Journal of Quality Measurement and Analysis *JQMA* 21(1) 2025, 43-67
e-ISSN: 2600-8602 *http://www.ukm.my/jqma*
https://doi.org/10.17576/jqma.2101.2025.03

AN MCDM FRAMEWORK USING COMBINED COMPROMISE SOLUTION AND INTEGRATED WEIGHTING METHOD: OPTIMIZING SUSTAINABLE ENERGY OPTIONS

(Rangka Kerja MCDM Menggunakan Penyelesaian Kompromi Gabungan dan Kaedah Pemberat Bersepadu: Mengoptimalkan Pilihan Tenaga Lestari)

SET FOONG NG*

ABSTRACT

The Combined Compromise Solution (CoCoSo) method is a relatively recent multiple criteria decision-making (MCDM) technique designed to address complex MCDM problems. This method evaluates and selects the optimal alternative based on multiple and often conflicting criteria. Given that criteria weights can significantly impact the decision-making process, it is crucial to devote particular attention to these weights. The aim of this study is to develop a framework to evaluate different MCDM evaluation models using the CoCoSo method, incorporating various objective weight methods and Integrated Criteria Objective Weight (ICOW) methods. A case study focusing on ranking sustainable energy options serves as the context for this MCDM problem. The study seeks to employ a comparative approach to identify the most appropriate weighting method for criteria in the CoCoSo framework. Relative Entropy Theory and the method of Lagrange Multipliers were used to derive ICOW. The case study results indicated that the MCDM model employing the ICOW method was identified as the most preferred model. The framework of CoCoSo method coupled with ICOW, along with the systematic approach in using similarity measures for ranking, offers valuable insights for MCDM practitioners and serves as a useful addition to the MCDM literature.

Keywords: multiple criteria decision-making (MCDM); Combined Compromise Solution (CoCoSo) method; objective weight method; Integrated Criteria Objective Weight (ICOW)

ABSTRAK

Kaedah Penyelesaian Kompromi Gabungan (CoCoSo) ialah teknik pembuat keputusan berdasarkan pelbagai kriteria (MCDM) yang agak terkini yang direka untuk menangani masalah MCDM yang kompleks. Kaedah ini menilai dan memilih alternatif yang optimum berdasarkan kriteria berbilang dan sering bercanggah. Memandangkan wajaran kriteria boleh memberi kesan ketara kepada proses membuat keputusan, adalah penting untuk menumpukan perhatian khusus kepada wajaran ini. Matlamat kajian ini adalah untuk membangunkan rangka kerja untuk menilai model penilaian MCDM yang berbeza menggunakan kaedah CoCoSo, menggabungkan pelbagai kaedah pemberat objektif dan kaedah Pemberat Objektif Kriteria Bersepadu (ICOW). Kajian kes yang memfokuskan pada kedudukan pilihan tenaga mampan berfungsi sebagai konteks untuk masalah MCDM ini. Kajian ini menggunakan pendekatan perbandingan untuk mengenal pasti kaedah pemberat yang paling sesuai untuk kriteria dalam rangka kerja CoCoSo. Teori Entropi Relatif dan kaedah Pengganda Lagrange telah digunakan untuk mendapatkan ICOW. Keputusan kajian kes menunjukkan bahawa model MCDM yang menggunakan kaedah ICOW dikenal pasti sebagai model yang paling diutamakan. Rangka kerja kaedah CoCoSo ditambah dengan ICOW, bersama-sama dengan pendekatan sistematik dalam menggunakan ukuran persamaan untuk pemeringkatan, menawarkan pandangan berharga untuk pengamal MCDM dan berfungsi sebagai tambahan berguna kepada literatur MCDM.

Kata kunci: pembuat keputusan berdasarkan pelbagai kriteria (MCDM); Kaedah Penyelesaian Kompromi Gabungan (CoCoSo); kaedah pemberat objektif; Pemberat Objektif Kriteria Bersepadu (ICOW)

References

Al-Aomar R. 2010. A combined AHP-entropy method for deriving subjective and objective criteria weights. *International Journal of Industrial Engineering* **17**(1): 12-24.

Alemi-Ardakani M., Milani A.S., Yannacopoulos S. & Shokouhi G. 2016. On the effect of subjective, objective and combinative weighting in multiple criteria decision making: A case study on impact optimization of composites. *Expert Systems with Applications* **46**: 426-438.

Bacon R. & Kojima M. 2011. Issues in estimating the employment generated by energy sector activities. Washington, DC: World Bank Group.

Barchielli A., Gregoratti M. & Toigo A. 2018. Measurement uncertainty relations for discrete observables: Relative entropy formulation. *Communications in Mathematical Physics* **357**(3): 1253-1304.

Benayoun R., Roy B. & Sussman B. 1966. ELECTRE: Une méthode pour guider le choix en présence de points de vue multiples. *Note de travail* **49**: 2-120.

Bottomley P.A. & Doyle J.R. 2001. A comparison of three weight elicitation methods: good, better, and best. *Omega* **29**(6): 553-560.

Brans J.P. & Vincke Ph. 1985. A preference ranking organisation method: The PROMETHEE method for multiple criteria decision-making. *Management Science* **31**(6): 647-656.

Bridgman P.W. 1922. *Dimensional Analysis*. New Haven: Yale University Press.

Carnia E., Amarti Z. & Supriatna A.K. 2018. Academic performance ranking by the use of the analytic hierarchy process (AHP) and TOPSIS methods. *AIP Conference Proceedings* **2043**(1): 020005.

Chakraborty S. & Yeh C.H. 2012. Rank similarity based MADM method selection. *2012 International Conference on Statistics in Science, Business and Engineering (ICSSBE)* in Langkawi, Malaysia.

Diakoulaki D., Mavrotas G. & Papayannakis L. 1995. Determining objective weights in multiple criteria problems: The critic method. *Computers & Operations Research* **22**(7): 763-770.

Edenhofer O., Pichs-Madruga R., Sokona Y., Seyboth K., Kadner S., Zwickel T., ... & Matschoss P. 2011. *Renewable energy sources and climate change mitigation: Special report of the intergovernmental panel on climate change.* New York: Cambridge University Press.

Edwards W. & Barron F.H. 1994. SMARTS and SMARTER: Improved simple methods for multiattribute utility measurement. *Organizational Behavior and Human Decision Processes* **60**(3): 306-325.

Evans A., Strezov V. & Evans T.J. 2017. Sustainability concepts of energy generation technologies. In Abraham M.A. (ed.). *Encyclopedia of sustainable technologies*: 3-10. Amsterdam, The Netherlands: Elsevier.

Fishburn P.C. 1967. Additive utilities with incomplete product sets: Application to priorities and assignments. *Operations Research* **15**(3): 537-542.

Haseena S., Saroja S. & Revathi T. 2022. A fuzzy approach for multi criteria decision making in diet plan ranking system using cuckoo optimization. *Neural Computing and Applications* **34**(16): 13625-13638.

Hwang C.L. & Yoon K. 1981. *Multiple Attribute Decision Making: Methods and Applications A State-of-the-Art Survey*. Berlin, Heidelberg: Springer-Verlag.

Ilham N.I., Dahlan N.Y. & Hussin M.Z. 2024. Optimizing solar PV investments: A comprehensive decision-making index using CRITIC and TOPSIS. *Renewable Energy Focus* **49**: 100551.

Ishizaka A. & Siraj S. 2018. Are multi-criteria decision-making tools useful? An experimental comparative study of three methods. *European Journal of Operational Research* **264**(2): 462-471.

Kacprzak D. 2024. A new similarity measure for rankings obtained in MCDM problems using different normalization techniques. *Operations Research and Decisions* **34**(2): 47-64.

Kumar A., Sah B., Singh A.R., Deng Y., He X., Kumar P. & Bansal R. C. 2017. A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renewable and Sustainable Energy Reviews* **69**: 596-609.

Liu X., Zhou X., Zhu B., He K. & Wang P. 2019. Measuring the maturity of carbon market in China: An entropy-based TOPSIS approach. *Journal of Cleaner Production* **229**: 94-103.

Lu M., Sun Y. & Ma Z. 2024. Multi-objective design optimization of multiple energy systems in net/nearly zero energy buildings under uncertainty correlations. *Applied Energy* **370**: 123620.

Ng S.F., Tukiman N., Ismail A., Khalid A.K., Yunos N.M. & Norizan N.A. 2023. A framework of nutrient analyser model for comparing food nutrients. *Current Nutrition & Food Science* **19**(7): 745-754.

Opricovic S. 1998. Multicriteria optimization of civil engineering systems. PhD Thesis. University of Belgrade.
Ozcalici M. 2023. Integrating queue theory and multi-criteria decision-making tools for selecting roll-over car washing machine. *Operations Research and Decisions* **33**(2): 99-119.
Ozernoy V.M. 1992. Choosing the "best" multiple criterlv decision-making method. *INFOR: Information Systems and Operational Research* **30**(2): 159-171.
Paramanik A.R., Sarkar S. & Sarkar B. 2022. OSWMI: An objective-subjective weighted method for minimizing inconsistency in multi-criteria decision making. *Computers & Industrial Engineering* **169**: 108138.
Post T. & Potì V. 2016. Portfolio analysis using stochastic dominance, relative entropy, and empirical likelihood. *Management Science* **63**(1): 153-165.
Rezaei J. 2015. Best-worst multi-criteria decision-making method. *Omega* **53**: 49-57.
Saaty R.W. 1987. The analytic hierarchy process—what it is and how it is used. *Mathematical Modelling* **9**(3-5): 161-176.
Sahin M. 2021. A comprehensive analysis of weighting and multicriteria methods in the context of sustainable energy. *International Journal of Environmental Science and Technology* **18**(6): 1591-1616.
Shannon C.E. 1948. A mathematical theory of communication. *The Bell System Technical Journal* **27**(3): 379-423.
Srinivasan V. & Shocker A.D. 1973. Linear programming techniques for multidimensional analysis of preferences. *Psychometrika* **38**(3): 337-369.
Stewart J., Clegg D.K. & Watson S. 2021. *Calculus*. 9th Ed. Toronto: Cengage Learning.
Villalba P., Sánchez-Garrido A.J. & Yepes V. 2024. A review of multi-criteria decision-making methods for building assessment, selection, and retrofit. *Journal of Civil Engineering and Management* **30**(5): 465-480.
Wang C.N., Dang T.T., Nguyen N.A.T. & Wang J.W. 2022. A combined Data Envelopment Analysis (DEA) and Grey Based Multiple Criteria Decision Making (G-MCDM) for solar PV power plants site selection: A case study in Vietnam. *Energy Reports* **8**: 1124-1142.
Wang T.C. & Lee H.D. 2009. Developing a fuzzy TOPSIS approach based on subjective weights and objective weights. *Expert Systems with Applications* **36**(5): 8980-8985.
Wu S. & Niu R. 2024. Development of carbon finance in China based on the hybrid MCDM method. *Humanities and Social Sciences Communications* **11**(1): 156.
Yazdani M., Zarate P., Kazimieras Zavadskas E. & Turskis Z. 2019. A combined compromise solution (CoCoSo) method for multi-criteria decision-making problems. *Management Decision* **57**(9): 2501-2519.
Yılmaz K., Dinçer A.E. & Ayhan E.N. 2023. Exploring flood and erosion risk indices for optimal solar PV site selection and assessing the influence of topographic resolution. *Renewable Energy* **216**: 119056.
Yilmaz B. & Harmancioglu N. 2010. Multi-criteria decision making for water resource management: A case study of the Gediz River Basin, Turkey. *Water SA* **36**(5): 563-576.
Zhou Y. & Xu J. 2011. Evaluation of enterprises liquidity value based on the relative entropy-topsis. *2011 International Conference on E-Business and E-Government (ICEE)* in Shanghai, China.

College of Computing, Informatics and Mathematics
Universiti Teknologi MARA
Johor Branch, Pasir Gudang Campus
81750 Masai
Johor, MALAYSIA
E-mail: ngsetfoong061@uitm.edu.my[*]

Received: 28 August 2024
Accepted: 30 November 2024

[*]Corresponding author