MCDA-96

96th Meeting of the EWG-MCDA

September 21-23, 2023 | Paris, France

ESSCA School of Management

Book of Abstracts

Organizing Committee:

Béatrice COLLIN | Guillaume SCHIER | Panos XIDONAS

Paris, September 2023

URL: https://mcda96.sciencesconf.org

A message from the *Organizing Committee*

It is our great pleasure to welcome you to the 96th meeting of the *EURO Working Group on Multiple Criteria Decision Aiding* (EWG-MCDA). The conference is organized by ESSCA and the main topic is *MCDA in Climate, Technology & Finance.*

ESSCA was founded in 1909 and for over 100 years is considered as one of the most prestigious *Grandes Écoles* in France. Today, ESSCA is consistently ranked in the top-list of European business schools according to *Financial Times*, also holding the unique *triple-crown* of AACSB, AMBA and EQUIS accreditations.

EWG-MCDA is one of the most historic working groups of EURO. The group was founded in 1975 by Prof. *Bernard ROY* (Université Paris Dauphine) and its main objectives are to contribute to the development, at a European level, of an original way of thinking in the field of multicriteria decision aiding.

On behalf of the *Organizing Committee*, we have the great pleasure to orchestrate this so critical scientific event for the scientific community. All the abstracts were strictly reviewed by the co-ordinators of the EWG-MCDA for securing the highest quality of content. We would like to thank you for your scientific contribution to the MCDA-96 conference and we look forward to having the opportunity to showcase and disseminate your research.

Yours sincerely,

Béatrice Collin, *Guillaume Schier* & *Panos Xidonas*

Session I

Thursday 21 September, 13:00-13:45

Chairman: *Roman Slowinski*

The session is devoted to the *Bernard Roy* Award, where the laureate presents a 45-mins lecture.

Session II

Thursday 21 September, 14:15-15:45

Chairman: *Panos Xidonas*

Keynote Speeches by Prof. *Ralph Steuer* and Prof. *Evangelos Triantaphyllou*

On the differences between tri-criterion and bi-criterion portfolio selection in graphs

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Abstract

Wanting to be as much Markowitz-like as possible, with ESG, renewable energy, and the like as a 3rd criterion, we track the development of tri-criterion portfolio optimization relative to its traditional bi-criterion counterpart. With tri-criterion problems having efficient surfaces as opposed to efficient frontiers, the development proceeds quite straightforwardly until introduction of the risk- free asset. At this juncture, it becomes clear that it is essentially impossible to pick a point on an efficient surface as one would pick a point on an efficient frontier. Due to the increasing prevalence of additional criteria in portfolio selection, it is recommended that efficient surfaces be included in the material when efficient frontiers are taught. The issues involved are discussed and amply illustrated.

Keywords

Multiple criteria decision aid, multi-objective programming, portfolio selection, security selection, portfolio optimisation.

Towards an intelligent MCDA approach for dealing with today's complex problems

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Abstract

Today's MCDA problems may involve alternatives and evaluative criteria which are more complex than ever. The data may be elusive to elicit too. Furthermore, decision makers may have to work in a complex and dynamic environment which is hard to adequately understand initially. For MCDA to be effective, it needs to be flexible and adaptive as the decision-making process evolves. For MCDA to be successful it should / must incorporate a multifaceted feedback mechanism in order to meet today's challenges. Many of the different definitions of "intelligence" agree on a single aspect, the capability of adaptation to a changing environment. Therefore, intelligent MCDA must be based on an appropriate multifaceted feedback mechanism which should be an integral part of MCDA. A sensitivity analysis module should be part of such multifaceted feedback mechanism, as it can shed light onto parts of the data in ways that are unique and useful. Other parts of such feedback mechanism may focus on discovering dynamic relationships that may exist when group MCDA takes place. This lecture examines all the above in a holistic manner.

Keywords

MCDA, intelligent systems, feedback mechanism, sensitivity analysis, group decision-making.

Session III

Thursday 21 September, 16:15-18:15

Chairman: *Salvatore Corrente*

Using qualitative information elicited from a panel to obtain robust conclusions: An application to improve integrated pest management systems

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Abstract

This presentation reports an MCDA comparison of Integrated Pest Management Systems in Spain (apples) and France (carrots), performed in the context of the OPTIMA project (EU H2020 grant agreement 773718). The comparisons are based on a sustainability assessment of the current practices and alternative systems, using data from field trials. These field trials were designed aiming at assessing OPTIMA IPM technologies, encompassing use of smart sprayers and use of biological plant protection products (bioPPP). The assessment comprised multiple criteria: environmental indicators (global life cycle emissions and risk for local species), social indicators (human health risks for farmers and local inhabitants), and an economic indicator (cost for farmers). This set of criteria was developed with the help of focus groups that included technicians, contractors, manufacturers, and academics. These stakeholders also participated in this study rating the importance of the criteria. From an MCDA standpoint, this work allowed developing an approach to elicit information concerning the importance of the criteria in a way that could be used for different methods, asking separately to rate the importance of improving the current situation and the importance of not worsening the current situation. To contrast compensatory and non-compensatory approaches, the selected methods were additive multiattribute value functions and ELECTRE outranking relations. Stochastic analyses were performed considering three sets of preferences concerning the relative importance of the indicators: no preferences (importance weights completely free to vary), preferences derived from the responses to a survey to OPTIMA stakeholders, and preferences derived from responses from the subset of stakeholders located in the crop region. As no single weighting vector was fixed, results allowed observing conclusions that are robust to weighting choices, thus identifying which changes are recommended.

Keywords

Robustness, Weighting, Outranking, Sustainability assessment, Agriculture, Pesticides.

Rigorous and efficient ways of eliciting the parameters of the Non-Compensatory Sorting model

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Abstract

In 2007, Bouyssou and Marchant gave an axiomatic characterization of a sorting model that they named the Non-Compensatory Sorting (NCS) model. This model is an idealization of ELECTRE-Tri, used with the pessimistic (or pseudo-conjunctive) assignment rule. Bouyssou and Marchant's axioms allow us to clearly understand the parameters of the model, namely, the limit profile(s) and the set of sufficient coalitions of criteria. It is hence possible to design rigorous elicitation methods in which the decision maker is asked to assign well-chosen alternatives into a category. The purpose of this talk is to present some questioning algorithms in the case of sorting in two ordered categories. The difficult part is the elicitation of the set of sufficient coalitions of criteria. We present an algorithm based on a depth first search exploration of the set of criteria coalitions. This algorithm is not optimal in terms of the number of questions (neither in the worst case nor on average) but it is flexible. Its performance is compared to that of an algorithm that is optimal in the worst case and to what is known about questioning strategies that are optimal on average. Such questioning strategies can hardly be used in real decision aiding processes because the number of questions rapidly increases with the number of criteria. However, we suggest different ways of getting advantage of these idealized procedures in practice. In particular, we make a connection with the ELECTRE-Tri model.

Keywords

Multicriteria sorting, Non-compensatory sorting model, ELECTRE-Tri, parameters elicitation.

An MCDA approach for robust strategic decision making regarding digital government development

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Abstract

Digital government development is the result of the development and progressive deployment of new technology systems in the public sector. United Nations as well as other international policy making organisations, such as European Union, highlight the fact that digital government development leads to more responsive, efficient, effective and equitable delivery of public services to all people, building public trust and ensuring transparency, participation and collaboration in country governance. However, according to World Bank as many as 87% of large public sector ICT projects failed or partially failed. That's why OECD states that there is a growing sense of awareness of the need to better tackle the challenges associated with public sector ICT investments and of understanding numerous variables that impact the effective realization of benefits in digitalisation projects. In this work, the authors, given the multicriteria nature of the decision problems that deal with the development of major digital systems supporting the operation a public sector, propose an MCDA approach, which focuses not only on the overall evaluation of the performance of the alternative actions but also on the robustness level of these actions. Such decision problems are considered as strategic decision problems and more specifically, they fall under the domain of political decisions and that's why they are often complex, multifaceted and involve many different stakeholders with different objectives and priorities. The aforementioned particularities, which are related to the specific aspect of political decisions and to the different points of view of the various stakeholders, are efficiently tackled in the proposed MCDA framework, in which these particularities are modelled and affect the evaluation of alternatives and the reaching of specific decisions. Particular focus is given to the discussion of those criteria that could most accurately describe the effects of alternative actions in the area of digital government development. A crucial issue, when dealing with the aforementioned decision problems, is the radical uncertainty about the present (e.g., lack or poor quality of information) and also about the future. In the literature it is mentioned that robustness analysis is a way of supporting political decision making, when dealing with uncertainties and ignorance. The proposed approach incorporates a concrete robustness evaluation approach, using appropriate measures covering three notions of robustness namely: robust solution, robust conclusion, and robust decision in a dynamic context.

Keywords

Digital government decisions, political decision-making, robustness analysis.

Utilising the hierarchical SMAA-PROMETHEE framework to assess hydrochars produced from hydrothermal carbonization of agrowaste

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Abstract

In the past decade, significant quantities of hydrochars have been generated through various hydrothermal carbonization (HTC) processes. These products have gained widespread recognition for their value and efficiency in applications related to energy, environmental uses, soil enhancement, and heavy metal recovery, among others. However, there is currently no comprehensive framework available for evaluating different hydrochars based on their unique characteristics. This study proposes a comprehensive assessment framework for hydrochars using Multi-Criteria Decision Aiding (MCDA) methodologies. The framework involves a hierarchical structure of independent criteria, categorized into three lines of evidence (LoE): Environmental, Economic, and Social LoE, each containing specific assessment criteria. Among the MCDA methods, Hierarchical-SMAA-PROMETHEE is identified as the most suitable for evaluating hydrochars according to the proposed framework. A case study is conducted to demonstrate the practicality and advantages of this framework for analysts and decision-makers. Hierarchical-SMAA-PROMETHEE stands out as a non-compensatory method, allowing a multi-level exploration of the decision problem (comprehensive vs. LoE) and providing robust recommendations on preference modelling and weight elicitation.

Keywords

SMAA, PROMETHEE, Hierarchical assessment, Hydrothermal carbonisation, Hydrochar, Waste-to-energy.

Assessing risk of disruption of supply chains of perishable products due to COVID-19 with VIKOR-GAIA

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Abstract

In the last few decades, the world experienced an abrupt rise in undesirable events that readily affect the economy and the environment. Recently, the spread of the COVID-19 pandemic instigated disruptions to global supply chain management. The ripple effects of these disruptions affected almost every economic activity. Under such circumstances, the handling of perishable products is a key challenge. Therefore, the current study focuses on the risk assessment of the supply chain of perishable products using the Multi-Criteria Decision Making (MCDM) approach followed by a visual analysis. For this purpose, a new hybrid method is proposed i.e., VIKOR-GAIA which is identified as the literature gap for this study. The methodology is used to assess the perishable products based on eight criteria. The outcome of the study revealed that meat and its byproducts experienced the highest risk followed by seafood and its byproducts. On contrary, flowers as gifts and for ornamental purpose is ranked lowest i.e., ninth which indicates a lower disruption in its supply chain. Afterward, the full problem description is visualized with GAIA. The findings of this research will help the authorities and policymakers to develop a proactive plan for perishable food items. Furthermore, the VIKOR-GAIA methodology can be extended to resolve other complex decision problems.

Keywords

COVID-19, Risk assessment, Perishable products, VIKOR GAIA, Supply chain disruptions.

A novel technique to improve the data visualization in multi-criteria decision-making

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Abstract

Multi-line charts, a common data visualization form in various applications and are commonly used in multi-criteria decision-making/decision analysis (MCDM/A), are favored for their capacity to represent multiple data series on the same graph. Yet, when the lines in the chart intersect and overlap, comprehending these charts can become challenging, emphasizing the need for thoughtful design and layout. In this paper, we define the visual complexity of multi-line charts in the spirit of that of connected perfect matching bipartite graphs. Then we propose a metric called the Coefficient of Complexity (CoC), to quantify the complexity of multi-line charts. Coupled with an algorithm designed to minimize this CoC, modeled as an integer linear optimization problem reminiscent of the traveling salesman problem, we offer a technique to improve these visualizations. The effectiveness of our proposed technique is substantiated through an illustrative example, and its applicability is broadened to the visualization of one Analytic Hierarchy Process (AHP) software as a unique case for reducing visual complexity via CoC. Additionally, we recognize the radar chart as another specialized form of the multi-line chart, thus adapt our technique to rearrange elements within radar plots.

Keywords

MCDM/A, optimization, data visualization.

Teaching multiple criteria decision analysis at Leiden University College

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Abstract

The importance of training future decision analysts in Multiple Criteria Decision Analysis (MCDA) is paramount, given the complexities of decision-making challenges and the need to account for multiple conflicting interests and diverse stakeholders. This type of training is one of the core objectives of the Laboratory I lead at Leiden University College in the Hague, the Decision Engineering for Sustainability and Resilience (DESIRE) laboratory. This presentation will introduce some learning insights from the work I have started at the DESIRE laboratory since October 2021 to educate students in MCDA. It will specifically include experiences from training students in the application of Multiple Attribute Value Theory (MAVT) for the renovation of one of the greenhouses of the Hortus Botanicus of Leiden University. MAVT was firstly used by one of my final year thesis students to shape the decision-making opportunity by interviewing 10 stakeholders from the Hortus Botanicus. The interview protocol used was an adaptation of the 10 devices proposed by Ralph Keeney to identify objectives. This resulted in comprehensive framework with objectives and criteria to assess different renovation strategies (i.e., the alternatives) for the Hortus. This framework of objectives and criteria was then used by 10 students in my course "Decision Analysis for Environmental Management". The students achieved these objectives during this course while interacting via email as well by interviewing the 10 stakeholders: 1. Consolidate the criteria set by identifying their best, worst and good enough performances; 2. Develop value functions for each criterion; 3. Weight the criteria based on their interaction with the stakeholders; 4. Propose competitive alternatives, in this case renovation strategies for the Hortus Botanicus; 5. Develop a performance score for each of the renovation strategies and test the sensitivity of the results. During this presentation, I would also like to discuss valuable strategies to better integrate MCDA in the training of future decision analysts.

Keywords

MCDA training, Real-world case studies, MAVT.

Assessing criteria weights through prioritization in collaborative decision making situations

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Abstract

The Weights Assessment through Prioritization (WAP) method allows to estimate criteria weights in a two-step procedure: a) the criteria are rank ordered by the decision maker according to their importance and b) the consecutive criteria according to the ranking are compared in a pairwise manner where the decision maker is asked to provide the range where the one criterion is more important than the other, utilizing visual techniques in an interactive manner. Linear Programming techniques are employed for the estimation of the compatible weights' vectors and the analysis of the robustness of the estimated barycenter solution. This research work is focused on the exploitation of the WAP method to small group decision aiding process where a common accepted weight's vector is been sought based on the minimization of its deviations from the borders of the individual assessed compatible weights' vectors. Also, an analysis of the estimated collaborative weights vector is taking place concerning the robustness as well as the divergence from the individual compatible weights' vectors.

Keywords

MCDA, Collaborative Decision Making.

Developing EBPO framework for assessing circular procurement practices in building and construction industry

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Abstract

Many studies developed strategies for circularity implementation in construction and building industry (CBI), by prioritizing, and analyzing circular economy (CE) barriers or enablers or both in CBI, using multi-criteria decision-making methods (MCDM). When it comes to keeping the input of barriers or enablers to MCDM methods lagged in clear refinement of these inputs. This study developed strategies for circularity in construction procurement with causal information among enablers, barriers, practices, and outcomes (EBPO) of circular construction procurement (CCP), from fuzzy cognitive mapping (FCM). For the first time, analysed EBPOs together in CE and CBI literature with casual knowledge and representation. Based on previous circular construction studies EBPOs are interconnected and influenced by each other. Enablers and barriers of CCP influence practices undertaken by organisations to employ circularity in construction procurement. These employed practices, functions and deploy outcomes. To incorporate causal information, a three-step methodology is used. 1. Using fuzzy Delphi method (FDM), shortlisted the potential EBPOs from the collected total of 69 EBPOs from literature, to keep a refined potential list of EBPOs to second step i.e., FCM. 2. Using FCM, developed a mental model with mental modeler software for potential EBPOs finalised from FDM, and incorporated the causal knowledge among EBPOs with graphical representation. Calculated indegree, outdegree, and centrality degree using a mental model. Based on FCM degree results, prioritised high important EBPOs and considered for 3rd step of methodology, i.e., SWOT/TOWS analysis and in this step, developed strategies for CCP. All CCP EBPOs analysed in this study are effects and practices of construction organisations at proximity and with a definitive impact by circularity perspective. Such as eco-innovation, brand value, Industrial symbiosis, lack of expertise etc. This work is helpful for both academicians and practitioners in making CCP decisions.

Keywords

Circular construction procurement (CCP), construction and building industry (CBI), enablers, barriers, practices, and outcomes (EBPO), fuzzy Delphi method (FDM), fuzzy cognitive mapping (FCM), SWOT/TWOS analysis.

Session IV

Friday 22 September, 8:30-10:30

Chairman: *Milosz Kadzinski*

Decision rules for drug discovery

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Abstract

Drug discovery is a complex and expensive process; many experiments end up with a negative result, proving a given molecule is not a promising candidate to be a biologically active agent and, therefore, should not be further considered. Reducing the number of these failures potentially saves time and resources available for more promising cases. To this end, we introduced a dominance-based rough set approach usable as a first filter, replacing well-known rules like the already classical Lipinski "rule-of-five" or Ghose filter. First, noisy data from real experiments are preprocessed and cleaned by finding consistent lower approximations for each decision class. Then, the clean data are used to build a decision model based on decision rules, decision trees, neural networks, or support vector machines. The models are validated and tested by domain experts, using real data. Finally, the best model is used to determine the molecules having the highest potential to be biologically active and, therefore, continuing as the focus of experimental verification.

Keywords

Drug discovery, active molecules, decision rules.

Sorting radiology departments in a disaster management assessment with G-ARASsort

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Abstract

This study presents a new multiple criteria group decision making (MCGDM) sorting method, named G-ARASsort - a new variant of the additive ratio assessment (ARAS) ranking method, to address a disaster management assessment problem through a group consensus. MCGDM sorting methods improve a decision-making problem by providing useful and unparalleled insights. Disaster management is one of the most critical areas of decision-making, where decisions are made under tremendous pressure. Radiology units play a central role in disaster management and the present study establishes a new disaster management assessment framework to assess their disaster readiness. The proposed method is applied to sort 37 radiology units into four ordered classes, defined through a Delphi panel. The results show that approximately 11% and 14% of the departments placed in the first (best) and the last (worst) classes, respectively. The findings can help the lower-class units improve their performance by using the upper-class units' performance as a yardstick. Additionally, healthcare directors can identify more reliable radiology units to turn to during disasters and prevent patient misallocation. A comparative analysis is also conducted to confirm the method's competency.

Keywords

Multiple-criteria decision analysis, multiple criteria sorting, group decision making, disaster management, radiology.

Multi-criteria analysis as a tool to cope with asymmetric information: An application to the hospitality sector

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Abstract

The hospitality industry, featuring various of actors such as hotels, restaurants, and online booking platforms, faces the challenge of asymmetric information between these entities and customers, leading to challenges in decision-making. To help, rating systems have been introduced, but they have flaws including inaccurate representation of service quality and lack of transparency in rating allocation. Rating systems often focus on the availability of amenities, not the intrinsic quality, leading to misrepresentation of the services offered. For instance, hotels may receive high ratings for having amenities like pools or gyms, neglecting the quality of rooms or services. Another challenge is transparency; customers are not privy to the process behind star ratings, and this varies between countries, making it challenging to compare hotels globally. The current systems overlook customer preference diversity. While they provide a general quality indication, they fail to meet specific customer requirements. For instance, some customers might value bed and bedding quality, while others might prioritize food quality. We propose a new rating model using multi-criteria analysis (MCA) theory, considering the unique challenges of the hospitality industry. The hotel evaluation model involves many criteria, which can be overwhelming for customers. To tackle this, we propose a model that includes preparation, optimization, and ranking. In preparation, an unweighted, disaggregated evaluation MCA is constructed. Value functions of criteria are redefined to yield precise preferences and the criteria are categorized for ease of evaluation. In optimization, the 'elimination by aspects' concept is used. Customers express their ‘must need’ requirements, which become constraints of the optimization model, eliminating unsuitable hotels. In ranking, customers rank their criteria priorities using the best-worst method for consistent results. This model aims to bridge the information gap, ensuring customers make informed decisions tailored to their specific needs.

Keywords

MCDM/A, asymmetric information, hospitality sector.

Quantifying the street-level quality of life using GIS, ELECTRE-TRI and human experts

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Abstract

Quality of life has been quantified in a number of ways and at various levels of granularity. For example, the Human Development Index and its variants are well-known indicators at country or regional levels. However, the area of quantifying quality of life at street level remains under-studied. This work is being carried out in collaboration with our industrial partner whose aim is to offer high-resolution quality of life indicator that can be integrated with geographic information systems. In this research, we obtained data for Mexico City from various different sources capturing different aspects of life, for example, road quality, crime rate, and availability of certain amentities etc. After cleaning and fusing these data from disparate sources, we used ELECTRE-TRI to sort each location (a grid point on the city map) into ordered categories (from high to low quality of life). The model was prepared and validated with the help of company experts. This was achieved by creating reference profiles that act as boundaries for each category and eliciting the indifference, preference, and veto thresholds with the help of experts from our industrial partner. As the work is in progress, our aim is to share our methodology and findings with the MCDM community seeking their feedback to improve this work.

Keywords

Quality of Life, ELECTRE-TREE, ELECTRE-TRI, Data Analytics, Spatial Decision Making.

Influential criteria definition for digital projects prioritization using HFLTS: An application to the automotive sector in CUPRA

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Abstract

Digitalization pushes manufacturing enterprises to re-adapt their working model and adopt new business models to face this organizational shift. Among the most established manufacturing sectors, the automotive industry is facing the challenge of how to rethink the traditional vehicle to incorporate digital technologies in the designing, manufacturing, and servicing processes. Unlike physical products (in this context automobiles), digital products for servicing like the website, the car configurator, the eCommerce platform, the car connectivity system, or the Mobile App for connecting with the vehicle, are mostly based on software. Thanks to their nature, digital products can be managed following an Agile approach. Among many other benefits, the Agile approach enables enterprises to develop new functionalities for digital products every 3 months, meeting the fast-changing customer needs and interests. However, in the context of managing multiple digital products simultaneously with limited economic resources and workforce, prioritization of new digital functionalities (from now on digital requirements) to develop is crucial. To cope with this task, practitioners can rely on different methodologies for prioritizing digital requirements (MoSCoW, Planning Poker, Cost of Delay, RICE, Kano, etc..) that are mostly subjective, relying on experts' knowledge and experience. This work focuses on the Cost of Delay estimation, trying to overcome the subjectivity issue by proposing a data-driven process estimation. The approach used, based on Delphi process and Hesitant Fuzzy Linguistic Term Sets, is considered to define the set of consensual criteria to adopt when estimating the cost of delay of a new digital requirement. The study has been conducted within CUPRA, involving 15 internal stakeholders (Product Managers and Business Owners) responsible for all the different streams of digital business currently running at the company. During 2 rounds of meetings, qualitative and quantitative data have been collected to measure the global consensus of panelists for each of the criteria of the framework.

Keywords

Requirements Prioritization, HFLTS, Delphi process, consensus evaluation, Agile.

Considering interactions between criteria and projects in portfolio decision analysis

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Abstract

We consider a multi-attribute portfolio optimization problem together with the conditions of intra- and between-project independence. When these two conditions hold, values of projects and portfolios of projects can be represented by additive value functions. On the contrary, if these conditions are violated, then more general functions are necessary. We propose an approach based on the 2-additive Choquet integral to aggregate values both at project and portfolio levels. We propose to model the problem in two steps. First, attribute values of projects are aggregated to represent the values of projects, and then, in turn, these can be aggregated to find a suitable value for each possible portfolio. Given the complexity, in terms of necessary parameters, we adopt a preference learning approach: given some preference statements of an expert, we consider the space of all compatible 2-additive capacities, and we use its barycenter. Finally, a simple combinatorial optimization problem is used to find the best portfolio under a number of budget constraints.

Keywords

Portfolio decision analysis, intra- and between-project independence, 2-additive Choquet integral.

Choosing an aggregation method for the Prison Life Index

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Abstract

When building an index, choosing an aggregation operator is a core issue. Some authors argue that indexes can be summarised by their aggregating function (Saisana et Tarantola, 2002; Nardo et al, 2005, OCDE, 2008; Munda, 2012), defining them formally as the mathematical combination of simple indicators representing different dimension of a concept for which the description or the evaluation are the objectives of the analysis (Saisana et Tarantola, 2002.) To choose an aggregation method is to answer to several theoretical issues that define the core property of these tools: what is the acceptable degree of compensation between the different indicators? In case of absence, full or partial substitutability, what does it say about the definition of the core concept being defined? How can one assure that the aggregation respects the comparability or incomparability of the used data? Paradoxically, those challenges are quite well identified in the literature (El Gibari, Gomez & Ruiz 2019; Annoni & Sconi 2022 to take two recent example) on index-building but to date, most CIs are built following linear aggregation, weighted or not (Greco, Ishizaka, Tasiou & Torrisi, 2019) which causes very specific shortcomings such as compensability effects, collinearity effects and lack of significance. These challenges are all the more significant that indexes are increasingly being used to evaluate highly multi-dimensional and complex realities as human rights at a global level (UNCHR, 2012; Merry, 2012). We show that it is possible to define an index as a multi criteria decision aiding (MCDA) problem where the decision-maker establishes theoretical, ethical and structural challenges. We use a real-life case application: the building of the *Prison Life Index*, a tool to evaluate prison conditions in the world and prison policies from rulemaking to implementation and focus on the selection of an *ad hoc* aggregation method. We adopt a method derived from ELECTRE-TRI (Bouyssou & Roy, 1992) and show its efficiency on an original data set collected for 4 countries: Chile, Georgia, Ireland, South Africa. The set comprises the results for 70 indicators that are related to the conditions of detention in each country over five categories: (1) connection with the outside, (2) physical protection, (3) material conditions, (4) medical care and (5) activities. We present the results of this aggregation method and its characteristics (estimation of the veto effect according to the elicitation of the decision-makers preferences, determination of the majority threshold) as well as a brief sensitivity and robustness analysis on existing data. We show that the properties of this method answer to the theoretical challenges identified when choosing an aggregation operator for an index and that MCDA offers multiple techniques and tools that should be more widely considered by index builders and international organisations using them.

Keywords

Composite index, rights, prison, aggregation, indicator.

An approach to investigate fairness using dominance-based rough sets analysis

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Abstract

Within data driven decision support, those making decisions may look to declare how openly stating (and providing) the data being utilised can facilitate greater transparency, trust, and acceptance of decisions by those for which the decisions are impacting. However, a false sense of transparency may be cultivated as the data could still be utilised inconsistently when determining decision outcomes. In our work, we propose an approach to investigate fairness within data driven decision making using the Dominance-based Rough Set Approach (DRSA). Within scenarios where decision outcomes can be one from a hierarchical set of outcomes, and determined based on multiple criteria, DRSA can be utilised to extract understandable IF-THEN decision rules from historical data. DRSA is commonly utilised to create a (single) set of decision rules from a (single) dataset, to then analyse for insights and/or future predictions. Conversely, in our work, we utilise separate data segments of a dataset, to create a separate DRSA ruleset for each data segment. When such data segmentation is done with respect to an attribute which should not be impacting decision outcomes, such as age in recruitment decisions, or gender in exam grades, then we would expect to see some consistency in the separate rulesets that are extracted. If there are significant inconsistencies between rulesets, with significant differences between criteria values that result in the same outcomes, this may suggest unfairness within the utilisation of the data being used to make decisions. During the covid-19 pandemic, for their second waves, several countries took a tiered approach to restriction of movement - making separate decisions to decide the level of restriction to be imposed in different geographical areas. The UK government announced such a tiered restriction system where areas were assigned a tier level between 1-4, with the higher the number the more severe the restrictions of movement. For these decisions, they declared a set of covid-19 related criteria to be used to determine what level of restrictions (tier) should be imposed in each area. Although the tiered system appeared to be a sensible approach many found it unsatisfactory, due to a lack of sufficient transparency. Utilising different government and open-source data sources and APIs, we explored the application of our fairness approach for this domain. Through comparisons of different DRSA rulesets, extracted from different geographical area data segments, we found inconsistencies in the allocation of tiers. We found the differences delineated an overall trend of inconsistency between the north and the south of England, with the inconsistencies driven mostly by London, suggesting that London was treated more leniently than the rest of the country. The approach could be utilized to explore fairness within other domains with an underlying dataset that can be sliced by an attribute that should not be impacting decisions, such as age or gender in recruitment or exam grade decisions.

Keywords

Dominance-based rough sets, Decision-fairness, Data-driven decision-making, Covid-19.

Integrating multiple ESG investors' Islamic preferences using fuzzy multicriteria methodological approach

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Abstract

The purpose of this study is to examine how the environmental, social, and governance (ESG) performance of Islamic finance companies affects their overall performance and market value. The research analyzed a total of 1273 publicly listed companies in 27 countries. Multiple regression analyses, along with a random-effect model and descriptive statistics, were employed to analyze the data. This challenge by developing a methodological approach based on an application of fuzzy multicriteria decision-making methods (MCDM) to integrate ESG investors' Islamic preferences, as jointly considered. The ESG Score served as the dependent variable (with and without Sharia), while the independent variables included three performance indicators (Return on Assets, Return on Equity, and Tobin's Q) as well as the Price-Earnings ratio. Additionally, several control variables were considered, such as firm size, age, financial leverage, and industry. This study contributes to the existing literature by expanding the analysis of ESG performance to Islamic countries and utilizing relatively uncommon dependent variables, such as market value. The findings suggest that ESG Score does have a significant influence on firm performance and market value since it is not yet considered a comprehensive measure of Islamic firm performance. However, it should be noted that this research is limited in terms of the lag effect analysis, which only considered a one-year lag period. Furthermore, the number of companies with available ESG scores is also limited.

Keywords

ESG, Islamic Finance, MCDM, Financial Performance, Market Value, Sustainability.

Decision making in insurance systems for the compensation of losses and damages caused by climate change effects: Case of cereals sector in Tunisia

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Abstract

In a country like Tunisia, characterized by an arid and semi-arid climate, cereal crop yields are often low and threatened by the effects of climate change, such as drought and yield losses. Therefore, the lack of self-sufficiency in cereals and the objective of stabilizing populations push the government to encourage local cereal production and protect farmers through a system of price compensation and agricultural disaster compensation. Generally, this government protectionist system is accompanied by compensation premiums provided by private insurance companies. In developing countries, agricultural insurance is underdeveloped or even non-existent in certain regions of Tunisia. Thus, the integration of agricultural production insurance into the compensation system requires consideration of a decision support system that is both complex and influenced by climate and behavioral uncertainties of farmers in terms of risk aversion. Some large-scale projects, such as ACCAGRIMAG, have attempted to introduce private insurance and financial institutions into this compensation system, but the attempts were weak, and the approaches used are conventional and not well-suited to the Tunisian model. In this article, we will attempt to identify most important actors, the general context of the study and highlight the most important factors that influence the decision-making system in compensation processes. In a second section, drawing inspiration from the French models of agricultural disaster compensation, we will propose an appropriate model to the Tunisian system, emphasizing the main criteria to be considered in the decision-making process of whether or not to compensate, clearly presenting the basic assumptions, the type of data to be collected, and the constraints to be considered in order to choose the most suitable multicriteria method for this study. Finally, we will present the most suitable multicriteria paradigm and the expected results of this study.

Keywords

Insurance, compensation, damage, climate change, cereal sector, mutlicriteria decision making.

Multi-criteria analysis of the performance and resilience of traditional and ESG ETFs in high inflation environments

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Abstract

Inflation is a critical macroeconomic variable that significantly influences the performance and capital allocation strategies of various investment vehicles, including traditional Exchange-Traded Funds (ETFs) and Environmental, Social, and Governance (ESG) ETFs. This research paper aims to explore the impact of inflation on the performance and capital allocation strategies of these two distinct types of ETFs. The initial phase of our investigation will center on the influence of inflation on conventional Exchange Traded Funds (ETFs). This analysis will entail a comprehensive exploration of how inflation-driven changes in the macroeconomic environment reverberate through the performance metrics of these ETFs. Furthermore, we will meticulously scrutinize the capital allocation strategies employed by conventional ETFs, placing particular emphasis on understanding how these strategies evolve in response to inflationary pressures. By conducting this analysis, we aim to develop a thorough understanding of the intricate interplay between inflation, capital allocation strategies, and the performance of conventional ETFs. Subsequently, our attention will shift to Environmental, Social, and Governance (ESG) ETFs. We will undertake a parallel analysis to that conducted for conventional ETFs, delving into how inflation influences the performance of ESG ETFs and the distinct capital allocation strategies they employ. This comparative analysis will shed light on the differing impacts of inflation on conventional and ESG ETFs, thereby offering a nuanced understanding of the performance dynamics exhibited by these two categories of ETFs in an inflationary context. Moreover, we will delve into the performance implications of ETFs that proactively adjust their capital allocation strategies in response to inflation. This will entail a meticulous performance analysis comparing ETFs that exhibit adaptive behavior with those that adhere to a static capital allocation strategy. Through this examination, we aim to gain insights into the effectiveness of capital adjustment as a response to inflation and the performance consequences associated with diverse capital during periods of inflation. In addition to performance analysis, we will explore the potential advantages of adaptive capital allocation strategies during inflationary periods. This will involve a thorough examination of the merits of flexible capital allocation strategies in mitigating the detrimental effects of inflation on investment returns. Finally, we will address the critical aspect of risk management for both conventional and ESG ETFs. Our discussion will encompass various risk mitigation techniques and strategies aimed at identifying and circumventing potential investment risks arising from inflationary conditions. This academic research, employing a multi-criteria methodology in portfolio management, aspires to equip investors with crucial insights for maneuvering the intricacies of investment decisions within an inflationary landscape.

Keywords

ESG, ETF, Portfolio, Inflation, Multicriteria.

Session V

Friday 22 September, 10:50-12:50

Chairman: *Constantin Zopounidis*

An extended version of the Sigma-Mu efficiency analysis on a sample of banks from the EU-wide stress test of EBA

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Abstract

The Sigma-Mu efficiency methodology introduced in Greco et al. (2019), evaluates, under the framework of Stochastic Multi-Attribute Acceptability Analysis (SMAA), the performance of alternatives by synthesizing the distribution of composite indicator values (CI) with two metrics: the standard deviation σ and the mean value μ. These two indicators are the starting points to compute for any alternative the σ-μ Pareto-Koopmans local efficiency with respect to the family of σ-μ Pareto-Koopmans frontiers (PKFs) and determine the global σ-μ Pareto-Koopmans efficiency score. However, the aforementioned model lacks of considering the Pareto dominance relation, leading to eventual inconsistent results in the σ-μ Pareto-Koopmans global efficiency scores. Therefore, the aim of this paper is to provide an extended version of the σ-μ efficiency analysis by introducing the concept of the Pareto dominance relation. To illustrate the whole approach, we evaluate the performance of a sample of EU-wide stress banks, that are published annually by the European Banking Authority (EBA), by considering not only financial variables, but also the environmental, social and governance factors (ESG) over the last five years available (2017-2021).

Keywords

Sigma-Mu efficiency, composite indicator, dominance constraints, EU-wide stress test EBA, ESG criteria.

A ESG rating model for SMEs using multi-criteria decision aiding

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Abstract

Through ESG assessments and ratings, companies can effectively measure their exposure to environmental, social, and governance (ESG) risks, identify opportunities for sustainable growth, and assess their long-term sustainability and future social and environmental impact. This process is crucial for listed small and medium-sized enterprises (SMEs) wanting additional support in their ESG transition. The importance of such assessments will only intensify in the future as the implementation of the Sustainable Finance Disclosure Regulation (SFRD) and the Corporate Sustainability Reporting Directive (CSRD) will require all listed companies to be on equal footing regarding ESG reporting. In this contribution, we propose to apply a multicriteria method (MURAME) to assess the sustainability profiles of SMEs. The considered procedure allows the assignment of a quantitative metric measuring a firm's environmental, social, and governance (ESG) efforts. The methodology is applied to a sample of European-listed SMEs: experimental results aim at capturing potential sector and country-specific effects, so as to identify leaders, followers and laggards. The obtained ranking shows some degree of robustness across different model parameterizations. Furthermore, in this contribution we propose to model and subsequently to document the benefits of voluntary disclosure of non-financial information, under a prudential scoring framework.

Keywords

Sustainability, ESG rating, SMEs, MURAME.

Financial distress prediction using a fuzzy MCDM approach with criteria interactions and TOPSIS sorting

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Abstract

Financial distress prediction is widely considered to be among the most intensively researched areas of finance, which presents the challenge of constructing efficient classification models. Various statistical and machine learning approaches have been used during the process of model development for credit rating systems. These approaches need a significant amount of data and are based on assumptions about the distribution of that data. The study presented here presents an integrated fuzzy credit rating model as a solution to these kinds of problems. An integrated fuzzy credit rating model is proposed as a potential solution to these types of issues in this research. In the research, the fuzzy best–worst approach, also known as fuzzy-BWA, is used to initialize the weights of the variables that influence creditworthiness. Additionally, fuzzy cognitive maps (FCMs) are exploited to consider the interactions among the variables. Finally, the fuzzy methodology for order of preference by similarity to ideal solution, also known as fuzzy-TOPSIS–Sort-C, is used to rank the companies. When compared to other multi-criteria decision-making (MCDM) approaches, the BWA was shown to be consistent, and this consistency was found to increase even more when the BWA was expanded to a fuzzy form. To further improve the effectiveness of variable weight calculation and incorporate the variable interactions, the weights obtained using fuzzy-BWA are combined with those from FCMs. Then, the TOPSIS-Sorting algorithm, equipped with the calculated fuzzy weights, is used in this work in an effort to mitigate the impact of human uncertainty on decision making. It has been discovered that the TOPSIS-sorting algorithm is able to solve the rank reversal difficulties that are inherent to the TOPSIS approach. In order to assess potential borrowers using the distinctive profile of the stated criteria, a dataset concerning 577 U.S. firms is used to validate the proposed model. The findings demonstrate improved accuracy in terms of both accuracy and the misclassification cost when attempting to forecast rating classes, which can help banks better assess the potential default of borrowing firms.

Keywords

MCDM Approach, Fussy, Cognitive map, TOPSIS Sorting, Distress prediction, Bankruptcy.

Multicriteria portfolio analysis for cryptocurrencies

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Abstract

This research aims to construct optimal portfolio with selected cryptocurrencies and SP500. The construction is based on the global minimum variance (GMV), minimum conditional value-at-risk (Min-CVaR) and certainty equivalence tangency (CET) criteria and model the dependence structure between cryptocurrencies and SP500 returns by employing elliptical (Student-t and Gaussian) and Archimedean (Clayton, Frank and Gumbel) copulas. We use GARCH-EVT-copula and ARMA-GARCH-EVT-copula models to perform out-of-sample forecasts and simulate one-day-ahead returns.

Keywords

Cryptocurrencies, Portfolio optimization, GARCH models, Extreme value theory, Copula models, Conditional Value-at-Risk.

On a portfolio optimization problem arising in proof-of-stake blockchains

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Abstract

We consider a portfolio optimization problem arising in some Proof-of-Stake blockchain environments. In this context, human decision makers (nominators) are in charge of finding and selecting suitable operators of the blockchain (validators). Their selection is driven by individual preferences over multiple criteria and therefore can be considered a MCDM problem. Beyond that, nominators frequently have multiple identities, and it is in their best interest to make a heterogenous selection of validators for each identity, which represent their preferences on aggregation. We formulate a multi-objective optimization problem where different metrics, mainly expected profitability, security and decentralization, are considered and we employ an evolutionary algorithm to study the Pareto frontier.

Keywords

Portfolio optimization, blockchains, multi-objective evolutionary optimization.

An application of MCDA procedure to the location of radioactive waste deposit according to Legislative Decree

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Abstract

The procedure followed by Sogin (company appointed by the Ministry for the location of the deposit of radioactive waste in Italy) regarding the suitability of the possible sites, has followed analytical procedures that do not find any confirmation in the scientific field of MCDA. The decisional process drawn up is clearly in contradiction with the provisions of art. 27 of Legislative Decree no. 31/2010, by which the technical and socio-environmental characteristics of the areas and the potential direct benefits to involved stakeholders, could be simultaneously quantified. Moreover, the structure of a decisional tree is missing and there is a remarkable mixture among factors and criteria, summarized in the irrational and schematic dichotomy of favorable and unfavorable, with a remarkable absence of weighting of them. This paper, taking into account the ministerial directives of the Legislative Decree, aims to highlight how the decision could be carried out according to the procedures of the MCDA, with the quantification of the criteria in their physical, environmental and social-economic values, in particular, regarding the seismic aspect through the introduction of specific veto thresholds, spreading the areas in more or less high eligibility bands. Especially the stakeholders who were completely ignored in the Sogin proposal, are also taken into account, as well as the specific economic and sustainability conditions of the area, completely disregarded by Sogin. Taking into account a set of areas, as already considered eligible by Sogin, an application of MCDA procedure aims to enlighten how to point out a rational and coherent decisional process, also by an analysis of robustness of the results as required by the directives imposed by the Legislative Decree.

Keywords

Legal provisions, stakeholders, decision tree, thresholds, robustness.

A new multi-method decision framework for anchor selection and tenant mix allocation optimization in shopping malls

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Abstract

The unstoppable growth of cities and the increasing pace of life has led to a genuine interest in implementing shopping malls. These malls have changed the customers' shopping patterns and are used to optimize both the building space required and the time spent by shoppers. Due to their acquired importance, these malls have become critical players in the sales sector. Thus, multiple marketing and scientific studies have been conducted to analyse and improve their sales and their attractiveness in gaining buyers. Nevertheless, most studies are limited to recommendations and are not based on comprehensive scientific methods. In particular, two main issues in shopping centres have been overlooked. Firstly, there is no defined scientific method to classify the shopping centre's anchors and regular tenants. Secondly, there is no method for allocating the position of the shops within the mall. Therefore, this paper presents a multi-method framework to classify anchors and tenants and to distribute them in the shopping mall. The multi-method framework comprises a new sorting method, a modified ranking method, a product correlation technique based on the implementation of ecological dynamics, an ecological interrelation index and a metaheuristic allocation algorithm. Finally, the paper provides a case of study to illustrate the performance of the new multi-method framework.

Keywords

Tenant mix problem, tenant allocation, MIVES sorting, shopping mall management, shopping mall optimization, modified MIVES.

An interactive preference-guided multi-policy deep reinforcement learning approach

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Abstract

Deep reinforcement learning has proven to be a powerful approach for solving complex decision-making problems with multiple conflicting objectives. However, efficiently exploring the Pareto front remains a challenging task due to the computational demanding learning process. In this work, we propose a novel interactive approach that incorporates preference information into a multi-policy deep reinforcement learning framework. By iteratively eliciting pairwise comparisons of non-dominated policies from a decision-maker, we propose to focus the search to solutions compatible with the user's value functions. The preference information is then incorporated into the reinforcement learning algorithm to guide the exploration towards the most promising region of the objective space. Furthermore, we propose to employ the Choquet integral to extend the model to handle non-linear value functions, enabling exploration in the non-convex region of the Pareto front. A series of experiments on benchmark problems is planned to assess its ability to discover policies that meet user aspirations while efficiently guiding the algorithm. By bridging deep reinforcement learning and multi-criteria decision-making, our proposed method offers an innovative framework for addressing multi-objective problems effectively, supporting decision-making interactively, and improving convergence towards preferred policies.

Keywords

Multi-objective optimization, Deep reinforcement learning, Decision support systems, Choquet integral.

Application of entropy weight and TOPSIS method in the selection of sustainable financial institutions in Europe

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Abstract

The growing public knowledge of concerns such as climate change, social inequity, and corporate fraud is fast transforming the market environment. Globally, investors are demonstrating a significant growth in demand for sustainable financial solutions. Sustainability and corporate behavior have an impact on financial institutions' reputation and commercial success. Environmental, Social, and Governance (ESG) aspects are a measurable evaluation of sustainability and corporate practices. However, ESG challenges, as well as the dangers and possibilities they offer, are becoming more important to financial institutions. However, this is a new and developing domain in which dangers are complicated, interconnected, and still evolving - with data sets and modeling surrounding them still in their infancy. Thus, selecting sustainable financial institutions based on ESG considerations is a difficult endeavor since it entails a complicated decision-making process encompassing many aims and organizational priorities. We propose an entropy based TOPSIS multiple criteria decision-making approach to handle this problem. In the current study, ethics is included as a fourth component of sustainability, alongside with the Triple Bottom Line, as ethics is important in purchasing behavior and financial institution selection. These sustainable financial institution selection criteria have been divided into 14 sub-criteria for evaluation. The findings show that economic considerations continue to drive sustainable financial decisions. Additionally, factors such as human rights, health training, safety systems, e-waste, reduction emissions, and controversies are found to be prioritized, when selecting a sustainable financial institution.

Keywords

Entropy weight, TOPSIS, sustainability, efficiency, green finance, decision making.

Reexamining the oil price & Islamic finance relationship: A multicriteria time series analysis

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Abstract

Our study revisits the relationship between oil prices and Islamic finance over the last two decades for developed and emerging countries through a multicriteria analysis time series approach. Specifically, we assess this relationship during turbulent times, considering the effect of recent healthcare shock and oil price shock caused by the coronavirus disease (COVID-19) pandemic and war in Ukraine, respectively. Therefore, we built an Autoregressive Distributed Lag (ARDL) specification using multicriteria time series tests that dealt with variables that did not require any transformation (detrending, stationarity, etc.), allowing us to use maximum available information. Our results reveal two interesting findings. First, although the oil sector has a significant impact on Islamic stock indices, there is a lack of evidence regarding a cointegration relationship, suggesting the absence of a long-term relationship and therefore a mean reversion between these two markets, particularly in developed countries. Second, since COVID-19, a mean reversion in the Islamic stock market (for both developed and emerging countries) has occurred, suggesting the presence of a cointegration relationship and active adjustment mechanism. The channel of investor behavior and market anxiety appears to drive this error correction mechanism. These findings indicate oil price–Islamic finance integration and market inefficiency.

Keywords

Multicriteria time series tests, Mean reversion Process, Cointegration, ARDL model, oil price volatility, Islamic Finance, COVID-19.

On multicriteria ESG sovereign assessment

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Abstract

In the last decade the global investment landscape has shifted towards sustainable investing due to a number of climate and energy related global initiatives but also due to major changes in the regulatory framework around the globe. In 2015, under the Paris Agreement, commitments were made to drastically reduce greenhouse gas emissions, bringing them "close to zero" by 2050. In the European Union, the financial sector in order to achieve the goals of the European Green Deal and other global climate-related commitments is gradually shifting long-term investments in sustainable projects and other net zero transition related activities, significantly facilitating the mobilization of capital towards these areas. As the demand for sustainable investing continues to grow, so does the importance of reliable and transparent data with a number of ESG rating agencies already established in this field. Yet, despite the increased interest in the field of ESG, a wide and growing divergence emerges between various raters of ESG evaluators when they assess the performance of the same corporates across the globe. In this paper, we focus on ESG sovereign assessment, and we construct a database of publicly available metrics, using a sample of 24 OECD countries. After all, the outmost purpose of ours is to explore the various multicriteria modeling dimensions of the ESG sovereign assessment problem and provide a standardized aggregate ESG sovereign evaluation.

Keywords

MCDA, ESG, Sovereign Assessment.

Session VI

Friday 22 September, 14:20-16:20

Chairman: *José Rui Figueira*

An exact method to compute the optimistic solution to linear bilevel problems with multiple objectives at the lower level

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Abstract

Bilevel programming is useful to model optimization problems with a hierarchical relation between two decision makers (the leader and the follower), who make decisions sequentially in a non-cooperative manner. The two decision makers control different sets of variables aiming to optimize their own objective functions. The leader commits to a strategy before the follower, who then optimizes his/her own objective function within the options restricted by the leader's decision. Dealing with multiple objectives at the lower level (semi-vectorial bilevel problems) is particularly challenging due to the existence of a set of lower-level efficient solutions for each leader's decision. In this work, we propose a general-purpose exact method to compute the optimistic solution to semi-vectorial linear bilevel problems. The method is based on the exhaustive search of efficient extreme solutions of an associated multiobjective linear programming (MOLP) problem with many objective functions. Therefore, its development required the design and implementation of an effective vector-maximum algorithm for MOLP problems. The method relies on a proposition stating that an optimistic optimal solution to the semi-vectorial linear bilevel problem is an efficient extreme point of this MOLP problem for which the number of objective functions is equal to the number of lower-level objective functions plus the number of upper-level decision variables plus one. Since the number of objective functions of the associated MOLP problem increases with the number of upper-level decision variables, and the number of efficient extreme points of a MOLP problem grows very quickly with the number of objective functions, this method is mainly adequate to bilevel problems with a small number of upper-level decision variables. This number is the dimension with the major impact on the computational effort required by the method. Based on the same principles, a local search heuristic procedure has also been designed to deal with problems in which the complete extreme point enumeration becomes impracticable within a reasonable computational time. The aim is to provide higher quality solutions when the exact method is not able to reach the optimal solution given a computational time budget. A computational study is presented to evaluate the performance of the exact method and the heuristic procedure, comparing them with an exact and an approximate method proposed by other authors, using randomly generated instances. Our approaches reveal interesting results in problems with few upper-level variables. The heuristic showed to be quite effective in problems where the global optimum is difficult to achieve.

Keywords

Linear bilevel optimization, Semi-vectorial bilevel problem, Multiple objective programming, Multiobjective simplex method.

Are negative interactions really exist in MCDA?

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Abstract

In the context of Multicriteria Decision Analysis, the Choquet integral model is mainly used to model preferences of a Decision Maker when some interdependencies between criteria exist. These interactions are taken into account through the Shapley interaction index. Its sign, which is not always stable using a same preference information, can be positive, null, or negative. Therefore, to be caution in the interpretation of interactions, the concept of necessary and possible interactions has been introduced. We show through some examples that, such Shapley interactions are not necessarily related to the classic independence property (in the sense of preferences). To overcome this limitation, we introduce a new interaction index based on the Kemeny distance, the d-interaction index, for which the sign is always nonnegative. Furthermore, we proved that there exist some interactions between criteria, when the independence property is violated, if and only if the associated d-interaction index is not null.

Keywords

Choquet integral; preferences; interaction; independence property.

A simple adaptation of the Dunn index to assess multicriteria partitions

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Abstract

Clustering or unsupervised classification has a long tradition in machine learning. Methods like the k-means algorithm, top-down or bottom-up hierarchical procedures, gaussian mixture models, etc. have demonstrated their usefulness in a lot of real applications. The aim here is to partition a set of objects into homogeneous and well-separated groups that are called "clusters". These approaches are based on a similarity measure that quantify if two objects are alike or not. By definition, a similarity measure is symmetric. In multiple criteria decision aid (MCDA), sorting methods are somehow related to supervised classification. Alternatives must be sorted into predefined (and often completely) ordered categories. These groups are defined by using limit or central profiles. Over the last 15 years, researchers have started to investigate the application of clustering techniques in multiple criteria decision aid. This can be viewed as a preprocessing step to sorting in contexts where categories are not known in advance. In MCDA, the comparison of pairs of alternatives, most of the time, leads to non-symmetric (valued or binary) preference relations. Therefore, the direct application of existing clustering methods is not appropriate. Different approaches have been proposed for multicriteria clustering. In this talk, we will investigate the simplest modification of the k-means algorithm that is compatible to non-symmetric "preference" relations. This will lead us to further develop indices allowing to assess the quality of a given multicriteria partition.

Keywords

Clustering, multicriteria partition evaluation indices, sorting.

Some notes on the joint improvement of inconsistency and incompatibility in a local AHP-GDM context

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Abstract

Two of the most important aspects of multi-actor decision-making are consistency and compatibility. In a local AHP-Group Decision Making context, consistency refers to the rationality of individuals when eliciting their judgements and compatibility to the representativeness of the collective position. Assuming that the Row Geometric Mean is the prioritisation method used in AHP, and that inconsistency and incompatibility are measured, respectively, by the GCI and GCOMPI, this paper offers a methodological framework for the joint improvement of the two indicators. The proposal contemplates small modifications in relative terms of the judgements of the collective pairwise comparison matrix and presents different variants for the joint improvement of inconsistency and incompatibility. Notable reductions in both indicators are obtained.

Keywords

AHP, Group Decision Making, Consistency, Compatibility, Efficiency.

Hierarchical DRSA-approach for the multiple channel retailing

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Abstract

The Covid-19 pandemic clearly showed that retailers require strategic guidance rather than ad hoc market response when transitioning from physical to multiple-channel sales. Integrating digital customer touchpoints in existing physical sales channels is an optimization problem requiring careful managerial planning and strategic thinking. Suboptimal solutions in terms of inadequate or improper specific multiple channel strategy implementation make retailers miss out on vital inter-channel synergies. Customer value is derived from an optimized combination of sales channels, their use, as well as their mutual interactions. So far, research efforts have been directed to quantify and objectify the existing two-dimensional multiple-channel strategic categorization. We introduced a model using the dominance-based rough set approach (DRSA) framework to derive a set of "if-then" decision rules. These rules served as a prescriptive managerial guideline for resource allocation on channel dimension attributes most important for implementing the planned multiple channel strategy and KPI prioritization in a specific strategic context. The derived multiple channel strategic roadmap proved to be a unique multiple criteria prioritization tool with strong managerial implications. The tool itself, however, is not without its limitations. Although the business scope of the roadmap is expanded through multiple channel dimensions later on, these qualitatively evaluated dimensions are intertwined with other quantitative KPIs. An improved version of the model is needed, one which separates qualitatively and quantitatively evaluated channel attributes. In this sense, qualitative inputs should all be analyzed simultaneously within a single, multiple dimension framework. By introducing advanced hierarchical ordering, we will be able to objectively extract all informational value from the observed channel attributes, allocating each retailer to a specific multiple channel strategy. By concluding the diagnostic phase, we will transition to the model's predictive (planning) aspect, where the modified DRSA method will be used to determine optimal levels of all analyzed quantitative KPIs, respective to the specific multiple channel strategy. This way, retailers will have a quantified pathway to each multiple channel strategy. This will allow for much more precise strategic planning and performance monitoring. There are several upsides to the proposed modifications of the previous model. Firstly, the practicality of the model is maximized through a clear cut between the diagnostic and predictive phase. Secondly, model prediction accuracy is improved through iterative segregation of qualitative and quantitative indicators. Thirdly, the derived output in the form of quantitative-based if-then rules can be easily combined into existing and widely spread strategic tools, such as Balanced Scorecard.

Keywords

Multiple Criteria Decision Aiding, Dominance-based Rough Set Approach, Multiple channel strategy, Brick-and-click retail, Omni-channel strategy

A multicriteria approach for the definition of priorities of intervention for roadway bridges and viaducts

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Abstract

In recent years, the assessment of structural performances and functionality of roadway bridges and viaducts has become a key issue in Italy and in most European Countries. Large part of the existing stock exhibits dimensional and functional deficiencies due to the aging of the structures and the ever-growing demanding traffic conditions and safety requirements, compared to the original design phase. Italy issued its own guidelines in 2020 to assess bridges and viaducts risk exposure and proposed a multilevel approach based on census, visual inspection and a preliminary and qualitative risk indicator, named classes of attention. To define this risk indicator, four types of risks are evaluated: structural and foundation risk, seismic risk, landslide risk and hydraulic risk. After this preliminary evaluation, in-depth tests and more accurate analyses should be implemented for any bridge or viaduct exposed to high risk. During the first application of these guidelines, several difficulties were detected in finalizing a ranking of the infrastructures included in the same class of risk. This paper proposes an AHP absolute model to rank roadway bridges and viaducts by priority on intervention, based on structural and foundation risks. In detail, to identify criteria, sub- criteria, and rating, and define the hierarchy, an extensive literature review was conducted a pool of experts was interviewed via a Delphi survey process. Focus groups were organized to validate the hierarchy by dynamic discussion and identify local and global priorities to support managers and decision makers in planning and undertaking maintenance activities.

Keywords

Roadway bridges, ranking, risk assessment, AHP, priorities of intervention.

An ESG assessment of companies based on ordinal proximity measures and extended best worst method

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Abstract

Many rating agencies evaluate the ESG criteria by means of scales based on linguistic descriptions. For instance, Refinitiv, a provider of financial market data, evaluates the relative ESG performance of companies using a rating scale consisting of letter grades ranging from D to A, associated with a linguistic description: {poor, satisfactory, good, excellent}. Refinitiv manages this scale in in a uniform way. However, sometimes, the linguistic description of the terms of the scale may lead investors to perceive these qualitative scales as non-uniform, in the sense that, they may appreciate different psychological proximities between the terms of the scales. Moreover, in decision-making problems with multiple criteria, one of the most important phases is the weighting process, which allows determining the relative importance of each criterion. The proposed methodology combines two approaches: ordinal proximity measures and the extended best-worst method with the aim to improve and enrich the rating methodology used by rating agencies. Ordinal proximity measures are used to collect information about how investors perceive the proximities between the linguistic terms used of rating scales. The extended best-worst method is applied to obtain the weights of the criteria. In this contribution, we applied the proposed method to address the issue of the construction of global linguistic scores for the companies based on their ESG performance. To do that, we considered 115 companies in the energy utilities sector obtained from Refinitiv Datastream during the period 2018-2021. The results illustrate the effectiveness of the proposed method and enrich the rating methodology used by Refinitv.

Keywords

Extended Best Worst Method, ordinal proximity measures, qualitative assessments, ESG scores, Refinitiv.

A multiple criteria approach for a sustainable urban logistics policies problem

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Abstract

Urban policymakers have sustainability targets for 2030 and in European countries there is a growing body of guidelines to define Sustainable Urban Mobility Plans (SUMPs) at the local level, and many cities are also defining specific plans regarding Sustainable Urban Logistics Plans (SULPs). It is challenging to collect real data to deal with urban logistics issues and it is expensive to quantify policy effects to make choices, in a context of conflicting interests among stakeholders. This paper aims to provide local policymakers with a Multiple Criteria Decision Analysis (MCDA) approach for assessing the classification of city logistics strategies from a sustainability perspective. This study deals with the characterization and comparison of alternative city logistics strategies, intended as a mix of policy measures, to organize Urban Freight Transport (UFT) in medium cities. In this research, an extension Deck Card Method (DCM), with interactions between pairs of criteria, was applied to a medium-sized city in Northern Italy to rank different strategies for future planning activities. The DCM allows the policymaker to intuitively model preference among various alternatives and different levels on criteria scales suitable.

Keywords

City logistics, Urban sustainability, Multiple criteria decision Analysis, Decision support, Deck of cards method.

ELECTRE TRI-nC method for evaluating socioeconomic and environmental performance of agroforestry in southwestern France

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Abstract

For half a century, the primary objective of Western public policies was to increase agricultural productivity and provide food at low cost. To achieve this goal, farmers used agrochemistry (pesticides, fertilisers), advances in genetics, new mechanisation and an ambitious support of European agricultural policy. Nevertheless, five decades of these intensive practices have brought to light the negative impacts, major environmental risks, and lasting upheavals in landscapes and the farming practices. Woods, groves and hedgerows were destroyed to enlarge the cultivated plots, the farms were greatly enlarged, the agricultural population was reduced, and the world economy took hold. Trees have an active role against erosion, as well as in soil conservation by storing carbon and allowing a rich biological life in the soil and sheltering auxiliary insects in the canopy. The rows of trees also play an important role as windbreaks and barriers to the atmospheric diffusion of pesticides. Trees create habitat for helpers of crop pests, especially in areas where hedgerows and thickets have long since disappeared. They can also be a reserve for fungal or bacterial pathogens. They make the rural landscape pleasant for the population. The new TETRAE-AC^{2}TION research project, aims to study the socio-economic and environmental performance of agroforestry systems (combination in the same agricultural parcel, of trees and crops) in Southwestern France. To evaluate the performance of these systems, we will use multicriteria decision support methods: ELECTRE Tri-nC. Qualitative and quantitative criteria will make it possible to understand the impacts of such a device on the microclimate, and the biodiversity. Also, on the enrichment of the soil for the mineral nutrition of plants, and positive externalities for humans. However, agroforestry should also make it possible to reduce crop pathogens with a view to reducing the use of pesticides. This study will be useful to provide stakeholders in the field, with decision-making support for their management system change, especially those in intensive processes. This is also very useful locally to reconcile the urban population with agricultural practices.

Keywords

Multicriteria Decision Aiding, ELECTRE TRI nC, Agroforestry, Field crops, Performances.

Introducing non-uniform qualitative scale into a group extended best-worst method

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Abstract

The Best-Worst Method (BWM) enables to determine the weights of criteria by means of comparisons. In this procedure the decision-makers give their preferences of the best criterion over all the other criteria and the other criteria over the worst criterion, using a numerical value from a given scale (e.g., using a number between 1 and 9 from the Saaty rating scale). However, in the decision-making models that employ qualitative information, it could be inadequate to represent the assessments provided by decision-makers using crisp values. Therefore, in recent years, several procedures based on fuzzy numbers, ordinal linguistic approaches or the 2-tuple linguistic method have been proposed for dealing with the vagueness and imprecision of this type of information. The main objective of this contribution is to present a new group decision-making model, called the GOPM-EBW method. This procedure introduces the concept of ordinal proximity measure in an extended best-worst group method. Ordinal proximity measures consider individuals' perception of linguistic terms on ordered qualitative scales, in way that, when applying these measures, the values obtained collect these perceptions over the scales preserving the ordinal information as much as possible. These values are considered into the qualitative scale used by the extended best-worst method in order to determine the weights of criteria. In addition, ordinal proximity measures are applied to obtain the importance of each decision maker in the procedure. In order to assess the applicability of the proposed methodology, we present an application of the proposed procedure to develop a ranking of companies taking into account some financial and sustainable aspects, as well as diversity and inclusion factors.

Keywords

Linguistic information, Group Extended Best Worst Method, Ordinal Proximity Measures, qualitative scales.

Session VII

Friday 22 September, 16:40-18:40

Chairman: *Luis Dias*

Multi-criteria decision aiding for built heritage value evaluation: Model and application in Québec City

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Abstract

Founded in 1608 by Samuel de Champlain and once the capital of France's vast empire in the New World, Québec City, the capital of the province of Québec, Canada, is one of the oldest North American cities. It was officially recognized by UNESCO in 1985 as a world heritage city, a distinction due in large part to the concentration of its preserved 17th and 18th century buildings, a unique characteristic in North America. Québec City prides itself on its long history and takes the preservation of its built heritage very seriously, not only for the older buildings but also for the more modern ones that are significant from an architectural perspective. As such, it has adopted very early on a proactive approach to the protection and enhancement of its built heritage. It does so through various mechanisms including the Commission of Urbanism and Conservation Québec where buildings identified as having a high heritage value are subject to protective measures. Like many cities, Québec is faced with various economic pressures to allow new profitable real estate investments. As cities rely on property taxes for revenue, it could be tempting to allow buildings to be demolished for development with greater tax revenues, sometimes at the expense of buildings with potentially a heritage value. In order to avoid such undesirable situations, the City recently identified a need for a mechanism to consistently assess the heritage value of a building, thereby ensuring its protection and allocating subsidies for restoration and preservation when pertinent. However, in order to ensure social acceptance, a transparent and rigorous methodology for the evaluation of a building's heritage value was needed. The processes in place were not totally satisfactory since they were often vague and subject to interpretations and biases. This identified need prompted the City to contact our research team, with extensive expertise in Multi-Criteria Decision Aiding (MCDA) and a history of collaboration with the City, in order to develop a multi-criteria methodology to rigorously assess the heritage value of a building and allocate each evaluated building to one of 5 heritage value categories. Furthermore, the requirement was that the developed methodology must be explicit enough to be applied with minimum interpretation by various qualified actors. The aim of this paper is to present our action research project and its results, obtained through a co-constructive approach with participants from within and outside the City's management team. We describe the methodology used to construct and validate the heritage value evaluation model including the criteria and the weights. We also present evaluation results obtained using a multi-criteria method, MACBETH. The methodology and model we developed are, to our knowledge, a first in heritage evaluation and can be extended and applied to different cities, with the potential of rendering heritage evaluation more explicit, rigorous, and transparent.

Keywords

MCDA, MACBETH.

A multicriteria approach for building sustainability composite indicators

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Abstract

The aggregation of composite indicators is a complex problem and has been tackled in different studies and there are numerous MCDA approaches to address this issue. One approach in the literature to find a natural system sustainability index considers the balance or compromise between an engineering solution of ‘‘maximum aggregate sustainability’’ and an ecological solution of ‘‘most balanced sustainability’’, by analyzing the most displaced indicator. This approach was proposed initially in a way that was generalized to all composite indicators and it was the basis for the studies which implemented Extended Goal Programming and Compromise Programming for building sustainability rankings. Despite these approaches having several operational advantages, some problems were identified, namely situations in which the natural systems or decision units present equal positions in the ranking but have different in reality sustainability levels. Thus, this paper proposes an approach for dealing with these problems, considering a new indicator for the most balanced sustainability using normalized entropy and integrating both measures mentioned before. One example of the literature was used to illustrate the functioning of the approach proposed, which provided promising results.

Keywords

Sustainability, composite indicators, multicriteria decision analysis, sustainability rankings, normalized entropy.

Stakeholders integration for MCDA sustainability assessment of energy technologies: A use case in energy storage

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Abstract

The global energy transition requires in many countries a high share of fluctuating renewable energy, which poses a challenge to energy supply and the reliability of energy systems. There are different strategies to mitigate these fluctuations, among these large-scale deployments of energy storage plays a crucial role. In addition to posing a technical challenge, these transitions involve different types of conflicts, such as resource criticality, and climate objectives. Decision-making in this context, involves different sectors of society that have different priorities and requires a tool such as Multi-Criteria Decision Analysis (MCDA) to facilitate communication between residents, decision-makers, and technology developers. Existing approaches and experiences with different formats of participatory MCDA include methodologies such as: mediated modelling techniques, decision conferences and decision analysis interviews. Despite having been successfully explained and applied, analysts agree on the barriers to further application of these participatory formats: the need for large efforts and resources for their implementation. This research aims to develop and implement an interactive decision support tool (software) to facilitate the integration of stakeholders in MCDA for sustainability assessment. The tool is intended to be implemented following decision conference concepts using online surveys available to stakeholders at the site and from remote locations. Through real-time interaction of stakeholder preferences with the MCDA model, this work aims to accelerate and support transparent decision-making processes. Based on the selection requirements of the MCDA method for sustainability assessment, the ELECTRE III method is used to model the decision problem. The tool is currently being tested and will be used for the first time in December 2023 during a workshop for sustainability assessment of energy storage technologies with stakeholders of the EU project StoRIES. In this contribution we will present and discuss the implementation phase of the developed interactive decision support tool for energy storage MCDA sustainability assessment.

Keywords

Participatory MCDA, stakeholders, sustainability assessment, energy storage.

Measuring artificial intelligence development: A new approach based on MCDA methods exploiting temporal information

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Abstract

Artificial intelligence (AI) has been of the main drivers for the development of cutting-edge technologies that are impacting the society at different levels. A first notorious aspect of such impacts is the multitude of fields on which AI methods can be applied, ranging from healthcare to climate prediction. Moreover, differently from many research domains, scientific advancements in AI can quickly lead to highly mature technological solutions due to the small gap between fundamental research and innovation generation. Such features have been contributing to place AI as a relevant topic in global policy. In this context, several AI indices have emerged as instruments to rank countries in terms of their AI development, according to criteria such as countries' levels of investment, innovation, and implementation of AI. These indices are helpful in providing guidance for the countries' policies, including the definition and/or updating of national and regional strategies. Some of the proposed AI indices are calculated by simply considering linear aggregation methods. Additionally, the data used in most of these indices are based on the most recent disclosures, meaning that the criteria values come from a given period of time. However, the trends in the evolution of the AI development of a given country or region can be very informative to understand the global landscape and also to enable decision makers to project the past into the future. Therefore, it becomes relevant to consider the criteria's historical data to justify actions and guide future choices. In this context, methods of multi- criteria decision analysis (MCDA) emerge as interesting tools to obtain robust ranks that reflect more accurately the complexity of decisions. Recent studies in MCDA exploit criteria temporal information to derive final rankings; an example of work is found in Campello, B. S. C, Duarte, L. T., & Romano, J. M. T. (2023), “Exploiting temporal features in multicriteria decision analysis by means of a tensorial formulation of the TOPSIS method” published in Computers & Industrial Engineering, 175, 108915. In the present contribution, we shall thus propose a new strategy to rank of countries according to their AI development levels by considering temporal analysis and the MCDA technique.

Keywords

Time-series analysis, Artificial Intelligence, MCDA.

A multi-criteria GDM model for consensual decision-making in sustainable finance

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Abstract

In the field of Multiple Criteria Decision Aiding (MCDA), achieving consensus among stakeholders is crucial when dealing with complex decision-making problems in domains such as finances. This abstract proposes the application of a novel approach, namely the fuzzy-based Minimum Cost Consensus (FZZ-MCC) framework, to define a multi-criteria Group Decision-Making (MCGDM) model that ensures consensual solutions. The FZZ-MCC framework combines the advantages of both fuzzy set theory and MCC models, offering a comprehensive and flexible methodology for handling uncertainties and imprecise information in decision-making processes. By integrating fuzzy set theory into the MCC framework, the FZZ-MCC approach enables a more accurate representation and management of stakeholders' preferences and enhances the understanding and generality of the decision-making process. To demonstrate the applicability of proposal, we present a practical case study focusing on a financial decision-making problem. The case study revolves around the selection of investment opportunities in the renewable energy sector, with considerations for sustainability, financial viability, and risk assessment. By employing the FZZ-MCC approach, decision-makers can reach a consensus-based solution that balances the interests and priorities of all stakeholders involved. The proposed approach provides decision-makers with a robust framework that guarantees consensual solutions while considering the multi-dimensional nature of sustainability and financial decision-making.

Keywords

Minimum Cost Consensus, Renewable energy, Multi-criteria decision-making.

A multiobjective approach to collaborative facility and fleet sharing in horizontal supply chain collaboration

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Abstract

In this paper, we focus on studying the collaborative facility and fleet sharing among firms operating at the same horizontal layer of a supply network and investigate the benefits derived from forming coalitions. Our research considers a two-echelon network setting where a group of suppliers operates multiple distribution centers and serves common retailers. The primary objective of the firms is to reduce costs through horizontal collaboration by sharing capacity and fleet resources. This collaboration not only leads to cost savings but also contributes to reducing the carbon footprint, promoting more sustainable operations. However, it is important to acknowledge that firms highly value their internal delivery fleet and aim to maintain a certain level of service by utilizing their own resources whenever possible. To address this, we model the problem as a multiobjective cooperative game, aiming to find acceptable trade-off solutions that satisfy the preferences of the different suppliers. Our proposed research aims to assist the suppliers in answering three critical questions: (1) What is the value or worth of forming a coalition? (2) Which players should collaborate with each other? (3) How should costs be allocated among the players within a coalition? To address these questions, we integrate a comprehensive framework that generates optimal coalition structures and compare three different cost allocation schemes: proportional allocation, Shapley value, and the core. These schemes provide decision makers with different approaches to distributing costs among coalition members. To further validate the effectiveness of our approach, we present a real application inspired by the beverage industry in Lebanon. The results of our analysis demonstrate significant opportunities for cost savings and the potential to achieve more sustainable operations, as evidenced by the possibility of using 40% fewer vehicles. Our research contributes to enhancing the collaboration process in terms of cost reduction, resource optimization, and sustainability.

Keywords

Horizontal Collaboration, Coalition Formation, Multiobjective Cooperative Games, Coalition Structure.

MCDA as a decision-making tool in the built environment: Challenges and potential

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Abstract

Multi-Criteria Decision Analysis (MCDA) is gaining particular attention as a powerful decision-making tool in the built environment due to its ability to address complex, multi-dimensional challenges with multiple and often conflicting criteria, as well as actively involve stakeholders in the decision-making process. This paper critically examines the use of MCDA in civil engineering projects, infrastructure management, and urban development, with a focus on its potential to support the protection and sustainable development of the built environment following United Nations Goal 11, which aims to make cities and human settlements inclusive, safe, resilient, and sustainable. MCDA can play a critical role in achieving this goal by facilitating evidence-based decision-making processes that consider a wide range of factors, such as environmental impacts, social equity, economic viability, and infrastructure resilience. The available literature has emphasized the absence of an evaluation of the needed applications of multicriteria analysis concerning effective case-by-case method selection in building environment management. The study underlines the use of MCDA techniques for prioritizing urban planning interventions, as well as the need to follow a methodology for picking the best MCDA method for a specific decision-making problem. The need for future research and development possibilities for integrated approaches from other fields that interface with urban planning is also highlighted, as well as the significance of establishing particular frameworks and procedures for the effective use of MCDA in building environment management and decision-making.

Keywords

MCDA, Sustainable Urban Planning, Decision Making in Civil Engineering, Build Environment.

Multiple criteria assessment for holiday parks

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Abstract

This study investigates the introduction of a multiple-criteria assessment scheme for holiday parks. Although these major complexes are usually evaluated similarly to hotels, these complexes present peculiar characteristics, such as: a) The allocation of the different activities to the different areas of the complex can result in significant satisfaction for the users, b) The enormous impact on the surrounding areas and the population of the parks need to be taken into account, and c) The sustainability of the parks and their economic impact can change over time. We propose a classification scheme that considers all the facets introduced above, integrating performance indicators for optimal service location and a sorting procedure. We apply our procedure to the classification of the UK holiday parks. We compare our results with the ones obtained with the assessment scheme introduced by Visit England, the UK national tourism agency – a non-departmental public body funded by the UK government.

Keywords

Multicriteria Classification, National Heritage, Territorial Planning.

Goal programming framework optimization for circular economy and sustainable development goals

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Abstract

This study presents a multi-objective goal programming model to tackle the challenge of optimal resource allocation while considering conflicting objectives related to economic growth, energy efficiency, environmental preservation, and circular economy (CE) development. This study pioneers the incorporation of waste minimization and recycling rates as crucial factors in evaluating and measuring circularity objectives. The CE concept has witnessed remarkable growth in recent years, presenting immense opportunities for sustainable development and encouraging businesses and industries to integrate CE principles into their strategies. By offering a substantial contribution to researchers and practitioners, this study enhances sustainable theory and provides practical guidance for enterprises seeking to enhance their sustainable development efforts.

Keywords

Circular Economy, Sustainability, Goal Programming, Multi-objective, Waste Minimization.

My contribution is more important than yours

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Abstract

Most of the scientific work is produced through collaboration. The articles have more than one author. Universities try to reward (and thus encourage) authors to publish good scientific papers. The simplest way to do this is to allocate a certain amount of money to an article. However, the question arises how to distribute this amount among the authors fairly. This paper proposes a method for determining consensus among authors. The quantitative nature of the technique makes it possible to use it to distribute the reward among those involved.

Keywords

Pairwise comparisons, consensus model, group decision making.