BOOK OF ABSTRACTS

Organization

ΠΕΡΙΦΕΡΕΙΑ ΚΡΗΤΗΣ
REGION OF CRETE

ΔΗΜΟΣ ΧΑΝΙΩΝ
MUNICIPALITY OF CHANIA-CRETE

HELORS
HELLENIC OPERATIONAL
RESEARCH SOCIETY

TECHNICAL
UNIVERSITY
OF CRETE

List of Abstracts

THURSDAY, NOVEMBER 20TH 2025

Session 1: Digital Transformation and Policy Making - Chair: Fotis Kitsios

1. Exploring the Factors Influencing Information Systems Performance in the Public Sector: Insights from Greek Digital Transformation 6
2. An Evaluation of the Key Factors Influencing the Success of Public Construction Projects 7
3. Managing the migration crisis in Greece: A two stage DEA-based policy assessment 8
4. Decision-Making in the Digital Era: Strategic IS Planning and Satisfaction in SMEs through Ordinal Regression Analysis 9

Session 2: Mathematical Programming and Optimization - Chair: Nikolaos Ploskas

5. An adaptive sampling framework for costly black-box problems 10
6. Voyage optimization: A Machine Learning & Operational Research synergy 11
7. Must-Have Feature Constrained Clustering 12
8. Combining explainable machine learning with multiobjective optimization for simultaneous hyperparameter and feature selection in marketing prediction tasks 13

Session 3: Environment and Climate - Chair: Nikolaos Diangelakis

9. Enhanced multicriteria algorithms for policy making: The case of sustainable arable agriculture in Poland 14
10. Towards a Greener Europe: Spatial Spillovers, Regional Heterogeneity, and the Limits of the Environmental Kuznets Curve 15
11. Towards an Integrated Approach of SCOR model with UTA and WAP methods in the Agri-Food Sector 16
12. Understanding citizens' acceptance of wind power installations: A synthesis analysis across five European regions 17

Session 4: Routing and Queuing Problems - Chair: Michael Madas

13. Optimizing long term fleet wide crew scheduling: An ML-OR synergy 18
14. The effect of reward-cost heterogeneity on strategic customers' behavior and associate welfare in a queueing system 19
15. Multiserver Real-Time System with Preemptive Priorities (Worst Case) 20

Session 5: Sustainability Assessment - Chair: Yorgos Goletsis

16. Sustainability assessment for residential properties: Application to the Greek market 21
17. Applying MCDA to the ESG framework: Trends and Challenges 22
18. Web activity and ESG performance of Greek and Cypriot banks 23
19. Evaluation of water treatment technologies: An MCDA Approach 24

Session 6: Simulation - Chair: Georgios Stavroulakis

20. Digital Twin Framework to Optimize Operations, Maintenance, and Resilience in Serbian Railways 25
21. A digital twin-based method for optimizing energy consumption of robotic arms 26
22. Exploring the Application of Quantum Machine Learning for Traffic Forecasting Problems 27
23. A Hybrid Quantum–Classical Physics-Informed Neural Network for Efficient Solving of Differential Equations in Mechanics 28

FRIDAY, NOVEMBER 21ST 2025

Session 7: Data Analysis and Forecasting - Chair: George Tzagkarakis

24. Statistical Evolution of ODI Cricket: An Operational Research Perspective 30

25. Adaptive Matrix Profile Indexing for Irregular Multivariate Time Series 31

26. Adaptive Electricity Price Forecasting for EV Charging: Integrating Exogenous Forecasts and Rolling Window Training 32

27. LSTM-Based Predictive Maintenance and Anomaly Detection for Serbian Railways 33

Session 8: Supply Chain and Logistics - Chair: Epaminondas Kyriakidis

28. A pick-up and delivery routing problem with stochastic demands and unordered customers 34

29. Inventory decisions under supply disruptions via conditional value-at-risk minimization 35

30. Electronic Supply Chain Support Platform for Recycling Used Refractories and Building Materials using MCDA Methods 36

31. Exposure-Aware Last-Mile Routing: A Conceptual Framework Integrating Street-Level Air-Quality Data 37

Session 9: MCDA Applications and Methodologies - Chair: Spiros Alexopoulos

32. Multi-Criteria Decision-Making in Transport Infrastructure: An AHP Modelling Approach 38

33. A spatial robust hybrid multicriteria framework for benchmarking analysis based on customer preferences 39

34. Balancing security, cost, operations, and compliance: An MCDM framework for gas TSO cybersecurity 40

35. System Dynamics and MCDA: From Parallel Approaches towards Hybrid Modelling 41

Session 10: Strategies for Sustainable Energy and Climate Solutions - Chair: Dimitrios Ipsakis

36. Optimal sizing and energy management for a PV-H2 autonomous system 42

37. AI-Driven Probabilistic Models for Robust Risk-Based Household Battery Scheduling 43

38. Integrating AI, OR, and CRM Intelligence for Predictive Energy Optimization in Hotels and Real Estate 44

39. Bridging Climate Services and Life Cycle Sustainability Assessment: Towards Integrated Climate-Informed Decision-Making 45

Session 11: Energy System and Sustainability - Chair: Athanasios Vavatsikos

40. Solar farm suitability analysis using MCDM methods in GIS environment: A literature review 46

41. Evaluating the sustainability and resilience of the long-term energy pathways in Switzerland: A multicriteria Group Decision Making framework 47

42. Assessing the suitability of the Technical University of Crete campus for installing a Concentrated Solar Power Vertical Furnace: A multicriteria decision analysis approach 48

43. Policy and Market Analysis for Accelerating Energy Renovations in Greece: A PESTLE and SWOT Perspective 49

Session 12: AI and Machine Learning for Decision Support - Chair: Irène Abi-Zeid

44. Supervised machine learning for maritime search and rescue operations planning 50

45. Towards an Article Reviewer Assignment Recommendation System Using Multicriteria Analysis and Machine Learning Methods 51

46. AI-Enhanced Decision-Support Approach for Streamlining Financing of Affordable and Sustainable Housing 52

47. Properties and applications of Pareto-optimal colorings 53

Session 13: Healthcare, Education, and Social Impact - Chair: Evangelia Krasadaki

48. Using the qualitative research tool MAXQDA to explore emerging digital skills 54

49. Exploring Determinants of Measles Vaccination Coverage Across Indonesian Provinces: A Machine Learning Approach 55

50. Study of Doctoral Students' Satisfaction in Greek Universities. Motivations and Barriers 56

51. Mapping the Digital Competences of Local Government Employees in Heraklion: A Qualitative Analysis and Thematic Coding of Interviews Based on DigComp 2.2 57

Session 14: Data-Driven Decision Making - Chair: Pavlos Delias

52. The integration of big data technologies for customer data management and customized marketing strategies 58

53. Interpretability in Artificial Intelligence: The Role of ANFIS 59

54. Weighted Centrality Measures for Transport Network Vulnerability Assessment Using Open-Source Data 60

55. A Preliminary Framework for DEMATEL Enhancement through Spectral Analysis 61

THURSDAY, NOVEMBER 20TH 2025

1. Exploring the Factors Influencing Information Systems Performance in the Public Sector: Insights from Greek Digital Transformation

Eleni Champipi[1],Maria Kamariotou[2], Konstantinos Ioannou[1], Fotis Kitsios[2]

[1] University of the Peloponnese, Department of Digital Systems
[2] University of Macedonia, Department of Applied Informatics

Abstract. It is widely accepted that the idea of digital transformation has significantly changed how companies operate. The use of digital technologies by the public sector has created a number of opportunities. According to previous studies, the quality of public services and the effectiveness of organizational procedures have both increased as a result of digitalization. However, the effectiveness of digital technology in the public sector depends on a variety of aspects. User satisfaction is regarded as one of the most important requirements for digital transformation. This article's goal is to investigate the variables that affect the performance of information systems (IS) in the public sector. Ordinal Regression Analysis was used to examine data gathered from IS users across numerous Greek public sector enterprises. The research's findings offer useful information to practitioners working on the creation of such systems. These insights can help them do their jobs more effectively and encourage them to consider these aspects when creating and implementing comparable systems in the public sector.

Keywords: Change management, Digital strategy, Digital transformation, Information Systems adoption, Public sector

2. An Evaluation of the Key Factors Influencing the Success of Public Construction Projects

Zisis Papastamatis[1], Isaak Vryzidis[1]

[1] Department of Civil Engineering, University of West Attica

Abstract. Public construction project management primarily focuses on delivering projects within defined scope, schedule, budget, and quality standards. The success of these projects is influenced not only by the legislative framework under which projects are strictly implemented, but also by the funding bodies, the contracting authority, public sector supervisors, the managing authority, and the project contractor. In this context, it is crucial to identify the factors that critically affect the project's success. The literature review highlights a significant amount of work in this field; however, only a few studies directly link critical success factors (CSFs) to the legislative framework. In this study, firstly, the CSFs identified in the literature for public projects are connected to the legislative provisions, especially those concerning the iron triangle. Then, 185 projects implemented under the legislative framework of Law 3669/2008 and 192 projects implemented under the legislative framework of Law 4412/2016, which replaces Law 3669/2008, have been studied and compared against these critical success factors. The results show a significant decrease in completion times, evidenced by shorter intervals during the different project phases, along with a notable reduction in budget overruns following the adoption of the legislative framework of Law 4412/2016, indicating that best practices were implemented. Additionally, areas for improvement have been identified.

Keywords: Project Success, Critical Success Factors, Public Projects, Construction Projects

3. Managing the migration crisis in Greece: A two stage DEA-based policy assessment

Irene Daskalopoulou[1], Athanasia Karakitsiou[2]

[1] Department of Economics, University of the Peloponnese
[2] Department of Business Administration, International Hellenic University

Abstract. We propose the measurement of citizens' perceived state efficacy in controlling the migration crisis using policy satisfaction levels as constrained by the migration burden, societal tolerance and institutions' control of migration. We focus on Greece as a frontline migration country and measure citizens' satisfaction with policy control of the crisis using 2020 data for a sample of 1,014 respondents. At the empirical level we adopt a two-stage DEA process to achieve a twofold aim. At the first stage, we estimate a multiple-output multiple-input DEA model in order to assess citizens' perceptions of policy efficacy in the domains of economic, social, health, education, defense and foreign affairs policy, as affected by the way in which the recent migration crisis has been handled, i.e. using burden, tolerance and institutional control of migration, as inputs. Ten such models are estimated at the regional (NUTS II) level given the unequal dispersion of migrants in the country and the different burden caused to local societies. At the second stage, we use Tobit analysis to sketch the socio-demographic and economic profile of satisfied with the migration policy citizens. Our approach is a new and innovative practical application of multicriteria methods that provides important evidence on the migration crisis as handled by an EU migration hub country. Our findings identify the migration crisis as a regional level experience, sketch the profile of satisfied citizens, and point to domains where more political effort is needed with regard to handling the migration crisis in Greece.

Keywords: Likert Scale-DEA, Migrants, policy evaluations, government efficiency

4. Decision-Making in the Digital Era: Strategic IS Planning and Satisfaction in SMEs through Ordinal Regression Analysis

Maria Kamariotou[1], Fotis Kitsios[1]

[1] University of Macedonia, Department of Applied Informatics

Abstract. It is crucial to consider how IS planning relates to how digital transformation tactics affect small and medium-sized businesses' (SMEs') performance. Management is unable to obtain a long-term information systems plan that can offer a competitive advantage due to the lack of formal procedures and strategic planning, as well as the fact that there is no advantage to implementing strategy in practice. IS and digital transformation must be used in tandem to enhance the operations of small and medium-sized enterprises (SMEs). This leads to an increase in consumer value, a decrease in costs, and reliable data. An empirical model for forecasting the strategic factors influencing IT executives' satisfaction in SMEs is presented in this paper. The data came from 294 IT managers working for small and medium-sized businesses in Greece. An analysis of the data was conducted using ordinal regression. In particular, the study's conclusions imply that managers must receive strategic information systems planning training in order to boost competitiveness. Furthermore, the manager bears the task of selecting the necessary information technology infrastructure to align the organization's structure and goals.

Keywords: IS strategy, SMEs, Satisfaction, Prediction, Ordinal Regression Analysis

5. An adaptive sampling framework for costly black-box problems

Emmanouil Karantoumanis[1], Nikolaos Ploskas[1]

[1] University of Western Macedonia

Abstract. Black-box optimization problems are widespread in engineering and scientific domains, where objective functions are unknown, have no explicit analytical representation, and are costly to evaluate. Derivative-free optimization (DFO) methods are often employed in such cases, yet they face challenges in high dimensions, mixed-integer search spaces, and scenarios with limited evaluation budgets. To address these limitations, we propose a unified framework that integrates adaptive sampling, surrogate modeling, and DFO solvers for efficient black-box optimization. The framework is explicitly designed to deliver near optimal solutions under a restricted number of function evaluations. The methodology is developed in distinct stages. It begins with Latin Hypercube Sampling to generate an initial design of experiments, followed by surrogate model construction with iterative refinement. Surrogates are optimized with derivative-based solvers to propose candidate solutions, while a DFO algorithm guided by an error maximization strategy identifies regions of largest model discrepancy for targeted resampling. Once the surrogate fails to provide reliable predictions, the process transitions to a warm-started DFO stage that directly evaluates the original black-box function, fully exploiting the available evaluation budget. This adaptive cycle enables the framework to balance exploration, exploitation, and computational efficiency. The versatility and effectiveness of the framework are demonstrated across three distinct real-world applications. In compiler optimization with mixed-integer variables, the framework significantly improves performance over existing DFO solvers and established tuning tools. In electromagnetic design, it achieves accurate solutions for waveguide and multilayer dielectric filter problems, reducing simulation costs by more than 95% compared to Monte Carlo and Polynomial Chaos approaches. In renewable energy, it improves Concentrated Solar Power system design by reducing investment and storage costs, surpassing conventional DFO solvers. Across all cases, the framework consistently provides robust solutions with significant reductions in computational cost, highlighting its applicability to both continuous and mixed-integer black-box problems under stringent evaluation limits.

Keywords: derivative-free optimization, black-box problems, adaptive sampling, surrogate modeling

6. Voyage optimization: A Machine Learning & Operational Research synergy

Dimitrios Kaklis[1], Takis Varelas[1], Evelina Bintevinou[1]

[1] Danaos Shipping Co

Abstract. This study presents a synergy between Machine Learning (ML) and Operational Research (OR) for voyage optimization in the maritime sector. The goal is to enable multi-objective, adaptable, and efficient decision-making in voyage planning. ML is employed for pattern extraction and predictive modeling, while OR provides the framework for optimization and prescriptive analytics.A key focus is on fuel oil consumption (FOC) estimation, which remains central to both operational efficiency and environmental performance. This study proposes a hybrid framework that combines analytical "white-box" methods with data-driven "black-box" models to deliver a predictive, multi-objective optimization scheme.The analytical (white-box) model is based on the admiralty coefficient, a classical naval architecture measure for estimating the power required for a vessel to achieve a target speed. The data-driven (black-box) model is trained on historical vessel operational data. Feature selection is guided by Pearson correlation analysis to identify significant parameters.

A hybrid approach is then introduced: the loss function of the black-box model is regularized by penalizing deviations from the white-box model's predictions. This allows the system to integrate physical principles with empirical learning, enhancing both interpretability and robustness.Finally, a non-linear OR model is formulated to optimize voyage revenue under constraints of emissions compliance and machinery performance. The FOC is transformed from a unit of tons/hour into a cost-based measure (USD/mile), aligning technical optimization with commercial objectives.

This ML–OR integration enhances traditional models by combining data-driven adaptability with structured optimization rigor. Such an approach is particularly relevant in complex maritime decision-making contexts such as supply chain planning, emissions reduction, and fleet scheduling, where large datasets and multiple objectives must be reconciled.

Keywords: Machine learning, non-linear programming, voyage planning, MADM model

7. Must-Have Feature Constrained Clustering

Zeliha Ergül Aydın[1] ,Zeynep İdil Erzurum Çiçek[1], Banu İçmen Erdem[1], Emre Çimen[1]

[1] Eskişehir Technical University

Abstract. This study introduces a novel approach to constrained clustering, addressing capacity constraints and requiring each cluster to contain at least one data point with a specific feature. While existing Constrained K-Means algorithms effectively enforce capacity limitations, they do not guarantee the inclusion of feature-based points in each cluster. We propose three new methods built on the Constrained K-means framework to overcome this limitation: Proximity-Aware Swap, Random Swap, and Greedy Constrained K-means.

In real-world applications—such as logistics, production planning, customer segmentation, carpooling, team formation, and project team assignment—clustering solutions must adhere to capacity restrictions and ensure that critical feature constraints are met. Our proposed methods are rigorously evaluated on 20 modified test problems derived from UCI datasets, measuring performance through Adjusted Mutual Information (AMI), Silhouette Score, Calinski-Harabasz Index, and run time.

Results demonstrate that all three approaches successfully enforce capacity and feature constraints, producing well-balanced and meaningful clusters. Proximity-Aware Swap is the fastest and most computationally efficient method, delivering high-quality clustering with minimal cost. This research significantly advances constrained clustering, offering scalable and effective solutions for practical applications.

Keywords: clustering, machine learning, constraint programming

8. Combining explainable machine learning with multiobjective optimization for simultaneous hyperparameter and feature selection in marketing prediction tasks

Konstantinos Zervoudakis[1], Stelios Tsafarakis[1]

[1] Technical University of Crete

Abstract. Machine Learning (ML) models have become increasingly important in marketing analytics because they can capture non-linear patterns that traditional statistical approaches often miss. However, selecting both the appropriate set of predictors and the proper hyperparameter configuration remains a major challenge, especially when the analyst also needs to consider the computational burden of the final model. In this study, a publicly available marketing dataset from Kaggle is used to build a predictive model for a key marketing outcome. A multi-objective optimization approach is adopted in order to address the problem of hyperparameter and feature selection, at the same time. Specifically, the Mayfly Optimization Algorithm is applied to search for the best hyperparameters and subset of predictors on a Random Forest classifier. The optimization process is guided by several classification metrics such as the F1 score and accuracy, as well as by an additional objective that estimated the computational complexity of the resulting model. In this way the search aimed not only at maximizing the predictive performance but also at finding solutions that are computationally efficient.

A Pareto front of alternative models is produced and an optimal trade-off solution that achieved high predictive performance with relatively low complexity is then selected. After the selection, a SHAP-based explainability analysis is performed in order to interpret the contribution of each predictor to the outcome. The SHAP results provided insight into the drivers behind the model's predictions and allowed a clearer understanding of the marketing factors that influence the targeted outcome. The study demonstrates that combining multiobjective optimization with explainable ML can lead to more transparent and operationally efficient predictive tools for marketing decision making. It also highlights that including computational complexity as an explicit optimization objective can be valuable when models need to be deployed in large scale applications.

Keywords: Machine Learning, Explainable Artificial Intelligence, Multiobjective Optimization, Marketing Prediction

9. Enhanced multicriteria algorithms for policy making: The case of sustainable arable agriculture in Poland

Nikolaos A. Diangelakis[1], Stelios Rozakis[1], Aleksandra Krol-Badziak[2], Flora Loukai[1], Elzbieta Kubinska[3]

[1] Technical University of Crete
[2] Institute of Soil Science and Plant Cultivation
[3] Cracow University of Economics

Abstract. The reform of the EU Common Agricultural Policy (CAP) 2023–2027 introduced eco-schemes as a central instrument to promote sustainable farming. However, their uptake in Poland and across the EU has fallen short of expectations, particularly among small farms.This study develops and applies an enhanced multi-criteria decision analysis (MCDA) framework to assess how eco-scheme incentives can be calibrated to encourage adoption in Polish triticale systems. Building on the PROMETHEE outranking method, we integrate elements of prospect theory to account for behavioral factors such as status quo bias and loss aversion, and extend the analysis with inverse optimization to identify the financial and managerial support levels needed for adoption. Furthermore, we employ multi-parametric optimization to (a) account for uncertainty associated with the criteria scores of the alternative scenarios and (b) investigate the sensitivity of the outranking method results to score changes.

Results show that conventional triticale monoculture remains preferred under standard PROMETHEE rankings, diverging from actual farmer behavior. Incorporating prospect theory improves the descriptive accuracy of farmer choices, while optimization indicates that targeted subsidies and reductions in managerial complexity are critical for shifting preferences toward eco-scheme alternatives. From a societal perspective, practices such as manure incorporation and simplified cultivation rank highest due to their environmental benefits, yet they require significant support to compete with monoculture at farm level. Our findings highlight that purely financial incentives are insufficient; complementary measures such as advisory services and training can substantially reduce adoption barriers. The proposed framework provides transferable decision-support for designing eco-schemes that balance farmer incentives with societal goals, offering evidence-based guidance for more effective CAP implementation.

Keywords: Eco-schemes, Sustainable agriculture, multicriteria analysis, PROMETHEE, policy support, Incentives, multi-parametric optimization

10. Towards a Greener Europe: Spatial Spillovers, Regional Heterogeneity, and the Limits of the Environmental Kuznets Curve

Michaela Chocholata

Bratislava University of Economics and Business

Abstract. The Environmental Kuznets Curve (EKC) hypothesis posits an inverse U-shaped relationship between economic growth and environmental degradation. This implies that rising income initially exacerbates ecological pressures, but subsequently enables improvements through innovation and regulation. However, many conventional EKC studies ignore spatial interdependencies between regions. This study fills this gap by applying spatial econometric methods to regional data from the European Union (EU), using greenhouse gas (GHG) emissions as the main indicator of environmental degradation.

The analysis uses cross-sectional NUTS2 data from 2022 and employs spatial autoregressive (SAR), spatial error (SEM) and geographically weighted regression (GWR) models. The results confirm the presence of significant positive spatial autocorrelation in emissions, indicating that regions with high emissions tend to cluster geographically rather than being randomly distributed. While GDP per capita has a modest negative effect, consistent with the EKC, the findings also reveal substantial spillover effects: economic growth increases emissions not only locally, but also in neighbouring regions. Further highlighting spatial heterogeneity, GWR analysis shows that the EKC does not hold uniformly across Europe.

The study emphasises the importance of coordinated climate and economic policies at a regional level. Rather than relying solely on uniform EU-wide measures, targeted interventions in high-emission clusters are essential to advance the EU's long-term goal of achieving a greener, carbon-free Europe. This paper was supported by the Grant Agency of the Slovak Republic (VEGA 1/0047/23) and is titled 'The importance of spatial spillover effects in the context of the EU's "greener and carbon-free Europe" priority'.

Keywords: Environmental Kuznets Curve (EKC), Spatial Econometrics, Greenhouse Gas Emissions, European Union Regions

11. Towards an Integrated Approach of SCOR model with UTA and WAP methods in the Agri-Food Sector

Georgios Sidiropoulos[1], Vasileios Zeimpekis[1], Nikolaos Tsotsolas[1]

[1] Universirt of West Attica, Business Administration Department

Abstract. The growing complexity of supply chain performance measurement (SCPM) in the agrifood sector necessitates the development of robust evaluation frameworks. This study explores the current state of research on performance measurement in agri-food supply chains and addresses the challenge of identifying appropriate Key Performance Indicators (KPIs). Despite extensive literature on country-specific value chains, a comprehensive evaluation model applicable across different contexts remains lacking. To bridge this gap, this research proposes an integrated approach combining the Supply Chain Operations Reference (SCOR) model with multi-criteria decision-making (MCDM) methods. SCOR provides a structured framework for linking performance metrics, processes, and best practices, making it a suitable model for assessing agrifood supply chains. However, selecting and prioritizing SCOR's Level 1 KPIs remains a challenge. This study introduces the Weights Assessment through Prioritization (WAP) method to determine the relative importance of KPIs, ensuring a more accurate performance evaluation. Furthermore, the integration of the Utilité Additive (UTA) method enables the inference of preference models based on expert rankings of supply chain efficiency. By combining SCOR with UTA, this approach offers a more refined and systematic evaluation of supply chain performance. The findings suggest that this integrated model enhances decision-making by providing a structured methodology for evaluating companies' supply chains. The proposed approach aids stakeholders in identifying performance gaps, prioritizing improvements, and optimizing supply chain management. Unlike conventional methods, the SCOR-UTA-WAP framework facilitates a comprehensive assessment, aligning expert judgments with data-driven analysis. This research advances SCPM methodologies by offering a scalable, industry-specific decision-support tool that improves evaluation accuracy and strategic decision-making in the agri-food sector. Future studies will focus on validating the model through empirical applications within agri-food enterprises.

Keywords: SCOR Model, Supply Chain Performance Measurement (SCPM), WAP Method, UTA Method

12. Understanding citizens' acceptance of wind power installations: A synthesis analysis across five European regions

Pavlos Fafalios[1], Eleftherios Siskos[1], River Huang[2], Iasonas Spanos[3], Peter Burgherr[2]

[1] School of Production Engineering and Management, Technical University of Crete
[2] Laboratory for Energy Systems Analysis, Paul Scherrer Institute
[3] SABO S.A.

Abstract. Wind power development frequently faces social opposition from local communities, citizens, and stakeholder organizations, making community acceptance crucial for the long-term viability and expansion of the sector. This study implements the Multi-Criteria Satisfaction Analysis (MUSA) method to measure and analyze the acceptance of citizens for wind power installations in their local area. The framework is complemented with a structured questionnaire that translates satisfaction into acceptance, based on a consistent set of criteria, including environmental concerns, community welfare, and personal benefits. The analysis was performed in five different regions in Italy, Austria, Portugal, and Greece. Subsequently, the respondents' answers were statistically examined to identify correlations between socio-demographic characteristics and acceptance levels across all levels of the questionnaire. Furthermore, geographic data and existing wind power installations were integrated to further uncover underlying patterns. The results demonstrate significant regional variations in overall acceptance, with long-term maintenance concerns and infrastructure neglect emerging as key determinants. Moreover, socio-demographic factors like age, education, and nationality, combined with proximity to existing wind installations, significantly impact acceptance levels. This synthesis analysis aims to provide evidence-based and actionable recommendations for policymakers, regional governments, industry stakeholders, and citizens to foster greater cooperation and promote the sustainable integration of wind power.

Keywords: multicriteria decision analysis, MUSA method, wind power installations, renewable energy, social perspective

13. Optimizing long term fleet wide crew scheduling: An ML-OR synergy

Takis Varelas[1], Nickolas Theodosiou[2], Evelina Bintevinou[1]

[1] Danaos Shipping Co
[2] Danaos Management Consultants SA

Abstract. Compared with other human resources management systems maritime crewing is highly complex because of particularities of marine profession. Seafarers are not work permanently and are employed on period basis. A crew appraisal scheme is utilized to evaluate the seafarers' performance as well as for optimization of the mentioned multidimensional (sometimes referred as multi-index) assignment the vessel-seafarer suitability. The main goal is to find the proper person for the proper vessel in right time with the highest confidence, keeping the seafarers availability pool as small as possible as well as maximizing the seafarers' satisfaction and reducing the non-productive cost of idle time between the ESO (estimated sign off) and AF (available from) dates. In this study a working binary integer model (MAP) is formulated and applied. The major novelties are: the extension of the two coordinates, the number of vessels from one to whole fleet and the time horizon from couple of weeks to several months as well as the addition of third dimension the teamwork index of the vessels' management team. The model is materialized as a synergy of AI (Machine learning) and operations research (AI-OR) where ML handles data pattern extraction and prediction and OR provides optimization and prescriptive analytics. The provided strategic decision support regarding the seafarers' availability pool synthesis (number, nationalities, class) is documented and evaluated.

Keywords: Machine learning, quadratic assignment problem, multicriteria analysis, appraisal schemes

14. The effect of reward-cost heterogeneity on strategic customers' behavior and associate welfare in a queueing system

Antonis Economou[1], Odysseas Kanavetas[2], Athanasia Manou[1]

[1] National and Kapodistrian University of Athens
[2] Leiden University

Abstract. We consider a single-server Markovian service system with strategic customers, who decide whether to join or balk based on their expected utility that depends on the service value, the waiting cost and the entrance fee that is set by the service provider. We assume that the customers are heterogeneous regarding the service value and the waiting cost rate. We determine the equilibrium customer strategies and calculate the associated equilibrium expected welfare and revenue. We explore the effect of customer heterogeneity on the equilibrium social welfare and revenue. Moreover, we discuss the price of ignoring heterogeneity by comparing the performance of the system when the administrator takes into account customer heterogeneity with its performance when he ignores heterogeneity.

Keywords: queueing theory, strategic customers, equilibrium customer strategies, join-or-balk dilemma, customer reward-cost heterogeneity

15. Multiserver Real-Time System with Preemptive Priorities (Worst Case)

Joseph Kreimer

Ben Gurion University of the Negev, Department of Industrial Engineering and Management

Abstract. Real-time systems (RTS) are widely used for the monitoring and control of physical processes. We consider a data acquisition and processing RTS with several servers (such as machine controllers, unmanned aerial vehicles (UAV), overhearing devices, medical monitoring devices, etc.) which can be maintained/programmed for different kinds of activities (e.g. passive or active). This RTS provides a service for real-time tasks arriving via several channels (such as assembly lines, surveillance regions, communication channels, etc.).We focus on RTS with a zero deadline for the beginning of task execution. In these systems, tasks are processed immediately upon arrival, conditional on system availability. That part of the task which is not executed immediately is lost forever, and queueing of tasks or their parts in such systems is not allowed. Nevertheless, while using the duality approach of changing the roles between tasks and servers, these RTS can be treated as queueing networks. Servers are subject to breakdowns and the system involves maintenance with several maintenance teams at its disposal. After repair a fixed server may be of certain kind of quality with corresponding probability These probabilities can be used as control parameters. Only after the repair is completed, the quality control procedure determines the quality type of fixed server. After maintenance, the fixed server will either be on stand-by or operating inside the channel. There is a single joint queue of fixed servers to all channels. We study these systems working under maximum load regime (worst case analysis, i.e. task of infinite length at each channel) with preemptive priorities assigned for servers of different activity kind. We assume that servers of the first kind of activity/quality have the highest priority, servers of the second activity/quality kind are the next priority in line, and so on. When a server of higher priority (than one of active servers) arrives from maintenance and all tasks are treated, then it immediately replaces an active server of lowest priority. When the operating server must be sent to maintenance, it is replaced by the fixed server on stand-by with highest priority. We consider the model with ample maintenance facilities and joint queue to all channels. We provide balance equations and show how to compute steady state probabilities and various performance measures, when both operation and maintenance times are exponentially distributed.

Keywords: preemptive priority, queueing network, real-time systems

16. Sustainability assessment for residential properties: Application to the Greek market

Michalis Doumpos[1], Dimitrios Karlis[2], Dimitrios Papastamos[3]

[1] Technical University of Crete
[2] Athens University of Economics and Business
[3] Cerved Property Services S.A.

Abstract. Environmental, Social, and Governance (ESG) considerations are playing an increasingly significant role in real estate, influencing various aspects of the industry. This talk focuses on the impact of ESG factors—primarily environmental and social (ES) rather than governance (G)—on property valuation, particularly in the context of automated valuation models (AVMs). The scope of the research is twofold. Initially, we propose the development of an ESG index/score for properties, incorporating relevant characteristics, and explore how this score can be use into AVMs. The score takes into account property specific characteristics related to environmental factors but also social characteristics mostly related to the location of the property. Our findings suggest that ESG score positively influences the predictive accuracy of AVMs, indicating that the market indeed accounts for these aspects while considering property pricing. Additionally, we examine alternative proxies for environmental characteristics in valuation, such as the Environmental Performance Certificate, which is becoming increasingly relevant in recent years. Real data from a financial institution in Greece are used to demonstrate the methodology

Keywords: Sustainability assessment, Real estate appraisal, Multicriteria decision analysis, Automated valuation models

17. Applying MCDA to the ESG framework: Trends and Challenges

Yorgos Goletsis[1], Vasiliki Spyridonos[1]

[1] University of Ioannina, Dept of Economics

Abstract. Environmental, Social, and Governance (ESG) criteria have become a central framework for evaluating corporate responsibility and long-term sustainability. Initially rooted in the financial sector, ESG considerations are now widely applied across industries to assess economic performance, social impact, environmental stewardship, and governance practices. Their growing adoption reflects regulatory pressures, rising stakeholder expectations, and recognition that sustainability-related risks and opportunities critically shape long-term competitiveness.

Yet, evaluating ESG performance remains inherently complex, requiring balance between financial outcomes and broader societal and environmental effects. Traditional single-criterion approaches focusing on profit or risk fail to capture this multidimensional nature. Multi-Criteria Decision Analysis (MCDA) provides a structured framework by systematically incorporating multiple criteria and diverse stakeholder preferences, enabling transparent evaluation of trade-offs among economic, environmental, and social dimensions, while also integrating both quantitative and qualitative evidence.

This study reviews 167 papers across multiple sectors to analyze how MCDA has been applied in ESG contexts. A bibliometric analysis maps the literature and highlights conceptual, methodological, and practical developments in this evolving field, identifying foundations and trends. Findings indicate that MCDA enhances sustainability assessments, supports responsible investment strategies, and improves the evaluation of corporate ESG performance.

Our analysis indicates that still, persistent challenges hinder the full integration of ESG and MCDA. These include inconsistent data reporting and disclosure, difficulties in standardizing indicators across countries and industries, and uncertainty or bias in expert-driven evaluations. Stakeholder heterogeneity further complicates weighting and aggregation of criteria, while governance aspects are often underrepresented compared to environmental or financial dimensions. Sector-specific barriers—such as high adoption costs for SMEs, unreliable data in emerging economies, and the complexity of aligning ESG objectives with digitalization, supply chains, or advanced technologies—restrict comparability and scalability.

Addressing these methodological and practical limitations is essential to strengthen the robustness, transparency, and policy relevance of ESG–MCDA applications. By overcoming them, MCDA can consolidate its role as a critical tool for sustainability-oriented decision-making and the advancement of responsible governance practices.

Keywords: Multicriteria analysis, MCDA, Environmental Social and Governance, ESG, sustainability

18. Web activity and ESG performance of Greek and Cypriot banks

Ioannis Tsountas[1], Konstantinos Tsagarakis[1], Constantin Zopounidis[1], Michalis Doumpos[1]

[1] School of Production Engineering and Management, Technical University of Crete

Abstract. This work focuses on evaluating the ESG performance of Greek and Cypriot Banks using also online data. Convectional data consist of data derived from the sustainability reports. Online data comes from the social media profiles of the Banks and from online searches. We proxy the social impact of the examined Banks by a normalized indicator resulting from the number of followers divided by the number of associate members. The company profile managers cannot directly affect both these indicators. Using a multi-criteria analysis, we assess the overall performance of the companies providing information beyond conventional indicators.

Keywords: ESG, Google Trends, LinkedIn

19. Evaluation of water treatment technologies: An MCDA Approach

Alexandros Psomas[1], Isaak Vryzidis[2], Athanasios Spyridakos[2], Nikos Tsotsolas[2]

[1] Brilliant Solutions Engineering & Consulting / National Technical University of Athens
[2] University of West Attica

Abstract. Per- and poly-fluoralkyl substances (PFAS), also known as "forever chemicals" due to their long-lasting persistence, are restricted by law to protect human health and the environment from negative consequences. An MCDA framework was established to rank alternative treatment technologies, designed to address PFAS in drinking water and wastewater. The Weights Assessment through Prioritisation (WAP) methodology was applied to rank a series of technical, economic and environmental criteria and determine their weights. The robustness of the value system was assessed through the Average Stability Index (ASI), and it was found to be very robust. The evaluation of the performance of alternative technologies on each criterion was based on available data from published studies. Preference curves were created to define the variation of preference on each criterion's performance values, using the Multicriteria Interactive Intelligence Decision Aiding System (MIIDAS). An Additive Value Model was established, which summed the partial value of the alternative technologies on each criterion and resulted in the total value of the alternative technologies on all criteria. Technologies were ranked in descending order of total value. The methodology was assisted by an expert group on the topic, which participated in interactive and iterative preference elicitation processes for weight assessment, preference curve development, and review of final rankings.

Keywords: PFAS, Drinking Water, Wastewater, MCDA, MIIDAS, WAP

20. Digital Twin Framework to Optimize Operations, Maintenance, and Resilience in Serbian Railways

Miloš Milenković[1], Nebojša Bojović[1], Nataša Milosavljević[2]

[1] University of Belgrade, The Faculty of Traffic and Transport Engineering
[2] University of Belgrade, The Faculty of Agriculture

Abstract. The Serbian railway system faces ageing infrastructure and rising maintenance costs, requiring innovative solutions for long-term sustainability and efficiency. This paper aims to propose a framework for Federated Digital Twin (FDT) for Serbia's railway infrastructure, focusing on improving resilience, operational optimization, and predictive maintenance. FDT for Serbia's railway infrastructure, using simulated data from machine learning, will support predictive maintenance, anomaly detection, and real-time safety insights. Optimization and simulation models, powered by cloud and edge computing, will improve resource allocation, while GIS tools and performance metrics will enhance resilience, efficiency, and safety. The objective of the paper is to point out the value of digital twins in optimizing railway operations by addressing infrastructure issues and safety at level crossings, enabling proactive maintenance, better decision-making, and enhanced efficiency for a safer, more resilient network. Effectiveness of digital twins should provide maintenance prediction and enhancing safety, particularly at level crossings by reducing risks and delays. By integrating two digital twins for infrastructure monitoring and safety, the approach should contribute to improved decision-making, operational continuity, and the overall resilience of the railway network.

Keywords: federated digital twin, railways, resilience, optimization, machine learning, simulation

21. A digital twin-based method for optimizing energy consumption of robotic arms

Dimitrios Emiris[1], Dimitrios Tsakoumis[1], Pavlos Eirinakis[1], Tobias Hohmann[2]

[1] University of Piraeus
[2] FFT Produktionssysteme

Abstract. Energy consumption in industrial robotics has become a key challenge as automation expands across manufacturing sectors. Robots are heavily utilized for repetitive tasks in production; thus, even small energy efficiency improvements in trajectory planning can yield significant energy savings. Achieving such efficiency requires moving beyond manual programming towards data-driven optimization approaches.

This work presents a Digital Twin (DT)-based framework for energy-efficient robotic motion planning. For any given robot task, the proposed method examines each robot movement, creating a large set of operational scenarios, i.e., different ways this movement can be implemented. Each examined operational scenario is defined by control parameters, such as position, velocity, acceleration, trajectory type, and axis configuration. Each scenario is evaluated in the DT environment, which integrates forward and inverse kinematics, spline interpolation, and a Functional Mock-up Unit (FMU) to estimate energy consumption. To manage the large solution space, Pareto filtering is applied to filter out dominated scenarios of movements, retaining only those that optimally balance execution time and energy use.

The reduced set of scenarios is then passed to an Integer Programming (IP) model, which selects the most efficient trajectory for each movement in a production cycle, while ensuring cycle-time constraints are met. The framework is designed to be extensible, allowing the inclusion of additional constraints such as time windows or coordination among multiple robots.

Computational experiments demonstrate that the integration of DT simulation, Pareto-based preprocessing, and IP optimization significantly reduces computational burden, while maintaining high-quality solutions. Embedding the methodology into offline robot programming workflows ensures compatibility with existing industrial practices, enabling engineers to automatically generate energy-efficient robot programs that remain feasible and ready for deployment.

Keywords: Digital Twin, Simulation, IP Optimization, Robot Trajectory Planning

22. Exploring the Application of Quantum Machine Learning for Traffic Forecasting Problems

Nikolaos Schetakis[1], Negin Alisoltani[2], Paolo Bonfini[3], Panagiotis Fafoutellis[4], Eleftherios Siskos[1], Eleni I. Vlahogianni[4], Georgios E. Stavroulakis[1]

[1] Technical University of Crete
[2] Gustave Eiffel University
[3] Quantum Innovation IKE
[4] National Technical University of Athens

Abstract. With the global rise in vehicle fleets, traffic forecasting has become a vital and rapidly expanding research area, essential for effective traffic management and the development of Intelligent Transportation Systems. The integration of Deep Learning and Big Data tools into transportation research has significantly improved forecasting accuracy. However, these models still face certain shortcomings, such as high computational complexity, which limits their real-time applicability, and issues with low performance when dealing with highly dynamic or unpredictable traffic patterns. Addressing these limitations is crucial for developing more reliable, efficient, and scalable traffic forecasting solutions. Recently, Quantum Computing and Quantum Machine Learning have emerged as promising paradigms, offering a novel computing scheme that has the potential to revolutionize the field. In this study, we use real, high-resolution traffic data from Athens, Greece, to compare classical and quantum approaches in terms of performance and efficiency. Results indicate that both approaches reach state-of-the-art error metrics, with classical ones being more efficient in terms of computational complexity and time. Nevertheless, quantum approaches exhibit promising potential in terms of model performance, especially as their complexity increases with more qubits, highlighting their future prospects in traffic forecasting.

Keywords: Quantum Machine Learning, Traffic Forecasting, QML, Quantum Neural Networks

23. A Hybrid Quantum–Classical Physics-Informed Neural Network for Efficient Solving of Differential Equations in Mechanics

Aliki Mouratidou[1], Napoleon Papoutsakis[2], Nikolaos Schetakis[1], Alessio di Iorrio[3], Georgios Drosopoulos[4], Georgios Stavroulakis[1]

[1] Technical University of Crete
[2] Quantum Innovation IKE
[3] Alma Sistemi Srl
[4] International Hellenic University

Abstract. In recent years, the integration of quantum computing techniques with machine learning models has shown potential to revolutionize computational methods in physics. The present work introduces a hybrid quantum-classical physics-informed neural network (HPINN) approach for solving differential equations, demonstrating its application to academic one-dimensional elastic rod and beam problems. By integrating quantum neural network layers within a classical PINN architecture, the HPINN leverages quantum computation to enhance the training efficiency in terms of fewer training epochs. A code implementation of this hybrid network is presented and demonstrates, through numerical experiments, that the HPINN achieves comparable and slightly better metrics to its classical counterpart while requiring a significantly lower number of training epochs. This finding suggests that quantum-classical hybrid approaches hold promise for accelerating the training of PINNs in solving complex physical problems.

Keywords: quantum–classical physics-informed neural network, partial differential equation, boundary value problems, computational mechanics

THURSDAY, NOVEMBER 21ST 2025

24. Statistical Evolution of ODI Cricket: An Operational Research Perspective

Pratik Mullick

Wroclaw University of Science and Technology

Abstract. This study investigates the long-term evolution of team performance in One Day International (ODI) cricket through a comprehensive operational research framework. Using data from 3,989 matches played between 1987 and 2023, we examine key performance indicators (PIs) such as first innings scores, run rates, wickets lost, runs conceded, wickets taken, and batting partnerships. Employing multivariate time series analysis, the Mann-Kendall test for trend detection, and Cohen's effect size with bootstrapping for robustness, we analyze how batting and bowling strategies have co-evolved over nearly four decades.

Our findings reveal a stable central trend in first innings scores but with a marked rise in exceptionally high totals, underscoring the shift towards more aggressive batting. Effect size analysis shows that while first innings run rates remain critical for establishing competitive targets, the ability to take wickets in the second innings exerts a far greater influence on match outcomes, with consistently large effect sizes observed. Partnership analysis further highlights that batting resilience, particularly in the second innings, is decisive in successful run chases, with middle- and lower-order contributions growing in importance over time.

The results challenge the prevailing perception that ODI cricket has become predominantly a batsman's game. Instead, they emphasize that bowling—especially wicket-taking in the second innings—remains central to determining outcomes. Beyond contributing to sports analytics, this work demonstrates how operational research methods can uncover evolving strategic patterns in competitive environments. Future research can extend this framework to other formats such as Test and T20 cricket to capture format-specific dynamics.

Journal Reference: Mullick, Pratik. "Evolution of team performance in One Day International cricket: an in-depth study of changing trends and effect sizes." Journal of the Operational Research Society (2025): 1-16. https://doi.org/10.1080/01605682.2025.2476057

Keywords: ODI cricket, statistics, performance analysis, Cohen's effect size, Mann-Kendall test

25. Adaptive Matrix Profile Indexing for Irregular Multivariate Time Series

George Tzagkarakis[1], Guillaume Renouard[2], Themis Palpanas[3]

[1] Institute of Computer Science, Foundation for Research and Technology-Hellas
[2] ESIGELEC
[3] LIPADE, Université Paris Cité

Abstract. Real-world time series data, such as those collected from environmental sensors or industrial systems, are often irregularly sampled and multivariate, posing significant challenges for traditional time series analysis techniques. Existing methods typically assume regular sampling intervals and univariate inputs, making them poorly suited for datasets where multiple variables interact over inconsistent timeframes. These limitations hinder the discovery of motifs—recurring subsequences that reveal system structure—and discords—anomalous patterns indicative of faults or unusual behavior. Effectively identifying such patterns in complex, noisy, and asynchronous data streams remains a key challenge in domains like IoT monitoring, climate science, and healthcare. To address these challenges, we introduce a method for efficient motif discovery and anomaly detection based on the matrix profile, a state-of-the-art data structure for similarity search in time series. Our framework extends matrix profile computation to handle irregularly sampled, multivariate time series, enabling robust pattern detection across diverse real-world conditions. We present an end-to-end pipeline that ingests raw time series data, applies preprocessing (e.g., normalization, alignment), and computes matrix profiles to automatically detect relevant motifs and discords. This is encapsulated in a lightweight and user-friendly Python toolkit that abstracts away algorithmic complexity and allows practitioners to analyze challenging datasets with just a few function calls. The proposed approach bridges the gap between cutting-edge time series methods and practical application, lowering barriers for researchers and engineers seeking actionable insights from irregular, multivariate data.

Keywords: Motif discovery, Anomaly detection, Multivariate time series, Irregular sampling, Time series analysis

26. Adaptive Electricity Price Forecasting for EV Charging: Integrating Exogenous Forecasts and Rolling Window Training

George Roussakis[1], Danique Thaens[2], Tobias Kers[2], Rommert Dekker[2], George Tzagkarakis[1]

[1] Institute of Computer Science, Foundation for Research and Technology-Hellas
[2] Erasmus School of Economics, Erasmus University Rotterdam

Abstract. Accurate electricity price forecasts are critical for optimizing flexible consumption, such as electric vehicle (EV) charging. Existing work has shown that multi-day ahead forecasts can reduce consumer costs, but two practical challenges remain. First, exogenous variables such as renewable generation, load, imports, and fuel prices are often unavailable beyond day-ahead horizons, leading researchers to rely on error-based proxies. Second, many studies train models on fixed datasets, which may limit their ability to adapt to changing market conditions. This paper proposes two extensions to address these issues. We outline an approach to incorporate multi-day forecasts of exogenous variables directly into electricity price models, and we evaluate rolling and expanding window retraining schemes to account for non-stationarity and seasonality. Using Dutch market data, we assess how these design choices affect both forecast accuracy and the downstream performance of forecast-based EV charging optimization. The results highlight the importance of realistic data pipelines and adaptive training strategies for improving the reliability and relevance of consumer-oriented forecasting applications.

Keywords: Electricity price forecasting, Electric vehicle (EV) charging optimization, Adaptive model training, Exogenous variables, Non-stationarity

27. LSTM-Based Predictive Maintenance and Anomaly Detection for Serbian Railways

Nataša Milosavljević[1], Miloš Milenković[2], Nebojša Bojović[2], Mirjana Bugarinović[2]

[1] University of Belgrade, Faculty of Agriculture
[2] University of Belgrade, Faculty of Transport and Traffic Engineering

Abstract. As a critical component of a nation's transport network, railway infrastructure requires consistent and effective maintenance to ensure continuous operation and safety. Equipment failures can reduce reliability, increase costs for both service providers and users, and pose significant safety risks. In this paper we propose a data-driven framework based on a different configurations of multivariate Long Short-Term Memory (LSTM) neural networks to enhance predictive maintenance and anomaly detection capabilities on a section of a railway line in Serbia. The model will utilize a comprehensive dataset encompassing historical maintenance records, operational data (train traffic volume, speeds, loading conditions), environmental factors (temperature, rainfall, humidity), and geospatial information (terrain details, embankment profiles). Proposed model provides accurate forecasts for maintenance needs, enabling proactive interventions that are crucial for reducing costs, preventing safety-critical incidents, and ensuring the reliability of the railway network. The research underscores the potential of solutions based on artificial intelligence for improvement of railway infrastructure management.

Keywords: railway infrastructure, predictive maintenance, anomaly detection, long short-term memory

28. A pick-up and delivery routing problem with stochastic demands and unordered customers

Epaminondas Kyriakidis[1], Theodosis Dimitrakos[2], Andreas Papasalouros[2]

[1] Athens University of Economics and Business
[2] Department of Mathematics, University of the Aegean

Abstract. A vehicle starts its route from a depot and visits N unordered customers. New goods are delivered to the customers and expired goods are collected from them. The demands of the customers are stochastic with known distributions. The actual demands are revealed when the vehicle arrives at each customer's site. During its route, the vehicle may return to the depot in order to unload expired goods and to restock with new goods. The cost structure includes travel costs between customers and travel costs between each customer and the depot. After the first visit at each customer's site two decisions must be made. The first decision is to choose the next customer that the vehicle will visit. The second decision is to choose how the vehicle will go to the next customer. The problem is to find (i) the minimum total expected cost for servicing all customers and (ii) the optimal decisions that must be made after the first visit at each customer's site. A suitable stochastic dynamic programming algorithm is developed for the solution of the above problem.

Keywords: vehicle routing problem, stochastic demands, dynamic programming

29. Inventory decisions under supply disruptions via conditional value-at-risk minimization

Eirini Tziora[1], Konstantina Skouri[1]

[1] University of Ioannina, Department of Mathematics

Abstract. Inventory decisions are often made under supply uncertainty, which can create significant financial concerns that require prioritizing the minimization of potential losses from worst-case scenarios over the optimization of expected costs. In this context, it might be better to assume a risk-averse behavior in response to uncertainties associated with the supply process. Therefore, employing a risk measure that accounts for extreme outcomes is particularly relevant. In this work, we apply the Conditional Value-at-Risk (CVaR), that allows us to focus on the tail-end of the system cost distribution, thereby addressing the worst-case outcomes more explicitly. Particularly, we apply this risk measure on inventory systems that deal with supply disruptions. More specifically, we formulate the CVaR for the cost of a single-echelon EOQ (with backlogging)-based inventory system facing supply disruptions and we determine the policy variables that minimize it. Then, comparisons are provided between the optimal decision variables via CVaR and those derived from average cost optimization. By integrating this risk-sensitive perspective, our study seeks to provide a more robust framework for decision-making under such an unreliable supply process.

Keywords: Conditional value-at-risk, Inventory, Disruption, Uncertainty

30. Electronic Supply Chain Support Platform for Recycling Used Refractories and Building Materials using MCDA Methods

Nikos Tsotsolas[1], Athanasios Spyridakos[1]

[1] University of West Attica, Business Administration Department

Abstract. Aluminosilicate refractory materials cover a wide range of metallurgical applications such as steelmaking, aluminum, copper and ferro-nickel industries as well as other sectors of industry such as cement industry, glass industry, refineries, power plants, brick and tiles industry, lime industry, incinerators, industrial mineral plants. For the production of this specific category of refractory materials, a range of alumino-silicate raw materials are used which are not produced in Greece and the companies are forced to import all required quantities from abroad. In fact, most of raw materials are not even available in Europe and are imported from third countries, with significant acquisition and transport costs and above all with extremely high dependence. A next step that must be taken is to support the supply chain operation of source, handling and processing of recycled refractory materials, but also of other building materials that show similar stages in the supply chain, with the aim of their complete and documented tracking, from disassembling to reusing of recycled materials. On the one hand, the aim is better organization of the available information regarding the supply and demand of recycled materials, as well as the continuous performance evaluation of the specific reverse supply chain in terms of profitability and environmental footprint. The main objective of this research proposal is the design and development of an electronic platform to support the recycling supply chain of used refractory and building materials using blockchain technologies and MCDA methods. Through the application of such methods, the grading (value) will be elicited and the classification of the materials will be produced. This documented information could be included, in accordance with EU guidelines, in the Digital Passport of Building Materials, which will act as a tool to enhance transparency and sustainability in the construction industry.

Keywords: Multicriteria Decision Aid, DSS, Construction materials, Waste classification, MCDA methods

31. Exposure-Aware Last-Mile Routing: A Conceptual Framework Integrating Street-Level Air-Quality Data

Alexandros Deligiannis[1], Michael Madas[1]

[1] University of Macedonia, School of Information Sciences, Department of Applied Informatics

Abstract. Urban last-mile distribution clusters vehicle activity in dense areas, creating trade-offs between operating cost and public exposure to air pollution that cost-only routing does not capture. This paper outlines the conceptual design of an exposure-aware routing framework that integrates street-level air-quality information with logistics optimization, with the aim of supporting cost–exposure-aware decision making in last-mile operations. The framework is organised in five layers: (i) a data layer combining an OSM (Open Street Map) road graph, taxi floating-car data for time-of-day speed and dwell proxies, population grids, and regional air-quality inputs, (ii) an environmental layer mapping (or, where needed, downscales) NO_2, PM_{10} and $PM_{2.5}$ fields to road segments to obtain time-dependent concentrations, (iii) a demand layer generating synthetic but city-calibrated delivery instances from population, land-use, and points-of-interest, (iv) an optimization layer addressing a multi-objective Vehicle Routing Problem (VRP) that minimises operating cost and population-weighted exposure, using precomputed exposure costs per segment derived from concentrations, travel time profiles and optional proximity weights, and (v) a decision layer producing efficient frontiers, scenario summaries and concise MCDA tables to support policy formulation (e.g., time-window adjustments, micro-hub use, low-exposure periods). The paper specifies data schemas, preprocessing steps, alignment of rasters to network geometry, and clear exposure-cost definitions. It also details algorithmic choices for solving the VRP in Python (e.g., ε-constraint or weighted-sum approaches with OR-Tools) and provides an evaluation blueprint for future studies, including illustrative baselines, indicative performance measures, and simple sensitivity checks. The contribution is a reproducible architecture and implementation plan showing how decision-grade, street-level air-quality information can be embedded in last-mile routing to inform sustainable urban distribution operations.

Keywords: Exposure-aware routing, Last-mile logistics, Vehicle Routing Problem (VRP), Multi-objective optimization, Population-weighted exposure, Street-level air quality, Floating car data (FCD), OpenStreetMap road network, Decision support systems (DSS), Multiple Criteria Decision Analysis (MCDA)

32. Multi-Criteria Decision-Making in Transport Infrastructure: An AHP Modelling Approach

Dimitrios Dimitriou[1], Maria Sartzetaki[1], Aristi Karagkouni[1]

[1] Department of Economics, Democritus University of Thrace

Abstract. This paper presents a modelling framework for AHP application to multi-criteria transport infrastructure investment decisions with a case application centered on airport investment. The methodological framework organizes the decision environment in a three-level AHP hierarchy (goal, criteria, and alternatives) in a comprehensive set spanning economic efficiency, airside and landside capacity, service quality, environmental externalities, safety, resilience, and multimodal connectivity. Stakeholder input is gathered from pairwise comparison and local priorities are inferred from the eigenvector method and rolled up to global priorities. Consistency is tested via the consistency ratio with iterative reporting when threshold values are breached. Methodologically, the paper provides a repeatable framework for criteria formulation, stakeholder selection, and judgement aggregation across disparate groups. Importantly, airport operators are included as a separate stakeholder group in parallel with airlines, air navigation service providers, ground handlers, regulators, surface transport agencies, local government, and affected communities. The case study considers a representative portfolio of investment options that together span the main classes of intervention in transport infrastructure. These include renewal of core assets to preserve reliability and safety, targeted expansion of user-facing facilities to relieve capacity bottlenecks, enhancements to external connectivity and access management to improve multimodal integration, and the deployment of integrated, collaborative operational systems to optimize day-to-day performance. Framed in this way, the alternatives cover physical, service, and digital dimensions of improvement, enabling a balanced assessment of trade-offs across cost, capacity, resilience, environmental impacts, and user experience. Results show that alternatives promising balanced improvements in throughput, punctuality, accessibility, and environmental performance are ranked ahead of projects maximising a single dimension. Broadly, the AHP framework provides a justifiable basis for investment prioritisation in the presence of multiple objectives and doubt.

Keywords: Analytic Hierarchy Process (AHP), Multi-Criteria Decision-Making (MCDM), Transport infrastructure planning, Airport operators, Investment prioritization, Stakeholder engagement

33. A spatial robust hybrid multicriteria framework for benchmarking analysis based on customer preferences

Anastasia S. Saridou[1], Athanasios P. Vavatsikos[1], Stafanos Katsavounis[1]

[1] Department of Production and Management Engineering, Democritus University of Thrace

Abstract. Customer Satisfaction (CS) research is an increasingly expanding field within marketing and is gaining significant attention for its role in assessing companies' performance. The presented innovative hybrid outranking framework incorporates three different multicriteria decision making methods to evaluate companies with multiple stores comparative performance based on CS metrics. A key feature of the framework is its integration with GIS technology, which facilitates the management, processing, and visualization of spatial data and enables the generation of geo-referenced results. PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) plays a key role by using customer feedback to calculate positive, negative and net flows. These flows indicate whether a company is outperforming or being outperformed by its competitors. The PROMETHEE method requires criteria weights are generated by the CRITIC (CRiteria Importance Through Intercriteria Correlation) method. This method is advantageous because it does not require any external input, relying solely on customer responses to calculate the weights. In addition, SMAA-O (Ordinal Stochastic Multi-Attribute Acceptability Analysis) is used to analyze the performance of individual stores within specific service areas relative to competitors using Monte Carlo simulations. The analysis produces results that highlight service areas around each store, allowing managers to perform detailed benchmarking analysis. Extending traditional CS analysis to the spatial context allows internal and external benchmarking analysis implementation based on each store performance and assists identification of areas for improvement.

Keywords: PROMETHEE, CRITIC, SMAA-O, Customer Satisfaction, GIS, Store performance, Benchmarking

34. Balancing security, cost, operations, and compliance: An MCDM framework for gas TSO cybersecurity

Spiros Alexopoulos

DESFA - Hellenic Gas Transmission System Operator

Abstract. The cybersecurity of European Union (EU) Gas Transmission System Operators (TSOs) represents a significant challenge for national and continental energy security. As gas transmission systems' infrastructure undergoes rapid digitalization, TSOs face an expanding attack surface and increasingly sophisticated threats. Securing these complex environments is not a single-objective problem but a delicate balancing act involving numerous conflicting priorities. This paper suggests that cybersecurity investment and strategy decisions within a gas TSO constitute a classic Multiple-Criteria Decision-Making (MCDM) problem. We identify and analyze the consistent family of criteria relative to the decision: security effectiveness, financial cost, operational integrity, regulatory compliance, physical safety, and system resilience. We also recognize challenges specific to the EU gas sector like IT/OT convergence, legacy systems, supply chain vulnerabilities, and cross-border interdependencies. We then propose a structured MCDM framework integrating the SIMOS method for a robust and direct criteria weighting process, and the MACBETH technique for constructing a cardinal value scale to score and rank alternatives. This framework provides TSO decision-makers with a transparent, justifiable, and robust methodology for evaluating and selecting cybersecurity solutions. An illustrative case study on selecting a Security Information and Event Management (SIEM) system demonstrates the framework's practical application. Finally, we discuss the potential for integrating Artificial Intelligence (AI) to create dynamic, adaptive decision support systems, aligning with the future of Operational Research (OR) in the energy sector.

Keywords: Energy Security, Critical Infrastructure, Gas TSO, Cybersecurity, Business Continuity, AI Threat Intelligence, Risk Management, Operational Technology (OT), Multiple-Criteria Decision-Making (MCDM), Decision Support Systems, SIMOS, MACBETH, Facilitated Modelling

35. System Dynamics and MCDA: From Parallel Approaches towards Hybrid Modelling

Alkaios Sakellaris[1], Nikolaos Matsatsinis[1]

[1] School of Production Engineering and Management, Technical University of Crete

Abstract. System Dynamics (SD) and Multi-Criteria Decision Analysis (MCDA) are two established approaches within Operational Research that support decision-making in complex and uncertain environments. SD focuses on modelling feedback loops and simulating system behaviour over time, while MCDA provides structured methods to evaluate alternatives across multiple, often conflicting criteria. Despite their different paradigms, both emphasize structuring problems explicitly, ensuring transparency of assumptions, involving decision-makers, and following iterative procedures.

There is increasing interest in combining the two through hybrid modelling, although examples remain limited. In existing applications, SD is often used to generate dynamic scenarios, while MCDA provides the evaluative framework to compare these scenarios against stakeholder values. On the other hand, results from MCDA can be used to surrogate parts of the SD model, providing preference-driven inputs or priorities that shape the system's structure and focus. These complementarities suggest that SD and MCDA are not substitutes but parallel approaches that can enrich one another when integrated.

Building on this starting point, this paper develops a conceptual framework inspired by UTA methods in MCDA. In UTA, preference elicitation reconstructs additive value functions from observed judgments. Following the same logic, we introduce dynamic elicitation in SD, defined as the process of fitting causal structures to observed time-series data and treating the resulting validated trajectories as inputs for subsequent modelling stages. This parallel highlights common ground between SD and MCDA and points to new directions for advancing hybrid modelling.

The contribution of this work is to present this conceptual framework of dynamic elicitation as a step toward the future evolution of hybrid modelling, positioning SD and MCDA as complementary tools within Operational Research and pointing to new opportunities for more holistic and transparent decision support.

Keywords: System Dynamics, Multi-Criteria Decision Analysis, Hybrid Modelling, Preference Elicitation, Dynamic Elicitation

36. Optimal sizing and energy management for a PV-H2 autonomous system

Androniki Maria Skandalaki[1], Vasileios Provatas[1], Eleftherios G. Kyriakou[1], Dimitra G. Kyriakou[1], Fotios D. Kanellos[1], Michalis Konsolakis[1], Spiros Papaefthimiou[1], Dimitrios Ipsakis[1]

[1] School of Production Engineering and Management, Technical University of Crete

Abstract. Hydrogen (H2) is considered as an energy medium that can be used in industrial processes (e.g. refineries, steel, ammonia) and in vehicular applications (e.g. cars, city buses) for transportation. Following this prospect and aiming towards a sustainable solution that will allow the EU target of 90 % reduction by 2040, as compared to the 1990s emission levels, the utilization of renewable energy sources (RES) as the means of green energy supply towards the splitting of water in PEM electrolyzers needs to be exploited through a systematic framework. Only in this way, Green-Hydrogen can provide an essential solution for the effective decarbonization and gradual replacement of fossil fuels.

Core aim of this study is the development and evaluation of an optimal design and energy management computational structure that will allow the sizing of Photovoltaic systems (PVs) and PEM electrolyzers with or without the use of short-term energy storage (batteries). This combined sizing and energy management strategy involves the following steps: a) utilization of weather data from a predefined area of installation in Crete, b) utilization of various hydrogen profiles (industrial based and seasonal based), c) simultaneous sizing of PVs, batteries and PEM electrolyzers under a robust energy management strategy that ensures 100% satisfaction of the hydrogen profiles, protection of the battery from excessive usage, minimal (i.e.<1%) total energy losses and minimum capital and operating expenses. All subsystems are utilized via validated mathematical models and a genetic algorithm is used in order to identify the optimal solution for the autonomous PV-batteries-electrolyzer system.

The results show that the sizing of the subsystems is irrelevant of the hydrogen profiles (equal yearly hydrogen production), but the autonomy of the overall system is significantly affected. In this way, the engineering team can select upon the best solution that will ensure an uninterrupted operation. As a step forward, this study also explores the dynamic operation of the PEM electrolyzer and presents the results from the application of feedback controllers (PID and model-based) that aim towards controlling hydrogen production and operating temperature under different trajectories and emerged disturbances.

Keywords: renewable energy sources, green hydrogen, zero emissions, water electrolysis, energy management, genetic algorithms

37. AI-Driven Probabilistic Models for Robust Risk-Based Household Battery Scheduling

Christos Tzagkarakis[1], Koen Boerjan[2], Ece Karakoyun[2], Rommert Dekker[3], George Tzagkarakis[1]

[1] Institute of Computer Science, Foundation for Research and Technology-Hellas
[2] Econometric Institute, Erasmus University Rotterdam
[3] Erasmus School of Economics, Erasmus University Rotterdam

Abstract. The increasing integration of renewable energy sources has amplified the importance of intelligent household battery management. Effective scheduling must balance volatile day-ahead electricity prices with uncertain household demand, while also accounting for battery degradation and operational costs. Existing approaches demonstrate the potential of risk-based operational strategies but remain constrained by limited data scope, short evaluation windows, and narrow model choices. This work proposes a novel forecasting and evaluation framework for risk-based battery operation in residential settings. The core idea is to generate joint probabilistic forecasts of household load and electricity prices and integrate these into a daily rolling-origin evaluation procedure. Unlike conventional fixed-window evaluations, this setup simulates scheduling decisions continuously across a full year, thereby capturing seasonal effects, long-term variability, and realistic decision dynamics. To improve the quality of the predictive distributions, we investigate modern probabilistic sequence models. Attention-based architectures such as the Temporal Fusion Transformer, autoregressive methods such as DeepAR, and convolutional approaches like Temporal Convolutional Networks will be considered. These may be further enhanced with conditional normalizing flows to produce calibrated multivariate forecasts over the full decision horizon. In parallel, robust non-deep learning baselines such as LightGBM with quantile loss and NGBoost will be benchmarked to ensure methodological transparency and interpretability.

The anticipated contribution of this research is a rigorous and extensible framework that couples advanced forecasting with risk-aware optimization, evaluated under conditions that closely mimic real-world deployment. By addressing methodological limitations in current practice, the study aims to provide new insights into the economic feasibility of residential storage and lay the groundwork for scalable, trustworthy battery scheduling strategies in future electricity markets.

Keywords: Probabilistic forecasting, Temporal Fusion Transformer, Multivariate time series forecasting, Electricity market

38. Integrating AI, OR, and CRM Intelligence for Predictive Energy Optimization in Hotels and Real Estate

John Issaris

Omicron Systems

Abstract. The hospitality and real estate sectors are under growing pressure to reduce energy consumption while maintaining comfort and profitability. Traditional building management relies on static rules or after-the-fact utility bills, providing limited insight into dynamic occupancy and usage patterns. This paper introduces a framework that integrates Artificial Intelligence (AI), Operations Research (OR), and Customer Relationship Management (CRM) intelligence for predictive energy optimization without requiring IoT or building management systems.

CRM systems enriched with AI modules, serve as the central intelligence layer. First, booking data and customer segmentation are used to forecast occupancy and segment-specific energy demand profiles. Second, asset-level AI scores, based on historical performance and maintenance records, provide estimates of equipment efficiency and potential failure risk. These scores are integrated into the optimization as adjusted capacity or efficiency constraints. Third, support and complaint analytics identify comfort-sensitive zones or customer groups, feeding into the optimization as weighted satisfaction constraints. Predictive maintenance schedules from the CRM further inform energy allocation, allowing the system to align downtime with low-cost periods.

The forecast outputs feed into a mixed-integer linear programming (MILP) optimization model, which determines cost-optimal operating strategies for HVAC scheduling, asset-level allocation, and maintenance planning. A pilot study in a mid-sized hotel demonstrates that CRM AI occupancy forecasting alone achieves a 20% reduction in demand uncertainty compared to naïve averages. Adding segmentation and complaint-aware weighting reduces forecasting error and comfort risk by a further 7%. When combined with asset health scores and OR optimization, the framework yields up to 25% energy cost reduction compared to rule-based scheduling, while maintaining guest comfort and reducing hidden costs from complaints and unexpected downtime. This study highlights the value of aligning technical and business-context AI within CRM systems with mathematical optimization, offering a scalable path toward sustainable and cost-effective building operations, even without IoT infrastructure.

Keywords: Predictive Energy Optimization, CRM-Integrated AI and Operations Research, Asset Intelligence and Complaint-Aware Forecasting

39. Bridging Climate Services and Life Cycle Sustainability Assessment: Towards Integrated Climate-Informed Decision-Making

Uglješa Stankov[1], Miroslav D. Vujičić[1], Biljana Basarin[1], Konstantinos P. Tsagarakis[2]

[1] University of Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management
[2] Technical University of Crete, School of Production Engineering and Management

Abstract. Life Cycle Sustainability Assessment (LCSA) provides a holistic framework for assessing environmental, economic, and social impacts across product life cycles, encompassing multiple sectors and geographic regions. While LCSA is inherently dynamic, current practice relies heavily on static datasets and lacks systematic integration of future-oriented climate variability. At the same time, climate services, such as climate projections, early warning systems, or risk maps, are not yet explicitly connected to LCSA, despite their clear potential for mutual reinforcement. This paper addresses this research gap by presenting results from three complementary sources, which will be co-evaluated. First, a systematic literature review identifies existing knowledge, unmet needs, and critical challenges at the intersection of LCSA and climate services, conducted in accordance with PRISMA guidelines. Second, insights from online searches will be collected using the Google Trends tool. Finally, we will analyse practices that companies and organisations apply in LCSA with a focus on climate, drawing on data gathered from social media. Building on this analysis, we propose a conceptual framework for incorporating region- and time-sensitive climate data into dynamic, cross-sectoral LCSA models, while also demonstrating how LCSA structures can inform the design of more targeted and user-centred climate services. By bridging these two complementary domains, the study advances interdisciplinary knowledge, supports evidence-based decision-making, and opens pathways for future collaborative research.

Acknowledgement: This paper is based upon work from HORIZON TMA MSCA Staff Exchanges: ClearClimate (grant agreement No. 101131220) and COST Action CA23157 European Network for Multiple-View Life Cycle Sustainability Assessment (MultiViewLCSA), supported by COST (European Cooperation in Science and Technology)

Keywords: Life Cycle Sustainability Assessment (LCSA), climate services, cross-sectoral sustainability, decision support, conceptual framework.

40. Solar farm suitability analysis using MCDM methods in GIS environment: A literature review

Adamantios G. Petkakis[1], Anastasia S. Saridou[1], Athanasios P. Vavatsikos[1]

[1] Department of Production and Management Engineering, Democritus University of Thrace

Abstract. Solar energy is recognized as a key renewable resource, valued for its abundance, adaptability to large-scale deployment, and potential to meet rising global energy needs. In recent decades many strategies and research have been established for the development and deployment of photovoltaic technology. A key challenge in the development of solar farms lies in identifying the most suitable locations, as site selection is crucial for maximizing energy production. Effective deployment of solar farms requires spatial planning to ensure technical efficiency, environmental compatibility and socio-economic viability. Geographic Information Systems (GIS) provide a robust framework for this task, due to their ability to integrate and analyze complex spatial datasets and decision makers judgments. When combined with MultiCriteria Decision Making (MCDM) methods, GIS facilitates a process of weighting, comparing and prioritizing diverse factors, including Global Horizontal Irradiance, slope and proximity to transmission lines. Over the past two decades, 48 studies have been published addressing similar topics. In this research, solar farm suitability analysis is assessed using key evaluation criteria. The literature review conducted indicates the criteria implemented and their spatial attributes to provide discussion related with the criterion types, preferences threshold values and their positive or negative influence on spatial suitability. Moreover, the methods employed for criterion weights elicitation, raw data standardization and synthesis of the per criterion performances are discussed in detail. The findings provide stakeholders with a scientifically grounded framework for decision-making, guiding the prioritization of regions most suitable for efficient and sustainable solar energy systems deployment.

Keywords: MCDM, GIS, Solar farms, Suitability analysis, Renewable energy

41. Evaluating the sustainability and resilience of the long-term energy pathways in Switzerland: A multicriteria Group Decision Making framework

Eleftherios Siskos[1], Evangelos Panos[2], River Huang[2], Peter Burgherr[2]

[1] School of Production Engineering and Management, Technical University of Crete
[2] Laboratory for Energy Systems Analysis, Paul Scherrer Institute

Abstract. The transformation of the European energy system is essential for achieving net-zero greenhouse gas emissions by 2050 and meeting long-term energy policy objectives. This study specifically examines the Swiss energy transition, evaluating the sustainability and resilience of the future national energy system in the face of potential disruptive events. The research employs a comprehensive methodological framework consisting of three key components: (i) an analysis of possible long-term energy pathways influenced by certain prevalent shocks, (ii) an integrated assessment of different energy system configurations, and (iii) a multicriteria evaluation that incorporates stakeholder input. Central to this evaluation is the development of a detailed database of sustainability and resilience indicators, created and quantified using data from various energy and economic models, Life Cycle Assessments, and targeted surveys addressing sociopolitical, regulatory, and legislative factors. A selection of these indicators is chosen and fed into an MCDA model, based on stakeholder feedback, to evaluate the national long-term energy pathways. The MCDA preference model, based on the PROMETHEE II method, is assessed with input from a broad group of stakeholders and experts. Additionally, stakeholder preferences regarding the importance of different criteria are gathered through voting mechanisms rooted in social choice theory. The impact of potential shock scenarios is assessed within stakeholder groups using the Deck of Cards method. The evaluation framework not only ensures the feasibility and appropriateness of the evaluation process but also facilitates a collaborative and inclusive assessment of the Swiss energy transition.

Keywords: Multicriteria Decision Aid, Group Decision Making, Decision Theory, Energy system resilience, Sustainability

42. Assessing the suitability of the Technical University of Crete campus for installing a Concentrated Solar Power Vertical Furnace: A multicriteria decision analysis approach

Marios Kazasidis[1], Eleftherios Siskos[1], Evdokia Kefalidou[1]

[1] Technical University of Crete

Abstract. Concentrated solar power is a renewable energy technology with significant advancements in recent years, exhibiting high potential for sustainable power generation. Utilizing innovative tower installations, known as vertical furnaces, it efficiently concentrates direct sunlight to generate high temperatures suitable for various industrial and energy applications. This study examines the suitability of the Technical University of Crete (TUC) campus in Greece to develop such an installation at a pilot scale, aiming to enhance the research capabilities of the institute. Under this prism, the TUC campus is benchmarked against 12 sites in 7 European countries, where similar installations are already in operation. The sites are assessed based on real data on a range of climatic and geographical criteria. The evaluation employs a multicriteria decision analysis methodology, ensuring the robustness of the results through specific indicators. The findings reveal TUC's strong potential as a prime candidate for establishing a concentrated solar power installation. Such a project could pave the way for pioneering research and innovation in renewable energy at TUC, strengthening its cooperation links with other European institutions and positioning it as a leader in sustainable technology.

Keywords: concentrated solar power, renewable energy, multicriteria decision analysis, benchmarking

43. Policy and Market Analysis for Accelerating Energy Renovations in Greece: A PESTLE and SWOT Perspective

Ioanna Andreoulaki[1], Aikaterini Papapostolou[1], Konstantinos Kefalas[1], Natalia Konti[1], John Psarras[1]

[1] Decision Support Systems Laboratory, National Technical University of Athens

Abstract. To address the climate crisis, the European Union (EU) has established specific targets related to the energy transition, emphasizing the urgent need to reduce energy consumption in the building sector. Based on the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD), increasing renovation rates are deemed necessary. The policies of EU Member States, including Greece, try to adopt and implement policies aligned with the targets and directives of the EU. However, the high costs discourage building owners and managers from implementing energy efficiency projects, despite the economic benefits arising from energy savings. At the same time, financiers face their own challenges, such as uncertainties about return on investment, lack of standardized risk assessment protocols, and limited awareness of long-term benefits, which further constrain the flow of capital into the sector. Therefore, it becomes evident that financial programs and investments in energy efficiency projects can play a very important role in increasing energy renovations. In this context, the scope of this paper is to conduct a market analysis, aiming to formulate and evaluate policy recommendations to increase investments in energy efficiency of the Greek building stock. Specifically, through PESTLE (Political, Economic, Sociological, Technological, Legal, and Environmental) and SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis, the factors of the internal and external environment influencing investments in energy efficiency in buildings are identified, along with the benefits, opportunities, potential weaknesses, and risk factors affecting this sector. At the same time, the current and desired state are assessed in order to propose improvements to national policies. The findings of this research are expected to support decision-making processes of both policymakers, financial institutions, and energy managers, contributing to the design of more effective strategies that enhance investments in building energy efficiency.

Keywords: Energy Efficiency Financing, Sustainable Investments, Building Retrofitting, Policy Recommendations, Energy Transition

44. Supervised machine learning for maritime search and rescue operations planning

Thomas Laperrière-Robillard[1], Michael Morin[1], Irène Abi-Zeid[1]

[1] Université Laval

Abstract. Maritime search and rescue operations are important humanitarian activities for locating and rescuing survivors in distress at sea. This project looks at how supervised machine learning can help improve the planning of search operations by predicting the probability of success of search plans. We tested four models—random forest, k-nearest neighbor, support vector machines, and neural networks. Our results show that using machine learning reduces the time required to evaluate search plans through simulation, enabling more candidate plans to be tested. This can enhance SAR Optimizer—the optimization and evaluation module currently used by the Canadian Coast Guard. By providing better search plan recommendations, our approach has the potential to increase the effectiveness of SAR operations and, ultimately, save lives.

Keywords: Supervised machine learning, Simulation, Maritime search and rescue planning, Canadian Coast Guard, Decision support system, SAR Optimizer

45. Towards an Article Reviewer Assignment Recommendation System Using Multicriteria Analysis and Machine Learning Methods

Maria Toula[1], Nikolaos Matsatsinis[2]

[1] Hellenic Army Academy and Technical University of Crete
[2] Technical University of Crete

Abstract. One of the most important problems is the development of valuable user profiles (consumers, products, paper reviewers, ...) with huge fields of application in e-business, e-governance etc. On the other hand, Artificial Intelligence (AI) in combination with Big Data, has developed rapidly, making it possible to utilize appropriate classifiers and large amounts of data to develop user profiles. Recommender Systems leverage users' information to suggest products or services and generally produce personalized recommendations for their users that best match their needs and preferences.

In the academic/scientific field, the assignment of papers to reviewers is an important field of application of the above systems. The quality of the assignment results depends on the correct selection of the reviewers. The application of multiple reviewer's characteristics (e.g. research interests, experience, citations, workload, conflict of interest, quality of work in the reviewer role etc.) as well as of multiple paper's characteristics (e.g. abstracts, keywords, IF demanding, time demanding etc.) allows us to more precisely determine the level of similarity between the reviewer's work and the paper under review based on paper-reviewer relevance, review completion speed, review quality and review non-acceptance risk.

In this work, a methodology was developed that combines AI methods and algorithms such as machine learning, data mining, text analysis, natural language processing, etc., and multi-criteria decision analysis to form the appropriate profiles of reviewers and of papers, to evaluate the papers-reviewers combinations and formulate the proposal of suitable reviewer per paper for the optimal assigning of papers-reviewers, avoiding conflicts of interest and equalizing the workload. To create profiles of reviewers, a hybrid methodology has been developed that is based on direct and indirect feedback. Finally, the above methodology was applied to a series of cases to evaluate its effectiveness.

Keywords: Recommender Systems, Machine Learning, Multi-Criteria Analysis, Data Mining, Text Analysis, Natural Language Processing

46. AI-Enhanced Decision-Support Approach for Streamlining Financing of Affordable and Sustainable Housing

Konstantinos Kefalas[1], Ioanna Andreoulaki[1], Aikaterini Papapostolou[1], Vaggelis Marinakis[1]

[1] Decision Support Systems Laboratory, National Technical University of Athens).

Abstract. Improving the energy performance of the European building stock is of paramount importance, especially considering the goals of the European Union to achieve carbon neutrality by 2050, and taking into account the fact that about one-third of buildings in the EU are over 50 years old according to the European Commission. From a social perspective, focusing on this category of buildings is crucial, since the worst performing buildings are often occupied by the most vulnerable groups, that do not have access to financing in order to implement energy efficiency measures and reduce the energy consumption of those buildings. The scope of this paper is to propose an innovative AI-driven decision support approach, that will be the basis for the development of an online tool, that supports and streamlines the implementation of a dual financing model for affordable and energy-efficient housing. The approach consists of three stages: Stage 1 – AI-driven Client Onboarding for the credit assessment of the potential homebuyers, Stage 2 – Energy Efficiency Evaluation, where an One Stop Shop analyses the state of the building and extracts its energy efficiency roadmap, and Stage 3 – Deal Closure, where the agreement between the lenders and buyers is automated thanks to a blockchain – based approach. The proposed methodology is being developed within the framework of the LEG-UP (Linking Energy Efficient Green Upgrades with Private Investments to support sustainable and affordable homes), an EU-funded initiative under the LIFE programme, that aims to promote a business model based on a financing structure consisting of a mortgage for the purchase of a new home for first-time buyers, and the acquisition of an energy efficiency loan to renovate the new property.

Keywords: Energy Efficiency, First Time Buyers, Digitalisation, Energy Transition, Renovation Loan

47. Properties and applications of Pareto-optimal colorings

Ioannis Mourtos[1], Michalis Samaris[1]

[1] Athens University of Economics and Business

Abstract. A typical matching market assumes a set of goods to be allocated to a set of agents who express their preferences among these goods. This defines a large variety of matching problems, differentiated by features like the available quantity per good, the criteria governing the agents' preferences and further rules that must be satisfied when allocating the goods to the agents. House Allocation, introduced by Shapley and Scarf, remains the most well-known matching market. Here, goods are heterogeneous and indivisible, the preference list of each agent is a linear order of a subset of the goods, each good must be allocated to exactly one agent and vice versa. We generalise this market in the context where each house can accommodate even all available tenants but some pairs of tenants cannot live together. Equivalently, we examine the list coloring problem in the case where the list of allowed colors for every vertex is linearly ordered, i.e., every vertex expresses strict and transitive preferences over its available colors (this becomes the housing market if the underlying graph is a clique). A coloring is Pareto optimal if no vertex can receive a more preferred color without some other vertex receiving a least preferred one. We provide a characterization of Pareto optimal colorings and show that Serial Dictatorship can be used to obtain such a coloring. Interestingly, and in contrast with housing markets even with quotas and non-strict preferences, not every Pareto optimal coloring is obtainable through Serial Dictatorship. The second aspect that differentiates our generalisation is that verifying whether a given coloring is Pareto optimal is coNP-complete. Given this, it is reasonable to consider special cases, apart from housing markets, for which the verifying problem can be solved in polynomial time.

Keywords: House Allocation, Pareto efficiency, Pareto optimality, List Coloring

48. Using the qualitative research tool MAXQDA to explore emerging digital skills

Ioannis Zervas[1], Emmanouil Stiakakis[1]

[1] University of Macedonia

Abstract. Digital skills encompass any kind of ability that a person needs to be effective in using digital devices and applications, and to demonstrate appropriate behavior toward digital technology. However, digital technologies are constantly evolving at a rapid pace, and consequently, digital skills are also developing quickly. Existing frameworks for assessing digital skills, such as the European Commission's DigComp, focus mainly on conventional environments and do not sufficiently cover disruptive technologies, including areas like AI and machine learning.

Our study aims to investigate future digital skills, precisely due to the rapid development of disruptive technologies, which are also the digital technologies dominating today. These could be the digital skills that the education system should prioritize more.

The first step of our methodological approach is to understand and document the unique characteristics and the differences of disruptive technologies compared to known digital technologies, such as office automation tools (hardware and software), ERP information systems, and other widely used enterprise solutions. Based on these characteristics, we categorized disruptive digital technologies into the following groups: 1. AI systems, 2. blockchain platforms, 3. extended (virtual, augmented, mixed) reality, 4. cloud services, and 5. Internet of Things and smart devices.

Since the study aims to explore the digital skills that will arise from developments in disruptive technologies, the chosen research methodology is qualitative research through in-depth interviews. Interviews were conducted with 15 experts, evenly distributed across the five groups of disruptive digital technologies mentioned earlier. The analysis of the interview data was performed using MAXQDA Analytics Pro (release 24.11.0), a qualitative research tool that allows coding of key phrases from the interviewees. Subsequently, the digital skills identified were communicated to the interviewees to avoid overlaps, facilitate further grouping, and verify them with the experts.

Keywords: digital skills, disruptive digital technologies, qualitative research, MAXQDA

49. Exploring Determinants of Measles Vaccination Coverage Across Indonesian Provinces: A Machine Learning Approach

Jamaliatul Badriyah

University of Sheffiled

Abstract. Uneven measles vaccination coverage across Indonesian provinces poses challenges to achieving equitable immunization. This study examines the determinants of provincial-level coverage using machine learning methods as an analytical tool. Socio-demographic and health system indicators were compiled from national datasets for the years 2020 and 2023. Random Forest and XGBoost models were applied with hyperparameter optimization to explore influential factors associated with vaccination outcomes. The XGBoost model provided the most reliable explanation of coverage variation (R^2 = 0.45, RMSE = 4.61, MAE = 3.62). Interpretation using SHAP values identified the most significant drivers of vaccination performance at the national level, such as early marriage, health insurance coverage, and maternal health conditions. Importantly, the analysis revealed that the relative importance of these factors differed across provinces, indicating that determinants of vaccination coverage are highly context-specific. These insights underline the value of machine learning for disentangling complex, multidimensional determinants of immunization coverage and offer evidence to support tailored policy actions aimed at reducing regional disparities in Indonesia's vaccination programs.

Keywords: Measles vaccination coverage, Indonesia, Socio-economics determinants of health, Machine learning

50. Study of Doctoral Students' Satisfaction in Greek Universities. Motivations and Barriers

Panagiotis Rekkas-Ventiris[1], Evangelia Krasadaki[1], Stelios Tsafarakis[1]

[1] School of Production Engineering and Management, Technical University of Crete

Abstract. This study investigates the factors influencing the academic experience of doctoral candidates in Greek universities, focusing on academic support from professors and peers, personal goals, and psychological well-being. It also examines the motivations and barriers encountered during their doctoral studies. A nationwide survey was conducted among doctoral candidates to explore the key areas contributing to their overall satisfaction or dissatisfaction. The multicriteria decision-making method MUSA was applied to evaluate satisfaction factors, while Factor Analysis was used to identify the main motivations and obstacles faced by candidates.

The findings reveal a high overall satisfaction level (approximately 80%), which aligns with strong satisfaction in terms of personal development and supervisory support. In contrast, satisfaction related to psychological well-being remains low. Among the various factors studied, career prospects emerged as the primary source of motivation, whereas psychological and financial instability were identified as the main barriers. By integrating the evaluation of doctoral candidates' satisfaction with an analysis of their motivations and barriers, this research contributes to the growing international literature on doctoral education and provides valuable insights for enhancing the doctoral experience.

Keywords: Doctoral candidates, Academic experience, Satisfaction, Motivations, Barriers, Psychological well-being, Career prospects, Greek universities, MUSA method, Factor analysis

51. Mapping the Digital Competences of Local Government Employees in Heraklion: A Qualitative Analysis and Thematic Coding of Interviews Based on DigComp 2.2

Yiannis Dimotikalis[1], Nikos Kounoupas[1], Christos Skiadas[2]

[1] Hellenic Mediteranean University, Dept of Management Science and Technology
[2] ISAST

Abstract. This study investigates the digital readiness of employees in different roles within local government in the Heraklion regional unit, using the European DigComp 2.2 framework as a reference point. DigComp 2.2 defines five key areas of competence: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving. The research employed a qualitative methodology through 13 semi-structured interviews with local government employees across diverse roles. The collected data were analysed using thematic coding and categorisation, supported by artificial intelligence mechanisms within a qualitative research approach.

The research questions focused on practices of information search and evaluation, the use of digital communication and collaboration tools, challenges in digital content creation, data security practices, and strategies for problem solving. In addition, the study examined the relationship between familiarity with technology and overall digital competence (H1), the influence of income on skills development (H2), and the role of professional duties in shaping digital readiness (H3).

The analysis revealed thematic codes and clusters aligned with the DigComp 2.2 dimensions. The findings highlight both deficits in critical competences and areas of positive digital engagement, role-based variations, and the need to strengthen critical and responsible technology use, emphasizing the transition from passive consumers to active producers of digital content. Overall, the results outline a heterogeneous profile of digital readiness, where basic functional literacy coexists with weaknesses in innovation and creative application. Five distinct profiles of digital users: Basic, Routine, Networked, Analytical, and Advanced, were identified, differentiated by role, education, and professional experience. These profiles underscore the need for targeted and flexible training programs, aligned with digital transformation strategies and the development of electronic government in public administration.

Keywords: Digital Readiness, Digital Skills, DigComp 2.2, Public Administration, Local Government, Digital Transformation, Electronic Government

52. The integration of big data technologies for customer data management and customized marketing strategies

Zoi Maria Panagiotou[1], Fotios Kitsios[1], Maria Kamariotou[1]

[1] University of Macedonia

Abstract. In recent years, the rapid increase in the volume and variety of data produced daily has made it necessary to use advanced analytics technologies to understand consumer behavior and predict purchasing trends. The purpose of this paper is to examine how Greek companies utilize Big Data Analytics technologies and corresponding data management strategies to strengthen their competitive position and improve their operational performance. Ordinal Regression Analysis was used to analyze data. The results of the research are expected to provide useful information for companies seeking to leverage Big Data to enhance their competitiveness, better understand their customers, and adapt their marketing strategies to the demands of the modern digital market.

Keywords: Big Data, Performance, Marketing Strategy, Machine Learning, Market Trend Analysis

53. Interpretability in Artificial Intelligence: The Role of ANFIS

George Atsalakis[1], Ioanna Atsalaki[1]

[1] Technical University of Crete

Abstract. Interpretability has emerged as one of the most critical challenges in Artificial Intelligence (AI), especially in high-stakes domains such as healthcare, finance, and autonomous systems, where decision transparency is essential for trust and accountability. Many powerful AI models, particularly deep learning systems, operate as "black boxes," offering high predictive performance but limited explainability. This lack of interpretability poses risks in terms of user trust, ethical accountability, and compliance with regulatory frameworks.

The Adaptive Neuro-Fuzzy Inference System (ANFIS) provides a promising pathway to address this challenge by integrating the learning capabilities of neural networks with the human-readable reasoning of fuzzy logic. Unlike deep learning models that produce opaque representations, ANFIS generates rule-based inferences that can be traced and understood by human experts. This feature makes it highly suitable for applications requiring not only accuracy but also transparency, such as medical diagnosis, energy forecasting, and financial decision-making.

Recent research highlights the value of ANFIS within the broader movement of Explainable Artificial Intelligence (XAI), where interpretable models are increasingly prioritized. Its adaptability allows it to dynamically adjust fuzzy membership functions based on data while still maintaining explicit reasoning pathways. Consequently, ANFIS can serve as a bridge between high-performance AI and the ethical requirement for explainability, ensuring that intelligent systems remain both powerful and trustworthy.

Keywords: Interpretability in AI, Explainable AI, ANFIS, Trustworthy AI, Ethical Accountability

54. Weighted Centrality Measures for Transport Network Vulnerability Assessment Using Open-Source Data

Dimos Touloumidis[1], Michael Madas[1]

[1] Information Systems and e-Business Laboratory, University of Macedonia

Abstract. Urban transport networks are critical infrastructure systems whose continuity directly impacts economic productivity, emergency response effectiveness and overall urban functionality. From an operational research perspective, the challenge lies in developing systematic approaches to identify and prioritize network components for maintenance, investment and contingency planning. This study presents a streamlined methodology for transport network vulnerability assessment using weighted centrality measures applied to Thessaloniki's road network.

The proposed framework leverages open-source OpenStreetMap data to construct a comprehensive network representation, incorporating maximum allowed link speeds and hierarchical road classifications, such as motorway, primary, secondary and residential, as weighting factors. Four centrality measures (degree, closeness, betweenness and flow betweenness centrality) are adapted to transport-specific contexts by integrating these weights, reflecting real-world operational characteristics of urban mobility patterns and traffic flow dynamics. The weighted centrality indicators are subsequently aggregated into a unified vulnerability index through mathematical optimization techniques.

This operational research approach enables systematic prioritization of critical network links and nodes, providing decision-makers with quantitative evidence for resource allocation and policy interventions. The methodology addresses the fundamental operational challenge of maintaining network continuity under resource constraints, where strategic investments must be directed toward components whose failure would most significantly impact system-wide performance. Results demonstrate clear hierarchical patterns of vulnerability, identifying key arterials and intersections requiring priority attention. The framework's computational efficiency and reliance on freely available data make it readily applicable to other urban contexts, supporting evidence-based operational decision-making in transport infrastructure management and emergency preparedness planning.

Keywords: Transport network vulnerability, Centrality measures, Infrastructure prioritization

55. A Preliminary Framework for DEMATEL Enhancement through Spectral Analysis

Pavlos Delias[1], Kerasia Kalkitsa[1]

[1] Democritus University of Thrace

Abstract. Traditional DEMATEL analysis is known for effectively mapping cause-effect relationships between system components but stops short of revealing deeper structural properties. This paper develops a preliminary framework that applies spectral analysis to DEMATEL's total relation matrix, unlocking insights into system dynamics previously beyond the method's original reach.

The framework exploits a mathematical property we establish: when expert assessments produce irreducible influence patterns (a condition typically met in practice), the total relation matrix admits eigenvalue decomposition. This decomposition yields two key analytical tools. First, the largest eigenvalue measures how strongly influences can amplify as they cascade through the system. Second, the associated eigenvector pinpoints which factors form coherent influence clusters and represent high-leverage intervention targets.

These spectral measures address critical gaps in conventional DEMATEL analysis. They quantify system stability, predict cascade risks, and identify strategic intervention points—capabilities that centrality measures alone cannot provide. The framework essentially converts DEMATEL from a relationship mapping technique into a prescriptive tool for system behavior.

We demonstrate this framework through a case study from the agro-food sector. The spectral analysis reveals amplification mechanisms and stability patterns that escaped detection in the original study, suggesting systematic ways to enhance intervention effectiveness. The approach maintains DEMATEL's computational simplicity while expanding its analytical scope significantly.

Keywords: DEMATEL, Nonnegative matrices analysis, Decision Support

ΠΕΡΙΦΕΡΕΙΑ ΚΡΗΤΗΣ
REGION OF CRETE

ΔΗΜΟΣ ΧΑΝΙΩΝ
ΚΥΔΩΝ
MUNICIPALITY OF CHANIA-CRETE

HELORS
HELLENIC OPERATIONAL
RESEARCH SOCIETY

TECHNICAL
UNIVERSITY
OF CRETE