff, HLM, Medina, Diamniadio and Guediawaye (Sow et al., 2021). There is no AQM station installed in the rest of the country. A reference grade monitor, a Teledyne T640 generates AQ data from the premises of the US Embassy, in Dakar. A very limited number of low-cost air monitors installed for research purposes are also found in the country.

3. Cost Estimate of the Deployment of Air Quality Monitors

The deployment of AQ monitors in all 14 regions is of paramount importance. Here we assume a minimum number of one (1) AQM dedicated to the monitoring of fine particles per region (Fig. 2). Deploying them will require a feasibility study, purchase, integration, and setup of the whole system. Cost estimates thus include cost of feasibility study, monitors, IT infrastructure, logistics, etc. A lump sum of €25,000 is assumed for the feasibility study. We consider a Beta Attenuation Mass (BAM) monitor Model 1020 from MetOne as our reference monitor that costs around €25,000/unit and as low-cost monitor, the Clarity NodeS costing €1,500/unit (Fig. 3). For logistics, we assume a team of three (3) workers that will rent a car, travel around the country, and spend approx. three days per region. We assume €100/day for the car rental, €100/day for fuel and €200/day per worker.

Figure 2: AQM deployment Map in Senegal in all 14 regions

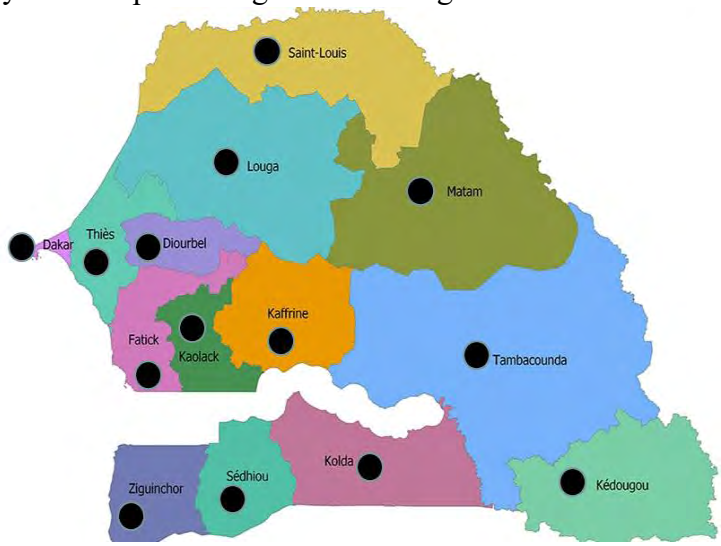


Figure 3: Monitors, BAM1020 (left) and Clarity NodeS (right).

Table 1 displays cost analysis of the deployment. The total investment cost of the deployment of the reference monitors is approx. €401,800 which is around 6 times higher than that of the low-cost monitor. However, both systems will require almost the same investment for operation and feasibility study. Highly skilled personnel will be required for the BAM while, low-cost sensors are easier to deploy and maintain. Data accuracy is of great importance, and nowadays can only be provided by reference monitors even though perspectives for low-cost sensors are encouraging. To obtain high quality data, low-cost monitors will require onsite calibration, that is why it should be added a

reference monitor in the second case, ending up with a hybrid network as depicted in Fig. 4 costing €97,800 (~4 times cheaper). The hybrid network integrates a reference monitor and a few well calibrated low-cost sensors all deployed in a region.

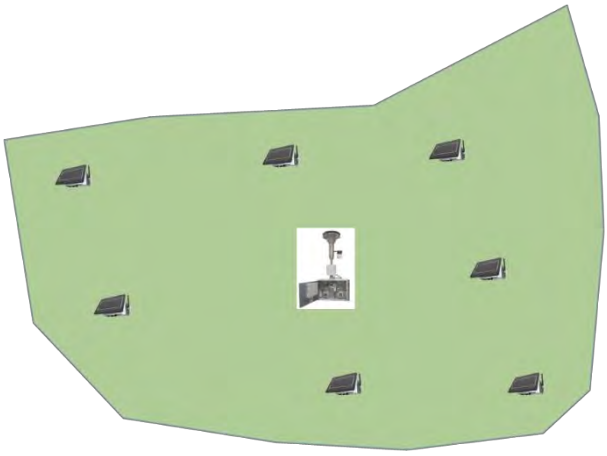
Table 1: Cost analysis of both reference and low-cost monitors configurations

Devices	Beta Attenuation Mass monitor (BAM 1020)	Clarity NodeS
Pollutants monitored	Fine particles (PM1; 2.5; 10)	Fine particles (PM1; 2.5; 10)
Total cost of monitors (€)	350,000	21,000
IT infrastructure (€)	10,000	10,000
Logistics (€)	16,800	16,800
Investment cost (CAPEX)	376,800	47,800
Operation cost (OPEX)*	18,840	18,840**
Feasibility study (€)	25,000	25,000
Total investment cost (€)	401,800	72,800
Skill level	High	Low
Accuracy	High	Low

*We assume OPEX: 5% of CAPEX

**The OPEX was kept as for the BAM 1020

Figure 4: The hybrid network with a reference monitor and a few low-cost sensors



4. Low-Cost Particulate Matter Sensors Comparison

A low-cost monitor uses simple and cheap components which include dust sensors, microcontroller unit (MCU), a power supply (battery plus connection to the grid, battery plus solar panels or direct connection to the grid without energy storage), electrical protection, a fan (with its controller), a laser diode (and its controller), and a photodiode (coupled to an amplifier/filter), a GPS module, data storage system, a communication system (Wi-Fi, Bluetooth, GSM, etc.), etc. Few other sensors could be added such as humidity, temperature, atmospheric pressure, sound, etc. The working principle is based on the light scattering and metering. The fan moves the air into the box, and when it is passing, the diodes through light scattering detect the particles. Such a monitor could integrate one or several dust sensors, and the final measurement will be the average value obtained. A market

survey was caried out to select an appropriate monitor to be used for the lcs-waca project. Guidelines and criteria proposed in the literature were applied to select the most suitable devices(Giordano et al., 2021; Zimmerman, 2022): power delivery, connectivity, sensors density, data access, sensor management, etc. Our goal is to monitor atmospheric pollution, in hospitals, in school premisses, on roadsides, in dumpsites, in industrial areas, and residential areas as well, etc. Monitors fulfilling following criteria were selected: (1) be powered by solar panels with integrated energy storage backup system (for continuous operation, as this helps to avoid power cuts as it is the case when plugged to electrical grid), (2) use cellular communication system (better developed than Wi-Fi in most places), and (3) data access through API or data storage system (micro SD-card). Devices available on the market and compared in this study are displayed in Table 2. Both IQAir outdoor and Purpleair use Wi-Fi and should be plugged to the grid. The Clarity Node-S uses cellular communication and solar panels for autonomous operation but was more expensive than Airnote and Airqo devices.

Table 2: Low-Cost Monitors Comparison

	Airnote	**Clarity Node-S**	**Airqo**	**IQAir**	**PurpleAir**
Sensors (PM, T, RH)	Yes	Yes	Yes	Yes	Yes
Solar panel	Yes	Yes	Yes	No	No
Energy backup	Yes	Yes	Yes	No	No
Cellular comm.	Yes	Yes	Yes	No	No
Data storage	No	No	No	No	Yes
Indoor appl.	Yes	?	No	No	Yes
Outdoor app.	Yes	Yes	Yes	Yes	Yes
Cost (€)	150	1,500	250	300	300

5. Testing and Calibration Methods

In August-October 2022, few Airqo devices were acquired and first tested – see Fig. 5. Each device is equipped with two PM sensors, has a GSM connection, is powered by solar panels and data can be accessed through an API platform. An important step is the calibration of devices before their deployment. Several models are found in the literature: Linear and quadratic regression models, Gaussian process models, Clustering model, Artificial neural network (ANN) model, and Hybrid random forest models. Although AI-based models are more efficient, we adopted a simple approach using a multivariate linear regression model. The general equation will look like eq. 1:

$$y = a_0 + a_1 x_1 + a_2 x_2 + \cdots + a_k x_k + \epsilon \quad (1)$$

where k is the number of independent variables ($x_1 \ldots x_k$) and $a_0 \ldots a_k$ are the regression coefficients. Here two independent variables, temperature and relative humidity would be used as they influence noticeably the concentration of pollutants in the atmosphere. Between September and October 2022, we were able to collocate the devices with a reference monitor in the Municipal Hall of the city of Pikine - see Fig. 5. The reference monitor belongs to the CGQA and was designed and manufactured by envea. The primary goal was to run the devices and compare the performance with that of the reference monitor and subsequently improved the data using a calibration model.

Figure 5: Airqo monitors installed in Pikine.

(a) (b)

6. Results and discussion

Figure 6 shows the hourly variation of the PM concentrations from both instruments as recorded on the 6th of October 2022. As can be seen, both instruments seem to present opposite trends. The station is located close to a very busy roadway, and the recorded concentration is highly influenced by the traffic, that's why the concentration peaks around 16:00 because of the traffic jam. This is not seen with low-cost sensors.

Figure 6: Hourly variation of PM2.5 and PM10 concentrations from both monitors (Airqo left, station in the right) on the 6th of October 2022

(a) (b)

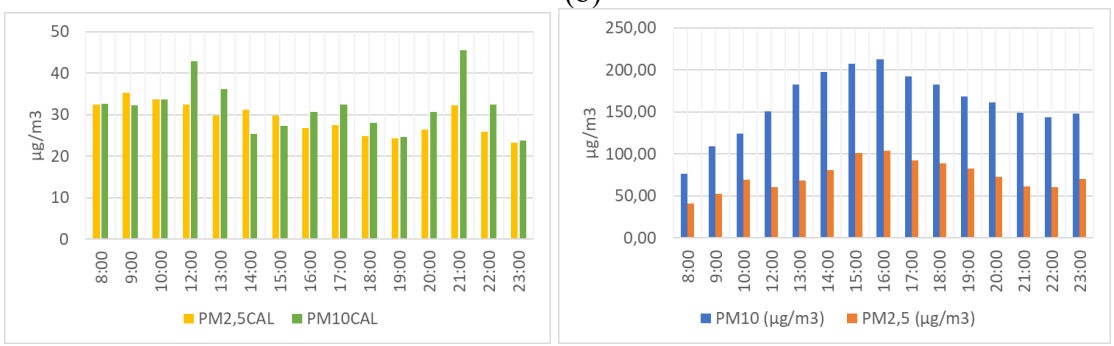


Figure 7: Correlation between PM2.5 and PM10 concentrations.

(a) (b)

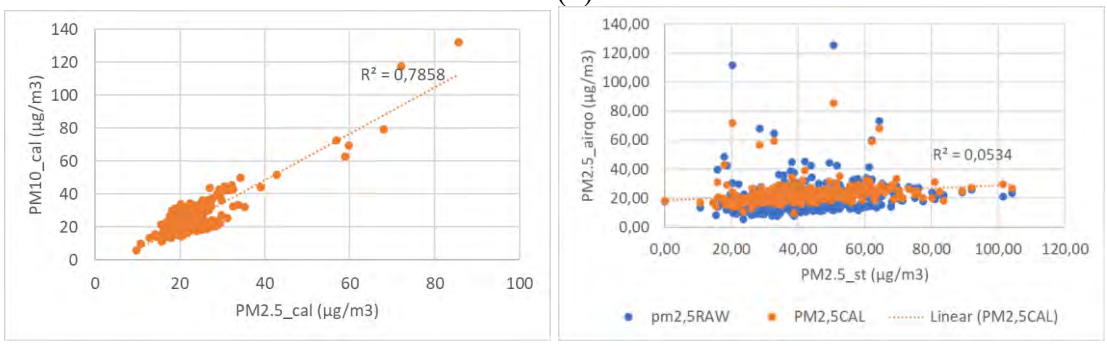


Fig. 7a shows good correlation between PM10 and PM2.5 from the low-cost sensor (R^2=*0.78*). While confronting PM2.5 concentrations from both the station and the low-cost sensor, no correlation appears (Fig. 7b). The same observation applied for the PM10 concentration. It was then concluded that the low-cost sensor does not perform well. Investigations are still going on to understand the poor performance of the Airqo device and acquire and test other devices.

7. Conclusions

Africa has a growing population in a context of rapid industrialization and high urbanization of its cities. In parallel, we are witnessing a growing pressure on natural resources and the environment followed by a deterioration of the air quality. However, governments have not yet taken adequate measures because of lack of data and adequate monitoring infrastructure. The consequences are already visible, with increasing rates of pulmonary diseases, cancer, stroke, and many other air pollution related diseases. In the framework of the lcs-waca project, few Airqo monitoring devices were acquired and tested. First testing did not allow to build the sought calibration models, as the results were not encouraging. Next direction will be to test other market available devices. The economic analysis led to the conclusion that hybrid networks of air sensors is the cost-effective configuration for AQM deployment in the Senegalese context.

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A comparative critical analysis of the major EFRAG, SEC and ISSB proposals,for climate disclosure

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Abstract

The climate disasters of the last decade have made it imperative that corporations provide climate-related risk information and ratings to investors and stakeholders alike. Lack of a consistent methodology for pertinent data disclosure, measurement, and interpretation of the physical and financial risks integral in corporate operations urged companies to devise their own appropriate guidelines and frameworks. The proliferation of emerging initiatives and their voluntary nature limited their effective implementation,credibility and, consequently, usefulness. A gradual change from the belief that disclosure requirements and reporting content should be established on a voluntary, market-determined basis to the explicit recognition that the formation and enforcement of such standards should be dictated by authority regulators is recently gaining momentum. The need to encourage the development of globally consistent standards, promote comparable metrics and narratives, and coordinate across approaches became evident as one that can be served only by international or State-backed regulators who have the executive authority to impose their decisions. This paper presents the major initiatives in the climate reporting field being developed in 2022 in the EU via the European Commission-EFRAG proposal, in the USA via the Securities and Exchange Commission (SEC) proposal, and globally via the International Sustainability Standards Board (ISSB) proposal. It goes on to compare these three major proposals in terms of jurisdiction, prescriptiveness, materiality, scope, compliance timeline, metrics employed, cost, assurance, and alignment with pre-existing standards. The paper concludes by critically evaluating the consequences of the introduction of the proposals for the climate cause, the reporting entities and the wider stakeholders, and by commenting on the impact of their adoption by the Greek corporate reality.

Keywords: *Non-financial reporting, Climate reporting, SEC proposal, EFRAG proposal, ISSB proposal*

JEL Classification: G11; G32; Q51; M4.

The effects of climate change to weather-related environmental hazards: Interlinkages of economic factors and climate risk

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Abstract

The global phenomenon of climate change has become increasingly intense in recent years due to the cumulative nature of environments. The effects of this phenomenon are now felt across the globe throughout the year. Environmental science is characterized by interdisciplinarity and the aforementioned phenomenon attracts more and more researchers to investigate it. A great number of researchers support the idea that climate change is strongly connected to some environmental hazards, and specifically, those correlated to extreme weather events. Following the Paris Agreement, and due to the increased concern regarding climate change impacts, several indices have been established. Climate Change Performance Index (CCPI) includes 59 countries and EU, which cumulatively emit 92% of global greenhouse gases, while Global Climate Risk Index (CRI) analyses to what extend countries have been affected by impacts of weather-related loss events. Both indices provide annual scores to each country and rank them based on those scores indicating the existing environmental situation. In our analysis we provide evidence regarding the connection of CCPI and CRI by using graphs, mapping visualization as well as econometric estimations in order to draw lines between indices. Moreover, we examine the interlinkages and we estimate the influence caused by socio-economic factors and emissions levels per country. We provide evidence regarding the high-ranked and low- ranked countries and how they perform not only to an environmental base but also to an economic base. Our main attempt is to testify whether economic growth is a great contributor to country's environmental performance and as a result to climate risk.

Keywords: *Climate change; climate risk index; extreme weather events;socio-economic factors, emissions.*

JEL Codes: O11, O40, Q20, Q30, Q43, Q54.

1. Introduction

Over the last years, it was observed that extreme weather-related environmental hazards appeared to rise continuously, worsening the current encumbered environmental situation while exposing more and more people to risk. A majority of researchers emphasize the fact that greenhouse gas (GHG) emissions are one of the main components of climate change. At the same time, the phenomenon of climate change appears to have a connection with the sea surface temperature anomaly as well as extreme weather events and environmental hazards. The global phenomenon of climate change has

become increasingly intense in recent years due to the accumulation of pollution and the associated environmental degradation. The effects of this phenomenon are now felt across the globe throughout the years. Other researchers connect climate change with other macroeconomic and environmental factors.

The purpose of this paper is to initially describe two of the most known climate indices, the Climate Risk Index (CRI) and the Climate Change Performance Index (CCPI), by briefly describing the meaning of the reported scores. Based on our knowledge, there is no published work yet that examines the possible causality of these two indices, as well as whether these indices are affected by socio-economic factors. We hope that such an attempt will provide evidence that will help us understand the interlinkages between the indices, the society and the economy. Based on this evidence, we can, therefore, propose actions that need to be taken in order to possibly improve the current situation of environment. The submitted work is part of the published paper Halkos, G., & Zisiadou, A. (2023). "The Effects of Climate Change to Weather-Related Environmental Hazards: Interlinkages of Economic Factors and Climate Risk." *Journal of Risk and Financial Management*, *16*(5), pp. 264, doi: **10.3390/jrfm16050264**.

2. Literature Review

Climate change is a phenomenon that raises a lot of attention in the last decades by researchers focusing both on its causes and impacts (Vieira et al. 2022; Mikhaylov et al. 2020; Bruhwiler et al. 2021; Shalini et al. 2021; Kron et al. 2019; Zheng et al. 2019; Cloy 2018; Chang and Hu 2019; Elum and Momodu 2017; Zakarya et al. 2015; Chang et al. 2018; de Castro Camioto et al. 2016; Tu et al. 2016; Chen et al. 2015; Belke et al. 2011; Niu et al. 2011; Pao and Tsai 2010; Tsai 2010; Neves and Lean 2010; Karvonen et al. 2010; Ramanathan and Feng 2009; Chapman 2007; Manish et al. 2006; Mirza 2003; Karl and Trenberth 2003). Nowadays, more and more concern has been raised due to the possible connection established between climate change and environmental hazards (Mikhaylov et al. 2020; Zheng et al. 2019; Cloy 2018; Chang and Hu 2019; Zakarya et al. 2015; Chang et al. 2016 de Castro Camioto et al. 2016; Tu et al. 2016; Chen et al. 2015; Belke et al. 2011; Niu et al. 2011; Manish et al. 2006).

In an attempt to analyze the impacts of greenhouse gas emissions (GHG), scientists such as Mikhaylov et al. (2020), Manish et al. (2006) and Bruhwiler et al. (2021) provide information regarding three of the main components of GHG emissions. More specifically, the three main GHG emissions are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), with CO_2 being the

major greenhouse gas (GHG) emission responsible for climate change. As it is underlined by Manish et al. (2006), the major industrial sector that causes almost 75% of CO_2 globally is the energy sector.

Based on the available information and published literature, it is well known that a great impact of the increased greenhouse gases (GHGs) is the alteration of the global surface temperature. More specifically, greenhouse gas (GHG) emissions lead to an unexpected warming of the globe's surface as well as the atmosphere, creating the known phenomenon of "global warming". As Ramanathan and Feng (2009) underline, this phenomenon, which has been observed for many years, is related to the extended risk humans are facing, which has recently been correlated to extreme weather events. Some of the most common meteorological hazards they list are rainfall, glaciers' sea ice retreat and the change in sea level as well as other observed events. The impacts of global warming are proven to severely affect humans' lives. Interestingly, there are chained effects connected to global warming. The increased temperature leads to the polar ice melting, causing the rise of the sea level. This phenomenon may have flooding areas close to the coast, in which agricultural production may be threatened, as an outcome. Any threat on the agricultural procedure may have an immediate impact to the economic growth, especially when these areas are agricultural and fishing focused regions (Mikhaylov et al. 2020). Regarding fishery, the rise of sea temperature may lead to increased risk for the aquatic animals and severe outcomes to region's biodiversity in general (Karvonen et al. 2010).

Consequently, climate change is strongly connected to some environmental hazards, and specifically, those correlated to extreme weather events. Following the Paris Agreement, and due to the increased concern regarding climate change impacts, several indices were established. Many researchers have emphasized that, during recent decades, specific events have been observed. More specifically, Elum and Momodu (2017) underline the fact that human activities have led to an increased number of greenhouse gas (GHG) emissions released in the atmosphere, increasing the challenges from the climate change perspective. At the same time, Kron et al. (2019) shed light to the increased trend of weather-related events and the consequences observed after the occurrence of those events. Here comes the importance of environmental indices and more specifically climate indices. Eckstein et al. (2021), in their report, provided evidence that people around the globe are facing the reality of climate change and the increased volatility of extreme weather events. Shockingly, in a period of two decades (2000–2019), over 475,000 people lost their lives worldwide, and a 2.56 trillion USD economic loss was reported as a direct result of more than 11,000 extreme weather events. The occurrence and intensity of weather-related disasters have increased in recent years all over the world, as mentioned by Kron et al. (2019).

Two interesting freely available indices are the "Climate Change Performance Index—CCPI" and "Climate Risk Index—CRI". In order to include these two indices in our analysis, it is crucial to understand the purpose and the components of these valuable instruments. Eckstein et al. (2021) published the latest report of the Climate Risk Index. This report, published in 2021, is named the "Global Climate Risk Index 2021", and as they underline, it includes the latest available data for 2019. This important index uses weather- and disaster-related variables in order to compute scores and ranks of countries, providing information on the level to which countries and regions have been affected by the impacts of climate-related extreme weather events (storms, floods, heatwaves etc.). It is important to mention that countries highly affected by these events receive lower scores on the Climate Risk Index, and as a result, they are placed at a lower position in the ranking. Thus, there is a negative relationship between CRI score and the risk that countries are exposed to. As the CRI score increases, the risk a country is facing decreases. Countries at the lower ranking positions are those that are more vulnerable to risk and received the lower scores. Mozambique (CRI score equals to 2.67), Zimbabwe (CRI score equals to 6.17) and the Bahamas (CRI score equals to 6.50) were the countries most affected by the impacts of extreme weather events in 2019. It is stated that developing countries tend to be more affected by and vulnerable to extreme weather events (Mirza 2003), a statement that is also raised in Halkos and Zisiadou (2019).

Following the same concept, Burck et al. (2022) published the latest report of the Climate Change Performance Index. This report, published in 2020, is named the "Climate Change Performance Index 2021", and as underlined, it includes the latest available data for 2019. The countries included in this index are responsible for the creation and emission of 92% of the total amount of greenhouse gases (GHGs) globally. The index uses four components in order to calculate and provide the final score and rank per country. These components are four environmental variables (greenhouse gas emissions, renewable energy, energy use, and climate policy), indicating that the index takes into consideration both the traditional methods of energy production that create GHG emissions and the environmentally friendly alternative methods of energy production, or the renewable energy sources. It is important to note that there is a positive relationship between CCPI score and the performance of countries recorded. As the CCPI score increases, the country has a better overall climate change performance. Countries at the lower ranking positions are those that are more vulnerable to climate change and thus received lower scores.

3. Methodology

The methodology that will be used in our analysis contains econometrics approaches and diagnostic testing that will provide evidence regarding the relationships between the dependent and independent variables and ensure that all OLS assumptions are valid. Moreover, mapping visualizations will illustrate the areas where high concentrations of emissions are observed. Similarly, charts regarding the comparison of CCPI scores and CRI scores as well as the sea surface anomaly temperatures over the years will be included in our analysis.

3.1. Hypotheses

Our main purpose is to examine and provide evidence regarding the possible linkage between the Climate Change Performance Index (CCPI) and Climate Risk Index (CRI) and the relationship, if any, with important macroeconomic and environmental variables. The initial step of our analysis is to establish the under-consideration hypotheses, which will be answered using the econometric specifications.

H1: *There is a connection between the Climate Change Performance Index and Climate Risk Index.*

H2: *Economic growth can affect the Climate Change Performance Index.*

H3: *Economic growth can affect the Climate Risk Index.*

H4: *Population can affect the Climate Change Performance Index.*

H5: *Population can affect the Climate Risk Index.*

H6: *Greenhouse gas emissions worsen the Climate Change Performance Index.*

H7: *Greenhouse gas emissions decrease the Climate Risk Index.*

H8: *Use of renewable energy can positively influence the Climate Change Performance Index.*

H9: *PM2.5 can adversely affect the Climate Change Performance Index.*

3.2. Data Selection and Variables

Our main aim in this paper is to examine the behavior and the determinants of two Climate Indices, the Climate Change Performance Index (CCPI) and the Climate Risk Index (CRI). Using cross-sectional data, we have the CCPI and CRI as dependent variables in our two model specifications. It is crucial, though, to mention that we are aiming to examine a possible causality

between these two variables, so each dependent variable of one model specification will also be included as an independent variable to the other model specification.

The model specifications to be estimated are the following:

$$Model\ 1: CRI_i = \beta_0 + \beta_1 CCPI + \sum_{i=2}^{7} \beta_i X_i + \sum_{i=8}^{11} \beta_i Z_i + u_i$$

$$Model\ 2: CCPI_i = \gamma_0 + \gamma_1 CRI + \sum_{i=2}^{7} \gamma_i X_i + \sum_{i=8}^{11} \gamma_i Z_i + v_i$$

where CRI stands for the Climate Risk Index for the year 2019Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε. for the available countries, CCPI stands for the Climate Change Performance Index for the year 2019Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε. for the available countries, Xi includes all macroeconomic variables of our model specifications and Zi includes all environmental variables of our model specifications for the year 2019. Regarding the macroeconomic variables included in our estimations, we use the GDP per capita, GDP growth, population density, population growth, access to electricity and the poverty ratio, whose data were retrieved by World Bank database for the year 2019Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε. , while the environmental variables used are greenhouse gases (kt), PM2.5 Mean Annual Exposure, PM2.5 % of population exposed to levels exceeding the WHO guideline, renewable energy consumption, whose data were retrieved by the World Bank database for the year 2019[4]. It is important to mention that we use year 2019 as the year of our analysis due to the fact that the latest CRI reported calculations were published for year 2019.

The two examined environmental indices, CRI and CCPI, are both connected to climate change, its causes and its impacts, and we aim to investigate whether there is any evidence indicating a possible influence of one index to the other. The causality, if any, of these indices will be examined using a Granger Causality test. This will be followed by model specifications with CRI and CCPI both as dependent and explanatory variables in exploring the magnitude of influence and their statistical significance.

4. Empirical Results and Discussion

4.1. Index Comparison over Time

Before we proceed in estimating the proposed econometric model specification presented in Section 3.2, we would like to provide initial knowledge of the evolution of the main two indices that we discuss on this paper. For this purpose, we present two figures (Figures A1 and A2) that compare

the CRI and CCPI scores for 2019 with other periods in the following Sections 4.1.1 and 4.1.2, respectively.

4.1.1. Climate Risk Index Comparison over Time

Figure A1 in Appendix B illustrates the comparison of the CRI scores for 2019 and the average CRI scores for a 20-year period (2000–2019), as was presented in the latest CRI report. Following the multilateral agreements regarding environmental issues, we expect to observe that the values of 2019 will exceed the average values of the 20-year period. As illustrated in Figure A1, in 2019, not all countries exceeded the mean value of CRI score of the 20-year period. The countries that follow an increasing trend of CRI score, and as a result face less risk, are Algeria, Belgium, Bulgaria, the Czech Republic, France, Germany, Hungary, Italy, Latvia, the Netherlands, Poland, Portugal, Romania, the Russian Federation, Slovenia, Switzerland, Thailand and the United Kingdom. The rest of the countries recorded CRI scores lower than the reported mean values.

4.1.2. Climate Change Performance Index Comparison over Time

Similar to Section 4.1.1, we analyze the evolution of the CCPI scores. However, in this case, we do not compare them with the mean value of a specific period, as in the CRI case, but we compare the year 2019 with year 2022. From all countries included in the analysis, we observed that 20 countries, in 2022, reported CCPI scores higher than those reported in 2019. More specifically, the countries accomplishing higher CCPI scores over the 3-year period (2019–2022) are Algeria, Australia, Austria, Bulgaria, Cyprus, Denmark, Egypt, Estonia, Germany, Greece, India, Indonesia, Ireland, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal and Slovenia. These results emphasize the fact that some countries following the environmental rules, agreements and establishments report great values and, as a result, better climate change performance over the years. Additionally, we can observe that only five countries report both greater values of CRI and CCPI scores over the years. These five countries are Algeria, Bulgaria, Germany, Portugal and Slovenia. As a further research proposal, we highlight the need for the examination and illustration of the evolution of environmental indices, starting with the Climate Risk Index and Climate Change Performance Index.

4.2. Causality Testing

Moving forward to the econometric analysis, we aim to examine the possible causality between the Climate Change Performance Index and Climate Risk Index. For this reason, the Granger

Causality test was performed on our collected data. The null hypotheses of the test indicate that the CCPI does not cause the CRI and, similarly, the CRI does not cause the CCPI. Based on the results presented in Table 1, regarding the hypothesis that the CCPI does not cause the CRI, we observe that the *P*-value of the test is greater compared to all significance levels, so we do not reject the null hypothesis and, therefore, it is proven that the CCPI does not cause the CRI. Similarly, regarding the hypothesis that the CRI does not cause the CCPI, we observe that the *P*-value of the test is greater compared to all levels of significance and, thus, we do not reject the null hypothesis proving that the CRI does not cause the CCPI.

Table 1. Granger Causality Test.

Pairwise Granger Causality Tests			
Null Hypothesis:	n	F-Statistic	Prob.
CCPI 2019 does not Granger Cause CRI 2019	53	0.20785	0.6504
CRI 2019 does not Granger Cause CCPI 2019		0.72913	0.3972

Concluding, based on the analysis presented above and the specific datasets used by the authors, we can confirm that, for Hypothesis 1, there is no proven connection between the Climate Change Performance Index and Climate Risk Index.

4.3. Cross-Sectional Analysis

Moving forward, in an attempt to examine the hypotheses under consideration, our analysis proceeds with the use of econometric model specifications and various diagnostics. More specifically, the two models described in Section 3.2 will be estimated using cross-sectional analysis, examining multiple sampled countries for a given year (2019). All related diagnostic tests will be conducted in order to secure the accuracy of all estimated outcomes.

4.3.1. Climate Risk Index

Our first attempt was to determine the variables that affect the Climate Risk Index. Using the specification of Model 1, as described in Section 3.2, we conducted cross-sectional OLS estimations, and we received the results provided in Table A1 (see Appendix A). The first column of Table A1 indicates all variables used in each model specification, the second column provides the results of the initial estimation of Model 1 (hereafter Model 1a) and the third column provides the results of the final estimation of Model 1 (hereafter Model 1b), which were specified based on diagnostic tests and

econometric criteria. For each estimation, we provide the calculated value of the estimator, the t-statistics of each estimator (values in parentheses) and the *P*-values of each estimator (values in brackets). The second part of the table includes all diagnostic tests needed when using cross-sectional analysis.

As we can observe, the initial model (Model 1a) appears to have only 3 statistically significant estimators (at some levels of significance) out of the 11 included variables. More specifically, economic growth, population density and greenhouse gas (GHG) emissions are observed to be statistically significant at the 90% and 95% level of significance but not at the 99% level of significance. Regarding diagnostic testing, as can be seen in Table A1, Model 1a does not suffer from heteroskedasticity due to the fact that all diagnostic tests provide probability values greater than α (for $\alpha = 0.10$, $\alpha = 0.05$ and $\alpha = 0.01$), leading us not to reject the null hypothesis, and indicating that Model 1a does not have heteroskedasticity problems. Examining for the Autoregressive under Condition of Heteroskedasticity effect (ARCH effect), we can state that the ARCH LM test of Model 1a received a probability value equal to 0.1765, greater than any usual α; thus, we do not reject the null hypothesis and the estimated model does not have any ARCH effect. Another diagnostic test we used is the Ramsey RESET test for specification errors, which gave a probability value equal to 0.9911. Once again, we do not reject the null hypothesis and the estimated specification does not suffer from specification errors. Last but not least, the authors used the Variance Inflation Factor (VIF) to examine for any possible multicollinearity. All values provided were much lower than 10, indicating that we do not have multicollinearity in Model 1a.

After examining all possible issues that a cross-sectional estimation may demonstrate, we should eliminate the statistically insignificant variables to receive the final estimation. For this attempt, we use the Akaike Information Criterion (AIC) and Schwarz Criterion (SC). Model 1b provides the final estimation, which includes only the statistically significant variables and the better AIC an SC values. Based on our estimations, only four variables appear to be statistically significant at the final approach of Model 1. More specifically, the GDP growth appears to be statistically significant at all levels of significance and has a positive effect on the dependent variable. With an increase of 0.01 of GDP growth, the Climate Risk Index will increase by 0.07246. It is important to mention, once again, that countries recording lower CRI scores appear to be riskier. In other words, the increased CRI score places each country in a safer position. That being said, the increase of GDP growth increases the final CRI score, ceteris paribus, leading to less climate risk for each country of examination. Based on this evidence, we observe that Hypothesis 3 is valid.

Similarly, we examined the population density variable in an attempt to test the validity of Hypothesis 5. As it is displayed (see Table A1, Appendix A) in Model 1b, the population density is statistically significant at 90% level of significance, leading to the validation of Hypothesis 5 that population can affect the Climate Risk Index. Moreover, we can emphasize the fact that the coefficient of estimation has a negative sign, meaning that, if population density increased by 1 unit, then the final CRI score would decrease by 0.02696, which basically increases the risk of a country. In other words, the densely populated countries are proven to be risker, regarding the Climate Risk Index, due to the fact that the increase of population density leads to the decrease of the CRI score, placing the countries in lower performance ranks.

Following the same analysis, we examined Hypothesis 7. Model 1b indicates that greenhouse gas (GHG) emissions are statistically significant at all levels of significance and negatively affect the CRI score. As it is observed, with an increase of 100 units (kt) in greenhouse gases (GHGs), the CRI score will decrease by 0.000644, which basically increases the risk of a country. In other words, countries that record higher levels of GHG emissions are proven to be risker, regarding the Climate Risk Index. To sum up, Hypothesis 7 is validated. Before moving to CCPI analysis, it is important to discuss the last variable that appears to be statistically significant in our analysis. The variable "access to electricity" is statistically significant at all levels of significance and positively affects the CRI scores, indicating that countries with access to electricity, or more specifically, countries where the majority of citizens have access to electricity, record higher CRI scores and as a result are proven to be less risky with respect to the Climate Risk Index.

4.3.2. Climate Change Performance Index

Our first attempt was to determine the variables that affect the Climate Change Performance Index. Using the specification of Model 2, as it was described in Section 3.2, we conducted cross-sectional OLS estimations, and we received the results provided in Table A2 (see Appendix A). The first column of Table A2 indicates all variables used in each model specification, the second column provides the results of the initial estimation of Model 2 (hereafter Model 2a) and the third column provides the results of the final estimation of Model 2 (hereafter Model 2b) which was specified based on diagnostic tests and econometric criteria. For each estimation, we provide the calculated value of the estimator, the t-statistics of each estimator (values in parentheses) and the *P*-values of each estimator (values in brackets). The second half of the table includes all diagnostic test needed when using cross-sectional analysis.

As can be observed, the initial model (Model 2a) appears to have only 2 statistically significant estimators (at some levels of significance) out of the 11 included variables. More specifically, population density is observed to be statistically significant at 10% and 5% level of significance, and renewable energy consumption is observed to be statistically significant at all levels of significance. Regarding the diagnostic testing, as can be seen based on Table A2, Model 2a does not suffer from heteroskedasticity due to the fact that all diagnostic tests provide probability values greater than the usual levels of α (α = 0.10, α = 0.05 and α = 0.01), leading us not to reject the null hypothesis and indicating that Model 2a does not have heteroskedasticity issues. Examining for the Autoregressive under Condition of Heteroskedasticity effect (ARCH effect), we can state that the ARCH LM test of Model 2a has a probability value equal to 0.9763, much greater than any α; thus, we do not reject the null hypothesis, and the estimated model does not have any ARCH effect. Similarly, the Ramsey RESET test for specification errors gave a probability value equal to 0.6489. Once again, we do not reject the null hypothesis, and the estimated regression does not suffer from specification errors. Finally, in the Variance Inflation Factor (VIF), all values provided were much lower than 10, indicating that we do not have multicollinearity issues in Model 2a.

To proceed to the proposed estimated model specification, we eliminated the statistically insignificant variables. Relying on the Akaike Information Criterion (AIC) and Schwarz Criterion (SC), Model 2b provides the final estimation including only four statistically significant variables. More specifically, the population density appears to be statistically significant at all levels of significance and have a positive effect on the dependent variable. In an increase of 1 unit of population density, the Climate Change Performance Index will be increase by 0.013127. It is important to mention, once again, that countries recording higher CCPI scores appear to have a better climate change performancecompared to the countries placed on the lower ranks of the index. That being said, the increase in population density increases the final CCPI score, ceteris paribus, leading to better climate change performance for each country examined. Based on this evidence, we observe that Hypothesis 4 is validated.

Similarly, we examined the renewable energy consumption variable in an attempt to confirm Hypothesis 8. As it is displayed (see Table A2, Appendix A) in Model 2b, renewable energy consumption is statistically significant at all levels of significance, leading to the validation of Hypothesis 8 that the use of renewable energy can positively influence the Climate Change Performance Index. More specifically, if the renewable energy consumption increases by 1 unit, the CCPI score will be increased by 0.441216, ceteris paribus, leading to a better performance of each

country analyzed. It is important to mention that this result was expected due to the fact that one of the four components of the CCPI score is the renewable energy use.

Other significant variables included in our analysis are the access to electricity and the poverty ratio. Based on results displayed on Table A2 (see Appendix A), the access to electricity positively affects the CCPI score, and if the variable increases by 1 unit, then the CCPI score will be increased by 0.402132, ceteris paribus. Similarly, the poverty ratio is statistically significant only at the 90% level of significance, and it is positively affecting the CCPI score by 0.209132 per 1 unit increase, ceteris paribus.

Considering Hypothesis 2, Model 2b indicates that GDP growth is statistically insignificant at all levels of significance, leading us to the conclusion that Hypothesis 2 is not validated. That is, based on the datasets used, GDP growth seems not to affect the CCPI score of each included country. The decision taken regarding Hypothesis 6, which examines whether greenhouse gas (GHG) emissions can worsen the CCPI score, is interesting. Based on our analysis, the GHG emissions variable appears to be statistically insignificant at all levels of significance without validating Hypothesis 6, allowing us to underline that greenhouse gases (GHGs) do not have an impact on the CCPI score. However, it is crucial to mention, once again, that the GHG emissions variable is one of the main components of the CCPI score calculations, and the rejection of this hypothesis raises a lot of concern for further examination.

Finally, examining Hypothesis 9, in which we consider whether PM2.5 exposure can adversely affect the CCPI score, once again, it is observed that PM2.5 variables (both the PM2.5 mean annual exposure and PM2.5 % of population exposed to levels exceeding WHO guidelines) appear to be statistically insignificant, leading us not to validate Hypothesis 9. This implies that, based on the data included in our analysis, PM2.5 exposure does not influence the CCPI score and the general climate change performance of the countries included.

What is important to mention is the fact that, in order to have a better understanding and a more accurate model specification to reach a general conclusion, it would be meaningful to include more periods in our analysis and use more advance econometric methods, such as the panel data analysis, in an attempt to include time dimensions in our analysis alongside the cross-sectional analysis.

5. Conclusions

The purpose of our paper was to initially describe two of the most known climate indices, the Climate Risk Index (CRI) and the Climate Change Performance Index (CCPI) by briefly describing the meaning of the reported scores. Our aim was to examine the connection of Climate Change

Performance Index and Climate Risk Index through econometric specifications and diagnostic testing. After reviewing the literature regarding climate change, global warming, greenhouse gas emissions and economic factors that may affect the extreme weather-related events and disasters, we established nine (9) under-examination hypotheses and we used freely available data, both economic and environmental, in order to conclude whether the assumptions can be scientifically proved.

Based on our analysis and findings, we concluded that there is no proven relationship between Climate Change Performance Index and Climate Risk Index for the period analyzed. However, it would be useful to examine, in further research, a greater time span and with the use of dynamic panel data to take into consideration both dimensions (time and country). Regarding the economic aspects that may affect the indices, we investigated the effect of economic growth on both the CCPI and CRI. As has already been described, the hypothesis regarding economic growth and CCPI was not validated, showing that there is no significant effect of economic growth to the Climate Change Performance Index of 2019, which is in great contrast with many researcher outcomes (Mikhaylov et al. 2020; Zheng et al. 2019; Cloy 2018; Chang and Hu 2019; Zakarya et al. 2015; Chang et al. 2017 de Castro Camioto et al. 2016; Tu et al. 2016; Chen et al. 2015; Belke et al. 2011; Niu et al. 2011; Manish et al. 2006). Contrary to this result, the hypothesis regarding economic growth and the CRI was validated, indicating that there is a statistically significant positive relationship between economic growth and the CRI. We should underline once more that, the lower the CRI score, the greater the risk a country is facing; thus, an increase in the economic growth leads to an increase of the CRI score and minimizes the extreme weather-related risks a country is facing.

Similarly, the hypotheses regarding population density and its impact on the CCPI and CRI were validated in both cases, proving that there is a statistically significant connection between the population density of a region and the risk it faces, as well as its performance regarding energy use and emissions. What is an interesting finding is the one related to Hypotheses 6 and 7 regarding the greenhouse gas (GHG) emissions. Although it is clearly stated in the CCPI report that one of the four components of the index is the greenhouse gas emissions, this variable appears to be statistically insignificant in Model 2 of our analysis, meaning that it is not proven to affect the CCPI, contrary to the statement of Mikhaylov et al. (2020). On the other hand, greenhouse gases (GHGs) are statistically significant in Model 1; thus, there is a significant connection between greenhouse gases (GHGs) and the CRI. We propose that this finding, regarding the not-proven relationship between greenhouse gases (GHGs) and the CCPI, needs further research including a greater time span so as to take into consideration the cumulative nature of the environment.

Moving forward, the hypothesis testing the relationship of use of renewable energy and the CCPI is validated, as was expected, since renewable energy is another component of the index. Contrary to the greenhouse gases (GHGs), the case of renewable energy was proven to be significant, following the suggestions of a great number of researchers (Halkos and Zisiadou 2023; Bruhwiler et al. 2021; Mikhaylov et al. 2020; Lisin 2020; Li 2017; Huang et al. 2016; Levin 2012; Pao and Tsai 2010; Tsai 2010; Elum and Momodu 2017; Albergel et al. 2010; Allen et al. 2009; Gregory et al. 2009; Matthews et al. 2009), giving us the hope that the scores of the index will be improved if we change the way we produce the energy we demand. As is obvious, the indices examined in this paper are connected to the Sustainable Development Goals (SDGs) introduced by the United Nations. More specifically, four SDGs could be attached to this analysis including Goal 7 "Affordable and Clean Energy", possibly referring to renewable energy sources, and Goal 11 "Sustainable cities and communities", which aims to reduce greenhouse gas emissions. Moreover, Goal 12 "Responsible consumption and production" could be correlated to both the overconsumption and production of energy over the latest years, as well as Goal 13 "Climate action", a goal that should be taken into consideration for a fruitful and prosperous future that we can bequeath to the next generations. Last but not least is the hypothesis regarding another environmental variable, PM2.5 exposure and its possible effect on the CCPI. The hypothesis is validated based on the data and the period we used in our analysis; however, we propose further research regarding environmental variables.

To conclude, climate change is a well-known environmental phenomenon of our era, which not only has effects on the environmental, but also on economics (production and consumption) and human health. Taking into consideration all events of the last decade, such as extreme weather-related hazards, natural hazards, technological hazards, the current pandemic and the energy crisis, we understand that there is an emergency regarding the future of the globe. Measures need to be taken in order to turn to more sustainable sources of energy, both for self-sufficiency and as an action to mitigate climate change. The reduction of greenhouse gases (GHGs) and the adaptation of eco-friendly and sustainable techniques of energy production may eventually help the globe tackle the threats of climate change and bequeath a more prosperous future to the next generations.

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Appendix A

Table A1. Climate Risk Index Model Estimations and Diagnostics[Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.]

Explanatory Variables	MODEL 1a	MODEL 1b
Constant	−172.419 (−0.8158) [0.4206]	
CCPI 2019	0.790548 (1.547723) [0.1315]	
GDP per capita	0.000101 (0.521093) [0.6059]	
GDP growth	5.150745 (2.223919) [0.0333]	7.246164 (3.924154) [0.0003]
Population Density	−0.05403 (−2.59398) [0.0142]	−0.02696 (−1.9467) [0.0572]
Population Growth	7.681571 (1.23921) [0.2243]	
Greenhouse Gases (kt)	-4.68×10^{-6} (−2.15511) [0.0388]	-6.44×10^{-6} (−3.56221) [0.0008]
PM2.5 Mean Annual Exposure	−0.21807 (−0.76672) [0.4489]	
PM2.5 % population exposed to levels exceeding WHO guideline	0.047364 (0.278458) [0.7825]	
Renewable Energy Consumption	−0.38238 (−0.88729) [0.3815]	
Access to Electricity	2.099157 (1.013409) [0.3185]	0.618877 (11.29171) [0.0000]
Poverty Ratio	−0.37217 (−0.74004) [0.4647]	
R^2 Adjusted	0.235506	0.307223
Akaike Information Criterion	9.339981	9.17019
Schwarz Criterion	9.826578	9.317522
White test	6.521023 [0.8364]	0.474757 [0.9759]
B–P–G test	6.202796 [0.8595]	0.65843 [0.9564]

Harvey test	0.698917 [0.7300]	0.684987 [0.6058]
Glejser test	6.987718 [0.8001]	1.840904 [0.7650]
ARCH (LM) test	1.827094 [0.1765]	0.024335 [0.8760]
Ramsey RESET test	0.000126 [0.9911]	3.533802 [0.6661]
VIF	None	None

Table A2. Climate Change Performance Index Model Estimations and Diagnostics Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.

Explanatory Variables	MODEL 2a	MODEL 2b
Constant	−4.82342 (−0.06767) [0.9465]	
CRI 2019	8.81×10^{-2} (1.547723) [0.1315]	
GDP per capita	4.08×10^{-5} (0.634641) [0.5302]	
GDP growth	−0.82773 (−1.01218) [0.3190]	
Population Density	0.018654 (2.702526) [0.0109]	0.013127 (2.792242) [0.0080]
Population Growth	-2.16×10^{0} (−1.03791) [0.3071]	
Greenhouse Gases (kt)	1.19×10^{-7} (0.152974) [0.8794]	
PM2.5 Mean Annual Exposure	0.102454 (1.088949) [0.2843]	
PM2.5 % population exposed to levels exceeding WHO guideline	0.028289 (0.499542) [0.6208]	
Renewable Energy Consumption	0.444271 (3.623036) [0.001]	0.441216 (5.200124) [0.0000]
Access to Electricity	0.352995 (0.504493) [0.6174]	0.402132 (13.91733) [0.0000]
Poverty Ratio	0.221154 (1.342491) [0.1889]	0.209132 (1.866772) [0.0693]
R^2 adjusted	0.380903	0.421804
Akaike Information Criterion	7.145685	**6.936843**
Schwarz Criterion	7.632282	**7.099042**
White test	4.356389 **[0.9583]**	1.362016 **[0.8508]**
B–P–G test	7.064146 **[0.7939]**	2.056374 **[0.7254]**
Harvey test	1.385019	0.627164

	[0.2273]	[0.6460]
Glejser test	9.398123 [0.5852]	2.542984 [0.6370]
ARCH (LM) test	0.000883 [0.9763]	0.002315 [0.9616]
Ramsey RESET test	0.211436 [0.6489]	0.000512 [0.9821]
VIF	None	None

Appendix B

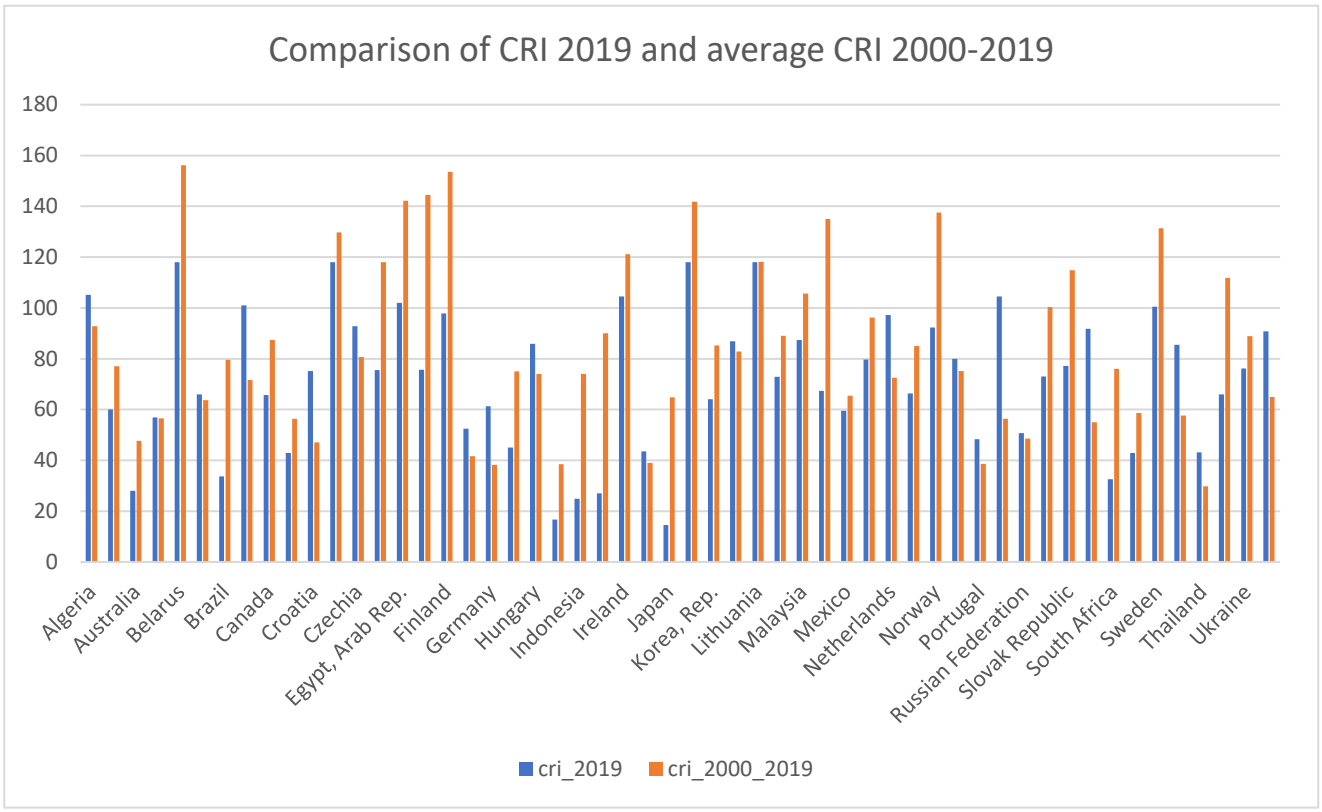

Figure A1. Comparison of CRI 2019 and Average CRI 2000–2019. *Conducted by the authors.*

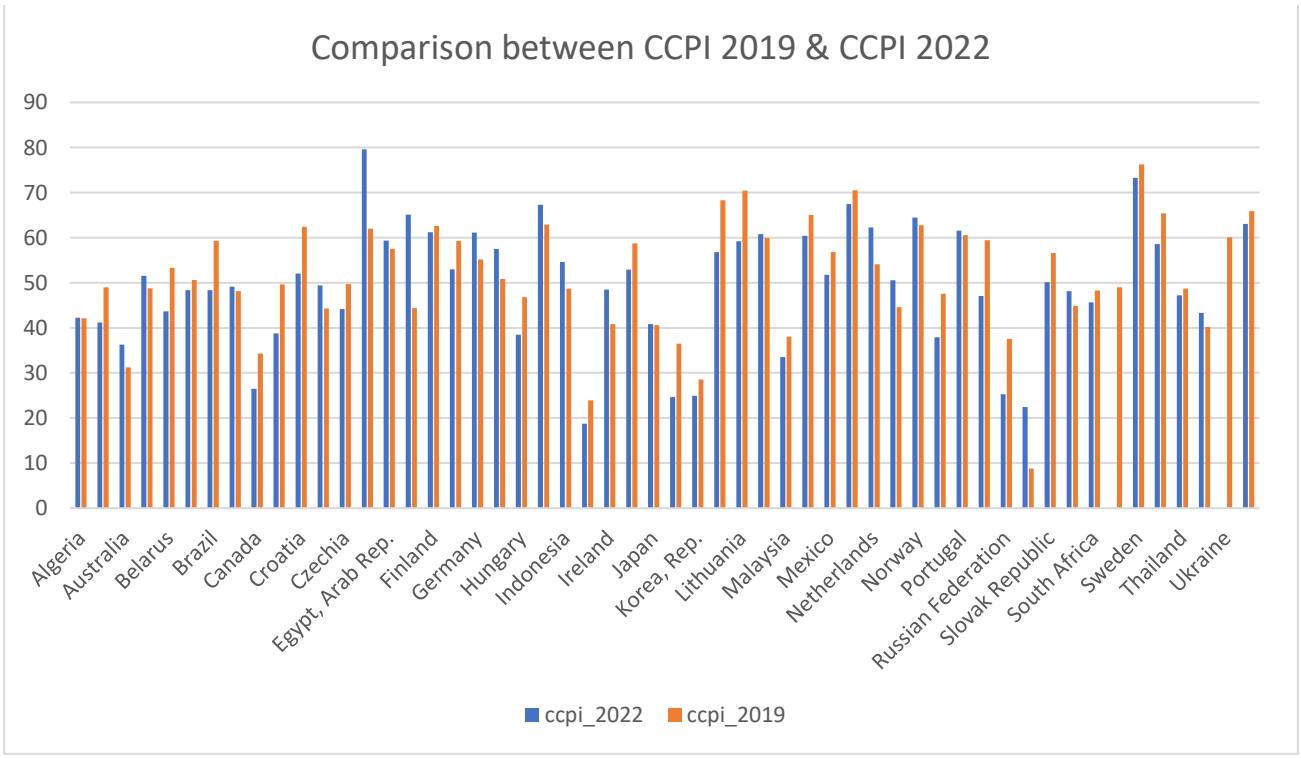

Figure A2. Comparison between CCPI 2019 and CCPI 2022. *Conducted by the authors*.

Improving collaboration of actors involved in Risk and Resilience Assessment Centers using Serious Games

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Abstract
Assessing the consequences of the occurrence of natural and technological hazards is critical and it should take place effectively and in a timely manner, so that key knowledge can be offered to the involved entities, as well as to businesses and citizens. This way, they will be able to adapt in time to possible disturbances and the associated mitigation practices and policies can reach their maximum potential. The Research Project "Risk & Resilience Assessment Center (RiskAC)" aims to create innovative infrastructure that will make it possible to perform rapid and effective data analysis of the evolution of a potential natural and/or technological risk and to evaluate the related consequences, assisting this way the decision-making process at the Prefecture of Eastern Macedonia and Thrace in Greece and providing at the same time timely information to businesses and citizens. The successful implementation of the Project requires the cooperation of a large number of people from different interdisciplinary groups who interact with each other, a fact that makes the process particularly dynamic and complex. A method for understanding, analyzing and interpreting complex problems is the so-called Serious Games, the design and use of which is an increasingly popular research field worldwide. The objective of the present paper is to explore the role of serious games in promoting the smooth and efficient collaboration of interdisciplinary teams and social partners in the field of resilience, using RiskAC as a case study.

Keywords: *Resilience, Risk, Natural and Technological hazards, Serious Games, Interdisciplinarity.*

JEL Classification: D81; D91; O32; O44; Q01; Q55; Q56

Ενίσχυση της συνεργασίας μεταξύ των διεπιστημονικών ομάδων ενός Κέντρου Εκτίμησης Ανθεκτικότητας και Διακινδύνευσης Κεφαλαίου μέσω Παιχνιδιών Σοβαρού Σκοπού

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Περίληψη

Η εκτίμηση των συνεπειών από την εμφάνιση φυσικών και τεχνολογικών κινδύνων είναι αναγκαία γνώση που πρέπει έγκαιρα να διασφαλίζεται και αποτελεσματικά να προσφέρεται στους αρμόδιους φορείς, στις επιχειρήσεις αλλά και στους πολίτες, ώστε να προσαρμόζονται εγκαίρως σε ενδεχόμενες διαταραχές και να αποδίδουν τα μέγιστα ενδεχόμενες πρακτικές και πολιτικές. Το Ερευνητικό Πρόγραμμα 'Κέντρο Εκτίμησης Διακινδύνευσης και Ανθεκτικότητας Κεφαλαίου Περιφέρειας Ανατολικής Μακεδονίας και Θράκης (ΚΕΔΙΑΚ-ΠΑΜΘ)' στοχεύει στη δημιουργία καινοτόμου υποδομής που θα παρέχει τη δυνατότητα ταχείας και αποτελεσματικής ανάλυσης δεδομένων σχετικά με την εξέλιξη μιας ενδεχόμενης φυσικής ή/και τεχνολογικής επικινδυνότητας και αποτίμησης των συνέπειών της, συμβάλλοντας στη διαδικασία λήψης αποφάσεων της Περιφέρειας και έγκαιρης ενημέρωσης των επιχειρήσεων και των πολιτών. Για την επιτυχή υλοποίηση του Προγράμματος απαιτείται η συνεργασία πολλών ατόμων από διαφορετικές διεπιστημονικές ομάδες που αλληλεπιδρούν μεταξύ τους, γεγονός που καθιστά τη διαδικασία ιδιαίτερα δυναμική και σύνθετη. Μια από τις μεθόδους κατανόησης, ανάλυσης και ερμηνείας πολύπλοκων προβλημάτων αποτελούν τα λεγόμενα Παιχνίδια Σοβαρού Σκοπού/Σοβαρά Παιχνίδια (serious games), ο σχεδιασμός και η χρήση των οποίων αποτελεί ανερχόμενο ερευνητικό αντικείμενο διεθνώς. Η παρούσα εργασία αποσκοπεί στη μελέτη του ρόλου των παιχνιδιών σοβαρού σκοπού στην προώθηση της ομαλής και αποδοτικής συνεργασίας διεπιστημονικών ομάδων και κοινωνικών εταίρων στο πεδίο της ανθεκτικότητας, χρησιμοποιώντας το ΚΕΔΙΑΚ ως μελέτη περίπτωσης.

Λέξεις Κλειδιά: *Ανθεκτικότητα, Διακινδύνευση, Επικινδυνότητα, Παιχνίδια Σοβαρού Σκοπού, Διεπιστημονικότητα.*

JEL Κωδικοί: D81, D91, O32, O44, Q01, Q55, Q56

1. Introduction

Resilience is increasingly considered as a vital element, critical pillar and at the same time key objective in the fields of risk management and disaster reduction (Graveline and Germain, 2022). It could be said that it has become a so-called "buzzword" lately (Heinzlef et al., 2020; Chelleri, 2012), as it is associated with a continuously growing volume of literature worldwide (Keating and Hanger-Kopp, 2020). According to the United Nations Office for Disaster Risk Reduction, resilience is "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management" (United Nations, 2016). The role of information sharing and effective communication among different actors and different sectors has been proven to be essential when disasters occur, to eliminate infrastructure disruptions and pave the way towards resilient communities (Chang et al., 2014).

A method for understanding, analyzing and interpreting complex problems is the so-called serious games, the design and use of which is an increasingly popular research area worldwide, with an established research line already in many scientific fields, including resilience and disaster risk management. Serious games are increasingly used to create awareness and boost knowledge acquirement in an engaging environment that calls for collaboration among different stakeholders (Agogué et al., 2015). They can also be used as a means for information provision around future situations associated with a high level of uncertainty, such as different risk scenarios (Van Pelt et al., 2015). The objective of this paper to enhance collaboration and information sharing in the field of disaster risk management and in particular among actors that are part of risk and resilience assessment centers using serious games. Such a center that has been created in northern Greece, as part of an EU research project, is used as a case study. The remainder of this paper is structured as follows:

The literature review section provides an overview of the concept of serious games, followed by some examples of existing game approaches with a focus on disaster risk management. After that, the case context is presented, with insights regarding the challenges faced by the actors involved. The next section describes the methodological approach that is followed to develop a tailored-made game for the case study, including an online interactive workshop that has been designed to collect input data for the game design. The paper concludes with some general thoughts regarding the use of serious games to enhance collaboration in similar situations and ideas for further research.

2. Literature Review

Although the term might sound new, in reality serious games is just a contemporary expression of theories and practices that have existed for centuries (Wilkinson, 2016). The concept of playing is intrinsically associated with human societies from ancient times, in every corner of the planet. In ancient Greece for instance, Plato was the first philosopher to emphasize the important role of playing in education (D' Angour, 2013).

Clark Abt, in his book *Serious Games* (1970) gives a definition of what makes a game "serious". According to him, "Serious games have an explicit and carefully thought-out educational purpose

and are not intended to be played primarily for amusement. This does not mean that serious games are not, or should not be, entertaining" (Abt, 1970). Shortly after, Duke (1974) published a book explaining why he considers games the language of the future. Almost fifty years later, many definitions of serious games can be found in the literature, by researchers in various scientific fields. In the context of the research presented herein, the following definition is considered suitable: Serious games are "experimental, rule-based, interactive environments, where players learn by taking actions and by experiencing their effects through feedback mechanisms that are deliberately built into and around the game" (Mayer, 2009; Lukosch et al., 2018).

Serious games can incentivize learning (Belloti et al., 2010) and it has been proven that collaborative learning in particular can be promoted and strengthened through the use of them (Oksanen and Hämäläinen, 2013). The concept of collaboration among diverse stakeholders and how to increase it lies in the core of many serious games in various scientific fields. For instance, in Roukouni et al. (2020) two collaborative serious games in the field of transport and logistics are presented. Mobinn (Mobilize Innovation) aims at increasing the understanding of blockers and enablers in the innovation process as well as at exploring the role of the different actors involved in the complex system of transport and logistics. The second game, Platform4barge, focuses on the container ecosystem and on the role of collaboration of multiple actors as well as the importance of data sharing in the era of digital platforms.

A recent overview of various digital and analog serious games which address issues related to disaster risk management is provided by Solinska-Nowak et al. (2018). The majority of the analyzed existing games focus on the ex-ante phase of prevention/mitigation (25 games) and preparedness (39 games) while there are several that address the response ex-post stage (22 games) and fewer that are dealing with the recovery phase (7 games). The authors claim that serious games can be valuable as they can help the persons involved to take into account different viewpoints than their own, while at the same time creating awareness and incentivizing collaboration with one another. They highlight however that additional research is necessary on the effectiveness of the games in the long-run. According to Scueller et al. (2020), stakeholders and scientist can often have a very different understanding of the concept of uncertainty and of what risk factors can actually entail, and the use serious games is able to tackle this hurdle, by creating awareness and enhancing collaboration, communication and inclusivity.

Increasing awareness of participants was also found to be an outcome of another serious game developed by De Ruiter et al. (2021). This serious game presents the challenges of an environment where multiple risk factors exist at the same time and it aims at assisting stakeholders in adapting and managing such situations in an as-effective-as-possible way. Gao et al. (2021) consider serious games to be one way to improve the level of understanding of the complexity of climate hazards, which can then pave the way towards resilience-oriented policy making. This is in line with the research of Fleming et al. (2020), where the role of serious games in bringing together different angles and facilitating the accomplishment of various stakeholders' objectives is underlined, with a focus on the fields of disaster risk management and climate change adoption.

3. Case Study: The Risk & Resilience Assessment Center (RiskAC)

The "Risk & Resilience Assessment Center (RiskAC)" is a research project, implemented under the Action "Reinforcement of the Research and Innovation Infrastructure", funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-

financed by Greece and the EU (European Regional Development Fund). It aims to create innovative infrastructure that will make it possible to perform rapid and effective data analysis of the evolution of a potential natural and/or technological risk and to evaluate the related consequences, assisting this way the decision-making process at the Prefecture of Eastern Macedonia and Thrace in Greece and providing at the same time timely information to businesses and citizens (RiskAC, 2023).

The realization of RiskAC is taking place as a result of the joint effort of approximately 80 experienced and young researchers from different Departments of the Democritus University of Thrace, the Aristotle University of Thessaloniki, as well as the national Institute of Engineering Seismology and Earthquake Engineering. The project aims at strengthening the decision – making process on matters related to risk and resilience in key sectors of the Prefecture of Eastern Macedonia and Thrace. The objective is to create an innovative risk and resilience assessment center which will:

- Collect and analyse data that describe natural and technological events (e.g. floods, earthquakes, technological disasters)
- Identify different scenarios of potential natural and technological risks with their associated consequences
- Disseminate the results of risk and resilience analyses (RiskAC, 2023)

The physical infrastructure of the project includes a Risk Assessment and Resilience Monitoring and Analysis Room (Figure 1a) and Mobile Data Collection Unit (Figure 1b); both of them are expected to be fully operational by August 2023.

Figure 1. a. The RiskAC Monitoring and Analysis Room **b.** The Mobile Data Collection Unit

One of the novelties that RiskAC entails is the holistic approach to risk and resilience assessment. Ten different interdisciplinary research groups have been formed, with a wide range of focus -from fire, seismic hazards and cultural capital to ICT and engineering infrastructure-, to record the existing situation, collect data regarding potential risks and run scientific models to observe the spatio-temporal evolvement of risks. These groups are presented in the following table of Figure 2.

Figure 2. The 10 interdisciplinary groups of RiskAC, with their corresponding logo.

The successful implementation of the project requires therefore the cooperation of a large number of people from different interdisciplinary groups who interact with each other, a fact that makes the process particularly dynamic and complex. These people have different backgrounds, different working "styles", possible different "language" one might claim; not in the sense of linguistics, but meaning that they have learned to communicate their work not necessarily in the same way. And yet, in the event of a hazard, harmonious cooperation is crucial for the Centre to respond on time and effectively and assist decision-makers in worrisome and alarming times. Hence, a strength of the project, the holistic approach and the large number of different perspectives involved, if not approached with caution it could potentially turned into a weakness. This challenged is planned to be addressed through the development and use of a tailored-made serious game, as Section 4 describes in more detail.

4. Methodological Framework and Application to the Case Study

The main learning objective of the game will be to help players realize the importance of efficiently working together as their decisions and actions within a risk resilience assessment center are highly interdependent. The game will attempt to highlight this characteristic and make players more aware of the interrelations of decisions and events; it should make actors aware of the existing challenges, as well as of the critical role that they can all have in achieving effective collaboration.

In order to accomplish these learning goals, the Triadic Game Design (TGD) philosophy will be used for the game development. According to the TGD, the following three main components of equal significance can be found in any game: reality, meaning and play. The first one is about depicting the existing system and interrelationships among the actors involved. The meaning component refers to making sure that knowledge transfer will take place through the game and last but not least, the play component consists of the defined rules of the game as well as of elements

related to the creation of a fun atmosphere that is essential for the game to be successful (Harteveld, 2011; Lukosch et al., 2018).

Our methodological approach comprises a comprehensive literature review, in – depth interviews with actors involved, as well as an online interactive workshop for the selected case study to collect data and observations, under the objective of designing a meaningful and engaging board game to incentivize and improve collaboration among all actors involved. The tailored workshop will be organized having members of each RiskAC team as participants. The remainder of this section provides a glimpse of the aforementioned workshop, which is planned to take place in late spring/early summer 2023.

The plan is to gather a representative number of each of the ten RiskAC teams at an engaging interactive online environment, to allow them to express their own perspectives, ideas and aspirations regarding how important is collaboration currently in the way they work, and what challenges they face in their day-to-day actions to achieve it. This way we will explore in depth the reality component of the TGD philosophy presented previously, to help us build the other two components: assign meaning and encompass playfulness.

The Miro platform will be used for the online interactive workshop, as it is currently one of the leading platforms in the field of organizing engaging online workshops (Miro, 2023), in combination with the Zoom online environment which will be used for the panel discussions. The workshop will start with a warming-up (ice-breaker) gamified activity, in which the participants will be invited to create their own avatar. Following that, an introductory presentation by the organizers (authors) will take place, to make participants familiar with the concept of serious games in general and the role of the game that is being developed in the context of the RiskAC project in particular. Next step will be to ask them for their input on the Miro board, based on their experience of the latest hazard event that occurred and for which RiskAC was asked to contribute with knowledge input to decision-makers. For this, the 4Ls retrospective matrix will be used, as shown in Figure 3.

More specifically, the participants will be asked to reflect on how the collaboration went with their colleagues of the rest of RiskAC teams , having in mind the following questions:

- Do you think that the RiskAC network was used in its full potential?
- What other ways of collaboration could have been useful for this case?
- What are the prospects of using additional ways of collaboration?
- What are the lessons learned from this event that can be applied to other hazard occasions in the future?

The participants will be able to express their thoughts, ideas and viewpoints using post-it notes for an allocated amount of time, and then they will be invited, if they wish, to justify their answers or/and comment on the answers of their colleagues during a Zoom plenary discussion.

Figure 3. The 4Ls retrospective matrix on Miro board.

Following that, the participants will be asked to join the Miro board again, to complete an impact/effort matrix for more effective collaboration (Figure 4). This means that they will have to think and suggest ways that according to their opinion could facilitate information sharing and communication, and hence improve collaboration among the different teams. Once again, the Miro post-its activity will be followed by a plenary discussion on Zoom.

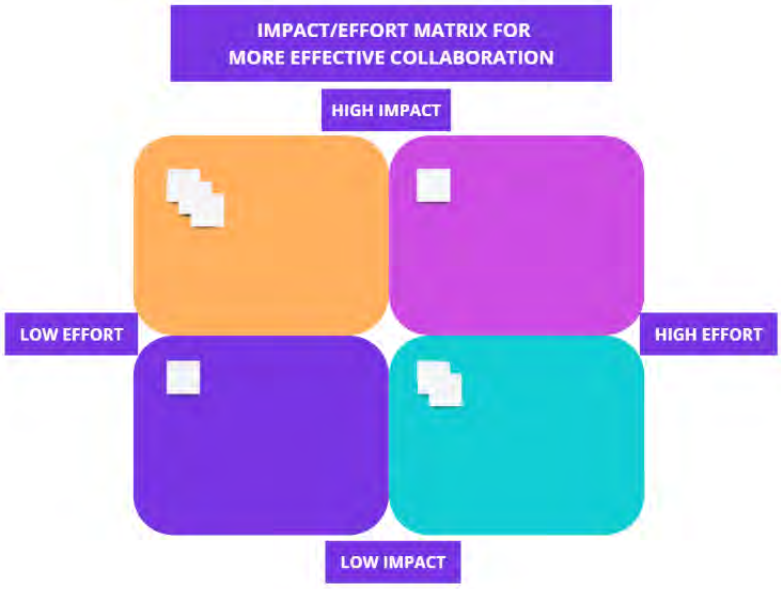

Figure 4. The impact/effort matrix on Miro board.

This valuable input from the participants will be incorporated into the design of the tailored-made serious game for RiskAC. Different roles will be assigned to the players, in order to make them look into matters through a different lens comparing to the one of the role they are used to. After the development of the first prototype of the game, a series of test-sessions will be scheduled with the workshop participants and/or other members of RiskAC to test the effectiveness of the game. Every game session will be introduced by a short briefing, during which the facilitator will explain the concept and the rules of the game and after the completion of the all game rounds, a debriefing will

follow. The role of the facilitator of the game will be to identify and analyze the negotiations and discussions that will take place among players, trying to support the process of play, but with minimum interventions to make sure bias is kept at the minimum possible level.

5. Conclusions

The research presented herein is on-going and aims at developing an interesting, flexible, and of course fun to play, game that will be able to provide valuable insights into the extremely critical issue of effective collaboration of different teams in the context of RiskAC, and which will be able to stimulate and enhance interaction between actors on the level of the center and beyond. The game can act as a trigger to start a valuable discussion and make actors aware of the need for collaboration to achieve resilience goals.

Therefore, in the present paper serious games are used as an instrument to interpret the dynamics and reveal interactions and tensions between researchers involved in the RiskAC project, who have very diverse backgrounds and can have different and sometimes even conflicting perspectives. Serious games can contribute to better understanding of their behaviour and serve as a way to observe negotiations among them. The present paper opens interesting pathways for the use of serious games as research instrument, as although being an established research method worldwide, in Greece its use is still limited.

Acknowledgments

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Modeling counter pollution policies: Defensive or aggressive? Which one is more effective

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Abstract

This work examines how the increment (or decrement) in the volume of the pollutants in a country is influenced by counter–pollution operations. The research takes place using an optimal control model, where the state variable is the volume of the pollutants and the control variables are two types of counter–pollution actions, the one is that which encourages the entrance of new polluting firms, therefore incrementing the volume, (defensive) and the other that doesn't increment the volume of pollutants (aggressive). Theproposed model is nonlinear and doesn't find analytical solutions, but the sensitivity analysis takes place with the use of numerical implementation of Pontryagin's maximum principle. In general, the proposed model admits two steady states (two different volumes of pollutants), one in which the volume of pollutants vanishes and the second in which there is a high volume of pollutants in a country. Whereas the defensive strategy is used at any time, it is not optimal not to use aggressive strategies if the volume of pollutants is below a certain limit.

Keywords: *Optimal dynamic control; Counter-pollution; Pollution modeling*

JEL Codes: C61; C68; Q52

Session 11
Sustainable Tourism

Searching for degrowth potential at the interface of tourism and the environment

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Abstract

The research purpose of the present study lies in investigating degrowth potential and identifying causality relationships at the interface of tourism and the environment among member states of the eurozone economic space from 1996 to 2019. It is explored if and how environmental degradation in terms of greenhouse gas emissions (GHGs) and a wide range of tourism-related variables are influenced. We alsotake into consideration the energy efficiency factor in the context of primary energy consumption. Based on unit root tests all variables under research are stationary. The Environmental Kuznets Curve Hypothesis was verified for all regression models suggesting that degrowth can be achieved at the interface of tourism and environmental quality. Research findings evidence four feedback hypotheses and one uni-directional relationship running from business tourism spending to GHGs. Specifically, a two-way relationship betweeninternal travel and tourism consumption and GHGs confirms the first feedback hypothesis. Further, a reciprocal causality relationship running from leisure tourism spending to GHGs confirmed by research results providing the second bi-directional causality relationship. The third feedback hypothesis indicatesthat capital investment spending Granger causes GHGs and vice versa offering evidence for the third hypothesis. Additionally, research results show that primary energy consumption impacts GHGs and vice versa disclosing the fourth feedback hypothesis. Practical implications call for effective environmental management to reduce environmental degradation levels and experience sustainable tourism growth with a long-run perspective.

Keywords: *degrowth; Environmental Kuznets Curve; tourism, energy;*

JEL Codes: Q50; Q56; Z3; Q43

Determining factors that secure tourist excursions to Veria

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ABSTRACT

The object of this paper is to investigate the determining factors that secure tourist excursions in the city of Veria. Three international and national cultural resources are chosen as a case study: the archaeological site of Vergina, the Altar of Paul the Apostle and the Church of Panagia Soumela.

The aim and basic questions of the research are to investigate the visitation of excursion tourists in these areas and whether they are factors that contribute to the development of tourist excursions in the area.

Initially, the mapping of the historical, cultural and religious attendance of the city and its wider area is attempted, as well as the description of its cultural heritage. The cultural concepts are clarified and the geographical data necessary for the realization of tourist excursions to these three "local emblematic monuments" are analyzed.

For the needs of the study, an on-site survey was carried out with questionnaires, which were gathered on-site in accommodation and catering businesses in Veria, during the period of the months of July and August 2022. The results obtained from the statistical analysis answer the initial questions and concerns of the study.

The main conclusion of both the theoretical and the empirical part of the research is that the archaeological site of Vergina, the Altar of Paul the Apostle and Panagia Soumela are a factor in the development of historical-cultural excursions in the wider area of the city of Veria and create, at the same time, an endogenous factor for development, with business and employment opportunities.

Key Words: *Tourism, tourist excursion, Veria*

JEL Codes: Z32; O44; O47; O52; Q56

1. Introduction

Excursion tourism includes a whole spectrum of organized groups, whose members share a love for nature and culture. These are the forerunners of the natural and cultural tourist excursion (Karameris, 1998). The concept of cultural tourist excursion is complex and at the same time topical, especially in today's era. As a cultural tourist excursion, it can be characterized as getting to know the historical, artistic and spiritual heritage, as well as the cultural creation of an area receiving a tourist stream. Regarding cultural tourism, the concept of education is also involved, that is, the wider satisfaction of the education of the tourist-excursionist, based on the exhibits with which he comes into contact (Kalligas, 2022). The exhibits also include areas with religious relics and a rich historical

religious past, which are characterized by increased movement of tourist-excursionists.

At the same time, "cultural environment" is defined as the set of human material and intellectual creations, in a certain country or in a certain era. The cultural environment includes monuments, ancient and modern, immovable and movable, and archaeological sites. Intangible cultural heritage is also included, which is expressed in historical reconstructions, customs, knowledge and techniques, as well as tools, objects, handicrafts and cultural spaces associated with them and with which communities and groups of individuals form part of their cultural heritage.

Intangible cultural heritage, passed down from generation to generation, is constantly recreated by communities and groups, in relation to their environment, their interaction with nature and their history. In this way, a sense of identity and continuity is created between them, contributing to the promotion of respect for cultural diversity and human creativity (Mitoula, Kaldis, 2018).

The "culture-loving tourist-excursionist" travels from place to place in order to fill the void caused by their daily life, which is often devoid of permanent and substantial interests", as characteristically said in 1978 by the late Manolis Andronikos, Professor of the Aristotle University of Thrace. With these words, the professor wanted to show that everyone should and can visit attractions, but also to be in places of special cultural interest, that is, to enjoy, on another scale, the quality, historical memories, cultural reserves and interest in pilgrimage.

In recent years there has been a shift of tourists towards new alternative forms of excursion or tourism such as historical, cultural, educational, pilgrimage etc. The forms of alternative tourism in question respect the environment and protect the cultural heritage of the area receiving the tourist stream (Καραγιάννης, Έξαρχος, 2006). Tourist-excursionists seek with their tourist excursions or tours the break from their everyday life, during the short or long duration of their free time. At the same time, climatic conditions are considered basic conditions, which are taken seriously, mainly by travel agencies, which assume their role as businesses, for the mediation and provision of services in tourist-excursion trips (Κοκκώσης, Τσάρτας, 2001).

In the context of alternative tourism, the gates of temples, churches and monasteries were opened, the walls of separation were torn down, the curtains of cultural isolation were thrown aside. Today, there is no longer any space inaccessible. As far as pilgrimage tourism is concerned, European countries took the lead, although they initially worried and experimented, but eventually gained useful experience in these issues (Λαγός, 2005. The Greek area, which is a spiritual region of conservatism, but cultivated by the Orthodox tradition and the principle of harmony, created the conditions for the development of pilgrimage tourism. Today, there are many places in Greece that host Holy Relics, miraculous icons and churches that accept pilgrim tourists (Οικονόμου, Καραγιάννης, 2022).

One such case is the research area, Veria. It is characteristic that in the city of Veria there are 72 churches (www.veria.gr/). The existence of these churches motivates pilgrims to understand this great religious reserve through pilgrimage tourism. This reserve is aimed at an audience with a high level of education, focused on visiting religious sites and various religious monument facilities. Visitors of this type seek to delve into all the elements of the religious wealth of the past and present of the host place (Venetsanopoulou, 2006).

Taking into account the above, the two research areas of the city of Veria were chosen: the Church of Panagia Sumela and the Altar of Paul the Apostle. However, given that at a distance of only 12.6 kilometers from Veria is the internationally interesting archaeological site of Vergina, it was also included in the objectives of this research. It should be noted that these three areas: the archaeological site of Vergina, the Church of Panagia Sumela and the Altar of Paul the Apostle, are, in our opinion, important poles of attraction and visitorship for tourists. The safeguarding and

protection of the cultural heritage of these monuments is also related to the promotion and highlighting of the local cultural heritage and is therefore linked to local development.

2. Description of the wider research area

The Regional Unit of Imathia administratively belongs to the Region of Central Macedonia, its capital is Veria and it is divided into 12 municipalities. Its area is 1,701 square kilometres and its population amounts to 130.026 inhabitants according to the 2021 census. It is noted that its population decreased by 10.549 people in the last decade, compared to 2011 (ESYE 2021).

The Regional Unit of Imathia borders to the north with the Regional Unit of Pella, to the east with Thessaloniki, to the southeast with the Regional Unit of Pieria and to the southwest with the Regional Unit of Kozani. It is one of the oldest inhabited areas in the Greek area and its name means "sandy area". It is still an important centre of Macedonia, with an interesting history, rich cultural tradition and remarkable archaeological sites. Human settlements began to appear in the area in prehistoric times, while on its borders is one of the oldest Neolithic settlements in Europe, Nea Nikomedia.

At the same time, the Regional Unit of Imathia has a rich natural environment, which creates further grounds for visitation. Within its borders is the mountain Vermio 2,052 m high and the rivers Aliakmonas 297 km long, Loudias 60 km long and Tripotamos 20 km long.

From the bioclimatic map of the region, it follows that the climate is continental. Winters are cold and northerly winds are observed, while summer is hot in the lowlands and cool in the high-altitude villages. Air temperature is one of the most important factors affecting the horizontal and vertical spread of both plant species and vegetation. The absolute maximum temperature is 42.2 °C and absolute minimum -16.8 °C. The coldest month is January and the hottest months are July and August (Gerakaki, 2010).

As for access, it can be reached by car through the existing road network, from the road axis of Egnatia Way that connects Thessaloniki with Veria and Western Macedonia and the provincial network of Naoussa - Veria - Alexandria - Thessaloniki and Veria - Naoussa - Edessa. Three stations of the Hellenic Railways Organization operate in the area: at Veria, Naoussa and Platy. In the health sector, 2 hospitals, 1 health centre and 18 regional clinics operate.

In terms of tourism infrastructure and services, there are 3 ski resorts in the area (Seli, 3-5 Pigadia, Chriso-Elafi), two mountain refuges at the "Balkoni" and "Mundaki" locations, areas for culinary activities, an air sports center in Veria , accommodation of various types and classes, agro-tourism units and traditional guesthouses, catering and recreation centers, museums and other cultural sites, general and alternative tourism offices, car and motorcycle rental companies, conference spaces, shopping centers, etc. (www.veria.gr/).

2.1. Historical - cultural past of the city of Veria

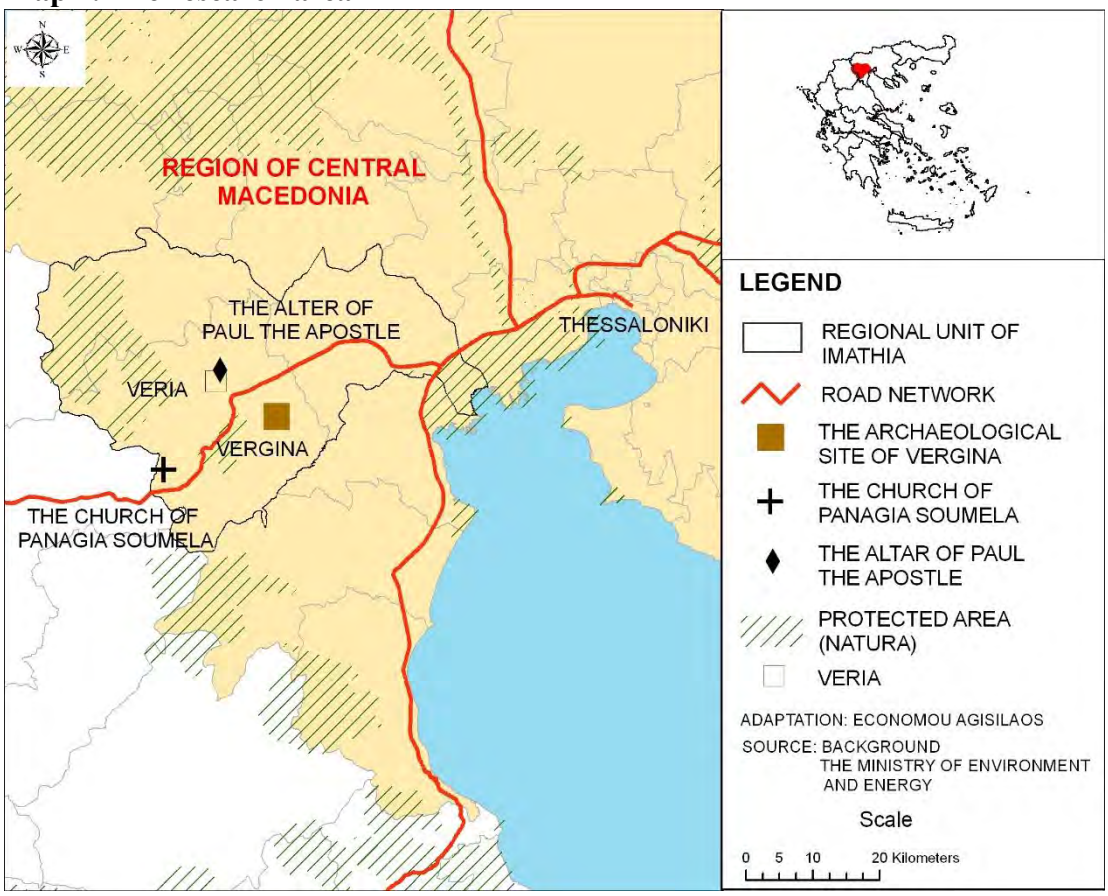
Known since the classical era, the city of Veria grew in Hellenistic and Roman times. The Apostle Paul and Silas preached Christian teaching in Veria and the well-known "Altar of Paul the Apostle" is preserved to this day. The most important and glorious era of Veria's past is that of the Hellenistic years, specifically the reign of the last dynasty of the Macedonians, the Antigonids. According to one version, Veria first became the seat of the "Commonwealth of Macedonians", had a Parliament, minted its own currency, while sports competitions were held in the area, called

"Olympia" or "Alexandria", in honour of Alexander the Great. The decline of the city began during early Byzantine times, due to the raids of the Slavic races.

During Turkish rule, Muslims and Jews settled in the city. At the same time, and especially in the 17th and 18th centuries, a Greek bourgeoisie was created, due to the existence of merchants in the area. In 1822 the city revolted against the Turkish yoke. It was liberated by the Greek army on October 16, 1912 and in 1946 Veria was declared the capital of Imathia (Μπριλάκης, 1976).

In addition to its ancient history and natural beauties, Veria is also notable for its intense cultural and spiritual activity. Worthy cultural events take place in the city, such as the Panhellenic Meeting of the Municipal Regional Theatres of the Country, the Panhellenic Festival of Amateur Theatre, the Panhellenic Guitar Competition, the Imathiotika, etc. Theatre performances, dance events, exhibitions, concerts and conferences complement the rich cultural life of the city (Κολτσίδας, 2012).

Map 1. The research area



Source: Agisilaos Economou (2022), Official background data from the Ministry of Environment and Energy

2.2. Brief description of the three research areas

The Altar of Paul the Apostle: The Apostle of the Nations, Paul, and his companions Silas and Timotheus were well received by the citizens of Veria who: "listened to Paul's preaching and willingly accepted it". Thus, Veria became one of the oldest episcopal seats in Greece. Exactly when the Apostle Paul visited Veria is not absolutely certain. However, his arrival there is placed between AD 44-60,

with AD 54 being the more likely date. The specific place where he taught is located in the center of the city of Veria.

The Church of Panagia Soumela: On the slopes of Vermio, near the village of Kastania, are the facilities of the Holy Pilgrimage of Panagia Soumela. It is an attempt to revive the famous monastery of the same name, the ruins of which are preserved on Mount Mela, near Trebizond on the Pontus. The pilgrimage has pan-Hellenic influence and multitudes of believers pass by to worship the miraculous icon that exists there, which according to tradition is the work of the Evangelist Luke (the above passage is from the texts of the blessed president of the "Panagia Soumela" Foundation, Panagiotis Tanimanidis) . The distance from Veria is 20.53 km and the estimated time distance is 23 minutes.

The archaeological site of Vergina: In 1938 excavations began at the archaeological site of Vergina and after being interrupted for some years, they were continued from 1959 to 1974 by professors Andronikos and Bakalakis. Through the discovery of the royal tombs in the area, the late Andronikos pointed out: "we have inscriptional testimony ... how at the end of the 5th century BC the Macedonians who lived in the first capital of the Macedonian kingdom... had Greek names." For the wider area, the palace, the historical context and especially for the royal tombs, there is photographic material left by the late Andronikos. The archeological site in question has developed into an internationally interesting visitor center and its visitors very often combine their visit with the city of Veria. The distance from Vergina to Veria is 12.6 km, and the estimated time distance 14 minutes.

3. The research

For the needs of the paper, an on-site survey was carried out with questionnaires, which were collected on site in accommodation and catering businesses in the city of Veria, during the period of the months of July - August 2022.

The main question of the research is whether the archaeological site of Vergina, the Altar of Paul the Apostle and the Church of Panagia Soumela, are a factor in the development of historical-cultural excursions in the wider area and whether they simultaneously create a coefficient of endogenous development, with opportunities for business activity and employment.

The investigation of the three emblematic aforementioned monuments is carried out through the analysis of the individual components. That is, the duration of the research, the areas where the research was carried out, the sample population, the technical collection of the data, the methodological background used to conduct the research and the method of analysis of the questionnaires which is SPSS.

243 questionnaires were collected from the survey. The sample was all tourist-excursionists. The distribution and collection of the questionnaires was done by mail and was based on random sampling, as the questionnaires were anonymous. The respondents were people who had just visited the three research areas. During the completion of the questionnaire, oral discussions were also held and notes were taken of serious and useful points for the researchers.

The formula for determining the minimum sample size required for a given population is as follows:

$$S = \frac{z^2 \times p\,(1-p)}{e^2}$$

$$1+ \frac{z^2 \times p\,(1-p)}{e^2 N}$$

Where the:
S = Minimum sample size to be investigated considering inputs.
N = Total population size. This is the size of the segment or population we want to assess.
e = Margin of error. Whenever a population is tested, there will be margin for error in the results.
z = Confidence percentage translates to z-score, the number of standard deviations a given proportion is away from the mean.
p = Standard deviation (in this case 0.5%).
Substituting where N= 314 where e= 0.03; where p= 0.005 and z=0.8289 we arrive at the size of 243 people (https://el.martech.zone/survey-sample-size-calculator/)

4. Presentation of some of the descriptive statistics and commentary on the research findings

Overview of the Research: Initially, approaching the respondents had some difficulties, since suspicion was expressed. After that, it became very friendly and easy, especially when we mentioned the main concerns of the research. That is, in the criterion for determining the visit, the degree of interest of the visit, the degree of participation and above all the gravity of the visit in the three regions.

Regarding demographic characteristics, 53% of the sample were men and 47% were women (see Figure 1). In terms of age, 13% were in the 18-25 age group, 20% in the 26-35 age group, 33% in the 36-45 age group, and 34% in the 55 and over age group (see Figure 2).

Almost all visitors, regardless of their gender, age and place of residence, consider the specific emblematic monuments to be an important attraction for the city of Veria and the Prefecture of Imathia.

Two categories of tourist-excursionists were distinguished: Those who come to visit for a few hours of entertainment (for coffee or for food) and those who stay 1-2 days, combining the visit with other excursions in various areas of the Prefecture of Imathia (see Figure 4).

The three emblematic monuments of the excursion undoubtedly have very strong historical, cultural and pilgrimage reasons for visiting. However, as was observed from the oral discussions we had with those who responded to the anonymous questionnaire, it appeared that the two groups of excursionists have clearly different characteristics and requirements in terms of the place of preference, the means of information and the length of their stay in the city of Veria.

In addition, as pointed out verbally by the tourist-excursionists with permanent residence in the nearby urban centre of Thessaloniki (see Figure 3), they were informed about the emblematic monuments of the area mainly by a friend or acquaintance and less from magazines or publications (see Figure 6) .

At the same time, a large percentage of the sample combines the visit to the three emblematic areas, with the aim of usually staying a few hours in Veria, as part of a day trip or a short visit. Another percentage comes to Veria having been informed by leaflets and brochures. These visitors usually stay for a few days, visit other areas of the Prefecture of Imathia and usually stay in hotels in the city (see Figure 5).

The visitors' main information/advertisement about the research area comes from an acquaintance (63%), which proves the positive feelings the area leaves in its visitors (surprise 32%,

curiosity 33%, admiration 35%) (see Figure 9). Also, when asked if their excursion was worth the effort, the vast majority (98%) answered positively (see Figure 7). The flow of culture-loving tourists would, perhaps, be greater and possibly more organized, if the agencies of the region promoted more aggressive advertising, with print and electronic media, in the three research areas in question (see Figure 8).

The results of the research show that the city of Veria is particularly loved by its visitors, since repeat visitors to the city (60%) are a very high percentage (see Figure 10). At the same time, a large percentage of them (70%) intend to visit at least one of the three emblematic monuments again (see Figure 11). Therefore, the archaeological site of Vergina, the Altar of Paul the Apostle and the Church of Panagia Soumela, are important attractions for the city of Veria, but also for the wider area of Imathia.

Figure 1. Gender

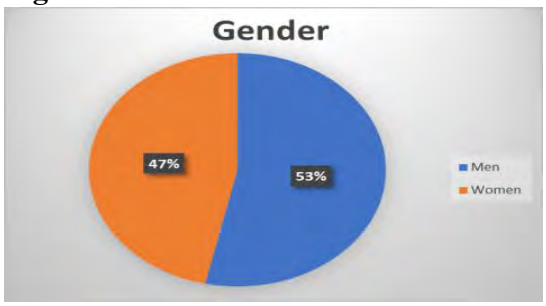


Figure 2. Age

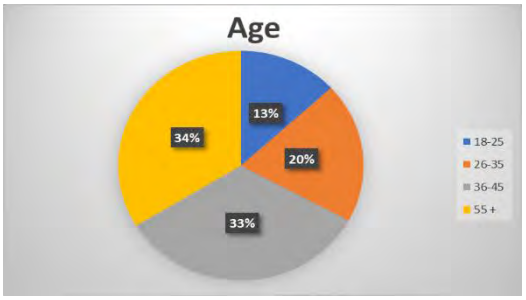


Figure 3. What is your permanent place of residence?

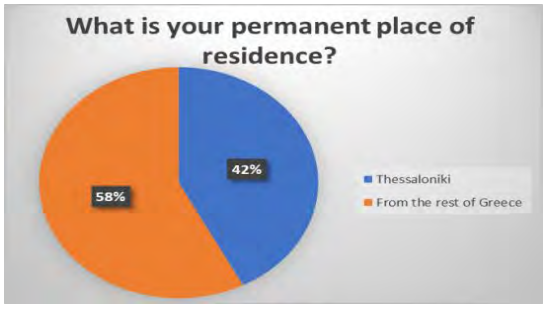


Figure 4. What is the duration of your σtay in the area of Veria?

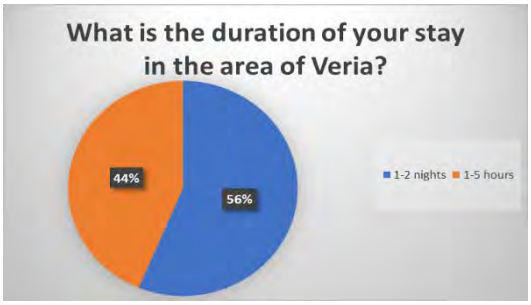


Figure 5. Will you visit other historical, sites?

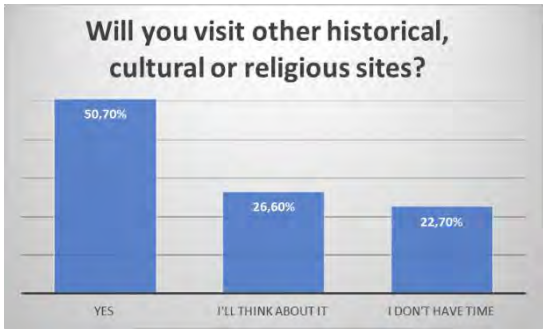


Figure 6. Where did you find out cultural or religious about the three emblematic areas of Imathia?

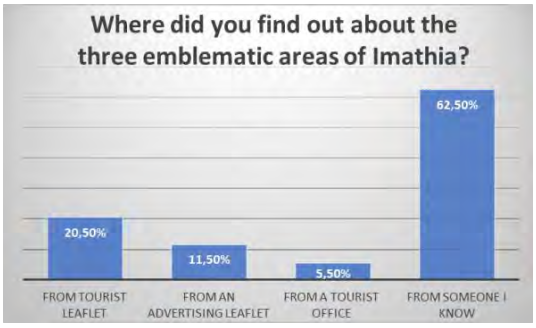


Figure 7. Was your excursion worth it?

Figure 8. Where did you get additional information about the three emblematic areas of Imathia?

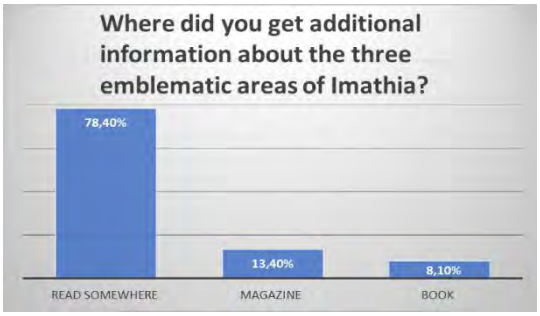


Figure 9. What did you feel when you emblematic areas of Imathia?

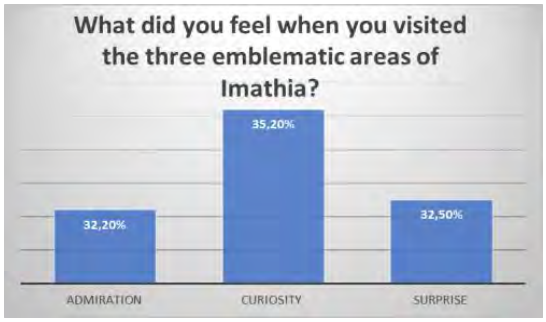


Figure 10. Have you visited these the visited the three these three emblematic areas before?

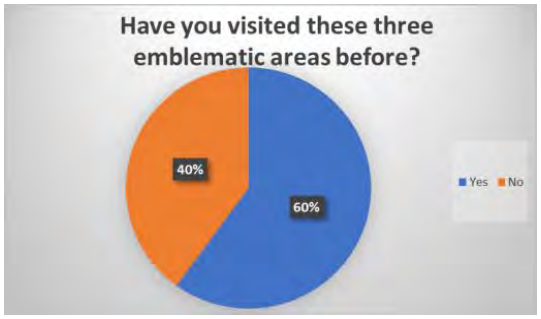
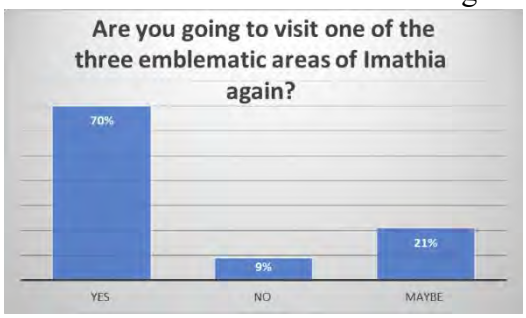


Figure 11. Are you going to visit one of the three emblematic areas of Imathia again?



5. Conclusion - Suggestions

The main conclusion of both the theoretical and the empirical part of this paper is that the archaeological sites of Vergina, the Altar of Paul the Apostle and the Church of Panagia Soumela, are a factor in the development of cultural tourist excursions in the city of Veria. At the same time, they are a factor of endogenous development, with opportunities for business activity and employment, since tourist-excursionists make use of the food and catering services of the area. It is up to the representatives and the authorities of the city of Veria and the Regional Unit of Imathia to make further use of these emblematic monuments of the region.

It is also useful to take measures to attract other social groups of excursionists to the area, as the survey showed that respondents wish to visit other places besides those of the case study during their trip. In this context, additional importance should be given to the management of natural and cultural resources and the rich natural and cultural environment of the city of Veria should be exploited. Also, the various cultural events that take place in the city throughout the year (e.g. Imathiotika, etc.) should be advertised and utilized.

Finally, in our opinion, the creation and organization by the Municipality of Veria of a "Workshop of Participatory Culture", which will inform and communicate the cultural news and events of the city, is considered important. This will strengthen the tangible participation of all cultural bodies and communities, for the promotion of all the historical-cultural-religious and natural monuments of Veria and the Regional Unity of Imathia.

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Sustainable development of the former Tatoi Royal Estate in Athens: economic, social and environmental impact

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ABSTRACT
In its long history, the former Tatoi Royal estate and its owners have played a catalytic role in the history of modern Greece. Today, the estate is a special development challenge as it brings together valuable natural resources, important building stock and remarkable architectural and cultural monuments, and their exploitation and promotion should be in accordance with the principles and objectives of sustainable development. A common feature of both foreign palace complexes and the Tatoi palace complex is the promotion of alternative tourism through activities within the site, which makes a significant contribution to operating costs. For instance, the estate has the necessary specifications for the holistic development of wine tourism and agritourism, through the vineyards and agricultural activities that will be revived during the redevelopment of the estate. The development of health and wellness tourism and conference tourism is also promoted, as both the large and spacious building stock and the surrounding area are conducive to such activities, as reflected in the framework of the redevelopment by the Greek Ministry of Culture. The aim is for the Tatoi estate to be transformed into an international tourist destination and to become an example of sustainable tourism development in Attica, which needs alternative models of attracting visitors, as it could be a very important route in ensuring the self-sufficiency of the estate. According to current research results, through a questionnaire answered by 132 people, when asked about the extent to which the Tatoi estate will contribute as a landmark to the tourist development of the country, 33.3% (N = 44) of the sample considered that the redevelopment project will bring significant tourism development, while 17.4% considered that it will contribute "Very much" (N = 23). In other words, almost one in two responded that the redevelopment will have an extremely positive impact on the tourist development of the area, while 71.2% of the sample intends to visit the estate more often after the completion of the redevelopment, which demonstrates the potential of the estate to offer both to a visitor from abroad, as well as to Athenian citizens. Also, according to the APT (Arbitrage Pricing Theory) one factor model, it emerged that both the economic as well as the social and environmental impact of the regeneration of the Tatoi estate increases linearly as the overall sustainability of the area is enhanced, while correspondingly the individual economic, social and environmental sustainability of the area decreases as the overall sustainability decreases.

Key Words: *Tatoi; Athens; Sustainable tourism; Sustainable Development*

JEL Codes: Z32; O44; O47; O52; Q56

1. Introduction

The Tatoi estate has been associated with all those moments when Greece was confronted with history. It inherited the heavy shadow and history of the Greek Monarchy but it was surrounded by a rich forest with intense agricultural and productive activity. The discussions and concerns regarding the concept of the Tatoi redevelopment are not recent, as various development projects have been proposed in the past but have not been successful. Urban regeneration is a difficult equation that needs thorough study in order to deliver the expected results, especially in the case of Tatoi, where there are a multitude of factors and specificities that need to be taken into account. The location of the estate in Attica, the climate and all those elements that make it unique are important prerequisites for it to become, through the appropriate management of course, a promising attractive tourist destination.

The basic principle of urban regeneration is the economic sustainability, while ensuring social and environmental sustainability at the same time. In the case of the Tatoi regeneration project, economic sustainability is emphasized in writing as the second basic principle, together with respect for the environment. Great importance is attached to the strong character, identity and coherence of activities in order to create unique landmarks that will act as attractions for visitors, the year-round use of the estate, efficient and effective operation and management, the possibility of securing possible grants & donations for funding, etc. In other words, the challenge is that in the future the operation of the estate will have as little burden on the state budget as possible, i.e., it will be fully self-sufficient so that any expenses will be covered by its own income.

The 2021 redevelopment plan includes distinct thematic interventions aimed at the holistic development and promotion of the estate. Briefly, utilizing the available resources of the estate, such as the rich building stock and the productive dynamics of the past, the proposed interventions are specialized in the following areas: a) history and culture, b) outdoor sports and recreation c) rural economy d) research and knowledge and e) Health & well-being.

2. Literature Review

A crucial component of the production model of Tatoi is the existence of a vineyard. It would be unfair, however, if the target was limited only to the production of wine, as the estate combines great virtues that lend themselves to further actions. The aim is for the Tatoi estate to become an international tourist destination and to become an example of sustainable tourism development in Attica. Given this, the development of wine tourism could be only one way to ensure estate self-sufficiency.

The importance of the operation of the estate in accordance with the principles of sustainability is particularly important for the Greek tourism development. Wine tourism is one of the few cases that combines the provision of services with the primary production of goods, namely wine. The obvious advantage for wineries or estates is the increase in sales, which is mainly due to wine lovers, since visiting the winery was rated as the most important of all the motivating factors. (Alebaki & Iakovidou, 2011). From 2009 until today there has been an increase in the volume of wine exports by 75% and an increase in the average price per liter by 22% due to wine tourism's great contribution to this, said Nikos Tavoularis, head of the Wine and Alcoholic Beverages, Department of the Ministry of Rural Development and Food in 2016.

The contact with a historical place and the production process by the visitors, encourages the purchase of those wines that satisfied them the most, taking into account more the taste than the price

(Asero & Patti, 2011). As a result, more and more wine varieties receive recognition and market value, as their brand name is a credibility for the consumer, since consumers, in addition to tasting themselves in the special areas of the wineries, have the opportunity to watch the production process with their own eyes. Given this, it can be understood that the brand name Tatoi could strengthen production and increase the income of the estate. An immediate advantage is also given to the primary production of wine itself, as the incentive of tourist promotion through the construction of a winery unit activates additional business plans or investments in the viticulture sector.

In order to understand the economic benefit resulting from the conversion of a vineyard into a wine tourism enterprise, some tangible economic data should be cited. Tourism, according to INSETE (directly and indirectly) in 2018 contributed from 25.7% (47.4 billion euros) to 30.9% (57.1 billion euros) to the creation of GDP. On the Wines of Greece website, it is reported that there are more than 1290 wineries with the annual production in 2017 ranging to 2.5 million hectoliters, which makes Greece the 17th wine-producing country in the world, with the total participation in the country's GDP ranging to 2%.

However, according to an unofficial count, there are 240 wineries that can be visited, while - until today- more than 100 have been certified by the Ministry of Tourism, as the Deputy Minister in 11/2022 provided the necessary evidence. Furthermore, 70% of wine producers active in wine tourism record profits of 150,000 euros, significantly greater than classical producers who have not linked wine production with tourism (Stavrinoudis et al., 2012). It is obvious that tourism has a multiplier effect on the income of a vineyard, as an entrepreneur decides to turn it into a wine tourism business. Given these facts, the promotion and development of wine tourism can substantially enhance both the income of winegrowers and the country's economy. In cases such as Tatoi, only the existence of wine tourism can contribute decisively to ensuring its sustainable operation and self-sufficiency, as it is not just a vineyard or a business, but an estate with deep cultural and environmental richness and history.

The contribution of wine tourism to Greek sustainable development should not be considered negligible. The facilities contribute to safeguarding and enhancing the landscape, as they are perfectly compatible with it without interfering with it aesthetically with possible negative effects, as has happened with some large tourist businesses. The protection of the environment and careful organic production is a key objective for all wine businesses, so their promotion and expansion should be an objective for Greek tourism policy. Tatoi has gathered all the necessary resources and specifications to become a viable wine tourism unit, taking advantage of all the benefits it has due to its location and history.

The COVID-19 pandemic highlighted in the foreground the inadequacies of the Greek tourism system, given that although arrivals were increasing every year, no plan was ever drawn up to deal with a potential crisis/threat. At present, in a health crisis of this magnitude, the majority of tourism businesses do not have premises capable of coping with protocols requiring distances between visitors. Places such as nightclubs, restaurants and many hotels, especially in the summer season, are very crowded and their future is uncertain under these circumstances. The wine tourism businesses or estates that include wine-related establishments such as, the Tatoi estate, are a major exception to this rule.

By having to make use of the large capacity of both their outdoor facilities, such as the vineyard or the estate itself, and their building stock, such as the processing and tasting area, they have a comparative advantage over other forms of tourism development. All the distances could easily be kept, and it would be possible for visits to be made by small groups, as many wineries or places of

wine interest already do. In a more developed phase, the estate could become a flagship of Greek or even international alternative tourism during the season, as it has all the qualifications to be considered a safe choice. The Tatoi estate should -and must- develop a comprehensive wine tourism package.

Agritourism could be defined as the set of educational and recreational activities offered on farms or other productive estates. Over the last 40 years, agritourism activities have grown dramatically as more and more people seek rural experiences (Barbieri, 2020). Research into agritourism began in the 1980s by describing the basic sociological and tourism elements of the area. Studies on rural sociology positioned agritourism as "an agricultural enterprise developed to diversify agricultural incomes and stimulate and develop rural areas". These studies have described the relationship between agrotourism and other types of agricultural enterprises, the motivations of farmers for their diversity, and the benefits of agrotourism to farm-household welfare.

The Tatoi estate was a model production unit and produced high quality goods that, by the standards of the time, could even be described as organic. The reconstruction of the estate would make much more sense if it were combined with a parallel agro-tourism development, bringing people closer to the unique conditions of production and, in part, of rural life. Sustainable development also passes through agritourism activities, which can and should be developed on a larger scale. Climate change mandates radical changes as both global population growth and the depletion of natural resources, along with other social factors, reinforce initiatives for specialized local agriculture (Barbieri, 2020).

In the coming decades, future agritourism sites will be defined by the type of visitors who will want to enter the site. Initially, 'intentional' visitors, i.e., those seeking to enhance their agricultural knowledge and experience through observation of agricultural processes and participation in hands-on activities are cited by Barbieri (2020). The second category, are those seeking recreation, i.e., those seeking any kind of recreational or hospitality service in an agricultural setting. Common to both cases is the simultaneous increase in demand towards specialized agritourism services. The Tatoi estate can offer both agricultural knowledge, as it was a pioneer in production activities (the first butter factory in Greece), and recreation as promoted in the regeneration plan.

The Covid-19 pandemic brought health issues to the forefront, as the many groups were the most vulnerable during this time, and wellness tourism after the pandemic has become a convincing answer to the needs of a modern society. Also, ageing is one of the biggest social and economic challenges facing the EU, as it triggers age-specific priorities and spending patterns that are part of the general consumer economy and identified as the "Silver Economy" (Ilario et al., 2019). The Silver Economy is driven by the emergence of a new consumer market and the need to improve the sustainability of public expenditure associated with ageing, Ilario (2019) highlights.

It is important to understand that wellness tourism, is not identical to health tourism, as the former is part of the latter and has distinct differences. Another confusion that exists is between health tourism and medical tourism, as the latter works reactively, while wellness tourism works proactively.

Health tourism is a sustainable development opportunity that can derive significant benefits from the cross-border availability of health services. The redevelopment plan for the Tatoi estate makes explicit reference to wellness, providing for the construction of a spa, as well as other initiatives. Wellness tourism is one of the largest and fastest growing industries worldwide, providing 100m jobs and 9% of global GDP, as wellness is a major international consumer trend. The Global Wellness Tourism Economy Report (2013 & 2014) provides the following data: wellness tourism is growing faster - at 9.1% per year - than the entire tourism sector (6.2%).

The wellness tourist is a tourist with a high economic profile, which is also clearly reflected in official statistical analyses. In particular, the domestic wellness tourist spends 178% more than the average tourist. Also, globally, it is a steadily growing global market with a reported size of about $639 billion in 2017 and is expected to reach a revenue of about $919 billion by 2022 (Kazakov, 2021).

Based on the aforementioned, it is important to understand that wellness tourism is a large market that will show great potential in the twenty-first century. Human stress, the demand for personalized services, the aging of society, are some factors that demand a holistic approach while the concept of wellness tourism will combine health, well-being and hospitality.

The holistic wellness model will shape a change in destination management approach because customers will seek combined and coherent wellness tourism destinations that offer an integrated health-wellness tourism concept, Kazakov (2021) emphasizes. In conclusion, the growing public interest in hiking, sports and adventure spas, subsequently generates attention from the academic community. The Tatoi estate has a package that can contribute to the holistic approach needed to heal the mind and body.

Conference tourism is a special form of alternative tourism which, especially in recent years, has been growing rapidly in Greece. According to the World Tourism Organization (UNWTO), every third business trip to Europe includes a conference. In the last five years, more than 60 million people make an annual trip from one country to another for the purpose of attending a conference and the duration of their stay is about 3 days (Delitheou et al., 2010).

There, an average amount in the range of 3000-4000 euros is allocated, of which about ¾ goes to hotels, agents and organizers and ¼ is channeled into the market and commercial activity at the conference venue. Conference tourism is included in the types of tourism that involve visitors of high economic, educational and social level and thus can bring significant inflows to a country (Weber & Chon, 2002).

The Tatoi estate has large buildings, capable - when fully restored - of accommodating a large number of congresses and visitors, such as the new or old dairy farms. In fact, according to the Central Council of Newer Monuments, new dairy farms have also been approved as a conference venue, which is particularly positive. If the outdoor space, which could host outdoor conferences or other related activities, is taken into account, it could attract a huge number of conferences, contributing greatly to the economic viability of the site.

Conference tourism activates a wide range of businesses directly or indirectly linked to the tourism sector, i.e., travel agencies, airlines, hotels, audiovisual equipment rental agencies (Braun & Rungeling, 1992). In other words, it employs a wide range of businesses which can employ a significant part of the active population, which creates positive multiplier benefits, contributing to the stimulation of the local and national economy in general.

It is important to understand the specific nature of this particular form of tourism product. The main characteristic of the development of conference tourism is the awakening of interest of both governmental bodies and the private sector to help take initiatives and finance important infrastructure projects related to business tourism, such as the establishment of conference and exhibition centers, the improvement of existing audiovisual equipment, etc. (Delitheou et al., 2010).

3. Methods and Data (Μέθοδοι και Δεδομένα)

Empirical analysis relates to the development and use of a common, objective language to describe and explain social reality. It can be qualitative or quantitative, based on statistical comparisons of the objects or cases examined by the researcher (Babbie, 1992).

The purpose of Quantitative research is to discover the causes of change in social phenomena through objective measurement and numerical analysis. Based on these data, the researcher starts with an existing theory and expects convincing answers in order to confirm them. In this study, the type of quantitative method used was sampling, i.e., data collection through a closed-ended questionnaire. Its characteristics can be summarized as follows: Fixed and rigid format has the ability to represent a large part of the population under study by highlighting general trends and finally focuses on questions related to specific variables.

The objective, as presented in scientific quantitative research, is generalization, i.e., the description of one or more population variables as well as the explanation of the relationships between population variables (Babbie, 1992). Research has always begun with a specific scientific concern about an issue and followed by a basic research question that it sought to answer.

In this thesis the focus is on the potential and prospects for sustainable development of the Tatoi estate.

Specifically, through the realization of an online quantitative survey with the use of a specially designed questionnaire, the opinion of the residents of Attica regarding the effects (economic, social and environmental) of the regeneration of the Tatoi estate was investigated. The online survey was carried out between May and June 2022. In particular, they were published in thematic-environmental groups related to the Tatoi estate on social media, accessible to all people who were members of the website or friends of the estate and residents of Attica. A total of 132 fully completed questionnaires were collected.

The questionnaire included 28 questions. Initially, the personal characteristics of the research participants were investigated such as gender, age, educational level and whether they know or have visited the Tatoi estate, -especially during the period of quarantine due to the covid 19 pandemic- so that they can gently enter the more specialized questions in the following sections of the questionnaire, such as the evaluation of the state of the estate, the building inventory, the update regarding the renovation works

The questionnaire also contained questions related to the perspectives that open up after the reconstruction of the Tatoi estate: The perception of the participants regarding the degree to which the said reconstruction will contribute to the strengthening of the sense of security, to economic development, to the development of new jobs and in attracting tourists as well as in the environmental promotion and protection of the area. Finally, their opinion on social issues, such as the project's contribution to social cohesion, was explored.

The last section of the questionnaire focused on the degree to which the sample considers that all the prescribed procedures for the proper utilization of the estate were followed and that the conditions for transparency in decision-making and ensuring the equal distribution of benefits to all groups of the population are met. All the questions were multiple choice, list, as well as Likert scale.

4. Empirical Results

4.1. Descriptive statistics

Regarding the extent to which the redevelopment of the Tatoi estate will contribute as a landmark to the country's tourism development, 33.3% (N=44) of the sample considered that the redevelopment project will bring about significant tourism development, 30,3% (N=40) answered "Neutral", 17,4% considered that it will contribute respectively "Very much" (N=23) and "A little" (N=23), while only 1,5% (N=2) answered "Not at all". Regarding the extent to which the redevelopment of the Tatoi estate will contribute as a landmark to the country's tourism development, 33.3% (N=44) of the sample considered that the redevelopment project will bring about significant tourism development, 30,3% (N=40) answered "Neutral", 17,4% considered that it will contribute respectively "Very much" (N=23) and "A little" (N=23), while only 1,5% (N=2) answered "Not at all". Also, respondents are asked to answer whether they intend to visit the site more frequently after the completion of the redevelopment plan, and the 71.2% (N=94) of respondents answered that they would visit the site more often, while 28.8% (N=38) disagreed with this suggestion.

4.2. The APT (Arbitrage Pricing Theory) one factor model

We grouped the variables into three factors: Economic factor, social factor, environmental factor. Each of these factors is the average of the individual variables that make it up per observation. Thus, the first observation of the economic factor is the average of the first observations of the individual variables from which the economic factor is derived. The same applies to the other two factors, namely the social and environmental factors. Regarding the variables that make up each factor, the following apply: Initially, for the economic factor, the employment support, the infrastructure enhancement, the increase in real estate prices in the area and the regeneration of the area and the opportunities for future tourism development, from the implementation of the estate's regeneration project, were selected as main variables. With regard to the social factor the variables chosen were safety level enhancement, recreation and entertainment opportunities enhancement, social cohesion enhancement, equal distribution of benefits and transparency in decision-making. Finally, with regard to the environmental factor, the variables of environmental upgrade, increase of urban greenery, reinforcement of fire safety and the improvement of the area's transport networks were selected. The basic hypothesis behind this classification is that each of these variables is equally weighted. We do not examine the optimal weighting and we consider the equal weight as optimal.

The next step is to factorized Tatoi's sustainable development. We consider this factor as the only "sustainable development" factor, representing the whole variables of this research. This is a one-factor model that accounts for the mean and variance of the individual factors. This methodology comes from finance and it is an APT (Arbitrage Pricing Theory) one factor model (Ross, 2013). Our basic factor, which explains means and variances, is the equal weighted summation (average) of our three main factors. Then the first observation of the "sustainable development factor" is the average of the first observation among the three factors (Fama & Kenneth, 1996).

Our model, then, is as follows: Y=a+bx+e. Y's are our three main factors (economic, social, environmental) and the X is the "sustainable development" factor. We test whether a,b are statistically significant as well as the sign of each. If a is statistically significant and positive, we say that the relevant factor has an excessive positive mean, which is not explained by the "sustainable" factor. It is totally idiosyncratic and based on people's perspective of the area. If the factor has no alpha and

positive beta, it is based on the "sustainable" factor and all people's view for this factor is explained by the sustainable development of Tatoi's concept. The following table summarized the explanations.

As we see, the economic factor has statistical significance a (-1.11, -6.62) and statistical significance b (1.36, 27.12). The R^2 is 0.85, which means that the one factor APT explains the variance of this factor very well. Economic factors have an excessive mean, not explained by the sustainability factor and are negative. Beyond the sustainability project, the economic impact of Tatoi area is negative. Moreover, since b is positive, the economic impact is positive when the sustainability project in Tatoi is positive. The economic impact increases linearly as the sustainability of Tatoi area increases and decreases as the sustainability decreases.

Table 1. The APT (Arbitrage Pricing Theory) one factor model results

Y=a+bX+e	
a>0 & b>0	The factor has excess mean from "sustainable development factor" that is idiosygratic among people's view. This means that the factor is not explained totally from the sustainable development of Tatoi. The bX part with positive b is the only part that is explained by the concept of sustainable development of Tatoi. the positive excess part (a) means that the factor has positive impact on this area other than the sustainable development of Tatoi.
a<0 & b>0	The factor has excess mean from "sustainable development factor» that is idiosygratic among people's view. This means that the factor is not explained totally from the sustainable development of Tatoi. The bX part with positive b is the only part that is explained by the concept of sustainable development of Tatoi. the negative excess part (a) means that the factor has negative impact on this area other than the sustainable development of Tatoi.
a=0 & b>0	The factor has no excess mean from "sustainable development factor" that is idiosygratic among people's view. This means that the factor is explained totally from the sustainable development of Tatoi. The bX part with positive b is the only part that is explained by the concept of sustainable development of Tatoi.
b=0 & a>0	The positive impact of this factor to this area is totally indiosygratic in a sense that it is differentiated by the concept of sustainable development of Tatoi.
b=0 & a<0	The negative impact of this factor to this area is totally indiosygratic in a sense that it is differentiated by the concept of sustainable development of Tatoi.

The social factor has statistical significance a (0.84, 5.07) and statistical significance b (0.69, 13.93). The R^2 is 0.60, which means that the one factor APT explains well the variance of this factor. The social factor has an excessive mean, not explained by the sustainability factor and it is positive. Thus, the social impact of Tatoi area is positive in excess of the sustainability project. Moreover, since b is positive, the social impact is positive when the sustainability project in Tatoi is positive. The social impact increases linearly as the sustainability of Tatoi area increases and decreases as the sustainability decreases.

The environmental factor has statistical insignificance a (0.27, 1.7) and statistical significance b (0.95, 20.00). The R^2 is 0.75 which means that the one factor APT explains well the variance of this factor. The environmental factor has no excess mean, not explained by the sustainability factor. We can say that, the environmental impact of the Tatoi area is positive and is affected totally by the

sustainability of the area. Moreover, since b is positive, the environmental impact is positive, when the sustainability project in Tatoi is positive. The environmental impact is increasing linearly as sustainability of the Tatoi area increases and it is decreasing as the sustainability decreases.

5. Conclusions

The redevelopment plan includes distinct thematic interventions aimed at the holistic development and promotion of the estate, as it has a rich stock of cultural resources which are in perfect harmony with the natural environment. The creation of museums and other related spaces for the promotion of the intangible and tangible cultural heritage of the estate is the main axis of the first proposed intervention of the redevelopment and could be enriched with additional projects and actions, such as the construction of a summer cinema. With this in mind, Athens should -and can- acquire another large cultural space, bringing citizens closer to an important monument of culture and history of the country.

The second intervention refers to the development of various activities, e.g., the construction of paths or cycling routes in the large forest areas of the estate, offering a unique experience and opportunity for visitors to get close to nature. Although the estate received a devastating blow in the recent fire in 2021, it should nevertheless not be forgotten how, with the opportunity of the redevelopment, a dynamic is offered to recreate and protect the forest and its gardens. The Covid-19 pandemic has highlighted the need for sports and recreation areas away from crowded cities. In fact, many people during the pandemic began to exercise regularly, searching for the nearest open spaces in their area. The estate should take this opportunity into account by developing suitable sports activities, such as mountain climbing, cycling, trekking, etc.

As mentioned in the previous chapter, the foundation stone of the estate was the 'Village'. The productive activity, even in difficult times, managed to keep the estate's finances flourishing and make it self-sufficient. In today's world, sustainability requires the total utilization of the productive potential to contribute to the maintenance and operation of the estate. These activities will be mainly of an agritourism nature and will be an additional attraction for visitors, making use of the buildings which will be revived from their former function, such as the olive mill and the winery.

The latter two interventions are the cornerstone of the new development logic required by modern times. Research, although a primordial concept, is called upon to provide solutions to contemporary problems such as improving production dynamics and protecting the environment. With this in mind, the hosting of research and other start-up activities in subjects related to the character of the estate, qualify by utilizing specific areas of Tatoi. Finally, activities related to wellness complete the visitor experience with more complex interventions, such as spa and wellness services. The meaning of these interventions has to do with the modern lifestyle which wears out "body and spirit" and the requirements of the visitor are much more specific.

With this in mind, the research interest of this study focused on the potential and prospects for sustainable development of the Tatoi estate. Specifically, through the implementation of an online quantitative survey using a specially designed questionnaire, the opinion of the residents of Attica regarding the impact of the planned redevelopment was investigated. Regarding the results of the present study, as they emerged from the processing of the data collected, the vast majority of people are in favor of the redevelopment plan, which seems logical since the chronic abandonment of the estate was an unpleasant situation for the society, compared to other palatial units abroad that are important landmarks and tourist attractions.

The overwhelming majority of the sample also stresses the need for a balanced weighting of regeneration interventions in all four key dimensions of sustainable development. As explained in the previous chapters, the productive form includes all the old buildings of a similar character that will be revived and operate in their original form, such as the winery and the olive mill. The second axis consists of those buildings that will operate in a differentiated form, targeting services. If, of course, the redevelopment in question had been planned several years ago, it is likely that the redevelopment axis would have consisted only of the provision of accommodation with the creation of huge hotels. However, the change in the development model and people's awareness of the value of sustainability has changed this trend. Of course, as it is understandable, the sample of 132 people is by no means safe for drawing safe conclusions. However, the fact that 71.2% of the total sample intends to visit the estate more often after the end of the redevelopment is an impressive finding, indicative of the need of the people of Attica to restore the estate to its former glory.

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Tourism and Corporate Social Responsibility. Case study: Tourism Businesses on the island of Lefkada.

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ABSTRACT
The present paper aims to investigate the relationship between tourism and Corporate Social Responsibility. The island of Lefkada was chosen as a case study. Lefkada is located on the western side of Greece, belongs to the Ionian Islands Region and is a developed tourist island. Its tourist development has the characteristics of coastal summer tourism and shows increased tourist traffic during the summer months. However, it also has many permanent residents during the winter. A special feature of Lefkada is that it is connected by land to the mainland Greece, therefore, the results of the research do not only apply to the island areas, but can be representative for all coastal tourist areas as well. The paper is divided into 5 distinct chapters, where the theoretical framework of Corporate Social Responsibility (CSR) is presented. Then the relationship between CSR and Greek tourism businesses is explored. In addition, it is investigated whether CSR is considered important by tourism businesses and whether they choose to integrate it into their overall development strategy. For the needs of the research, a questionnaire was shared to 130 tourism businesses on the island of Lefkada. The results showed that Corporate Social Responsibility is considered quite important for the tourism businesses owners of Lefkada, and they are willing to adopt it.

Key Words: *Corporate Social Responsibility, Tourism, Tourism Businesses, Lefkada, Tourism Product*
JEL Codes: Z32; O44; O47; O52; Q56

1. Introduction

The aim of this study is to investigate the relationship between tourism and Corporate Social Responsibility (CSR). Regarding CSR, it should be noted that it has become an integral element in the operation of modern businesses, while according to literature review, the definition of CSR is quite complex and ambiguous. A representative definition of CSR states that CSR is how companies manage the business processes to produce an overall positive impact on society. From the other side it is mentioned that, "CSR theories apply when an enterprise integrates social demands into its strategies" (Hamid, 2010). In addition, one of the earliest and most prevalent definitions argues that "the code of Corporate Social Responsibility addresses the expectations that society may have of businesses and organizations" (Carroll, 1979). Similarly important is the definition of Edward Freeman (1984), who expresses that the CSR code refers to the responsibility that the business has

not only towards maximizing its profit but also towards its stakeholders (such as suppliers, consumers, shareholders, employees) (Freeman, 1984).

In the early days of the appearance of CSR, the liberal classical current, with Milton Friedman (1970) as a key representative, referred to the ideas of social responsibility and the promotion of desirable "social" purposes as a socialist policy undermining the basis of the free market and economy in recent decades. Nowadays, Classic views on corporate social responsibility represent shareholders and state that companies should fulfill the expectations of their shareholders in terms of profitability and financial viability. The modern approach to social responsibility refers to the set of policies, strategies and applications that result to favorable outcomes in terms of the well-being of society as a whole (Akmese, et.al., 2016).

In the context of this work, it should be noted that CSR plays a crucial role in the operation of tourism businesses, which aim to serve the public interest and should adhere to high standards of corporate governance and transparency. In order to clarify the relationship, the basic categories of tourism, are presented. These categories have been developed within the framework of the development of the tourism industry:

- Professional tourism.
- Urban tourism.
- Social tourism.
- Cultural and Religious tourism.
- Winter tourism.
- Mountain tourism.
- Coastal tourism.
- Ecotourism.
- Health and wellness tourism.

The last decade, a continuously growing number of Tourism businesses are engaging and incorporating CSR into their business models aiming at the improvement of the environment, the quality of life of local communities or the welfare of their employees (Bohdanowicz & Zientara, 2009: Font et.al. 2006).

In Greece, tourism can be characterized as a developing industry and it has become a key pillar of the Greek economy. There are thousands of businesses, mostly small and medium sized, that operate due to tourism in Greece (Eurostat, 2019). Therefore, the contribution of the tourism industry is crucial to GDP. Consequently, it is obvious that CSR will be a critical point for the course of tourism businesses, regardless of their small or medium size. Many of them already seem to appreciate the potential benefits of taking responsibility for being sustainable and understand it as a business model which leads to better relationships with stakeholders and produces a positive reputation (Tamajon, Aulet 2013).

2. The Corporate Social Responsibility as a parameter in tourism businesses.

Corporate Social Responsibility constitutes a unique combination of corporate policies and practices within an international framework of economic and political relations and transactions. The contemporary challenges and pressures faced by the tourism industry are leading to rapid changes in the tourism sector. Therefore, many industries turn to CSR as yet another tool to differentiate themselves within this environment and strengthen their position, shaping a culture that allows them to stand out and avoid the risk of sterile service replication. Based on the definitions that were given,

there are many approaches and corresponding theories regarding CSR. According to Dahlsrud (2006), five dimensions are distinguished:

- Voluntary character,
- Stakeholders,
- Social dimension,
- Environmental dimension, and
- Economic dimension. (Dahlsrud, 2006)

Similarly, the research of dimensions leads to the need for defining the tourism product, both as a concept and as a broader notion upon which corporate social responsibility for tourism can be supported.

According to Koutoulas (2001), the tourism product has two levels and based on the literature there is a classification of six distinct characteristics. The concept of the tourist product is quite complex and we can observe that, indirectly but clearly, when referring to a product, we are also referring to concepts such as consumption and any behavior that leads to consumption. Initially, we should start from the point that the tourism product is, as mentioned, a complex product because tourism is basically a horizontal economic activity that concerns a set of individual sectors. However, tourism continues to branch out, interacting with many other sectors, which in turn are related to tourism and the tourism product on a second level.

Therefore, according to the Greek Network for CSR, in order to clarify the relationship between tourism and corporate social responsibility, Corporate Social Responsibility in the context of any business and specifically tourism business has the following characteristics: (CSR Hellas, 2016).

1. It is not just about compliance with legislation, as compliance with legislation and regulatory provisions are prerequisites for the lawful operation of the business. Under the spectrum of Corporate Social Responsibility, practices go beyond those provided by laws
2. It is not within the scope of the Public Relations of the tourism business. Although the boundaries of some Corporate Social Responsibility actions may overlap, it must be ensured that a business does not incorporate Corporate Social Responsibility purely and solely for public relations reasons into its strategies.
3. It is not contradictory to the business purpose, which was and remains the production of financial profitability. The main reason for the existence of a business is to generate benefits for its shareholders. However, the above should be accompanied by actions that protect the environment and include social responsibility practices.
4. It doesn't only cover charitable actions and commercial sponsorships, through which businesses promote their brand or products.

CSR is understood as a methodological approach that attempts to satisfy social, environmental, and economic issues, which are a key lever for the development of tourism businesses in Greece. According to Martinuzzi & Krumay, (2013) CSR is the obligation of a business to act in accordance with the primary goals of society, to comply with laws or regulations, and it is also dependent on the political, institutional, and cultural framework of its businesses (Martinuzzi & Krumay,2013). All of these directly link CSR to sustainable development.

The goals for sustainable development in tourism are identified as the priorities and expectations regarding what sustainable development is, seeking to mobilize global efforts around a common set of goals (Mathioudakis, 2018). These goals call for global action among governments, businesses, and civil society to create a dignified life and opportunity for all, while preserving and ensuring the resources for future generations (Meadows, et.al. 1972).

3. Research - Data

For the purposes of the research, a structured questionnaire consisting of eighteen questions was created and distributed to 130 Tourism Businesses on the island of Lefkada. The survey was conducted during the spring of 2022, specifically in the months of March, April, and May.

To complete the data collection process and overall evaluation of the findings with accuracy and success, basic criteria were taken into account to ensure the extraction of reliable conclusions. The final research tool that was developed consisted of closed-ended questions and questions weighted on a five-point Likert scale. The main goal was for the questionnaire to have a short duration, in order to make it easy and quick to complete, which was mainly considered an advantage and therefore there was a relatively easy response to the call for participation in the research. The analysis of the results was carried out using 3 different tools such as Microsoft Excel, the open source statistical analysis software GNU PSPP3, and the built-in tools of the Microsoft Forms application of the Microsoft 365 platform. The research was devided into 3 distinct parts:

A. Characteristics of tourism.
B. Relationship between Tourism Business and CSR.
Γ. Demographic data.

The development of the work case was based on highlighting the correlation between CSR and Greek tourism businesses, regardless of size, and also the rate to which CSR is perceived as an organized and business model practice by tourism businesses.

Regarding the sampling, a simple random and anonymous sampling was conducted without collecting individual, personal data from a wider population engaged in tourism professions with a final sample size of n=130 and a maximum estimation of approximately 0.087.

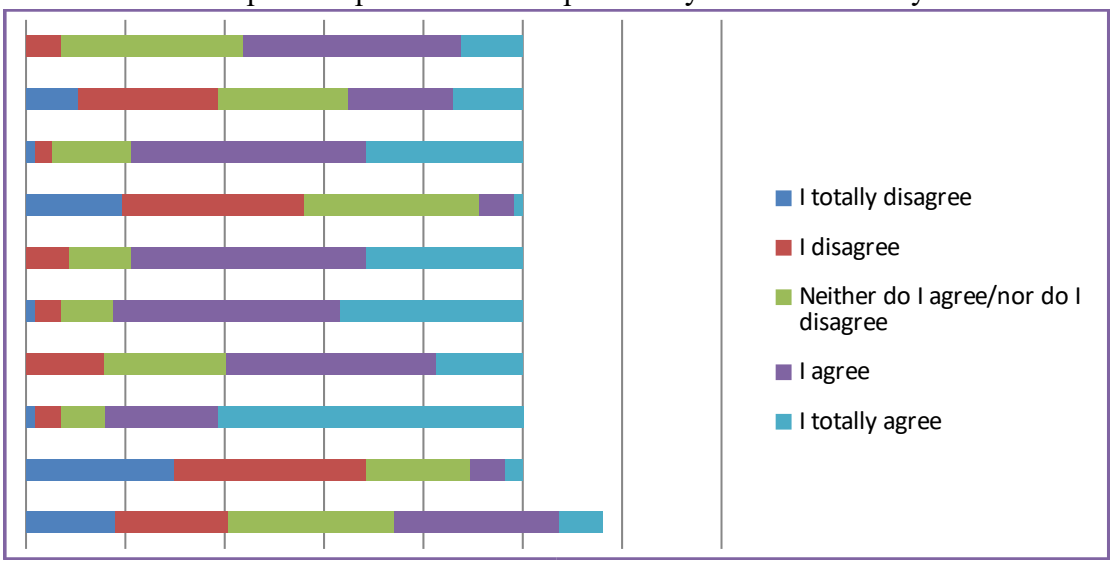
4. Empirical analysis

In the field of empirical analysis, after the necessary information was collected through the questionnaire, the basic trends regarding the CSR and Greek tourism businesses were identified.

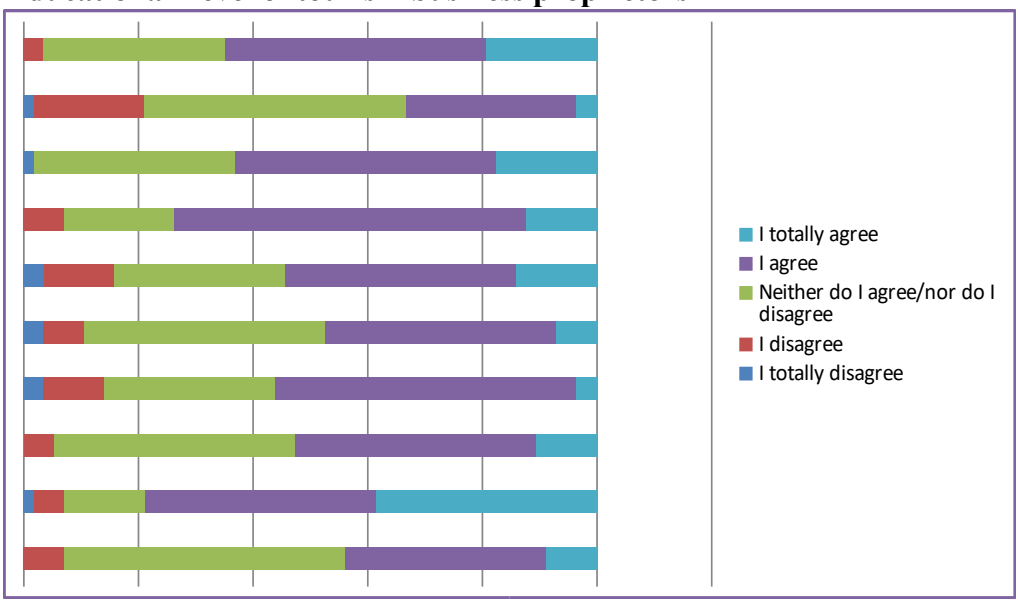
First of all, the analysis of demographic data (Part C), shows that the dominant age group is between 21-30 years old, since 60% of the respondents are at the 21-30 age group, followed by the 31-40 age group with 18%. This is a crucial element for our research as it indicates that the basic productive ages in the tourism industry, both for men and women, are between 21-40 years old. Furthermore, in the question regarding educational level, 73 responses indicated the option "Bachelor's degree", providing yet another important dimension regarding the CSR and tourism in consistance with the perceptual framework developed by educational level (see Picture1 below). This data indicates a high level of education for the tourism business proprietors.

Moreover, as mentioned above, the size of businesses is rather small and/or family-owned since 49% of the sample is in businesses with 1-5 employees while their average operating years belongs primarily to the classification of 5 years and below, since 47% have 5 years or less of operation. This highlights something that is already known about the Greek economy but especially the tourism industry, that the main unit is small and new businesses do not have organized CSR strategy. Additionally, they may not be able to incorporate it as easily into their business plan as an older and larger business that can incorporate the appropriate laws such as the laws 2190/1920, 2778/1999,

3016/2002, 3693/2008, 3873/2010 (Gkagkaletsiou, 2020), through which the code of corporate governance and the concept of corporate social responsibility are more broadly established.



Picture 1. Educational Level of tourism business proprietors

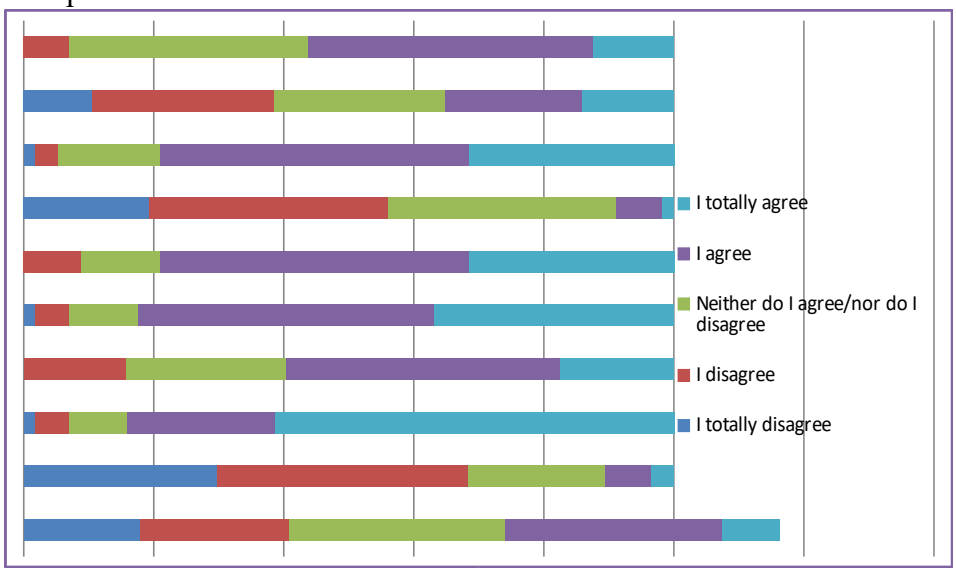


Picture 2: Part A of the Questionnaire

In the following, regarding the topic of tourism characteristics Part A of the Questionnaire (see Picture 2 above), it was evident from the overall responses that tourism is of high importance, while special emphasis is given on the trend of forming a strategic corporate social responsibility policy (43.9% in favor), although 36.8% neither agree nor disagree with this issue. In line with the literature review, a considerable agreement among respondents is observed about the contribution of tourism to the country's economic development (61.4% strongly agree - 22.8% agree). However, high percentage of the respondents agree both in terms of putting limits to tourism development and diversification, as well as in the development of alternative forms of tourism beyond the maritime sector.

As far as the basic trends part B of the Questionnaire (see Picture 2 below), it should be noted, that the first major trend highlights the importance of tourism for the economy and the development of society. Meanwhile, the second basic trend indicates the fact that tourism can be improved and

diversified on multiple levels. Additionally, it appears that the sample confirms the classic "saying" about "seasonal tourism," while considering it negative (Van Dieren, 1995). Also, it is important to note that almost more than 50% of the sample believes that the development of tourism based on seasonality has negative impacts and therefore sustainable development is promoted as a solution due to the overconsumption of natural resources and a subsequent lack of natural resources (Pezzoli, 1997). Finally, the development of other types of tourism is considered necessary, while there seemed to be relative awareness despite the fact that we are talking about a framework of small and medium-sized enterprises.



Picture 3. Part B of the Questionnaire

However, CSR is becoming increasingly known in the tourism industry as mentioned above, therefore there is a need to incorporate it into the strategic plan of even smaller businesses. This is evident from the most critical point of the questionnaire which highlights the relationship between a tourism business and CSR. This trend appears to be correlated with both the educational level and the growing importance of tourism in Greece. In addition, based on the collected responses, there seems to be an understanding of CSR as a strategy that takes into account not only the environment and the local community, but also the framework of sustainable development (question 5 - Part B), although there is a significant degree of uncertainty, possibly due to a lack of planning at a central level related to sustainability. However, as noted, the just treatment of employees is equally important, as the adaptation of CSR is to the corporate governance model (79% agreement in question 2 and 56.1% in question 4). This inevitably leads us to understand that CSR is perceived as a very important factor.

5. Qualitative correlations

In order to provide more qualitative data about tourism businesses connection to CSR some correlations from the analysis of the Likert-type questions were conducted within the framework of the statistic data analysis.

The first correlation is compares the two major trends of this research, the firist major trench which is the high importance of tourism for the economy and the development of society with the second basic trend that reveals that tourism can be improved and diversified at multiple levels. Furthermore, it appears that the sample confirms the classic "saying" about "seasonal tourism," considering it to be negative (Van Dieren, 1995). However it is noted that there is a strong correlation

between the 50% of the respondents considering that the development of tourism based on seasonality has negative effects, and sustainable and eco-friendly development is preferred due to the overconsumption of natural resources and therefore, the lack of them (Pezzoli, 1997). Finally, the development of other types of tourism is deemed necessary, and there seems to be some awareness despite the fact that we are talking about a framework of small and medium-sized enterprises.

Similarly, there is a significant correlation in tourism development with respect to the environment, as emerges from the combination of Questions 9 in Part A and 7 in Part B. Likewise, emphasizing the importance of CSR strategies is extremely crucial, as Greek tourism needs to take into account both the aspect of just development and sustainability (Questions 4-5/Part B and 6-7/Part A).

CSR seems to expand its significance in the tourism sector, therefore, there is a need to integrate it into the strategic plan of even smaller businesses, such as the majority of tourism businesses in the Greek market. There is also strong correlation between the high importance of the connection of CSR to tourism with the educational level of the tourism business proprietors..

In Part B, as previously mentioned, the argument regarding the broader role of CSR in the tourism industry is evident. In addition, based on the collected responses, it appears that there is an understanding of CSR as a strategy that not only takes into account the environment and local community but also sustainable development as a whole (Question 5 - Part B). Although there is still a significant level of uncertainty, possibly due to the lack of government-level planning related to sustainability.

However, there is also important evidence that that just treatment of employees and engagement of CSR to the corporate governance model are highly correlated (79% agreement in Question 2 and 56.1% in Question 4). This indicates that CSR is perceived as a very important strategy, which nowadays clearly and obviously fits into the perceptual framework of even smaller businesses that will, of course, have to manage to integrate it into their business model, both economically and strategically, as well as technologically and ethically, creating a unique network of future challenges and sustainability.

6. Conclusions

Corporate Social Responsibility is undoubtedly one of the most critical topics for contemporary businesses and not only in Greece. According to the empirical analysis of data, it has been observed that CSR is a central point of discussion for many tourism businesses in Lefkada, and it is not a one-dimensional and unilateral practice related only to the environment or the local community. Particularly in Greece, CSR has gained special interest in recent years, as it has been noted that many businesses, even small and medium size, are engaging or are willing to engage to a greater or lesser extent, a corporate social responsibility model with dynamic characteristics (Mathioudakis, 2018).

In addition, after the decade-long crisis (2010-2020) that plagued the Greek economy, the issue of sustainable development through European policies and the incorporation of CSR into the Greek tourism industry has become very important.

More specifically, and according to the results of this research, the importance of CSR for the tourism sector was evident both in terms of the development of the tourism product and in the concept of diversification, which in turn will contribute both to the local community and to the environment and the economy more broadly as mentioned also by Tamajon & Aulet (2013).

Finally, tourism businesses and not only them, will have to adapt to modern standards and regulations, starting from ESG criteria in order to be competitive and sustainable, but mainly to have

a symbiotic nature with the local communities in which they operate. In this sense, Corporate Social Responsibility is transformed from a business practice of the few into a reality for the many.

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Barriers and drivers in implementing sustainability practices in Greek universities

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Abstract

The implementation of sustainability practices is set as a priority for Greek universities according to the Charter of Greek Universities for Sustainability. The success of any organization's objectives and in particular the achievement of sustainability objectives is strongly related to the administration's perspectives. However, limited research has been done regarding members of the university administration's perception towards the adoption of sustainable practices in Greek universities. This study aims to examine the administration's perceptions towards the adoption of sustainable development practices and the factors that affect their implementation. The barriers and drivers towards implementing sustainability practices in university institutions are also examined. The analysis is based both on sampling, addressing questionnaires to the rectorates of Greek universities, and on the collection of secondary data on the sustainability practices performed by the institutions. Results suggest that the most popular initiativesare energy savings and recycling in the environmental sector. The adoption of actions is mainly affected by the leadership capacity of the university's management on sustainability issues. Lack of financial resources and malfunction of the administration are the main barriers to the adoption of analogous practices. Finally, the motives that could boost sustainability in universities are a combination of financial support, and awareness raising towards sustainability.

Keywords: *Barriers; drivers; university administration, sustainable development*

JEL Codes: M14, M19, Q01, Q56

Session 12
Environmental Education

Perceptions of secondary school students about renewable energy sources

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Abstract

Renewable energy sources have been introduced in the past twenty years in Greek education in the contextof environmental education and education for sustainability. As the geopolitical developments of the last year affected the countries' energy planning, it became clear that renewable energy sources can serve a dual role, on the one hand, their exploitation can contribute to the protection of the environment and on the other hand to lead a society towards energy autonomy and sufficiency. The purpose of this work is the empirical analysis of high school students' opinions, attitudes and knowledge about renewable energy sources. The analysis is based on quantitative analysis of 4500 questionnaires filled in person by junior high school students of Attica, Greece. The preliminary findings indicate that, to a significant extent, Greek students have a lack of basic knowledge about renewable energy sources. It is concluded that students are positive about the exploitation of renewable forms of energy in relation to the protection of the environment.

Keywords: *Renewable energy awareness, secondary school students*

JEL Codes: I20; Q20; O30; O40

Trash Art as an educational tool to protect the environment: The Case of Skyros Project

Η Τέχνη (Trash Art) από επαναχρησιμοποιούμενα υλικά ως εκπαιδευτικό εργαλείο για την προστασία του περιβάλλοντος: Μελέτη περίπτωσης Skyros Project

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Abstract
Trash art is a new form of art that is made from waste materials and follows the rules of art. These objects are collected and transformed into art. Environmental art is an educational tool that is reinforced through art. This literature review aims to investigate how trash art affects people's behavior toward the environment. The case study is the Skyros Project, where eight mosaics from trash art have been completed as part of this program. Skyros Project is a novel program of the Department of Public and Community Health of the University of West Attica that takes place at Skyros Port. Art as a tool cultivates and aware people of the environment. People that participated in Skyros Project adopted awareness and an active role in environmental issues.

Keywords: *Trash art, Skyros Project, Environmental Education, Education for Sustainability*

1. Introduction

Artists use art to express themselves and their work to call to action their audience. It is a way of social effect and a nexus between people and the environment (Pollak and MacNabb 2000, Williams 2001). Many different forms of art are used to express displeasure and call to action society (Doyle, 2001; Robertson, 2001; Branagan, 2003; EBC, 2005; Belfiore & Bennett, 2006; Kent, 2010). Also, art is a wake-up call for society to many social issues like wars, poverty, social injustice, and AIDS and a way for people to protest through movements (Doyle 2001, Branagan 2003a,b,c, Educational Broadcasting Corporation 2005, Jordaan 2008).

Wastes constitute one of the most critical issues in the environment nowadays. The increase in population, urbanization and the increase in consumption have led to much waste throughout the world. Education and culture influence the attitude of people toward these problems. Environmental Education is a method of training that is reinforced through Art.

Art is made by different persons; each has a different attitude toward the physical environment. Trash art is a category of art. Scientists research and develop new strategies to protect the environment, while artists come up with novel ways to increase the environmental awareness of society through sentiments (Song, 2009). The purpose of this study is to examine the effectiveness of promoting environmental awareness and sustainability through the summer camp "Skyros Project".

1.1. Trash Art

Trash art is a form of art that is made from rubbish and other waste objects. These objects are collected and transformed into art. Otherwise, they would end up in a landfill, without a second use. This form of art aims to inform society about environmental issues and vital art (Kent, 2010).

The use of art connects with people emotionally and is an effective way to encourage people to reverse problems like climate change in this case (Curtis et al., 2012). In other words, trash art is an alternative way to protect the environment. Jackson (2005) based on "Triandis' Theory of Interpersonal Behaviour" concluded that emotions affect people's environmental awareness.

The German artist Schult was one of the first creators of trash art. He uses rubbishes to create artwork that is characterized by social and ecological awareness. He led the way in eco-art. One of his masterpieces was exhibited at Northern Rhinea in 1996. Its title is "People - Rubbish". It represents 1,000 physical-size human figures made from recycled materials, metallic and zinc cans, and electronic waste products (Beckman, 2008).

According to Schult, humans in the Stone Age used their rubbishes to create useful tools. They used animals' bowels to make archery bowstrings and blood for rock paintings. The trash art movement started around 40 years before in the United States of America. It includes Urban Art, which is the need of people to express themselves in the big cities, where they live (Beckman, 2008).

1.2. Environmental Art

Environmental art is a form of art that aims to familiarise the natural world, explain physical phenomena and inform people about environmental problems. The materials of the environment are used to create artwork. This form of art includes different techniques to describe and represent nature (Jacobson et.al, 2016).

Nowadays, environmental problems, like climate change, and the relegation of biodiversity, are a worldwide phenomenon (Worldwatch Institute, 2012). Many artists are concerned about these problems (Cembalest 1991, Goldberg 1991, de Groat 1994, Cless 1996, Kirn 2000, Branagan 2003a,b,c). As result, different forms of art are developed towards the environmental issue like Ecoart/Ecological Art, Environmental Art, Land Art, and Art in Nature (Kagan, 2014).

Environmental art is a way to express concerns, opinions, and environmental awareness. It can be adapted to different school courses like history, biology, maths, and, physics. For instance, students can learn about the percentage of decomposition of different materials to collect data about the quantities of waste products in their region and their biodegradation time (Song, 2010). For these reasons, environmental art in schools can make students aware of environmental issues, inform students about current environmental problems, and provide knowledge to them (Song, 2017).

1.3. Environmental Education through Art

Environmental art is an educational tool that is reinforced through art. It is characterized by its non-stational approach that goes by social, economic, technological, and cultural changes. Also, it responds to environmental issues like climate change (Skanavi-Tsaboukou, 2004).

Bradshaw (2016) carried out a project on Environmental Art at a school and concluded that there was an increase in the empathy of the students toward environmental issues. The same result came up from the study of Song (2017) highlighting that students have a heightened interest in the environment, readiness for gaining further knowledge about environmental issues and become active members of society.

Ozsoy (2012) studied that the incorporation of art into environmental education is an alternative way for people to express themselves and contributes to different states. Moreover, art can be a voice even for marginal people and contributes to political reform (Alexander 2003, Belfiore and Bennett 2006).

Nowadays, children have narrow contact with their natural environment (Mckibben, 2006).

1.4. Skyros Project

Skyros Project is a multi-awarded communicational program, based on the successful cooperation between the University of West Attica and the Skyros Port Authority. It is a summer Academy for Environmental Educators taking place on the island of Skyros. Skyros Project has received a significant number of global awards throughout the years. It is a practical program in which students from different universities and countries attend (Skanavis et al., 2020).

The Port of Linaria is a small multi-awarded public port (Skanavis et al., 2019). It is an area of environmental awareness and the betterment of human health (Antonopoulos et al., 2020). Several outdoor activities are organized there to trigger the public's environmental interest. In these actions of this project citizens, tourists, passengers, and children participate. The port has been included as a member of the 86 award-winning European marines in the Trans Europe Marina program (Antonopoulos et al., 2017).

2. Methodology

This paper reports a comprehensive and systematic literature review exploring the approaches of art to environmental projects in education (Kitchenham, 2004). The work used the PubMed and Cochrane Library academic databases. The search string considered the following keywords: Environmental Art Programs, Primary Education, and Elementary School.

2.1. Case Study: Skyros Project

The artistic workshop of Skyros Project is a novel program of the Department of Public and Community Health of the University of West Attica that takes place at Skyros Port. From 2019 up to 2022 eight mosaics from trash art have been completed as part of the Skyros Project. Four have been posted publicly on the island of Skyros and the other four have been created in Primary and high schools at Athens College. Ostensive three of them appeal in Figures 1, 2, and 3. The materials that have been used are mainly glasses, stones, bottle caps, buttons, mirrors, and other waste materials. At Project Trash Art students from schools and universities, and local society is participating during the summer months.

Figure 1. Mosaic with four jellyfishes, Skyros 2022.

Figure 2. Mosaic with a mermaid, Skyros 2021.

Figure 3. Mosaic with a boat, Athens College 2021.

3. Results

Environmental education programs, such as the "Skyros Project", can play a crucial role in changing peoples' willingness and attitude toward the environment. These types of programs are necessary for education. Kids nowadays are aware of environmental threats but they have limited connection with the environment (Louv, 2008).

Art is an effective way to motivate society to deal with environmental problems even though scientists don't combine art with science (Curtis et.al, 2012). Many ecologists and environmentalists work to solve different environmental problems such as loss of biodiversity and climate change with no effectiveness. The use of art, as presented by scientists at a conference of the Ecological Society of Australia, was an emotional approach to the environment. Art aims at the well-being of people (Curtis et al., 2012).

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Awareness of teachers at Primary and Secondary Schools through Trash Art into environmental issues and actions

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Abstract
An artwork reveals concerns and aspects of environmental ethical issues, environmental philosophy, social ecology, evolved technology, environmental degradation, and social alienation. Teachers learn how to develop environmental education and encourage students and citizens to respect environmental behavior, through Trash Art and ecological thinking. This study aims to investigate the connection between Trash Art and nature through a literature review and quantitative research. The environmental awareness of teachers at Primary and Secondary Schools and to which degree the development of environmental awareness drives to respect environmental behavior has been examined. The connection between art and nature, using natural and artificial materials for art, results in the revaluation of human presence in the environment.

Keywords: *Ecology, Trash art, Environmental Education, Environmental Communication, Actions*

1. Introduction

The objective of this study is to:

- People gain knowledge, skills, and responsibility for the environmental issues
- Investigate how environmental practices affect and aware people
- How people can participate in different environmental actions such as trash art

1.1. Degradation of environment

Climate change is the major environmental issue of this century (Caselli et al., 2021). The principal cause of climate change is the burning of fossil fuels (Perera and Nadeau, 2022). The atmospheric CO_2 measured at Mauna Loa Observatory is increasing as shown in Figure 1, based on NOAA Earth Research Laboratory. The red color represents the mean monthly value and the black color the mean annual value. In 1960 the concertation of atmospheric CO_2 was below 320 ppmv, whereas in 2020 the atmospheric CO_2 exceeded 400 ppmv. The CO_2 concentration is increasing by around 0.35% per year (NOAA, 2022).

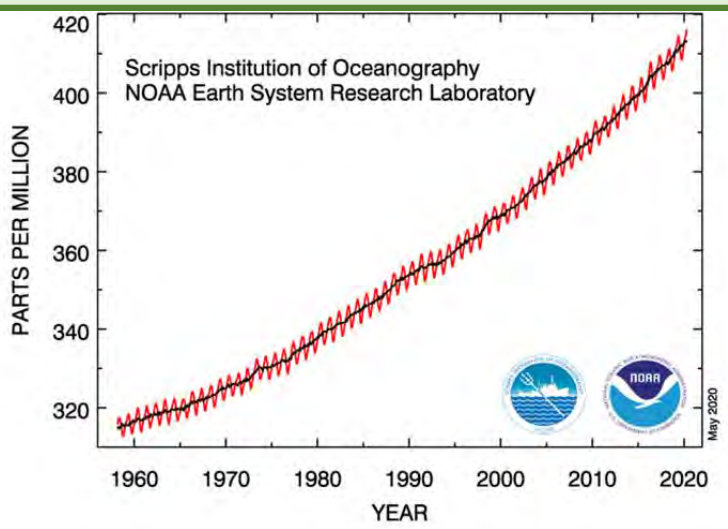


Figure 1. Atmospheric CO_2 at Mauna Loa Observatory

Due to climate change, the global average temperature is increasing, deserts are expanding and the sea level is rising (Malhi et al., 2021). In Figure 2, the mean increment of the earth's surface temperature from 1950 to 2020 against the pre-industrial period based on various models is shown. A near-term projection is shown in green. The period time 1983-2012 was the warmest 30-year period of the last 800 years (IPCC, 2018).

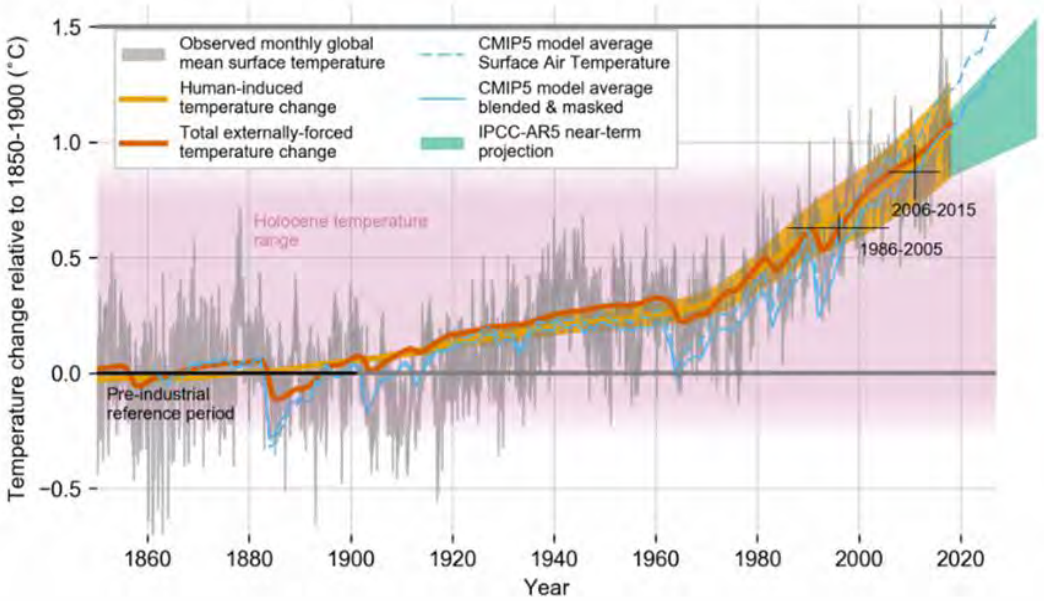


Figure 2. Temperature change at the earth's surface (IPCC, 2018).

Climate change affects people's physical and mental health in the assessed regions (IPCC, 2022). A solution is to take advantage of Renewable Energy Systems (Delponte and Schenone, 2020).

1.2. Environmental Education

Environmental education at schools aims to inform and raise awareness about environmental issues. Through this form of education, people gain knowledge, skills, mindset, and motivation to

solve and prevent environmental problems as a group and individually. Also, environmental education aims to build new ethics between people and the environment and develop different environmental activities at schools (Sterling, 1993).

The beginning of environmental education is based on the ecological movement of the decade of the 60s. Later, in the first decade of the 20th century, these movements were referred to as "preservation", "study" and "protection" of the environment (Kousoulas, 2008).

Environmental education is an ethical recognition progress and meanings clarification, to develop the necessary capacities and attitudes for people and society to understand and value the relationship between humans, civilization, and the natural environment. Environmental education requires practical work for decision-making. That leads to a behavior code toward concerns and problems regarding society and nature quality (Kousoulas, 2008).

1.3. Environmental ethics

An ethic of respect and responsibility towards nature could be characterized as an environmental ethic. On the one hand, the relationship between humans and nature gives the last one an ethic of respect, on the other hand, the relationship between humans and technology applies pressure to nature (Theodoropoulou et al., 2009).

Our behavior towards the environment is crucial, as there are good and bad ways to live in this. In particular, talking about the environment is where we stand but haven't built. Our attitude affects and modifies the environment, so we should follow some environmental ethics (Theodoropoulou et al., 2009).

According to Georgiopoulos (2002), ethics is a set of rules that determine good and bad, justice and injustice, acceptance and unacceptance, etc. Humans should comprehend this set of rules, to understand and follow them. In other cases, these rules can be unconsciously followed by instinct.

Environmental ethics is an effort to organize ethical rules towards the non-human beings on the planet, and to find a way to include them also into the ethical community. Education could contribute to this effort through the cultivation of respect and responsibility towards nature. To fill this gap, humans should also understand and absorb environmental values (Georgiopoulos, 2002).

1.4. Environmental actions

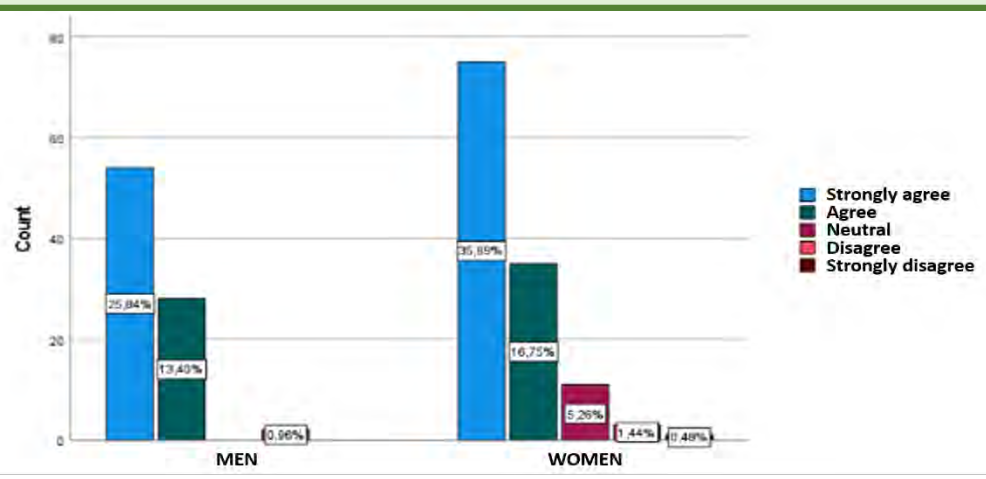
Several environmental actions are carried out by different organizations and universities around the world. Creating art using discarded objects is a world-famous master art piece (Prasad, 2021).

2. Methodology

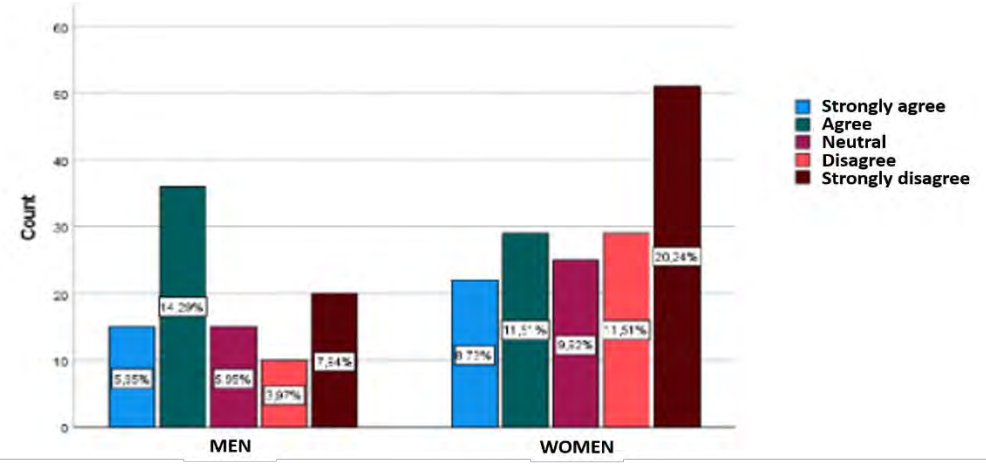
A systematic literature search and quantitative research were conducted to investigate the connection between Trash Art and nature (Kitchenham, 2004). A questionnaire of 19 questions was conducted. The sample size is 255 teachers from Athens College, 109 from the primary and 136 from the secondary school during October-November 2021.

3. Results

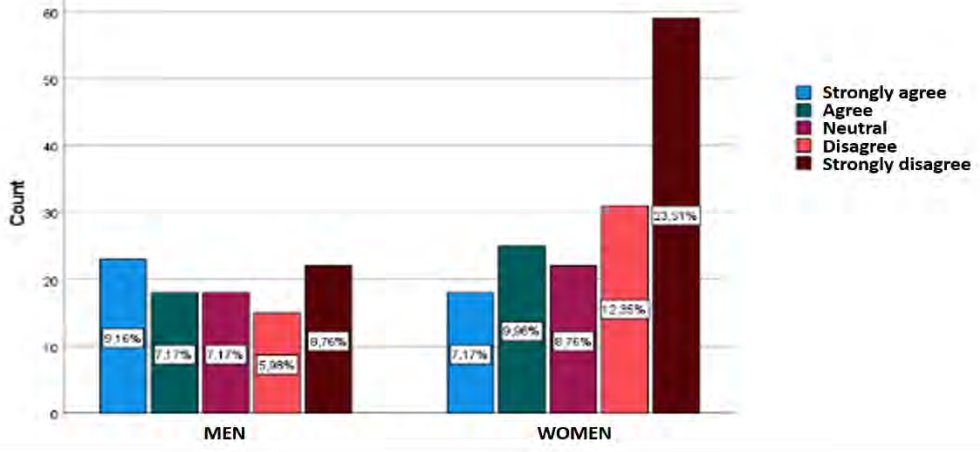
The first question is: Do you agree that education affects the environmental awareness of people? The results show a correlation between the gender and the degree of affection. Most of the women strongly agree at a percentage of 35.89%, whereas most of the men at 25.84%.



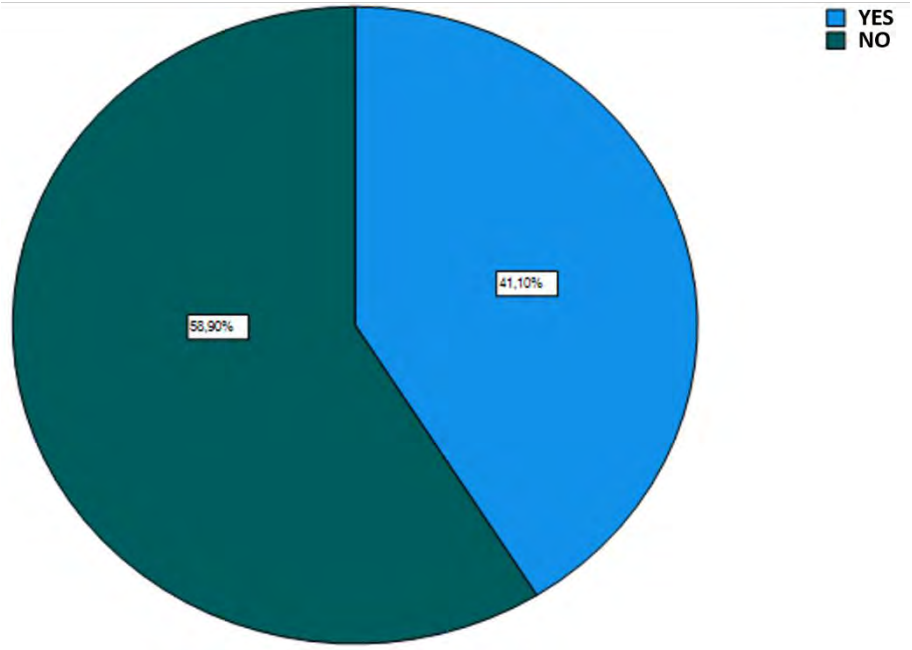
The second question is: Do you agree that trash art can provoke guilt? Based on the results there is a correlation between the gender and the emotion of guilt. Most of the women strongly disagreed at a percentage of 20.24%, whereas most of the men agreed at a percentage of 14.29%.



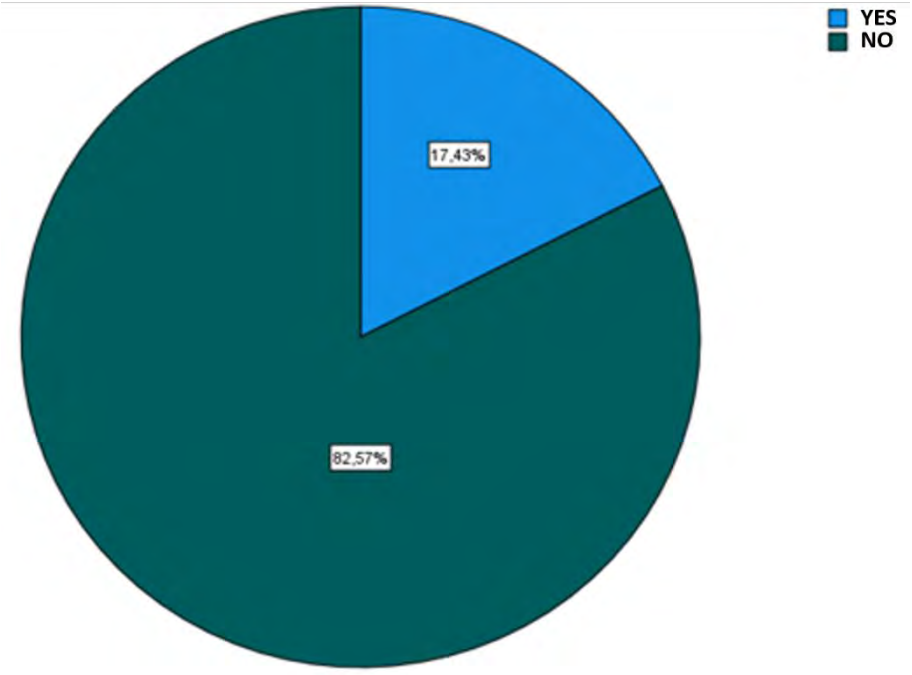
The third question is: Do you agree that trash art can provoke sadness? The results show a correlation between the gender and the emotion of sadness. Most of the women strongly disagreed at a percentage of 23.51%, whereas most of the men strongly agreed at a percentage of 9.16%.



The following yes/no pie charts refer to the question: Have you ever attended any edification relevant to the environment? The first pie chart refers to primary school teachers and the second one to secondary school teachers.



Most teachers at primary schools haven't attended any edification relevant to the environment (58.90%).



At a percentage of 82.57%, secondary school teachers haven't attended any edification relevant to the environment (58.90%). Primary school teachers have involved a higher percentage in environmental edification than secondary school teachers due to their participation in the school lesson flexible zone and at the skill laboratory of the Institute of Educational Policy (IEP).

4. Conclusions

Teachers at primary and secondary schools believe that art is beneficial on sentimental and gnostic levels. It is found that art contributes to the free expression of their emotional life and awareness. At the gnostic level, teachers believe that through art the comprehension and understanding of examined lessons are easier while they develop skills such as critical thinking. Teachers believe that art promotes environmental education and is a tool and a way to express. Moreover, art is considered to be a way of experiential learning. Experiential learning plays a key role to promote art. Based on the teachers, knowledge acquisition, active participation, and pleasure are basic characteristics that promote art. Moreover, based on the teachers' opinion, art contributes to sentimental and gnostic levels. Its application is considered easy if some edifications are carried out.

This study is focused on environmental actions through the art of the teachers from Athens College in the academic year 2021-2022. In future research, a higher number of teachers and schools could be examined for further analysis.

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The theoretical framework of Ecotherapy

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Abstract

Ecotherapy is a relatively new concept, but its roots can be traced in the past. It is process that aims at human contact to and interaction with nature. This interaction sets the foundation for mutual benefits to both humans and the natural environment. Ecotherapy is based on several theoretical models, such as the “Biophilia Hypothesis”, the "Psychophysiological Stress Recovery Theory", the "Attentional Restoration Theory" and the "Extension of the Attentional Restoration Theory". Additionally, there have been developed various methods of Ecotherapy that promote the interaction between human and nature, such as gardening, contact with animals, exercise in green environments or even a simple walk by the sea or in a forest, can be considered Ecotherapy.

Keywords: *Ecotherapy, theoretical models of Ecotherapy, methods of Ecotherapy*

JEL Codes: Q56; Q57

Environmental Educators' Personality Characteristics A Psychometric Case Study at Environmental Educators' Academy, Skyros Island

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Abstract

Over the last decades, there's been considerable scientific interest in the psychological and personality correlates of pro - environmental behavior. Environmentalism has begun to be examined from the perspective of its association with personality traits, using the Big Five Personality model. This study innovates by attempting a measurement of the personality traits of a sample of environmental educator trainees, using a psychometric tool that can also measure sub factors of the main 5 traits. Testing was conducted during a team-building workshop,as part of the Environmental Education Summer School program, in Skyros- Greece, during the 2016 to 2020 period. Results showed that the Environmental Educator group scored significantly lower than the General Population on Emotional Stability ($t=-4.46$, $p<0.001$) and its subscales Emotional Control ($t=-4.20$, $p<0.001$) and Impulsiveness Control ($t=-3.93$, $p<0.001$), while scoring significantly higher on Openness ($t=4.72$, $p<0.001$) and its subscales Openness to Knowledge ($t=2.68$, $p<0.01$) and Openness to Experiences ($t=5.83$, $p<0.001$). The article highlights the personality traits that seem to describe people with the sensitivity, concern, and motivation, as well as the activation necessary for disseminating promotive information on environmental issues. The findings may be helpful in the design of environmental education programs, in the recruitment and professional development of environmental educators, and in the building of efficient environmental educator teams

Keywords: *Environmental Educators, Personality, Big 5*

JEL Codes: A29

Health promotion through Ecotherapy:Impact on young students

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Abstract

In recent years, humans' contact with natural environment has been decreased, while they experience at the same time nature's change and destruction. This disconnection from nature, affects them negatively and in different ways. However, a growing body of research shows the positive effects to people from their connection to nature. Ecotherapy is a process that aims at human interaction with nature. This interaction improves human health and development on many levels, as well as the healing process. Meanwhile, Ecotherapy operates as a treatment for planet's destruction, since its approaches affect people's perceptions, resulting in nature friendly behavior change. Finally, applying methods of Ecotherapy to young students is very beneficial to them. These benefits concern students' health, but also their cognitive development and their school performance.

Keywords: *Environmental hazards, natural environment, human health, Ecotherapy, students,benefits, school performance*

JEL Codes: Q56; Q57

CONFERENCE PARTICIPATING BODIES

No	Affiliation	Department
1	Agricultural University of Athens	Department of Agribusiness and Supply Chain Management
2	Agricultural University of Athens	Department of Agricultural Economics and Rural Development
3	Alioune Diop University of Bambey	Department of Physics
4	Aristotle University of Thessaloniki	Department of Veterinary
5	Aristotle University of Thessaloniki	Department of Forestry and Natural Environment
6	Athens University of Economics and Business	Department of International & European Economic Studies
7	Centre for Research & Technology (CERTH)	Chemical Process & Energy Resources Institute (CPERI)
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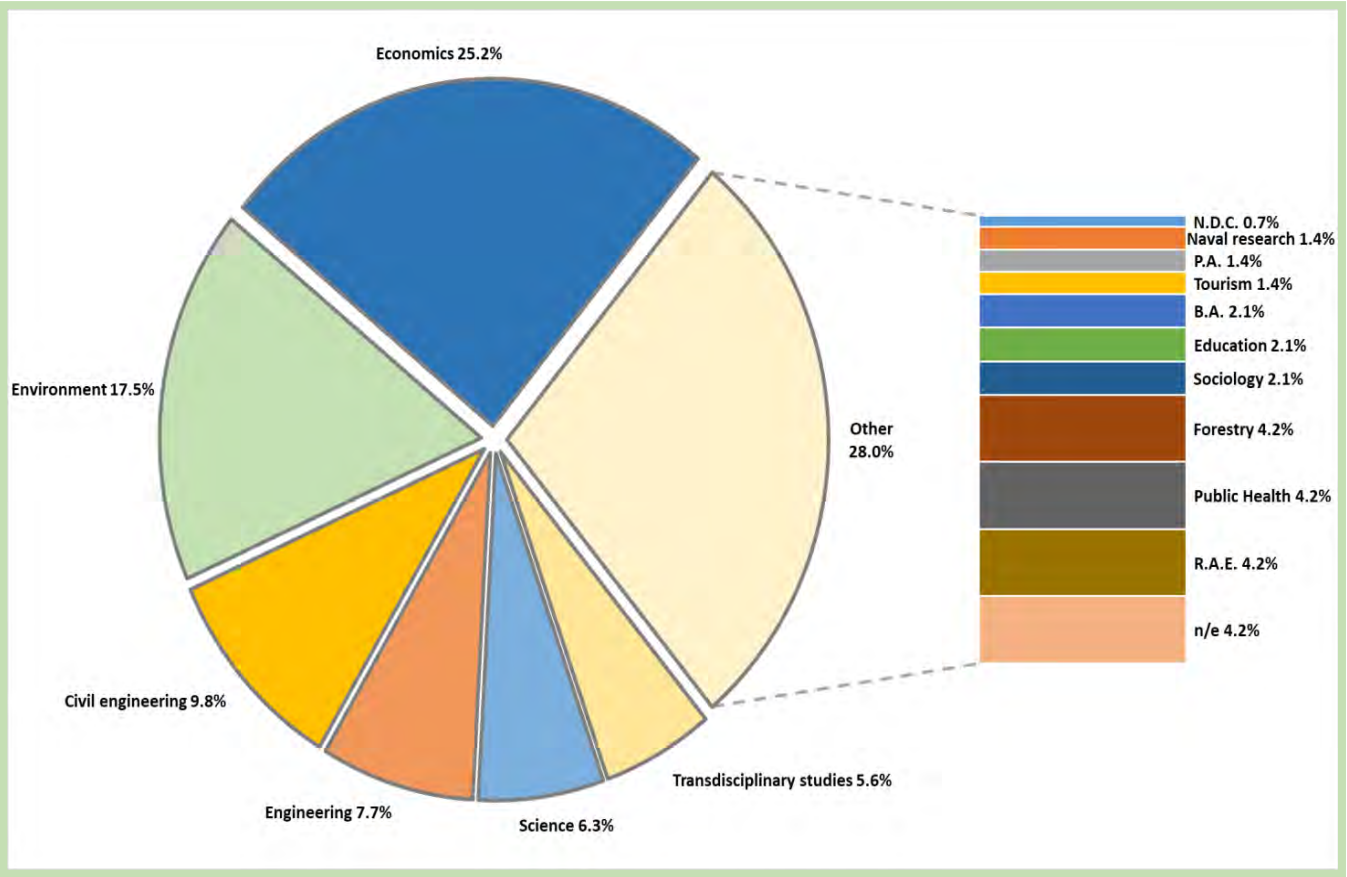

Note: N.D.C.: National Documentation Center; P.A.: Public Administration; B.A.: Business Administration.