Ca' Foscari University of Venice
Department of Economics

MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

EURO Working Group on Multicriteria Decision Aiding

April 10-12, 2025

Aula Baratto, Ca' Foscari University of Venice

Abstracts Book

Updated: 4th April 2025

Keynote Session

Incorporating ESG Factors in Multicriteria Portfolio Optimization: An Overview and Empirical Evaluation

Michalis Doumpos
Technical University of Crete
School of Production Engineering and Management (Greece)
mdoumpos@tuc.gr

Abstract

Portfolio optimization is a fundamental problem in finance, with further implications in other areas as well. The modern portfolio theory grounded on the seminal work of Markowitz on the mean-variance model, has been traditionally based on financial decision criteria about return and risk. However, non-financial criteria related to sustainability issues have gained major interest. The primary framework in this context relies on environmental, social and governance (ESG) factors. This leads to an enhanced three-dimensional portfolio optimization framework, that covers return, risk, and ESG. This presentation begins with an overview of the developments on the introduction of ESG in a multicriteria portfolio optimization context. An extensive empirical investigation is also presented using a data set from the US market that covers the period 2014-2024. In the analysis, two MCDA models, namely an outranking and an additive value model, are implemented in the context of SMAA and sigma-mu efficiency analysis. The evaluation models are employed for asset screening based on ESG criteria, and they are combined with different bi-objective and multi-objective models for portfolio optimization. The results are compared in terms of their out-of-sample performance, assessed with respect to financial metrics, ESG criteria, and robustness indicators.

Keywords

Portfolio optimization, Sustainable investments, ESG, Multi-objective optimization, Efficiency analysis

Session 1

Multicriteria Approaches to Financial Portfolio Optimization

The effects of the introduction of volume-based liquidity constraints in portfolio optimization with alternative investments

Antonella Basso
Ca' Foscari University of Venice (Italy)
basso@unive.it

Diana Barro, Stefania Funari, Guglielmo Alessandro Visentin
Ca' Foscari University of Venice (Italy)

Abstract

Recently, liquidity issues in financial markets and portfolio asset management have attracted much attention among investors and scholars, fuelling a stream of research devoted to exploring the role of liquidity in investment decisions. In this paper, we aim to investigate the effects of introducing liquidity in portfolio optimization problems.

For this purpose, first we consider three volume-based liquidity measures proposed in the literature and we build a new one particularly suited to portfolio optimization.

Secondly, we formulate an extended version of the Markowitz portfolio selection problem, named *Mean-variance-liquidity*, where we assume that investors, besides the classical preferences for a high return and a low risk, wish to achieve at least a predetermined liquidity level L. This three-objective problem is formulated through an optimization problem in which the goal is to minimize the portfolio variance subject to the usual constraint on the expected portfolio return and an additional constraint on the portfolio liquidity.

Thirdly, we consider a sensitivity analysis, with the aim of assessing the trade-offs between liquidity and return, on the one hand, and between liquidity and risk, on the other hand. In the second part of the paper, the portfolio optimization framework is applied to a dataset of US ETFs comprising both standard and alternative, often illiquid, investments. The analysis is carried out with all the liquidity measures considered, allowing us to shed light on the relationships among risk, return and liquidity.

Finally, we study the effects of the introduction of a Bitcoin ETF, as an asset with an extremely high expected return and risk.

Keywords

Portfolio optimization, Liquidity measures, Return-liquidity opportunity cost, Trading volume, Alternative investments

ELECTRE Tri-BR outranking method within PERTUSATU framework: application to formation of a stock portfolio

Oberti Pascal
University of Corsica (France)
oberti_p@univ-corse.fr

Leca Frédéric
University of Corsica (France)

Ozayo Saliha,
University of Corsica (France)

Abstract

The purpose of this communication is to present the ELECTRE Tri-BR outranking method, developed at the University of Corsica in the PERTUSATU economic approach to public policies; and apply it to the formation of a stock portfolio. By comparing the profiles of 50 actions with two central reference actions, target and alert, evaluated on 8 criteria, the method allows, by criterion and for all, to assign the alternatives into 6 ordered classes. A sensitivity analysis of the categorical assignments will be presented, as well as the coding in RStudio.

Keywords

Outranking, ELECTRE Tri-BR, PERTUSATU, Economics, Computing

Mitigating ESG scores divergence in multi-criteria portfolio decisions: The case study of blue economy

Sofia Baiocco
Università Politecnica delle Marche (Italy)
s.baiocco@pm.univpm.it

Amelia Bilbao-Terol
Universidad de Oviedo (Spain)

Mar Arenas Parra
Universidad de Oviedo (Spain)

Abstract

In this study, we propose a novel portfolio selection method that incorporates environmental, social, governance (ESG) pillars, and controversy scores, integrating investor sustainability preferences into multi-criteria decision-making. We investigate how portfolio allocations vary when utilizing ESG ratings from Refinitiv and Morningstar, addressing the potential impact of rating discrepancies on sustainable investing.

Financial performance is evaluated using expected return and conditional value-at-risk (CVaR), while sustainability is assessed across four distinct dimensions: environmental, social, governance, and controversy. To manage the complexity of multiple objectives, we develop two goal programming models: one incorporating Refinitiv ESG scores and the other utilizing the Morningstar ESG risk scores. In this approach, the first phase determines the aspiration levels for financial and sustainability goals by constructing a financial efficient frontier and a non-dominated sustainability surface using the NSGA-II algorithm. In the second phase, we apply the Best-Worst Method (BWM) to weight objectives based on investor preferences. We validate our models through an empirical application, constructing portfolios from the constituents of two blue economy funds.

The key contribution of our approach lies in its disaggregated treatment of sustainability dimensions, mitigating the compensation effect inherent in aggregated ESG performance. In addition, we analyze differences in portfolio allocations between the two models to assess the reliability of ESG scores, offering insights into the implications of ESG divergence for sustainable investment strategies.

Keywords

Sustainable Portfolio Selection, ESG ratings, Multi-Criteria Decision-Making, Goal Programming, Blue Economy, Conditional Value-at-Risk

Sustainable Index Tracking

Sebastian Utz
University of Augsburg (Germany)
sebastian.utz@uni-a.de

Ralph E. Steuer
University of Georgia (USA)

Maximilian Wimmer
University of Regensburg (Germany)

Abstract

We introduce a new methodology for modeling optimal institutional portfolios, and using this methodology, we report on results that combine the benefits of passive investing with the needs of sustainable investors. Sustainable investment is perhaps the fastest growing area in the mutual fund industry today. It is based upon the desire of many investors to only allocate investment dollars in a way that supports ethical corporate behavior and keeps an eye on the general social good. However, as an investment strategy, the objective is still to generate successful financial returns. One strategy to construct portfolios that has significantly increased in popularity recently is index tracking. In traditional index tracking, the goal is (i) to maximize portfolio return while simultaneously (ii) minimizing the tracking error to a certain index. In this paper, we present an algorithmic trading strategy by extending such a bi-criterion model to include sustainability as a third criterion. Hence, the goal is to construct portfolios that (a) maximize portfolio return, (b) minimize tracking error, and (c) maximize portfolio sustainability, i.e., our methodology is based on the hypothesis that in sustainable investing, sustainability is a third criterion, and this causes the classical bi-criterion efficient frontier to become a tri-criterion efficient surface. We show that a S&P 500 tracking portfolio which has at least the sustainability of the Dow Jones Sustainability Index (DJSI) does not generate worse financial performance than the S&P 500 and commonly used benchmark portfolios. However, the increase in sustainability is significant. A feature of this approach is that it allows the decision maker to use a robo advice-like tool to reach final investment decisions based on personal preferences.

Keywords

Socially responsible investing, Tracking error, Multi-Criteria Decision Making

Tracking-based green portfolio optimization

Diana Barro
Ca' Foscari University of Venice (Italy)
d.barro@unive.it

Marco Corazza
Ca' Foscari University of Venice (Italy)

Gianni Filograsso
Ca' Foscari University of Venice (Italy)

Abstract

In this contribution, we discuss how to effectively integrate financial and sustainable investment goals, with a specific focus on greenness and ESG (Environmental, Social, and Governance) features. Sustainable investing has attracted increasing interest, accompanied by a growing commitment to align investment decisions with ethical and environmental values. Among thematic investments, green and energy-related assets have gained prominence, capturing the attention of both institutional and retail investors. However, traditional portfolio allocation models and non-optimized strategies often fall short in accommodating the complexity and flexibility required by these evolving preferences. To address this gap, ESG-tailored allocation approaches must be developed to adequately represent investors' preferences and sustainability commitments. This contribution introduces a novel ESG-focused tracking error model to optimize portfolio allocation by simultaneously considering financial and sustainability objectives. Specifically, we propose a dual-benchmark framework, where one benchmark reflects a financial target and the other captures ESG considerations. The objective function is formulated as a convex linear combination of the two benchmarks, governed by a parameter that reflects the investor's preference trade- off between financial performance and ESG alignment.

A symmetric tracking error measure is used to passively replicate the financial benchmark, while an asymmetric measure is designed to track—and potentially outperform—the thematic ESG benchmark. Identifying appropriate benchmarks and selecting the parameter λ are key modeling steps that shape the overall risk-return and ESG profile of the portfolio. In addition to benchmark-based optimization, sustainability is further embedded in the model through the introduction of explicit constraints, such as a required minimum greenness level and an upper bound on portfolio carbon intensity.

An empirical application to the EUROSTOXX 600 equity market illustrates the model's effectiveness across various λ values, each corresponding to different investor sustainability profiles and risk- return preferences. The flexibility of the proposed framework allows for a transparent and customizable investment process. Furthermore, the choice and design of benchmarks are critically discussed, highlighting their role in aligning portfolio construction with both financial objectives and sustainable mandates.

Keywords: Tracking Error, Portfolio optimization, Green sustainability, ESG, EUROSTOXX 600

Multi-objective Portfolio Optimization considering Entropy as Diversification Objective

Meriem HEMICI
University of Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj (Algeria)

Fouad Ben Abdelaziz
NEOMA Business School, Rouen Campus (France)
fba@neoma-bs.fr

Djaafar ZOUACHE
University of Mohamed El Bachir El Ibrahimi, Bordj Bou Arreridj (Algeria)

Abstract

Financial markets are considered a fundamental driver of economic growth. Due to their rapid development, portfolio optimization has become one of the most complex problems in finance. This paper addresses the multi-objective portfolio optimization problem (MOPOP) with three key objectives: maximizing return, minimizing risk, and maximizing entropy to generate a well-diversified portfolio.

To tackle this challenge, we adapt the original Manta Ray Foraging Optimization (MOMRFO) algorithm to handle the MOPOP problem. Our adapted version, referred to as MOMRFO/ED, incorporates epsilon dominance to store non-dominated solutions in an external archive. Additionally, we control the external archive population using crowding distance to limit its size, thereby preventing unnecessary complexity in the MOMRFO/ED algorithm. The best solutions (leaders) are selected from the external archive to enhance solution quality and accelerate computational convergence.

We conduct extensive experiments using real-world financial data from major markets across two distinct periods—before and during the COVID-19 pandemic. Our proposed algorithm is compared against three state-of-the-art algorithms. The statistical analysis of the comparative results demonstrates the superiority of MOMRFO/ED in terms of IGD, HV, SP, SR, and Jensen Index (JI) metrics. Moreover, our findings indicate that models incorporating Shannon's entropy outperform those using Minkowski and Yager's entropy. This advantage is attributed to Shannon's entropy's enhanced ability to efficiently reallocate assets in response to market fluctuations.

Keywords

Multi-objective portfolio optimization, Risk, Entropy, Manta ray foraging optimization, Epsilon dominance.

Ca' Foscari University of Venice
Department of Economics

MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Optimizing Real Estate Portfolios: A Fuzzy MCDA Methodology for Risk and Return Analysis

Rubina Canesi
Department of Civil, Environmental and Architectural Engineering (ICEA), University of Padova, Padova, (Italy)
rubina.canesi@unipd.it

Chiara D'Alpaos
Department of Civil, Environmental and Architectural Engineering (ICEA), University of Padova, Padova, (Italy)

Abstract

The complicated interaction of hazards among several properties and projects makes the creation and subsequent management of real estate portfolios very difficult. Critics of conventional valuation techniques including internal rate of return (IRR) and net present value (NPV) have pointed out how oversimplified this complexity is and how erroneous evaluations result. This study suggests a fuzzy multi-criteria decision analysis (MCDA) method to assess real estate (RE) investment portfolios. Two criteria types are included in the model: market risks and project operational risks. Market risks include sub-criteria such as capital market risk, valuation risk, and market growth rate risk. Project operational risks include construction risk, leasing risk, rental risk, leverage risk, and tax risk, among others. Fuzzy set theory is used to evaluate these risk factors in order to handle natural uncertainty and inaccuracies. Fuzzy MCDA multilayer framework combines risk evaluation with the NPV and IRR of every single property in the portfolio. It allows for optimized composition of the portfolio with respect to overall risk minimization and investment return maximization. This method enables a structured way to compare different portfolio combinations based on their combined risk profiles. The suggested approach addresses the shortcomings of current portfolio valuation practices that frequently underestimate and do not accurately model the increasingly complexity dynamics of the real estate market. Combining fuzzy logic and MCDA techniques, this study proposes a flexible decision support tool for fund management companies. The model is particularly relevant for real estate investment funds to be set up and managed by asset management companies (SGRs in Italian). When creating new funds with multiple properties, this approach can assist in optimal selection of properties to be included in the investment portfolio, considering their risk factors and potential expected return. The research is a part of broader decision analysis, which integrates fuzzy risk assessments and financial metrics to enhance real estate portfolio valuation and capital allocation decision making.

Keywords

Fuzzy logic, Real Estate Portfolio, Risk Assessment, Optimization

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Optimising Sustainable Circular Waste Management: A Portfolio Theory Approach Through a Multiple Case Study of Practice and Performance Linkage

Kannan Govindan
Centre for Sustainable Operations and Resilient Supply Chains (CSORSC), Adelaide Business School and Institute for Sustainability Energy and Resources, University of Adelaide, Adelaide, SA (Australia)
Centre for Sustainable Supply Chain Engineering, Department of Technology and Innovation Danish Institute for Advanced Study, University of Southern Denmark, Odense (Denmark)
kannan.govindan@adelaide.edu.au

Devika Kannan
Centre for Sustainable Operations and Resilient Supply Chains (CSORSC), Adelaide Business School and Institute for Sustainability Energy and Resources, University of Adelaide, Adelaide, SA, Australia
Centre for Sustainable Supply Chain Engineering, Department of Technology and Innovation, University of Southern Denmark, Odense (Denmark)

Laura Gregersen
Centre for Sustainable Supply Chain Engineering, Department of Technology and Innovation, University of Southern Denmark, Odense (Denmark)

Mikkel Stampe Nielsen
Centre for Sustainable Supply Chain Engineering, Department of Technology and Innovation, University of Southern Denmark, Odense (Denmark)

Simon Ølholm
Centre for Sustainable Supply Chain Engineering, Department of Technology and Innovation, University of Southern Denmark, Odense (Denmark)

Abstract

Sustainable Circular Waste Management (SCWM) plays a critical role in mitigating the global waste crisis by transitioning from linear to circular models. While existing research provides foundational knowledge on SCWM, there is a need for empirical analysis to explore its implementation, performance trade-offs, and strategic optimisation. This study integrates portfolio theory to conceptualise SCWM as a diversified investment in waste management practices, balancing risk, sustainability impact, and economic feasibility. A multiple case study approach, focusing on Denmark and Indonesia, includes 11 interviews across various sectors, revealing country-specific drivers, barriers, and performance measures. Findings demonstrate how an optimal mix of reduce, reuse, recycling, waste-to-energy, and disposal strategies can enhance sustainability outcomes while minimising systemic risks. By applying a portfolio perspective, this research provides valuable insights for policymakers, researchers, and organisations to develop risk-adjusted, performance-optimized SCWM strategies, bridging the gap between theory and practice.

Keywords

Sustainable Circular Waste Management, Portfolio Theory, Multiple Case Study, Risk Optimization, Performance Linkage, Drivers, Barriers, Practices.

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Integrating Social Multi-Criteria Evaluation into European Commission Impact Assessments: a workflow analysis approach

Nicole Ostlaender
European Commission, Joint Research Centre (Italy)
nicole.ostlaender@ec.europa.eu

Abstract

The European Commission's Better Regulation Agenda underlines the importance of evidence-based policymaking through systematic ex-ante impact assessments. These assessments aim to evaluate policy options by considering their social, economic, and environmental impacts, thereby guiding decision-makers toward the most suitable solutions. Due to the multidimensional nature of these assessments, establishing a robust methodological framework is key for ensuring coherent and transparent comparisons. Social Multi-Criteria Evaluation (SMCE), grounded in the principles of multi-criteria decision analysis (MCDA), meets these requirements by facilitating the integration of technical dimensions and social perspectives, for a structured, inclusive, and transparent appraisal of policy alternatives. This study explores the integration of SMCE into the European Commission impact assessment (EC IA) process.

Despite the structured nature of both EC IA and SMCE, their internal architectures exhibit some distinct differences. To effectively integrate SMCE into the EC IA, we employed workflow design and domain modelling techniques to systematically analyze and map both processes. Initially, we documented the relevant parts of the EC IA workflow, including actors and key artifacts, and subsequently constructed a corresponding SMCE workflow using the same principles. Through a detailed analysis and alignment of both workflows, we designed a hybrid process that incorporates SMCE elements directly into the EC IA framework. To support the practical implementation by policy makers, we devised, together with our target audience, a visual guide that delineates all steps, decision points and artifacts of this hybrid process in a user-friendly and intuitive format.

The feedback from policy makers on our integrated approach was very positive, and we have substantially enhanced the clarity with which SMCE's role and added value in EC IAs are understood. We also observed that the well-structured integration helps policy makers to apply SMCE more consistently. We conclude that the workflow analysis approach taken may hold broader applicability beyond EC impact assessments, offering potential benefits to any process where the incorporation of multi-criteria decision-making can provide added values like transparency, coherence and stakeholder engagement.

Keywords

Social Multi-Criteria Evaluation, Better Regulation, European Commission impact assessments, Workflow analysis and design, Domain modelling

Session 2

Sustainable Development and Urban Planning with MCDA

A dynamic approach to Strong Sustainability: theoretical foundations for practical application

Beatrice Mecca
Politecnico di Torino
beatrice.mecca@polito.it

Isabella M. Lami
Politecnico di Torino

Matteo Brunelli
Università di Trento

Abstract

The sustainable development of cities requires a focus on what is essential for global ecosystems and economies. Rather than entering the scientific debate on the weak/strong sustainability dichotomy, we have taken the need for strong sustainability as a starting point and concerned ourselves with its applicability. To do so, we have introduced an original three-tier strong sustainability performance range corresponding to as many ways of aggregating and presenting indicators. We are proposing the Strong Strict, Strong Complementary and Strong Integrative Sustainability. To encompass these three declinations, we adopt a parsimonious elicitation method introduced by Labreuche and Grabisch, ensuring that the problem remains manageable. The advantages of this method in supporting the awareness of DMs regarding their choices are illustrated through the application to a case study concerning the transformation of a listed historic building located in the city of Turin, Italy.

Keywords

Strong Sustainability, Urban Development, p-ary Choquet integral

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Bridging strategy and practice: the IBTool as an innovative multicriteria system for sustainable urban transformation

Francesca Abastante
Politecnico di Torino (Italy)
francesca.abastante@polito.it

Giuliano Poli
Università Federico II di Napoli (Italy)

Francesco Piras
Università Federico II di Napoli (Italy)

Abstract

In the context of sustainable urban planning, monitoring and evaluation systems are essential for supporting decision-making processes and guiding Public Administrations (PAs) toward informed, responsible, and sustainable choices. Despite the proliferation of sustainability guidelines and indicators, the transition from strategic frameworks to local operational implementation remains a significant challenge.
The GLOSSA research project (a *GLOcal Knowledge-System for the Sustainable Assessment of Urban Projects*), funded as a Project of Relevant National Interest (PRIN), addresses this issue by proposing a qualitative and quantitative multi-methodological framework comprising: i) A set of operational indicators designed as theoretical models to guide the implementation of urban transformation projects while quantifying and certifying their performance (Abastante and Mecca, 2025; Hiremath et al., 2013); ii) the Indicators' Based Tool (IBTool), a multi-criteria evaluation software capable of prioritizing indicators and assessing the performance of alternative urban settings or projects (Cerreta et al., 2020); iii) training activities for PAs, designers, and students, aimed at fostering the sustainable transition of urban areas.
This research here presented primarily focuses on the IBTool, which is structured into four main modules:
1. *Data Storage*, which hosts - and allows users to manage - the database of operational indicators identified through inductive and deductive methodologies;
2. *Validation*, compounded by questionnaire-based assessment of indicators, enabling their classification in terms of relevance and calculability using the Fuzzy Delphi Method (FDM, Kuo and Chen, 2008) ;
3. *Weighting*, which provides DMs with an application of the Best-Worst Method (BWM, Rezaei 2015, 2020) to assign weights to the identified indicators and select Key Performance Indicators (KPIs);
4. *Performance/Impact Assessment*, which implements the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS, Hwang and Yoon, 1981) to derive a synthetic index representing the overall sustainability of the proposed design alternatives.
The innovative contribution of this research lies in its ability to integrate multiple qualitative and quantitative evaluation methodologies (as indicators, questionnaires, and multi-criteria analyses) within the comprehensible software IBTool. This integration aims to bridge the gap between academic research and practical applications, fostering a cultural and operational shift in the conception and management of urban transformation processes.To demonstrate the validity of the IBTool, we tested it in assessing the current level of sustainable development in three neighborhoods in the city of Cagliari (Italy).

Keywords

GLOSSA, IBTool, indicators, Best-Worst Method, TOPSIS

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Exploring the potential of multi-objective optimization for the co-construction and co-evaluation of urban transformation alternatives

Caterina Caprioli
Interuniversity Department of Regional and Urban Studies and Planning (DIST), Politecnico di Torino (Italy)
caterina.caprioli@polito.it

Marta Bottero
Interuniversity Department of Regional and Urban Studies and Planning (DIST), Politecnico di Torino (Italy)

Elena De Angelis
Interuniversity Department of Regional and Urban Studies and Planning (DIST), Politecnico di Torino (Italy)

Abstract

Urban and regional transformations are characterized by an increase in complexity, resulting from the interaction of multiple social, economic, environmental and political factors, as well as different points of view from various stakeholders. Consequently, urban and regional planning faces increasingly complex challenges, requiring tools that can support decision makers in their choices. A great number of studies have been conducted on the evaluation of predefined alternatives. However, there is still opportunity for innovation and support can be provided for the construction of alternatives, with a view to optimizing the primary objectives, while respecting the existing constraints (Colorni and Tsoukias, 2020). In this context, multi-objective optimization appears to be particularly well-suited, as they facilitate the resolution of the optimization problem based on diverse objectives, including conflicting ones, thereby yielding the desired solution(s) (Figueira et al 2005). These models have been extensively utilized on a territorial and urban scale for the optimal allocation of functions and infrastructures. However, there is also a case for their use on a smaller scale, for the co-construction and co-evaluation of alternatives for regeneration and transformation of areas. Specifically, this work explores this opportunity. Starting from a review of the literature, we try to understand the existing contribution on this topic, related potential, limits and possible future trajectories of research. The present study constitutes a continuation of the investigation which was previously undertaken with respect to the co-costruction and co-evaluation of alternatives for the transformation of an undervalued area in the city of Turin (Italy). In this earlier study, a multi-agent system and a multicriteria analysis had combined (Caprioli, 2025). The present study will attempt to overcome the limitations encountered in previous experience through the use of a multi-objective optimization approach.

Keywords

Multi-objective optimization, Sustainable development, Alternative design

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Towards Excellence: Developing a Multidimensional Benchmarking Framework for Assessing Success in Mobility as a Service (MaaS) Systems

Davide De Vita
Polytechnic University of Bari (Italy)
d.devita2@phd.poliba.it

Nunzia Carbonara
Polytechnic University of Bari (Italy)

Marco Locurcio
Polytechnic University of Bari (Italy)

Antonio Messeni Petruzzelli
Polytechnic University of Bari (Italy)

Michele Ottomanelli
Polytechnic University of Bari (Italy)

Abstract

As cities continue to grow and urbanization accelerates at an unprecedented pace, challenges such as traffic congestion, air pollution, and the inefficiencies of existing transportation infrastructures have become increasingly pressing (Jones, 2014; ITF, 2021). Mobility as a Service (MaaS) has emerged over the past decade as an innovative concept that offers the potential to address these challenges, at least partially and in combination with other solutions (Hensher et al., 2020).

MaaS represents a transformative shift in the mobility landscape, benefiting users and changing the way industry stakeholders normally operate. It provides a seamless, integrated, and user-friendly platform that allows travellers to plan, book, and pay for trips across multiple transportation modes—including public transit, ride-sharing, car-sharing, and bike-sharing—through a single digital interface (Hietanen, 2014; Kamargianni & Matyas, 2017; Sochor et al., 2018). By enabling multimodal and intermodal travel, MaaS simplifies the travel experience, reduces dependency on private vehicles, and promotes environmentally sustainable mobility solutions (Arias-Molinares & Garcia-Palomares, 2020; Hensher et al., 2020). Furthermore, MaaS fundamentally alters the industry architecture of mobility (Jacobides et al., 2006). Instead of operating in isolated silos, mobility service providers collaborate within a cohesive ecosystem (Kamargianni and Matyas, 2017), delivering in concert an integrated value proposition to users (Sochor et al., 2018; Adner, 2017).

While the concept of MaaS has been widely discussed and numerous pilot projects and applications have been launched globally by both governments and private entities, its practical development as a service has been relatively slow and fragmented. Despite significant interest, no MaaS initiative has yet scaled up to become a dominant or widely adopted model (Hensher et al., 2020). Numerous challenges—including issues of stakeholder collaboration, data sharing, integration of diverse mobility modes, and balancing financial viability with public policy goals—have limited the scalability and long-term sustainability of MaaS systems (Kamargianni & Matyas, 2017; Karlsson et al., 2019; Zhang & Zhang, 2021). Surprisingly, both the literature and practice lack a standardized framework to assess the performance of MaaS systems comprehensively. This represents a significant and important gap, as the absence of a systematic evaluation approach makes it difficult to measure success, identify best practices, and understand performance gaps across different

MaaS implementations. Without such a framework, policymakers, transportation authorities, and service providers lack the tools necessary to benchmark initiatives, drive improvements, and scale successful models (Hensher et al., 2020; Sochor et al., 2018).

To address this challenge, our work introduces a comprehensive benchmarking framework for evaluating the success of MaaS initiatives by adopting a multidimensional approach and applying Multi-Criteria Decision Analysis (MCDA) techniques. The methodology is mixed and multi-phased. First, we conducted a comprehensive review of the extant literature on MaaS, with a focus on influential and highly cited works. By using Scopus as the primary database, we identified and analysed 43 seminal papers on MaaS to uncover prevailing theories, metrics, and conceptualizations of success in MaaS systems. This literature review provided insights into the multi-dimensional nature of MaaS systems, which necessitate an evaluation framework that goes beyond simplistic or unidimensional metrics. From this analysis, we synthesized a theoretical framework that defines success in MaaS systems across six critical dimensions: Technical, Organizational, Economic & Financial, User, Societal, and Contextual. These dimensions reflect the diverse aspects of MaaS systems, capturing both operational performance and broader societal impacts. Second, we quantified the relative importance of the six dimensions in determining MaaS success by applying the Analytic Hierarchy Process (AHP) (Saaty, 1980; Ishizaka and Labib, 2011). In this phase, we consulted a panel of esteemed experts in the fields of research in urban mobility, transportation planning, and MaaS implementation. Through structured interviews providing pairwise comparisons of each dimension, experts offered insights into which dimension is more important in defining MaaS success. Third, we developed and administered an online survey targeting global MaaS practitioners, researchers, and policymakers to gather data on and identify potential descriptors of each dimension and their corresponding indicators. This phase involved defining and operationalizing our framework to ensure its practical relevance. Descriptors were selected based on their ability to characterize the six dimensions effectively, while indicators were chosen to ensure measurable and actionable evaluations of these descriptors. Finally, the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon, 1981; Shih et al., 2007) was employed to develop the benchmarking framework. In particular, we defined an "ideal MaaS solution" based on the optimal performance of each indicator across the six dimensions. This ideal solution serves as a benchmark against which actual MaaS systems can be evaluated. By collecting extensive data from MaaS systems and projects globally, we populated the benchmarking framework and calculated the proximity of each system to the ideal solution.

We believe that our research may contribute significantly for both theory and practice.

From a theoretical perspective, this research contributes significantly to the field of business ecosystem theory (Moore, 1996; Adner, 2017; Jacobides et al., 2018) by proposing a novel framework to assess the performance of an ecosystem. While prior literature on ecosystems has largely focused on conceptual development or qualitative analysis, this study provides a quantitative, multi-dimensional tool for performance evaluation, specifically within the MaaS domain. The conceptualization of six critical dimensions—Technical, Organizational, Economic & Financial, User, Societal, and Contextual—advances the understanding of how ecosystems operate and succeed. Although the framework is tailored to the unique attributes of MaaS, the underlying multi-dimensional approach has broader applicability. It introduces a structured method for ecosystem evaluation that can inspire further research into performance metrics for other ecosystems.

From a practical point of view, the proposed benchmarking framework provides a standardized and comprehensive tool for evaluating the success of MaaS initiatives, addressing the fragmented and inconsistent assessment practices in the field. By integrating the AHP and TOPSIS techniques, the framework combines methodological rigor with practical applicability. This approach enables stakeholders—including policymakers, transportation authorities, and MaaS providers—to derive

actionable insights from the evaluation results. It may indeed support data-driven decision-making, facilitate resource allocation, policy formulation, and prioritization of investments to scale MaaS projects effectively.

Keywords

Mobility as a Service, MaaS, Evaluation Framework, MCDA, Ecosystem

References

Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. Journal of Management, 43(1), 39-58.
Arias-Molinares, D., Garcia-Palomares, J.C., 2020. The Ws of MaaS: understanding mobility as a service from a literature review. IATSS Res. 44 (3), 253–263.
Hensher, D.A., Ho, C.Q., Mulley, C., Nelson, J.D., Smith, G., Wong, Y.Z., 2020. Understanding Mobility as a Service (MaaS): Past, Present and Future. Elsevier.
Hietanen, S. (2014). Mobility as a service: The new transport model? Eurotransport, 12(2), 2-4.
Hwang, C. L., & Yoon, K. (1981). Multiple attribute decision making: Methods and applications. Springer-Verlag.
ITF, 2021. The innovative mobility landscape: the case of mobility as a service. International Transport Forum Policy Papers, No. 92. OECD Publishing, Paris.
Ishizaka, A., & Labib, A. (2011). Review of the main developments in the analytic hierarchy process. Expert Systems with Applications, 38 (11), p.14336-14345.
Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. Strategic Management Journal, 39(8), 2255–2276.
Jacobides, M. G., Knudsen, T., & Augier, M. (2006). Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. Research Policy, 35(8), 1200–1221.
Jones, P., 2014. The evolution of urban mobility: the interplay of academic and policy perspectives. IATSS Res. 38 (1), 7–13.
Kamargianni, M., Matyas, M., 2017. The business ecosystem of mobility-as-a-service. In: Paper Presented at the 96th Transportation Research Board (TRB) Annual Meeting. Washington, DC.
Karlsson, I.C.M., Mukhtar-Landgren, D., Smith, G., Koglin, T., Kronsell, A., Lund, E., Sarasini, S., Sochor, J., 2020. Development and implementation of Mobility-as-a- Service –A qualitative study of barriers and enabling factors. Transport. Res. Part A 131, 283–295.
Moore, J. F. (1996). The death of competition: Leadership and strategy in the age of business ecosystems. Harper Business.
Saaty, T. L. (1980). The analytic hierarchy process: Planning, priority setting, resource allocation. McGraw-Hill.
Shih, H. S., Shyur, H. J., & Lee, E. S. (2007). An extension of TOPSIS for group decision making. Mathematical and Computer Modelling, 45(7–8), 801–813.
Sochor, J., Arby, H., Karlsson, I.C.M., Sarasini, S., 2018. A topological approach to mobility as a service: a proposed tool for understanding requirements and effects, and for aiding the integration of societal goals. Res. Transp. Bus. Manag. 27, 3–14.
Zhang, Z., Zhang, N., 2021. Novel development scheme of mobility as a service: can it provide a sustainable environment for China? Sustainability 13 (8), 4233.

Assessing Multi-Dimensional Impacts in Urban Regeneration: A Decision-Support Framework for Public Building Reuse

Marta Bottero, Giulio Cavana, Federico Dell'Anna
Interuniversity Department of Regional and Urban Studies and Planning (DIST), Politecnico di Torino, Turin (Italy)
marta.bottero@polito.it

Danny Casprini, Alessandra Oppio
Department of Architecture and Urban Studies (DAStU), Politecnico di Milano, Milan (Italy)

José Rui Figueira
CEG-IST, Instituto Superior Técnico, Universidade de Lisboa, Lisbon (Portugal)

Abstract

The reuse of public buildings plays a crucial role in fostering sustainable urban development by generating positive social, economic, and environmental impacts. However, selecting and prioritizing the most beneficial projects requires a structured and transparent decision-support framework. This study introduces a Multi-Attribute Value Theory-based model to assess urban regeneration initiatives, ensuring that interventions maximize social value while aligning with broader economic and environmental sustainability goals.

A structured multi-criteria assessment evaluates projects based on 12 key indicators across three dimensions: economy, environment, and society. To enhance the robustness and comparability of the evaluation process, this study employs an extended version of the Simos-Roy-Figueira (SRF) method (Bottero et al., 2018) for determining value functions. This approach defines the shape of the value functions for each criterion based on decision-maker preferences, transforming raw data into value scores for each alternative project. Additionally, the method is used to derive criteria weights, capturing the relative importance of each dimension in a structured and systematic manner.

A key innovation of the model is its discounting mechanism, designed to incentivize projects with higher social impact scores by adjusting evaluation outcomes accordingly. This approach strengthens the model's ability to align urban regeneration efforts with long-term sustainability objectives.

A case study in Turin, Italy, demonstrates the model's effectiveness in guiding policymakers and urban planners toward more sustainable and socially inclusive redevelopment strategies. Findings highlight the importance of participatory governance, functional mixité, and energy self-sufficiency in shaping the future of urban spaces.

By combining quantitative evaluation with stakeholder engagement, this research provides a practical decision-support tool for cities seeking to transform public assets into vibrant, community-driven spaces. The model represents a significant advancement in bridging the gap between urban policy and social impact assessment, promoting transparency, accountability, and sustainability in decision-making processes.

Keywords

Urban regeneration, Social impact assessment, Decision-making, Public asset reuse

Ca' Foscari University of Venice
Department of Economics

MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Beyond Financial Metrics: A MCDA-Based Methodology for Social Value Assessment in Portfolio Selection

Alessandra Oppio
Department of Architecture and Urban Studies (DAStU), Politecnico di Milano (Italy)
alessandra.oppio@polimi.it

Marta Dell'Ovo
Department of Architecture and Urban Studies (DAStU), Politecnico di Milano (Italy)

Abstract

Decision-aiding in urban regeneration projects involves complex trade-offs between financial returns, environmental sustainability, and social impact. While economic and environmental factors are often assessed using well-established methodologies, evaluating Social Value remains a significant challenge due to the lack of standardized metrics and decision-support tools. This research explores how Multicriteria Decision Aiding (MCDA) can enhance portfolio selection in urban regeneration by integrating and maximizing social impact assessment into investment evaluations.

Building upon an existing framework, this study refines a multi-criteria model composed of 6 dimensions and 25 evaluation criteria. Despite the absence of standardized measurement techniques for social indicators in the literature, we propose a systematic method to assign quantitative scores to social impact indicators by defining benchmark values and decision rules, thus ensuring a more robust and replicable evaluation process.

The proposed approach strengthens portfolio selection strategies by providing a decision-support tool that enables investors, policymakers, and urban planners to systematically compare and rank urban regeneration projects based on their social impact performances. The integration of MCDA techniques ensures that trade-offs between financial, environmental, and social objectives are explicitly modeled, leading to a more transparent and informed decision-aiding process. This contribution reinforces the role of MCDA in sustainable urban development, demonstrating how structured evaluation frameworks can guide investments toward more inclusive and resilient cities.

Keywords

Social Value, Scoring system, Urban regeneration

Session 3

Recent Trends in MCDA for Building Composite Indicators

Analysing Human Development Index with a MultiCriteria Decision Aiding Perspective

Meltem Öztürk
Universite Paris Dauphine, PSL Research University, CNRS, Lamsade, Paris (France)

Abstract

The Human Development Index (HDI) is a widely recognized indicator designed to emphasize the importance of human capabilities, rather then the GNI (Gross National Income) per capita in the development of countries.

Numerous scientific and media articles have been written to critisize the structure of the problem— namely, the criteria defining human development, for instance the absence of environmental or fairness issues,—or the aggregation method, which relies on the geometric mean. These critiques often propose alternative structuring approaches or new aggregation methods.

In this article, we adopt a different perspective. We analyze, from an axiomatic sperspective, the implications of using the geometric mean. Specifically, we address the following questions: What are the mathematical properties that uniquely characterize this operator? How can these properties be interpreted in the context of human development? How can we explain the axiomatic differences between the geometric mean and the arithmetic mean? Are there some notable differences between the use of arithmetic mean and geometric mean when we use them on Human Development Index where data on the three dimensions are higly correlated? We will show theoretical results as well as simulation ones.

Furthermore, we examine the consequences of recent modifications to the HDI formula.

This study aims to demonstrate how Multi-Criteria Decision Analysis (MCDA) tools can be used to analyze and construct composite indicators. This is particularly relevant since most indicators are designed using a weighted sum—a generalization of the arithmetic mean—without properly considering the meaning of decision parameters. For instance, indicator designers often interpret weights as measures of the importance of criteria, whereas in MCDA, weights simply represent trade-offs. The impact of criteria on the final result remains highly dependent on the normalization applied to the data.

Using the Human Development Index (HDI) as a case study, we will illustrate the consequences of using the geometric mean and different types of normalization on the interpretation of trade-offs between dimensions.

Keywords

Composite indicator, MCDA, axiomatisation, normalisation, trade-off

Environmental, social, and governance evaluation for European small and medium enterprises: A multicriteria approach

Diana Barro
Ca' Foscari University of Venice (Italy)

Marco Corazza
Ca' Foscari University of Venice (Italy)
corazza@unive.it

Gianni Filograsso
Ca' Foscari University of Venice (Italy)

Abstract

The exposure to environmental, social, and governance (ESG) risks can be effectively measured by companies to identify opportunities for long-term sustainable growth, along with the social and environmental impact. This process is crucial for listed small and medium-sized enterprises (SMEs) wanting additional support in their ESG transition, and for European SMEs it will be required by the implementation of the Corporate Sustainability Reporting Directive (CSRD), starting from 2026. In this contribution, we propose to apply a multicriteria decision aiding approach to assess the sustainability profiles of SMEs. The methodology, which allows the measurements of a firm's ESG efforts (ESGness), is applied to a sample of European-listed SMEs, controlling for potential sector-specific effects, in order to understand what is the situation on the ESG front, and to identify ESG leaders and laggards. The model can provide valuable information for the firm, and for a broad spectrum of stakeholders, including policymakers and investors. The obtained rankings show some degree of robustness across different model parameterizations. The benefits of voluntary disclosure of sustainability information are investigated under a prudential scoring framework.

Keywords

ESG, Multiple Criteria Analysis, Small and Medium-sized Enterprises (SMEs), Sustainable Policy

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

An enhanced simulation-based approach for multicriteria evaluation problems of SME's performance

Maria Rosaria Pappalardo
University of Catania (Italy)
maria.pappalardo1@unict.it

Silvia Angilella
University of Catania (Italy)

Michalis Doumpos
Technical University of Crete; University Campus (Greece)

Constantin Zopounidis
Technical University of Crete; University Campus (Greece)

Abstract

In previous works, a methodology, called sigma-mu efficiency analysis, combining elements from multicriteria decision aid with Data Envelopment Analysis (DEA), has been proposed to manage uncertainty in decision alternatives' performance.

This approach provides a ranking of alternatives assigned iteratively to a set of Pareto-Koopmans efficiency frontiers considering their expected performance (μ) and variability (σ) between different sets of criteria weights within the context of Stochastic Multi-attribute Acceptability Analysis (SMAA). In this paper, we enrich the assessment of alternatives' performance through the consideration of additional parameters beyond μ and σ, namely, skewness and kurtosis. These parameters offer valuable insights into the shape characteristics of the probability distribution of composite indicators, i.e. symmetry and tailedness. This study addresses this aim by adopting the versatile Dirichlet distribution for the criteria weights, which is a suitable tool for modeling the uncertainty with respect to the relative importance of the evaluation criteria.

Empirical findings are presented based on a data set of European Small and Middle-Sized Enterprises (SMEs) spanning from 2018 to 2022.

Keywords

Multicriteria decision analysis, Composite indicators, SMEs, ESG criteria, Kurtosis and skewness, Dirichlet distribution

Identifying ties in countries' AI capability ranking through the Kullback-Leibler Divergence

Renata Pelissari
Universidade Presbiteriana Mackenzie (Brazil)
renata.infante@mackenzie.br

Betania Silva Carneiro Campello
Universidade Estadual de Campinas (Unicamp)

Guilherme Dean Pelegrina
Universidade Presbiteriana Mackenzie (Brazil)

Leonardo Tomazeli Duarte
Universidade Estadual de Campinas (Unicamp)

Abstract

In a previous study of ours, we proposed a novel methodology for ranking countries based on their artificial intelligence (AI) capabilities as an alternative to the Global AI Index (GAII). Our methodology integrated the Choquet Integral, an unsupervised approach for identifying its parameters, and the Stochastic Multicriteria Acceptability Analysis. This combination demonstrated greater robustness by effectively modeling interdependencies between criteria and mitigating biases associated with weight determination. Despite these advancements, a key issue remained unresolved: the inability to construct rankings that allow for ties. In real-world decision-making contexts, especially in the construction of indices, differentiating between alternatives based on statistically insignificant differences may not reflect reality and could lead to misleading conclusions.

Given this context, our new study introduces the use of the Kullback-Leibler (KL) divergence to generate rankings that accommodate ties. Building upon our previous methodology, which generates the ranking acceptability index matrix, we employ KL divergence to analyze this matrix and derive the final ranking. In this new proposal, we calculate the KL divergence for each pair of countries across all ranking positions to capture both localized and aggregated dissimilarities. Alternatives are considered tied if two conditions are met: (i) the KL divergence between their probability distributions in a specific ranking position is below a defined threshold, indicating localized similarity, and (ii) the total KL divergence, summed across all positions, is below an additional threshold, ensuring overall distributional similarity. The final ranking is established iteratively, starting with the alternative holding the highest probability for the top position. Potential ties are then evaluated using the KL divergence criteria, allowing multiple alternatives to share the same rank when appropriate. We applied the proposed methodology to construct a new AI country capability index based on GAII data. Further computational tests are planned to test other heuristics than the one presented here and to refine the thresholds.

Keywords

Multicriteria Decision Analysis, SMAA, Acceptability index

Ca' Foscari University of Venice
Department of Economics

MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

An Explainable Composite Indicator Based on Decision Rules

Silvano Zappalà
University of Catania (Italy)
silvano.zappala@phd.unict.it

Salvatore Corrente
University of Catania (Italy)
salvatore.corrente@unict.it

Salvatore Greco
University of Catania (Italy)
salgreco@unict.it

Roman Słowiński
Poznan University of Technology and Polish Academy of Science (Poland)
roman.slowinski@cs.put.poznan.pl

Abstract

Composite indicators are widely employed in various fields to classify or rank alternatives evaluated on multiple criteria. Their construction falls within the domain of Multiple Criteria Decision Analysis (MCDA), where different methods are chosen based on key technical aspects, such as the measurement scales of criteria, the degree of acceptable compensation between them, and potential interactions among criteria. However, beyond the final classification or score assigned to each alternative, it is crucial to ensure the explainability of results and the transparency of the procedure.

In this paper, we propose a method for constructing an explainable composite indicator using decision rules. The Decision Maker (DM) provides simple preference information, either in the form of classifications (e.g., alternative a is assigned to class C_1, while b is assigned to class C_2) or pairwise comparisons (e.g., a is preferred to b) on some reference alternatives. We then apply the Dominance-Based Rough Set Approach (DRSA) to derive decision rules that systematically explain these preferences by relating class assignments of reference alternatives with conditions concerning threshold performances on some selected criteria. These rules explicitly link the DM's judgments to the performance of alternatives on subsets of criteria, clarifying the underlying rationale. Moreover, they serve as a basis for recommending classifications or rankings for new alternatives of interest.

To illustrate the applicability of our approach, we present a real-world decision-making case study.

Keywords

Composite indicators, Dominance-Based Rought Sets Approach

Multidimensional evaluation of deprivation evaluation thought Expert judgements

Luca Anzilli
Department of Management, Economics, Mathematics and Statistics, University of Salento, Italy

Marta Cardin
Department of Economics, Ca' Foscari University of Venice, Italy

Silvio Giove
Department of Economics, Ca' Foscari University of Venice, Italy
sgiove@unive.it

Abstract

We propose an approach for the assessment of deprivation (poverty) of a region based on expert judgments, under the hypothesis that individual outcomes are represented by multidimensional variables (Calia & Ferrante, 2024; Dhongde & Dong, 2022). This is an important issue in the context of inequality and well-being (Bertin, Giove, & Carrino, 2018; Bourguignon & Chakravarty, 2003; Carrino, Farnia, & Giove, 2024; Decancq & Lugo, 2012).

The indicators used to assess individuals' achievements across various dimensions are numerous and expressed in different measurement units. Some of them are continuous (income, wealth, consumption), others discrete (number of durable goods), or dichotomous/binary, either by definition or after being transformed through comparison with a social norm, usually through a pre-fixed threshold. Multidimensional inequality indices are used to summarize the degree of deprivation or poverty into a single real number, thus providing a direct comparison of different distributions. The produced ranking can subsequently assist policymakers in adopting appropriate strategies. To this purpose, many contributions have appeared in the specialized literature; we refer to Calia & Ferrante (2024), which employs a CES function together with Generalized Entropy, and Decancq & Lugo (2012), which explores the multidimensional Generalized Gini family of indices and the S-Gini generalized index. A different perspective on multidimensional inequality indices proposes alternative measures of inequality (Calia & Ferrante, 2024; Decancq & Lugo, 2012). However, extending one-dimensional measures to the multidimensional case remains a challenge.

In this contribution, we develop a method that extends some well-known approaches using expert judgment to elicit key parameters, such as those that determine whether an attribute qualifies an individual as poor. In doing so, we capture and formalize group preferences, avoiding the normative approaches used in many applications, which are often unjustified. The starting point is the multidimensional poverty estimation procedure proposed by Dhongde & Dong (2022), based on a sampled Achievement Matrix where each row represents all the achievement vectors. From this matrix, another matrix, the Deprivation Matrix, is obtained, where the entries take values in {0,1}, using suitable thresholds for each attribute/criterion. In our contribution, we aggregate by row of the Deprivation Matrix, computing a deprivation index δi\delta_iδi for individual iii, extending what was originally proposed by Dhongde & Dong (2022) and the references therein. They introduced three possible methods—the Union, the Intersection, and the Intermediate approach—to select the subset of people considered poor within the population. Conversely, in our proposal, we assign a degree of poverty to each individual, increasing the granularity of the classification and surpassing the limiting strong focus axiom (Bourguignon & Chakravarty, 2003; Dhongde & Dong, 2022), which implies that the deprivation index is insensitive to increases in values

above the pre-fixed threshold. We at least partially overcome this limitation by asking a group of experts for their own thresholds, i.e., the minimum number of deprived attributes necessary to classify an individual as poor. Using a group decision-making procedure, we aggregate these expert-defined thresholds and compute a deprivation index, which can be interpreted as the probability that an individual is classified as poor or as a fuzzy classification. These values are subsequently used to compute a general poverty index for the considered region, aggregating individual poverty indices using suitable aggregation operators such as the Ordered Weighted Averaging (OWA) operator (Cardin & Giove, 2015; Cardin, De Nadai, & Giove, 2019; Peragine et al., 2021).

Keywords

Deprivation valuation, Poverty, Aggregation operators, OWA

References

Bertin, G., Giove, S., & Carrino, L. (2018). The Italian regional well-being in a multi-expert non-additive perspective. Social Indicators Research, 135, 15-51.
Bourguignon, F., & Chakravarty, S. R. (2003). The measurement of multidimensional poverty. Journal of Economic Inequality, 1, 25–49.
Calia, P., & Ferrante, M. R. (2024). Multidimensional quantitative indicators. In S. S. Jodhka & F. Rehbein (Eds.), Global Handbook of Inequality.
Cardin, M., & Giove, S. (2015). A grid-based optimization algorithm for parameters elicitation in WOWA operators: An application to risk assessment. Advances in Neural Networks: Computational and Theoretical Issues, 37, 207-215. Springer Science and Business Media Deutschland GmbH.
Cardin, M., De Nadai, G., & Giove, S. (2019). A method based on OWA operator for scientific research evaluation. Neural Advances in Processing Nonlinear Dynamic Signals, 102, 299-306. Springer Science and Business Media Deutschland GmbH.
Carrino, L., Farnia, L., & Giove, S. (2024). Measuring social inclusion in Europe: A non-additive approach with the expert-preferences of public policy planners. Journal of the Royal Statistical Society, Series A: Statistics in Society, 187, 229-257.
Decancq, K., & Lugo, M. A. (2012). Inequality of wellbeing: A multidimensional approach. Economica, 79, 721-746.
Dhongde, S., & Dong, X. (2022). Analyzing racial and ethnic differences in the USA through the lens of multidimensional poverty. Journal of Economics, Race and Policy, 5, 252-266.
Peragine, V., et al. (2021). On multidimensional poverty rankings of binary attributes. Journal of Public Economic Theory, 23, 248-274.

Modelling confidence and optimism in Stochastic Multicriteria Acceptability Analysis

Sally Giuseppe Arcidiacono, Salvatore Corrente, Salvatore Greco
Department of Economics and Business, University of Catania, Catania (Italy)

Abstract

We propose a Multiple Criteria Decision Aiding methodology to take into account confidence and optimism of a Decision Maker (DM) on their preferences. Alternative performances on different criteria are aggregated using a weighted sum, while the whole space of feasible weight vectors is taken into account through Stochastic Multicriteria Acceptability Analysis. The overall evaluation of an alternative is derived as the average of evaluations across feasible weight vectors. We consider a DM that handles robustness concerns exploring how alternatives' evaluations change perturbing a reference weight vector. Greater confidence results in more emphasis on weight vectors close to the reference, while greater optimism shifts focus toward weight vectors yielding higher evaluations for an alternative. To model this, we introduce a non-additive probability distribution over feasible weight vectors and compute a non-additive expected value using the Choquet integral. For model manageability, we define a capacity that can be represented as a transformation of a probability distribution in the space of feasible weight vectors. The degree of dispersion in the probability distribution reflects the DM's confidence in their preferences, with lower dispersion indicating greater confidence. Similarly, the values assigned by the probability transformation correspond to the DM's level of optimism, with higher values indicating greater optimism. Within this framework, we propose a procedure to infer capacity parameters from DM preferences. We demonstrate our methodology through an application in composite indicator construction

Keywords

Decision Support Systems, Multiple Criteria Decision Aiding, Stochastic Multicriteria Acceptability Analysis, Non-additive probability distribution, Choquet integral

Ca' Foscari University of Venice
Department of Economics

MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

A methodology to construct a reduced Composite Indicator for Digital Divide: An application to the Digital Economy and Society Index (DESI)

Giuseppe Bruno
University of Naples Federico II (Italy)
giuseppe.bruno@unina.it

Antonio Diglio
University of Naples Federico II (Italy)

Carmela Piccolo
University of Naples Federico II (Italy)

Eduardo Pipicelli
University of Naples Federico II (Italy)

Abstract

The rapid development of Information and Communication Technologies (ICTs) is a key driver of economic and social transformation. However, disparities in access and usage—commonly referred to as the Digital Divide (DD)—risk hindering inclusive development. While the DD has been widely explored in the literature, growing attention is now being given to its measurement, particularly through Composite Indicators (CIs), which account for its multidimensional nature.
CIs are widely used in policy analysis, yet their reliability depends heavily on appropriate methodological design. Many existing indices rely on a large number of indicators, under the assumption that more data increases accuracy. However, this can lead to redundancy, distortion in rankings, and limited usability, especially at sub-national levels where data availability may be lower. These issues highlight the need for leaner, more manageable tools to evaluate and monitor the DD both between and within countries.
This paper proposes a methodological approach to construct a reduced Composite Indicator for DD measurement. Using the Digital Economy and Society Index (DESI)—the main CI currently adopted in the EU—as a reference, the proposed method employs correlation analysis and Principal Component Analysis (PCA) to identify and eliminate redundant indicators. The goal is to preserve the interpretative power of the original index while improving its usability and adaptability.
Empirical validation with 2020 data from 29 EU countries shows that the reduced version of DESI yields comparable results to the full index, confirming the presence of redundancy in its structure. Thanks to its streamlined nature, the reduced index proves easier to apply in different contexts, including at sub-national levels where data gaps often exist.
This study contributes to the literature by offering a simple yet robust methodology to design reduced versions of complex indicators. Due to its general structure, the approach can be replicated for other CIs or future DESI releases. From a policy perspective, more accessible and adaptable tools like the one proposed can support consistent monitoring and evaluation of digital transformation efforts, aligning local and national actions with broader European strategies and benchmarks.

Keywords

Digital Divide, Composite Indicators (CIs), Digital Economy and Society Index (DESI)

Session 4

Advancements in MCDA methods and latest applications

Ca' Foscari University of Venice
Department of Economics

MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

The *Prison Life Index*: Applying ELECTRE TRI for Ordinal Indicator Aggregation with Limited Compensation

Lola Martin Moro
Conservatoire national des Arts et Métiers (France)
lolamartinm@gmail.com

Meltem Öztürk Escoffier
Université Paris Dauphine (France)

Abstract

Composite indexes are quantification tools designed to synthesise complex information into an accessible format, often intended for the general public. They are used in a versatile way. There appears to be no domain or concept that cannot be addressed by a composite index. Initially developed primarily in economics and finance, composite indexes are now widely used across diverse fields, including sustainability studies and human rights. Public and private actors rely on them for decision-making, policy formulation, advocacy, and critique. However, despite their apparent simplicity—offering synthetic results and clear rankings, composite indexes are often perceived as "*black boxes*," where the methodological and technical assumptions underlying their construction remain opaque.

A growing body of research calls for greater methodological transparency to ensure that composite indexes produce meaningful and comprehensible insights. A key aspect of composite index design is the aggregation method used to transition from individual indicators to a synthetic result. However, while much research focuses on data collection, statistical correlation analysis and the determination of the weighting system, the aggregation itself receives less attention. Most composite indexes of popular use rely on a weighted sum.

We argue that the weighted sum is frequently inadequate for aggregating indicators in composite indexes, as it relies on unrealistic assumptions well identified by the literature, such as full compensation between criteria and the equivalence of cardinal and ordinal values. In this presentation, we introduce ELECTRE TRI as an alternative aggregation method for the *Prison Life Index* (PLI) a composite index evaluating the respect of the fundamental rights of people in prison by States based on international standards. Using real data from five countries, collected between 2022 and 2024, we demonstrate the advantages of ELECTRE TRI in handling ordinal data—expert evaluations measured on an eight-level qualitative scale. This method seems appropriate when there is a need for limited compensation between indicators due to its outranking approach and the introduction of veto as well as majority thresholds. We also conduct a sensitivity analysis to show the influence of the decisional parameters on the outcomes, opening some interesting research perspective on sensitivity analysis for ordinal data. Our objectives are twofold: to illustrate the method's suitability for the PLI's specific constraints and to highlight its broader applicability to composite indexes, particularly in the domain of human rights. More generally, we advocate for the use of MCDA tools to develop well-informed indexes in a transparent, comprehensive, and meaningful way.

Keywords

Composite indicator, MCDA, Compensation, Aggregation, ELECTRE TRI, Sorting

Multicriteria Decision Aiding with Deck of the Cards based Ordinal Regression

Maria Barbati
Ca' Foscari University of Venice (Italy)

Salvatore Greco
University of Catania (Italy)
salgreco@unict.it

Isabella Lami
Politecnico di Torino (Italy)

Abstract

We present the deck-of-cards-based Ordinal Regression (DOR) (Barbati, Greco and Lami 2024), a new multicriteria decision-aiding procedure that conjugates the deck-of-cards method with an ordinal regression approach to define a multicriteria value function representing the preferences of the decision maker (DM). The deck-of-cards method allows the DM to express the ranking order of a set of reference alternatives along with the intensity of preferences between reference alternatives. An ordinal regression procedure (Jacquet-Lagreze and Siskos 1982) is then used to define a multicriteria value function that represents the ranking of the reference alternatives as well as the preference intensity. This approach can be applied to define value functions with different formulations, such as weighted sum, additive value (Keeney and Raiffa 1976), or Choquet integral (Choquet 1953). The value function thus obtained can be used to comprehensively evaluate alternatives of a multi-criteria decision problem. The elicitation of the DM's preference information using the deck-of-cards method can be extended to other methods to collecting DM'S preferences using different scaling procedures, such as AHP (Saaty, 1977), BWM (Rezaei, 2015) and MACBETH (Bana e Costa & Vansnick, 1994). Using any of these methods, a set of reference alternatives can be presented to the DM to provide the required pairwise judgments. By applying the same methods, a comprehensive value $v(a)$ can be assigned to each alternative a. Then, by applying an ordinal regression procedure to the values $v(a)$, the multicriteria value function representing the DM's preferences can be induced.

Keywords

Ordinal Regression, Deck-of-cards method, value functions, scaling procedures

References

Barbati, M., Greco, S., & Lami, I. M. (2024). The Deck-of-cards-based Ordinal Regression method and its application for the development of an ecovillage. European Journal of Operational Research, 319(3), 845-861.
Bana e Costa, C. A., & Vansnick, J. C. (1994). MACBETH—An interactive path towards the construction of cardinal value functions. International Transactions in Operational Research, 1(4), 489–500.
Choquet, G. (1953). Theory of capacities. Annales de l'Institut Fourier, 5(54), 131–295.
Jacquet-Lagrèze, E., & Siskos, J. (1982). Assessing a set of additive utility functions for multicriteria decision-making, the UTA method. European Journal of Operational Research, 10(2), 151–164.
Keeney, R. L., & Raiffa, H. (1976). Decisions with multiple objectives: Preferences and value trade-offs. Cambridge University Press.
Rezaei, J. (2015). Best-worst multi-criteria decision-making method. Omega, 53, 49–57.
Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. Journal of Mathematical Psychology, 15(3), 234–281.

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

A multicriteria Group Decision Making framework for the evaluation of the sustainability and resilience of the long-term Swiss energy pathways

Eleftherios Siskos
Technical University of Crete (Greece)
esiskos@tuc.gr

Evangelos Panos
Paul Scherrer Institute (Switzerland)

River Huang
Paul Scherrer Institute (Switzerland)

Peter Burgherr
Paul Scherrer Institute (Switzerland)

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, Energy system resilience, Sustainability

A Decision Support Framework for Evaluating Policy Strategies

K.Nadia Papamichail
The University of Manchester (United Kingdom)
nadia.papamichail@manchester.ac.uk

Peter Strong, Aditi Shenvi, Xuewen Yu and Jim Q Smith
University of Warwick (United Kingdom)

Abstract

This paper presents a multi-criteria decision support system (DSS) for helping policymakers to assess countermeasure strategies in complex and uncertain decision-making settings. Drawing from Bayesian decision analysis, we have developed a structured approach to assessing countermeasure strategies in terms of multiple and conflicting criteria such as public health, economic viability and social well-being. The work highlights how expected utility scores can be used to balance trade-offs between immediate effects with long-term consequences. The framework accounts for uncertainty in data and predictions and combines expert judgment with real-time data.

The work was carried out as a response to a gap in the literature for developing Bayesian subjective utility models to address deep uncertainty in evolving and complex decision contexts. We demonstrate how a systematic, data-driven decision support system can improve policy responses to crises. The framework has been applied to a Covid-19 setting but could be applicable to broader public health crises.

The work has been included in the WHO (World Health Organization) Covid-19 Research Database. The research has been 'highly commended' for the prestigious Goodeve Medal 2024 of the UK Operational Research Society (top 3 papers published in 2023 by the Journal of Operational Research Society).

Keywords

Decision support system, multi-criteria decision analysis, expected utility, emergency management.

Generalising the distance-induced ordered weighted averaging (DIOWA) operators

Sajid Siraj
University of Leeds (United Kingdom)
S.Siraj@leeds.ac.uk

Chengju Gong
School of Economics and Management, Harbin Engineering University (People's Republic of China)

Abstract

We introduce a generalized version of distance-induced ordered weighted averaging (DIOWA) operators. These operators offer a unique advantage by incorporating ideal argument values while simultaneously considering the attribute values as variables. Three variants of the DIOWA operators are proposed and examined: a) the Hamming-distance-induced OWA operator, b) the normalized Hamming-distance-induced OWA operator, and c) the weighted Hamming-distance-induced OWA operator. Their effectiveness is demonstrated through an application to a practical problem, namely the ranking of Chinese provinces based on their science and technology (S&T) development levels. The proposed operators are shown to be a valuable addition to the decision analysts' aggregation toolbox. To take it further, our plan is to also incorporate uncertain information in these operators, usually represented by various types of fuzzy numbers, for example, hesitant fuzzy numbers, intuitionistic fuzzy numbers, linguistic fuzzy numbers, to name a few.

Keywords

Ordered weighted averaging, Ranking the science and technology development levels, fuzzy numbers

An improvement of the arithmetic Heuristic Rating Method

Jacek Szybowski
AGH University of Krakow (Poland)
Jacek.Szybowski@agh.edu.pl

Konrad Kułakowski
AGH University of Krakow (Poland)

Abstract

In the papers by Kułakowski (2015) and Kułakowski, Grobler-Dębska, & Waś (2015), a new decision-making technique named Heuristic Rating Estimation (HRE) was introduced. This method is particularly useful when the priorities of some referential alternatives are initially known. However, as noted in Kułakowski (2016), in the case of the arithmetic AHP, for some specific data, the procedure may not work.
We have introduced an improvement of the arithmetic AHP which circumvents this obstacle by using a singular value decomposition and calculating a pseudoinverse matrix. We illustrate the effectiveness of this method with an example.

Keywords

Pairwise comparisons, Heuristic Rating Estimation, singular value decomposition, pseudoinverse.

References

Kułakowski, K., 2015. A heuristic rating estimation algorithm for the pairwise comparisons method. Central European Journal of Operations Research, 23(1), 187–203.
Kułakowski, K., Grobler-Dębska, K., Waś, J., 2015. Heuristic rating estimation: geometric approach. Journal of Global Optimization, 62(3), 529–543.
Kułakowski, K., 2016. Notes on the existence of a solution in the pairwise comparisons method using the heuristic rating estimation approach. Annals of Mathematics and Artificial Intelligence, 77(1), 105–121.

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Towards an MCDA approach for supporting sustainable decision making in agri-food production processes

Nikos Tsotsolas
University of West Attica (Greece)
ntsotsol@uniwa.gr

Eleni Koutsouraki
Green Projects SA, R&D Dept. (Greece)

Aspasia Antonakaki
Green Projects SA, R&D Dept. (Greece)

Abstract

Sustainable development is defined as the management and conservation of the natural resource base and the orientation of technological change so as to ensure the continued satisfaction of human needs for present and future generations. The current work discusses the main points of a research project, which deals with the development and extensive piloting of a Holistic Voluntary Protocol for the management of agri-food products, which focuses on 5 main objectives. Food must be: Safe and healthy, trustworthy, fair (social participation and economic equality), environmentally friendly, and economically profitable. Towards the fulfillment of the aforementioned key objectives that enhance the sustainability performance of agri-food products, cutting-edge technologies (blockchain, IoT, AI) and specialized practices are adopted throughout the supply chain, starting from seeding, planting and animal breeding and moving to the completion of the cycle in the processes of recycling and reuse. For supporting decisions concerning processes throughout the whole agri-food chain an MCDA holistic approach has been developed. The MCDA methods, which are implemented in two DSS modules, use as input data fusion from two cloud-based platforms. The first one is GP CoreIoT^{TM} platform, a comprehensive telemetry system that enables cloud-based data acquisition, management and visualization using IoT devices with sensors at farms, process facilities, warehouses and transportation means. The second platform is KalaΘos^{TM}, an innovative traceability and marketing platform for agri-food products using blockchain and AI technologies. The various decisions under question refer to the selection of alternative actions at the different production stages for a better sustainability performance of each specific product. Following the aggregation-disaggregation approach the preference models of different buyers or other stakeholders are elicited based on their expression of preference. The present research discusses the modeling and application of a specific form of UTAdis method, which encompasses the notions of Stochastic UTA in order to deal with several evaluations of products characteristics that lead to different product evaluation on sustainability performance. Along with stochastic UTAdis, MUSA and WAP methods are also applied in the two DSS modules in order to provide further support to the decision makers.

Keywords

Agri-food, DSS, UTAdis Method, WAP method, MUSA method, Data fusion, Dustainability

Deck of Cards method for Hierarchical, Robust and Stochastic Ordinal Regression

Silvano Zappalà
University of Catania (Italy)
silvano.zappala@phd.unict.it

Salvatore Corrente
University of Catania (Italy)

Salvatore Greco
University of Catania (Italy)

Abstract

We consider the recently introduced application of the Deck of Cards Method (DCM) to ordinal regression proposing two extensions related to two main research trends in Multiple Criteria Decision Aiding, namely scaling and ordinal regression generalizations. On the one hand, procedures, different from DCM (e.g. AHP, BWM, MACBETH) to collect and elaborate Decision Maker's (DM's) preference information are considered to define an overall evaluation of reference alternatives. On the other hand, Robust Ordinal Regression and Stochastic Multicriteria Acceptability Analysis are used to offer the DM more detailed and realistic decision-support outcomes. More precisely, we take into account preference imprecision and indetermination through a set of admissible comprehensive evaluations of alternatives provided by the whole set of value functions compatible with DM's preference information rather than the univocal assessment obtained from a single value function. In addition, we also consider alternatives evaluated on a set of criteria hierarchically structured. The methodology we propose allows the DM to provide precise or imprecise information at different levels of the hierarchy of criteria. Like scaling procedures, the compatible value function we consider can be of a different nature, such as weighted sum, linear or general monotone value function, or Choquet integral. Consequently, the approach we propose is versatile and well-equipped to be adapted to DM's characteristics and requirements. The applicability of the proposed methodology is shown by a didactic example based on a large ongoing research project in which Italian regions are evaluated on criteria representing Circular Economy, Innovation-Driven Development and Smart Specialization Strategies.

Keywords

Multiple Criteria Analysis, Deck of Cards-Based Ordinal Regression, Scaling procedures, Robust recommendations, Multiple Criteria Hierarchy Process

Session 5

Multicriteria Decision Aiding in Public Policy and Governance

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Multi-Criteria Decision-Making/Aiding in Business-State Relations: A Systematic Literature Review

Sarah Ben Amor
University of Ottawa (Canada)
Benamor@telfer.uottawa.ca

Ali Esmaeili Aftabdari
University of Ottawa (Canada)

José Carlos Marques
University of Ottawa (Canada)

Abstract

The complex and dynamic interaction between business and state actors plays a crucial role in shaping economic development, regulatory frameworks, and public-private partnerships. Governments worldwide implement industrial policies, regulatory governance, and strategic interventions to balance economic growth, social welfare, and environmental sustainability. However, these decisions involve multiple, often conflicting, criteria that make policymaking highly complex. Traditional decision-making approaches frequently struggle to address the trade-offs between diverse stakeholder interests, economic efficiency, and regulatory constraints. In this context, Multi-Criteria Decision-Making/Aiding (MCDM/A) methods have gained prominence as systematic tools for evaluating alternatives, structuring complex problems, and improving transparency in business-state decision-making. Despite the increasing application of MCDM methods in various sectors, there is a lack of a consolidated review focusing on their specific use in business-state relations. Without such a synthesis, policymakers, researchers, and practitioners face challenges in understanding the effectiveness of MCDM/A approaches and identifying best practices.

This study conducts a Systematic Literature Review (SLR) following the PRISMA guidelines to ensure methodological transparency and reproducibility. The review incorporates a structured search strategy across multiple academic databases, complemented by backward and forward snowballing techniques. A rigorous screening and quality assessment process is applied to identify relevant studies that explicitly address the application of MCDM/A in business-state interactions. Extracted data include the context of application, decision problems addressed, stakeholder involvement, evaluation criteria used, and key challenges and uncertainties faced in implementation. Preliminary findings indicate that MCDM/A contributes to more structured and transparent decision-making, facilitating the integration of diverse economic, social, and regulatory factors. However, challenges such as methodological subjectivity, computational complexity, difficulty of balancing stakeholder interests, and the inherent uncertainties in this context, remain prevalent. By synthesizing existing research, identifying trends, and highlighting research gaps, this review provides a comprehensive overview of the role of MCDM in business- state decision-making and offers recommendations for future studies and policy applications.

Keywords

Multi-criteria decision-making, Multi-criteria decision-aiding, Business-state relations, Industrial policy, Regulatory governance, Public-private partnership

Assessing Citizen Acceptance for Wind Energy in Central and Southern Europe: A Multi-Regional, Multicriteria Analysis

River Huang
Paul Scherrer Institute (Switzerland)
river.huang@psi.ch

Eleftherios Siskos
Technical University of Crete (Greece)

Peter Burgherr
Paul Scherrer Institute, ETH Zurich (Switzerland)

Abstract

Amid escalating climate change challenges and the European Union's drive toward decarbonization, renewable energy sources have become pivotal in regional and local energy strategies. Although wind energy has demonstrated technical and economic viability, its deployment often faces challenges due to low levels of public acceptance. It is influenced by concerns related to environmental impact, aesthetics, and community well-being. This study employs a multi-region, multicriteria satisfaction analysis (MUSA) framework to assess citizens' acceptability of wind power. By integrating a diverse set of evaluation criteria and sub-criteria, the preferences of local residents and their underlying motivations influencing their degree of acceptance for wind energy projects are assessed using the MUSA method. In total, over 300 questionnaires were physically completed by the participants, in different regions of Austria, Portugal, Italy, and Greece. The results reveal significant geographical discrepancies and underscore the necessity of adopting tailored, context-specific approaches to engage the communities and formulate policies, ultimately contributing to more effective and sustainable renewable energy deployment.

Keywords

Satisfaction analysis, multicriteria decision analysis, renewable energy sources, wind energy

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Is the C-K theory of design useful to transform health systems?

Christine Huttin
Aix Marseille university and Endepusresearch
huttinc@gmail.com

Abstract

In recent communications at EWG-MCDA meetings, Prof C Huttin initiated a review of design theories, useful for decision aiding tools in health policies (Huttin,2024). This paper discusses some applications with empirical studies. Design approaches have already been used by academics, policy makers and managers in life science and healthcare. Thinking first about values (Keeney et ales,1992,1996) helps to design Value Assessment Frameworks and Advanced Value Frameworks; however, it is driven by Outcome researchers, for valuation of main technologies. Advances of design theories from cognitive and behavioral sciences have helped to design physicians 'reminder systems, patients 'decision aids and their implementation in health care organizations. Soft Operational Research (e.g., Tsoukias, Colorni, Pluchinetta) helps to structure decision-making processes but case studies in healthcare are limited.

This paper focuses on C-K theory with its application to expand the scope of innovative solutions to transform health systems. Different user cases are presented, they include disease econometrics, choice modeling, and the use of random price generators. The selection of alternatives for user cases mainly relates to medical policy problems (e.g. Huttin and Hausman,2021). However, such approaches require scaling up for bigger samples and comprehensive user cases. The current milestone using C-K theory, aims to generate data elements on economic and financial information, in particular from conversation of care and expand the dataspace, with innovative applications of the algorithms. The development of such economic models impacts the architecture of national or international accounting systems; they may require the design of ad hoc or satellite health accounts with this additional type of information. However, the architecture of health accounts is more driven by environmental communities who dominate methodological advances (e.g. agriculture, forestry management etc.); modeling techniques in international health accounting generate specific tracers to integrate in aggregate indexes. The expansion of the K space may be used for the health targets under the SDG global agenda. The statistical methods used to transform this K space, their selection process and the identification of key parameters estimates will determine to a certain extent the transformation of health systems and will nurture the C concepts (e.g. more justice in reallocation of services and access to care).In Global Health policies, comparable national estimates are used: e.g. "Global Burden of Diseases" (GBD) and risk predictors for health risk evaluation. In relation to global pricing, the agenda refers to "Universal Health Coverage" (UHC), to accelerate access to affordable medical services in different regions of the world. Additional economic and financial information on populations with methodologies such as Hierarchical Bayesian Modeling (HBM) and its countervailing use (e.g., physicians reversed conjoint models, Huttin, 2017), with trained models on bigger samples and comprehensive user cases, contribute to structuring the pathway to transformative changes.

Keywords
Global Health policies, Pricing, C-K theory, Value Framework

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

The weight of an economic criterion in the multi-criteria evaluation (ELECTRE methods) of agroforestry systems in south-west France

Roxane Sybile Simamindra
INRAE, UR ETTIS, F-33612 Cestas, France
sybile.simamindra@inrae.fr

Odile Phelpin
INRAE, UR ETTIS, F-33612 Cestas, France

Francis Macary
INRAE, UR ETTIS, F-33612 Cestas, France

Abstract

Agroforestry is emerging as a key component of a diverse range of adaptation strategies because of its ability to mitigate climate change, while enhancing the socio-economic and environmental sustainability of rural development. Agroforestry describes land use systems and practices in which woody perennial plants, such as trees, shrubs are intentionally grown alongside agricultural crops or livestock on the same plot of land, in specific spatial and temporal configurations. This approach can diversify and increase farmers' incomes by providing food, wood, while also providing environmental and social benefits such as improved soil fertility, erosion control, water regulation, carbon storage, increased biodiversity and resilience to natural disasters.

In addition to exploring the motivations and factors limiting the development of agroforestry, this study of the national TETRAE program, aims to investigate its agro-environmental and its socio-economic performance in field crops in south-west France. The aim is to identify and analyse the environmental, agronomic and economic impacts of trees on agricultural plots. In a first step, we made an analysis with six qualitative and quantitative agri-environmental and behavioral criteria, based on the literature and discussions with experts: functional biodiversity, cultural practices, landscape amenities, woody vegetation management, workload, knowledge and external support. The ELECTRE Tri-nC model was used to assign agroforestry systems into four performance categories, and ELECTRE III to rank them within each category. In a second step, we constructed an economic criterion from Net Present Value (NPV) of the profitability of these agroforestry systems. The objective of the economic evaluation of agroforestry systems is to assess the long-term economic viability of agroforestry systems. The economic data came from survey of farmers on the costs associated with agroforestry systems and the income they generate. The economic criterion was then integrated with the six other criteria in order to conduct a multi-criteria decision analysis by using ELECTRE methods.

Keywords

Agroforestry; Field crops; Analysis for decision support; ELECTRE methods; Net Present Value indicator; TETRAE program

Acknowledgements: This work is carried out as part of the national TETRAE program with the financial support of INRAE and the regional Nouvelle-Aquitaine Council. We thanks Valentine Jung and Blandine Hottekiet-Genetier, agronomists in training, for their help.

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Lessons from Empirical Applications of Social Multi-Criteria Evaluation: A Systematic Literature Review

Egle Basyte Ferrari
Joint Research Centre, European Commission (Italy)
egle.basyte-ferrari@ec.europa.eu

Abstract

Ex-ante policy assessment has become broadly institutionalised across governments to systematically assess the impacts of proposed interventions on different social groups and overall economic, social, and environmental outcomes. In recent years, there has been a resurgence of interest in analytical tools that can tackle complex policy issues and move beyond traditional linear-rational approaches. One such framework is the Social Multi-Criteria Evaluation (SMCE), which proposes a systematic integration of public engagement with multi-criteria analysis in policy appraisal. It provides a structured approach to option comparison and decision-making, accounting for conflicting objectives and uncertainties, and facilitating the integration of technical expertise with diverse social values and perspectives to promote more informed, inclusive and transparent choices.

A systematic review of scientific literature has been conducted to examine empirical SMCE applications since its conceptual formalisation by Munda (2004) and to offer practical insights with regards to SMCE use in policy appraisal. A total of 54 papers published between 2006 and 2023 and reporting on different case studies have been identified and analysed. The applications cover diverse geographical contexts, spanning 20 countries, mostly in Europe (37) and Latin America (9). A vast array of policy fields is represented, including environment (especially management of natural resources), energy, agriculture, land use (urban and rural planning and development), cultural heritage, and transport. SMCE was mostly used for aiding decisions pertaining to local and regional level government.

The reviewed studies emphasize SMCE's potential to enhance mutual learning among different actors, mitigate conflicts, empower social actors, promote inclusiveness, and increase transparency in policymaking. They also highlight that the effective implementation of SMCE requires addressing challenges, primarily linked to engaging social actors in the process in the pursuit of empowerment, learning, and legitimization aims. Such challenges include participant representativeness, power asymmetries, and resource constraints (time and financial). Clear communication is identified as crucial to ensure transparency and foster trust.

Overall, the findings underscore the SMCE framework's adaptability across diverse social and political contexts and policy domains while also revealing frequent deviations from its *ideal* application, often resulting in partial implementation. Such deviations are not uncommon also for other analytical tools used in policy formulation and appraisal and reflect possible capacity constraints but also the inherent complexity of public policy processes that necessitate context-sensitive adaptations. By illustrating how different SMCE steps have been applied in real-world settings and examining emerging lessons, this review deepens the understanding of the role and potential of similar integrative frameworks in public policy appraisal, making it relevant for both scholars and practitioners.

Keywords

Social Multi-Criteria Evaluation, multi-criteria analysis, literature review, policy appraisal

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

A comparative assessment of the main ESG rating frameworks

Giuseppe Bruno
University of Naples Federico II (Italy)

Manuel Cavola
University Pegaso (Italy)

Anna Del Balzo
University of Naples Federico II (Italy)

Eduardo Pipicelli
University of Naples Federico II (Italy)
eduardo.pipicelli@unina.it

Abstract

The global transition towards sustainability has triggered a profound reconfiguration of socio-economic activities, with particular emphasis on the role of the production sector, a major contributor to global emissions. In response, governments and international bodies have advanced regulatory frameworks to promote Environmental, Social, and Governance (ESG) accountability among private enterprises. Central to this evolution is the introduction of the Corporate Sustainability Reporting Directive (CSRD) by the European Union, which enhances transparency and standardization in ESG reporting.
However, while regulatory efforts aim to harmonize sustainability disclosures, the landscape of ESG evaluations remains fragmented. Multiple ESG rating agencies have developed proprietary frameworks for assessing performances, often relying on diverse criteria, data sources, and scoring methodologies. These heterogeneous approaches result in considerable variations in how companies are rated, raising concerns about the comparability and reliability of ESG metrics.
Against this backdrop, this paper presents a critical analysis of ESG ratings through a methodological lens, aiming to investigate the structural divergences that arise from the heterogeneous evaluation frameworks employed by leading rating agencies.
Specifically, a systematic cross-agency comparison is conducted using matched samples of companies from two distinct yet sustainability-relevant sectors: agri-food and textile/fashion. The methodology involves selecting firms rated by main agencies, mapping and normalizing rating scales, and performing inter-agency ranking analyses based on absolute values and relative positioning within the industry sector.
Findings reveal how subjectivity in criteria weighting, data interpretation, and sectoral benchmarking significantly contributes to rating inconsistencies. Also, they underscore the methodological opacity and fragmentation in the ESG rating landscape, challenging the notion of cross-agency comparability and pointing to the urgent need for standardized, transparent evaluation protocols. The research contributes to the broader discourse on ESG measurement reliability, offering a replicable framework for rating comparison that stakeholders can apply across industries to critically interpret ESG performance indicators.

Keywords

ESG, Ratings reliability, Sustainability

Ca' Foscari University of Venice
Department of Economics

EWG MCDA
99th EWG-MCDA Meeting
April 10-12, 2025, Ca' Foscari University of Venice

Integrating Cost-Benefit and Multi-Criteria Decision Analysis in Digital Twin-based decision support for Positive Energy Districts: a case study

Franco Corti
DSEA, Department of Economics and Management, University of Padova (Italy)
franco.corti@unipd.it

Abstract

The transition towards Positive Energy Districts (PEDs) presents a complex multi-dimensional challenge, requiring tools that integrate real-time monitoring, energy optimization, and strategic decision-making. This paper explores the use of Digital Twin (DT) technology as a decision-support system, combining Cost-Benefit Analysis (CBA) and Multi-Criteria Decision Analysis (MCDA) to assess PED implementation strategies. Inspired by the integration of CBA and MCDA in environmental decision-making, this research adapts a hybrid evaluation framework to assess alternative energy efficiency and renewable energy integration scenarios in urban districts. Using the ExPEDite project as a case study, this work leverages a DT of a district in Riga, enriched with real-time data on energy consumption, building stock performance, and user behavior. The proposed methodological approach applies CBA to quantify economic feasibility while MCDA evaluates non-monetary benefits such as resilience enhancement, and citizen engagement. To integrate these assessments, we adapt an aggregated decision-support model, enabling the ranking of energy interventions based on their overall impact. This study contributes to advancing PED design by integrating into urban planning the economic analysis of scenario simulations formulated in DT dynamic platform, allowing stakeholders to weigh trade-offs between financial, environmental, and social criteria in a structured manner.

Keywords

Positive Energy District, Digital Twin, Cost-benefit Analysis, Multiple criteria decision Analysis, Decision Support

Incomparable AHPSort

Alessio Ishizaka
Department of Information Systems, Supply Chain Management and Decision Support, NEOMA Business School (France)
alessio.ishizaka@neoma-bs.fr

Arash Moheimani
Department of Information Systems, Supply Chain Management and Decision Support, NEOMA Business School (France)

Gerarda Fattoruso
Department of Economics, Management and Territory (DEMeT), University of Foggia (Italy)

Salem Chakhar
University of Portsmouth (United Kingdom)

Abstract

This paper presents the Incomparable Analytic Hierarchy Process-based method for sorting problems (Incomparable AHPSort), which is based on the traditional Analytic Hierarchy Process (AHP) by incorporating indifference and comparability thresholds. The indifference threshold groups alternatives into classes based on their global priority, while the comparability thresholds, defined for each criterion, assess local priorities within each class to ensure consistency in their ranking. These thresholds improve the accuracy of error classification and comparability within classes, which is essential in sectors where assuming comparability among alternatives could lead to significant risks. The method has been applied on production errors in the automotive industry. A detailed analysis of the method's features, as well as how this method serves as a generalization of AHPSort, yielding more detail and complexity, is discussed in the paper. Validated by the quality team, this method enhances precision in multi-criteria sorting problems, enabling decision-makers to prioritize critical issues and allocate resources more effectively, ultimately driving improved operational efficiency.

Keywords

Decision Analysis, Multiple criteria analysis, Incomparability, automotive, AHP