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Editorial Message: Special Issue on Fuzzy Decision-Making Methods for Sustainable Developments of Industrial Engineering

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Under the background of information, integration and intelligence, the object of industrial engineering extends from traditional manufacturing system to generalized production system including development, design, and supply and sales service. In addition to focusing only on quality and cost, design, production cycle, market response, resource consumption and environment should also be considered to achieve sustainable development of the entire system. However, integrating multi-dimensional issues into decision making is not easy because it requires policy coherence and linkages between sectors and actors. The challenges include how to develop consistent and easy-to-understand indicators to support decision making, establish monitoring and evaluation processes, track progress towards achieving the sustainable development goals, and strengthen the infrastructure for data collection, analysis and effective use in decision making. Therefore, powerful operational research tools are needed to solve these decision problems in industrial engineering for decision makers from a multi-dimensional perspective. Multiple criteria decision-making (MCDM) methods can flexibly handle multi-dimensional and discrete decision-making problems with quantitative or qualitative information. Over the past several decades, many MCDM methods have been proposed to solve problems with different conditions and emphases. These MCDM methods have been generalized to fuzzy contexts, and many applications have been achieved in different areas.

This special issue dedicates to addressing sustainability development problems in industrial engineering using fuzzy decision-making methodologies, especially those fuzzy MCDM methods. After the reviewing process, eleven papers have been selected for publication in this special issue according to the review criterion on technical contributions. Among them, the first five focus on developing new MCDM methods using fuzzy information. The last six papers are selected to investigate sustainability developments in emerging economies, supply-chain, and healthcare system using MCDM methods.

The first paper, presented by Weihua Su, Le Zhang, Shouzhen Zeng, and Huanhuan Jin, provides a multi-criteria group decision-making method within the context of fuzzy-social network based on hesitant probabilistic fuzzy sets and carries out corresponding innovation on trust propagation operator and dual-feedback mechanism. The validity of the decision-making framework is verified by a case study of sustainable developments of industrial engineering concerning renewable energy project selection.

The next paper, presented by Zaoli Yang and Harish Garg, models quantitative and qualitative decision information in MCDM problems using q-rung orthopair uncertain linguistic sets. They integrate the power average operator and partitioned Maclaurin symmetric mean operator into a single framework and propose a synthetic aggregation operator which not merely captures the multi-interrelationships among membership degrees and attributes but wipes out the adverse impact of extreme values.

The third paper, investigated by Fuyuan Xiao, develops a cost-aware, fault-tolerant, and reliable strategy for

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operator scheduling on fuzzy complex event processing systems under uncertain environment based on the TOPSIS method with triangular fuzzy numbers. Through a case study, the author proves that the proposed method can adequately make use of network resources to achieve continuous and highly available complex event processing regardless of dynamic operator migrations under fuzzy environment.

The next paper, by Ahmed Shoyeb Raihan, Syed Mithun Ali, Sanjeeb Roy, Miki Das, Golam Kabir, and Sanjoy Kumar Paul, presents an integrated approach comprising a fuzzy analytical hierarchy process and fuzzy comprehensive evaluation method to identify and classify risks in the soft drink supply chain. The outcome of this study indicates that the overall risk level in the supply chain of the soft drink industry is between low and medium, and the loss of reputation and brand image are the most significant sub-risk, and natural disasters are the least significant sub-risk.

The purpose of the fifth paper given by Chengli Zheng and Yuanyuan Zhou is to address MCDM problems and obtain a decision result that satisfies most of decision makers in a group. A consensus reaching process is constructed in this paper using an interval fuzzy number judgment matrix. The main innovation of this method is the consensus measure based on objective and subjective compatibility degrees. The practicality of the proposed method is verified by a case study of express-packaging recycling in circular economy.

The following paper, written by Ahmad Hashemi, Hamed Gholami, Uday Venkatadri, Sasan Sattarpanah Karganroudi, Samer Khouri, Adam Wojciechowski, and Dalia Streimikiene, proposes a heuristic algorithm for set covering problems based on coefficient and fitness values. The proposed algorithm is better than the simulated annealing algorithm in terms of quality and also has advantages in terms of time.

The seventh paper, investigated by Zhang Yu and Syed Abdul Rehman Khan, proposes a multi-objective uncertain equilibrium model of the green supply-chain network and integrates the theory of stochastic programming and fuzzy mathematical programming. They use Monte Carlo simulation to deal with random parameters and fuzzy parameters in the model. An application concerning the location of distribution centers in supply-chain network and carbon emission in the process of production and transportation in uncertain environment is presented.

The next paper, written by Asma Erjaee, Sepehr Hendiani, Shohreh Moradi, and Morteza Bagherpour, sets up a healthcare system sustainability performance evaluation index system by collecting 62 attributes and 15 criteria for three sustainability dimensions, considering the increasing pressure for applying sustainability practices in diverse organizations and systems. An evaluation model based on the trapezoidal fuzzy membership function is constructed to obtain the sustainability level of healthcare system under imprecise conditions. Finally, the performance status of each attribute is explained by the proposed fuzzy performance importance index to identify the attributes that need to be improved in the implementation of sustainability.

Next, Aqsa Mohiyuddin, Abdul Rehman Javed, Chinmay Chakraborty, Muhammad Rizwan, Maryam Shabbir, and Jamel Nebhen study Internet of Things used in healthcare and sustainable industry. Using a hybrid approach of machine learning algorithms and fuzzy logic, they propose an adaptive neuro-fuzzy inference system for data protection to improve and determine the degree of security like breaches and data integrity. The proposed system can be used to improve and enhance the path to the cloud for secure data storage.

The tenth paper, written by Reza Lotfi, Bahareh Kargar, Mohsen Rajabzadeh, Fatemeh Hesabi, and Eren Özceylan, constructs three hybrid fuzzy and data-driven robust optimization models based on stochastic programming to solve resilience and sustainable healthcare supply-chain management problems. These models consider risk attitudes of decision makers, with a model being suitable for conservative decision makers. The authors also demonstrate that the number of costs increases with increasing fuzzy cut, confidence level, robustification coefficient, resiliency coefficient, and CVaR confidence level.

Finally, Seyed Hossein Razavi Hajiagha, Jalil Heidary Dahooie, Niloofar Ahmadzadeh Kandi, Edmundas Kazimieras Zavadskas, and Zeshui Xu propose a fuzzy MCDM model that considers the economic, social, and environmental impacts on sustainability to solve process portfolio selection problems. After determining the criteria for process portfolio evaluation, the magnitude of the interrelationships among processes is determined by the fuzzy decision-making trial and evaluation laboratory. A set of rule base for process importance assessment based on fuzzy reasoning is also proposed.

These papers bring a rich collection on fuzzy decision-making methods for sustainable developments of industrial engineering. As the guest editors of this special issue, we would like to acknowledge the Editor-in-Chief, Professor Wei-Yen Wang, the previous Editor-in-Chief, Professor Shun-Feng Su, and the editorial office for their great support and kind help to achieve this special issue. We would also like to acknowledge all reviewers for their support in the evaluation of the papers submitted to this special issue.