Guest editorial: Preface to the special issue on the neutrosophical approach: applications in management decision and organizational research methods

1. Introduction

Decision-making (DM) is one of today's most exciting research fields in management, economics, business and other sciences (Holian, 2006). Furthermore, organizational research methods as strong tools for benchmarking and efficiency evaluation play critical roles in organizational and management studies, including qualitative and quantitative approaches (Holian, 2006; Brewerton and Millward, 2001; Plowman and Smith, 2011; Symon and Cassell, 2012). However, in the various challenging real-world problems, especially in management and organizational complexities, the observed values of the data are often imprecise or vague because of incomplete and/or non–obtainable information. Uncertainty modeling plays a crucial role in managing data imprecision by simulating the DM process of humans with incomplete or erroneous facts (Symon and Cassell, 2012; Dequech, 2000; Brown, 2020; Morrison, 2021).

Numerous essential and ground-breaking studies have previously been conducted in uncertainty modeling, which has seen recent rapid advancements. There are various ways to handle these uncertainties. Fuzzy logic is an approach to calculating the values based on "degrees of truth" instead of the usual Boolean "true or false" logic. Zadeh (1965) first introduced the term fuzzy sets (FSs) against certain logic where the membership degree is a real number between zero and one. However, Zadeh's FSs cannot deal with certain cases in which it is difficult to define the membership degree using one specific value. To overcome this lack of knowledge, Atanassov (1986) introduced an extension of the FSs called the intuitionistic fuzzy sets (IFSs). Although these concepts can handle incomplete information in various real-world issues, they cannot address all types of uncertainty, such as indeterminate and inconsistent information. As a generalization of FSs, IFSs, picture FSs, Pythagorean FSs, and spherical FSs, the neutrosophic theory originated by Smarandache (1999). Neutrosophic set (NS) can deal with uncertain, indeterminate and incongruous information where the indeterminacy is quantified explicitly and truth membership, indeterminacy membership and falsity membership are completely independent. It can effectively describe uncertain, incomplete and inconsistent information and overcome some limitations of the existing methods in depicting uncertain decision information. Moreover, some extensions of NSs, including interval neutrosophic set (Ye, 2014; Garg, 2018; Zavadskas *et al.*, 2021), bipolar NS (Akram and Smarandache, 2018; Zhan *et al.*, 2019), single-valued NS (Edalatpanah, 2019; Karabašević *et al.*, 2020), simplified NSs (Köseoğlu *et al.*, 2020), multi-valued NS (Peng *et al.*, 2017), neutrosophic linguistic set (Garg, 2019); and neutrosophic structured element (Edalatpanah, 2020a) have been presented.

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Furthermore, this logic has been applied in various domains of science and engineering such as supply chain management (Abdel-Baset *et al.*, 2019) performance evaluation (Edalatpanah, 2020b), knowledge management (Zuñiga *et al.*, 2019), human resource management (Liang *et al.*, 2018), tourism management (Bhaumik *et al.*, 2021), learning management system (Radwan *et al.*, 2016), traffic control management (Nagarajan *et al.*, 2019), quality management system (Refaat and El-Henawy, 2019), medical diagnosis (Dhar, 2021), etc. In addition, some generalizations of NSs, such as the Plithogenic set (Smarandache, 2018), have been proposed in recent years. Therefore, we call NSs with their generalizations and variants, the neutrosophical approach. This special collection aims to compile recent developments in methodologies, techniques and applications of neutrosophical approaches in management and organizational research methods for various practical problems.

2. Published research

The special issue entitled "The neutrosophical approach: applications in management decision and organizational research methods" includes nine accepted publications out of a significant number of submissions after rigorous peer review.

Zhang *et al.* (2023a) presented a combined TODIM-BSC and neutrosophical method for assessing the performance of a private insurance company. Using the balanced scorecard (BSC) system, they identified the performance assessment indicators, analyzed the performance of the insurance company's agencies, and ranked them utilizing the TODIM DM technique. The practicability and efficacy of the proposed model were validated by a case study of private insurance agencies based on 26 criteria of agencies.

Single-valued neutrosophic sets (SVNSs) are useful measures for addressing potential complexity issues with three components: indeterminacy, truthfulness and falsity. Farid *et al.* (2023) developed some new aggregation operators (AOs) for information fusion of SVNNs to tackle multi-criteria group decision-making (MCGDM) issues by using SVNSs. Motivated by the characteristics of Einstein operators, they introduced two novel hybrid AOs: the "single-valued neutrosophic Einstein prioritized weighted average (SVNEPWA) operator" and the "single-valued neutrosophic Einstein prioritized weighted geometric (SVNEPWG) operator". In addition, a comparative analysis and authenticity analysis of the proposed MCGDM technique with existing approaches are provided to evaluate its applicability, validity and superiority.

There are numerous transportation and solid transportation problems (STP) methods in the transportation literature in crisp, FSs and IFSs situations. Nonetheless, STP has never been investigated with NSs. Qiuping *et al.* (2023) attempted to address this void by developing an alternative method of solving this model with NSs. First, triangular neutrosophic numbers (TNNs) were employed to symbolize demand, transit capacity, accessibility and cost. Then, the neutrosophic STP was transformed into an interval programming problem using the idea of variation degree. The optimal solution's lower and upper bounds were then retrieved using two basic linear programming models. The findings show that the proposed model is not overly complex but more adaptable and applicable to practical problems. The effectiveness of the proposed algorithm is also demonstrated by the fact that it enables decision-makers to define their tolerances for uncertainty, falsity and acceptance.

Hezam *et al.* (2023) studied sustainable transport investment projects (STIP) based on a discrimination metric. They analyzed the most suitable transport project, one of the most important aspects of transport infrastructure schedules. To address the STIP assessment issue within SVNSs, they discussed a complex proportional assessment (COPRAS) paradigm. A SVNS is a valuable process to handle uncertainty to make the operation more useful when dealing with uncertain characteristics. First, a novel discriminating measure for SVNSs is presented, along with a discussion of its elegant qualities for determining the significance

degree or weight values of criteria from a sustainability standpoint. Second, an integrated strategy based on the discrimination measure and the COPRAS method is introduced for SVNSs. Finally, comparison and sensitivity analyses demonstrate the robustness and reliability of the proposed framework.

A NS is more adaptable than an IFS because it evaluates indeterminacy with a second component and does not depend on its uncertain features. As time goes on, it becomes clear that NSs are not up to the task of being a parameterization tool, so the idea of a soft set (SS) is introduced. SS uses approximate mapping to determine the degree to which objects in the initial universe correspond to prescribed attributes, thereby providing a measure of uncertainty. The neutrosophic soft set (NSS) is then characterized to give NS a parameterization mode. In real-world DM scenarios, such as medical diagnosis, product selection, recruiting procedure, etc. additional classification of parameters into their relevant sub-parametric valued non-overlapping groups is often observed. Using its aggregation procedures and decision-support system, Zhao *et al.* (2023) defined an unique neutrosophic hypersoft set hybrid termed possibility single-valued neutrosophic hypersoft set (psv-NHSS) for evaluating investment projects. The adopted technique is implemented in a real-world situation involving the investment evaluation of a hydroelectric power station project. Single-valued neutrosophic parameterized complex fuzzy hypersoft set (sv-NPCFHSS) is a novel neutrosophic hypersoft set hybrid that Zhang *et al.* (2023b) characterized, along with its aggregation operations and decision-support system for evaluating real estate residential projects by monitoring various risk factors. The suggested model possesses the characteristics of the majority of existing fuzzy SS-like models and addresses their drawbacks.

As a crucial step in assuring the efficacy of their operations, companies have welcomed the incorporation of sustainable policies and practices throughout the supply chain. Sustainable supply chain management (SSCM) practices provide businesses with a number of benefits, as evidenced by research and operational programs of enterprises. These benefits include, among others, improved environmental, social and economic performance, as well as a heightened ecological consciousness. Therefore, Aytekin *et al.* (2023) investigated the performance-influencing factors and theories of SSCM in the textile industry using a neutrosophic approach. To accomplish this, the MULTIMOORA-mGqNN process is used to evaluate the literature review's extracted parts. Results demonstrated that SSCM performance is crucial for guaranteeing corporate success and competitiveness, achieving customer satisfaction and leaving the environment in a desirable condition for future generations.

The role of entrepreneurship as a growth engine in economic systems is distinctive. Consequently, governments need to encourage entrepreneurship if they want to thrive in the long run. Practical measurements are the key to elevating the impact of this entrepreneurial advocacy. In light of this, Wang *et al.* (2023) developed a novel integrated dynamic multi-attribute decision-making (MADM) model based on NS for evaluating government entrepreneurship support. In addition, they presented a dynamic neutrosophic weighted geometric operator to aggregate dynamic neutrosophic information due to the fluctuation in the size of indicators across distinct periods. The results demonstrate the adaptability of the DM-based paradigm.

Smarandache established two distinct neutrosophic components. One of these methods is the neutrosophic numerical components, which consist of the aforementioned three variables. The other variety, which he designated as Neutrosophic Numbers (NN), consists of literal neutrosophic parts. NN consists of a crisp parameter and a value with a literal indeterminacy parameter (I), and can explain the restricted confident and restricted indeterminate information using formula $A = a + bI$. To evaluate the safety performance in building projects, Li *et al.* (2023) suggested a framework based on the combination of data envelopment

analysis (DEA) and NN to expose deficiencies with the rational measurement and recommend possible strategies. This hybrid model evaluates a new approach as an indicator of safety performance, and several units are compared. Results indicate that initiatives with a greater focus on safety concerns, like as training and equipment, are more efficient.

3. Concluding remarks

In this special issue, nine papers illustrate the application of various modeling and optimization techniques in neutrosophical environments to real-world problems. This collection of scientific works provides us with a rare opportunity to obtain a deeper grasp of the interdisciplinary approach and the relationships between diverse research subjects.

As guest editors, we extend our sincere gratitude to the reviewers who gave us invaluable feedback while revising the articles and evaluating them. Last but not least, we would like to extend our greatest appreciation to the respected individuals who made it possible for us to realize our ideas and who offered an exceptional and welcoming environment for this special edition. Lastly, we would also like to thank all authors for their contributions. This project only materialized due to their diligence, dedication and foresight.

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References

Abdel-Baset, M., Chang, V. and Gamal, A. (2019), "Evaluation of the green supply chain management practices: a novel neutrosophic approach", *Computers in Industry*, Vol. 108, pp. 210-220.

Akram, M. and Smarandache, F. (2018), "Decision-making with bipolar neutrosophic TOPSIS and bipolar neutrosophic ELECTRE-I", *Axioms*, Vol. 7 No. 2, p. 33.

Atanassov, K.T. (1986), "Intuitionistic fuzzy sets", *Fuzzy Sets and Systems*, Vol. 20 No. 1, pp. 87-96.

Aytekin, A., Okoth, B.O., Korucuk, S., Karamaşa, Ç. and Tirkolaee, E.B. (2023), "A neutrosophic approach to evaluate the factors affecting performance and theory of sustainable supply chain management: application to textile industry", *Management Decision*, Vol. 61 No. 2, pp. 506-529, doi: 10.1108/MD-05-2022-0588.

Bhaumik, A., Roy, S.K. and Weber, G.W. (2021), "Multi-objective linguistic-neutrosophic matrix game and its applications to tourism management", *Journal of Dynamics and Games*, Vol. 8 No. 2, pp. 101-118.

Brewerton, P.M. and Millward, L.J. (2001), *Organizational Research Methods: A Guide for Students and Researchers*, Sage Publications, London.

Brown, D.J. (2020), "Affective decision making under uncertainty", *Lecture Notes in Economics and Mathematical Systems*.

Dequech, D. (2000), "Fundamental uncertainty and ambiguity", *Eastern Economic Journal*, Vol. 26 No. 1, pp. 41-60.

Dhar, M. (2021), "Neutrosophic soft matrices and its application in medical diagnosis", *Journal of Fuzzy Extension and Applications*, Vol. 2 No. 1, pp. 23-32.

Edalatpanah, S.A. (2019), "A nonlinear approach for neutrosophic linear programming", *Journal of Applied Research on Industrial Engineering*, Vol. 6 No. 4, pp. 367-373.

Edalatpanah, S.A. (2020), "Neutrosophic structured element", *Expert Systems*, Vol. 37 No. 5, e12542.

Edalatpanah, S.A. (2020), "Data envelopment analysis based on triangular neutrosophic numbers", *CAAI Transactions on Intelligence Technology*, Vol. 5 No. 2, pp. 94-98.

Farid, H.M.A., Garg, H., Riaz, M. and Santos-García, G. (2023), "Multi-criteria group decision-making algorithm based on single-valued neutrosophic Einstein prioritized aggregation operators and its applications", *Management Decision*, Vol. 61 No. 2, pp. 382-420, doi: 10.1108/MD-04-2022-0484.

Garg, H. (2018), "Non-linear programming method for multi-criteria decision making problems under interval neutrosophic set environment", *Applied Intelligence*, Vol. 48 No. 8, pp. 2199-2213.

Garg, H. (2019), "Algorithms for possibility linguistic single-valued neutrosophic decision-making based on COPRAS and aggregation operators with new information measures", *Measurement*, Vol. 138, pp. 278-290.

Hezam, I.M., Mishra, A.R., Krishankumar, R., Ravichandran, K.S., Kar, S. and Pamucar, D.S. (2023), "A single-valued neutrosophic decision framework for the assessment of sustainable transport investment projects based on discrimination measure", *Management Decision*, Vol. 61 No. 2, pp. 443-471, doi: 10.1108/MD-11-2021-1520.

Holian, R. (2006), "Management decision making, ethical issues and 'emotional' intelligence", *Management Decision*, Vol. 44 No. 8, pp. 1122-1138.

Karabašević, D., Stanujkić, D., Zavadskas, E.K., Stanimirović, P., Popović, G., Predić, B. and Ulutaş, A. (2020), "A novel extension of the TOPSIS method adapted for the use of single-valued neutrosophic sets and hamming distance for e-commerce development strategies selection", *Symmetry*, Vol. 12 No. 8, p. 1263.

Köseoğlu, A., Şahin, R. and Merdan, M. (2020), "A simplified neutrosophic multiplicative set-based TODIM using water-filling algorithm for the determination of weights", *Expert Systems*, Vol. 37 No. 4, e12515.

Li, J., Alburaikan, A. and de Fátima Muniz, R. (2023), "Evaluation of safety-based performance in construction projects with neutrosophic data envelopment analysis", *Management Decision*, Vol. 61 No. 2, pp. 552-568, doi: 10.1108/MD-02-2022-0237.

Liang, R.X., Jiang, Z.B. and Wang, J.Q. (2018), "A linguistic neutrosophic multi-criteria group decision-making method to university human resource management", *Symmetry*, Vol. 10 No. 9, p. 364.

Morrison, F.A. (2021), *Uncertainty Analysis for Engineers and Scientists: A Practical Guide*, Cambridge University Press.

Nagarajan, D., Lathamaheswari, M., Broumi, S. and Kavikumar, J. (2019), "A new perspective on traffic control management using triangular interval type-2 fuzzy sets and interval neutrosophic sets", *Operations Research Perspectives*, Vol. 6, 100099.

Peng, J.J., Wang, J.Q. and Yang, W.E. (2017), "A multi-valued neutrosophic qualitative flexible approach based on likelihood for multi-criteria decision-making problems", *International Journal of Systems Science*, Vol. 48 No. 2, pp. 425-435.

Plowman, D.A. and Smith, A.D. (2011), "The gendering of organizational research methods: evidence of gender patterns in qualitative research", *Qualitative Research in Organizations and Management: An International Journal*, Vol. 6 No. 1, pp. 64-82.

Qiuping, N., Yuanxiang, T., Broumi, S. and Uluçay, V. (2023), "A parametric neutrosophic model for the solid transportation problem", *Management Decision*, Vol. 61 No. 2, pp. 421-442, doi: 10.1108/MD-05-2022-0660.

Radwan, N.M., Senousy, M.B. and Riad, A.E.D.M. (2016), "A new expert system for learning management systems evaluation based on neutrosophic sets", *Expert Systems*, Vol. 33 No. 6, pp. 548-558.

Refaat, R. and El-Henawy, I.M. (2019), "Innovative method to evaluate quality management system audit results' using single value neutrosophic number", *Cognitive Systems Research*, Vol. 57, pp. 197-206.

Smarandache, F. (1999), "A unifying field in logics", *Neutrosophy: Neutrosophic Probability, Set and Logic*, American Research Press, Rehoboth.

Smarandache, F. (2018), "Plithogenic Set, an extension of crisp, fuzzy, intuitionistic fuzzy, and neutrosophic sets-revisited", *Neutrosophic Sets and Systems*, Vol. 21, pp. 153-165.

Symon, G. and Cassell, C. (Eds) (2012), *Qualitative Organizational Research: Core Methods and Current Challenges*, Sage Publications, London.

Wang, C., Hu, Z. and Bao, Z. (2023), "Evaluation of the government entrepreneurship support by a new dynamic neutrosophic operator based on time degrees", *Management Decision*, Vol. 61 No. 2, pp. 530-551, doi: 10.1108/MD-03-2022-0305.

Ye, J. (2014), "Similarity measures between interval neutrosophic sets and their applications in multicriteria decision-making", *Journal of Intelligent and Fuzzy Systems*, Vol. 26 No. 1, pp. 165-172.

Zadeh, L.A. (1965), "Fuzzy sets", *Information and Control*, Vol. 8 No. 3, pp. 338-353.

Zavadskas, E.K., Bausys, R., Lescauskiene, I. and Usovaite, A. (2021), "MULTIMOORA under interval-valued neutrosophic sets as the basis for the quantitative heuristic evaluation methodology HEBIN", *Mathematics*, Vol. 9 No. 1, p. 66.

Zhan, J., Akram, M. and Sitara, M. (2019), "Novel decision-making method based on bipolar neutrosophic information", *Soft Computing*, Vol. 23 No. 20, pp. 9955-9977.

Zhang, K., Xie, Y., Noorkhah, S.A., Imeni, M. and Das, S.K. (2023a), "Neutrosophic management evaluation of insurance companies by a hybrid TODIM-BSC method: a case study in private insurance companies", *Management Decision*, Vol. 61 No. 2, pp. 363-381, doi: 10.1108/MD-01-2022-0120.

Zhang, H., Zhang, Y., Rahman, A.U. and Saeed, M. (2023b), "An intelligent sv-neutrosophic parameterized MCDM approach to risk evaluation based on complex fuzzy hypersoft set for real estate investments", *Management Decision*, Vol. 61 No. 2, pp. 486-505, doi: 10.1108/MD-05-2022-0605.

Zhao, J., Li, B., Rahman, A.U. and Saeed, M. (2023), "An intelligent multiple-criteria decision-making approach based on sv-neutrosophic hypersoft set with possibility degree setting for investment selection", *Management Decision*, Vol. 61 No. 2, pp. 472-485, doi: 10.1108/MD-04-2022-0462.

Zuñiga, V.C., León, A.M., Nogueira, D.M., Valencia, D.A. and Romero, J.M. (2019), "Validation of A Model for knowledge management in the cocoa producing peasant organizations of vinces using neutrosophic Iadov technique. Infinite study", *Neutrosophic Sets and Systems*, Vol. 30, pp. 253-260.