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Advances and Challenges

 Springer

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Preface

He who knows all the answers has not been asked all the questions.

—Confucius

In today's complex and rapidly changing world, decision-making is a critical task that managers and decision-makers must navigate with precision and insight. Decision making (DM), i.e., multi-criteria decision-making (MCDM) or multi-attribute decision-making (MADM), is a sub-discipline of operations research (OR) that analyzes multiple conflicting criteria in decision-making problems considering the details as much as possible. Furthermore, data envelopment analysis (DEA) is a widely used nonparametric linear programming method for assessing the efficiency and productivity of decision-making units (DMUs). The theory and applications of DEA are spread over a wide area in production and beyond and are very diverse. DEA is also compared or combined with other disciplines. Over the past few years, researchers have developed several DM or DEA (DMDEA) methods to help decision-makers analyze and solve challenging problems. Consequently, it is appropriate to prepare an edited book to bring researchers working in these diverse fields on a common ground and share their experiences. In addition, this would be a chance to give direction to future challenges/trends related to DMDEA.

This book explores the theory and applications of DMDEA, encompassing deterministic and uncertain environments. It delves into combining DEA with machine learning techniques and the fusion of DEA models with various decision-making frameworks. The chapters cover various topics, from new modeling approaches to uncertainty handling and applications in diverse sectors.

The initial chapters provide foundational concepts and recent advancements in DEA. The chapter "[Merging Data Envelopment Analysis and Structural Risk Minimization: Some Examples of Use of Multi-output Machine Learning Techniques on Real-World Data](#)" discusses how DEA can be combined with machine learning techniques to handle multi-output scenarios, improving decision-making under real-world conditions. The chapter "[A New Network Data Envelopment Analysis Model for Efficacy Evaluation of Decision-Making Units](#)" introduces a new network DEA

model for evaluating DMUs, considering the network structure of processes involved, specifically applied to the Iranian airline industry. The chapter “[Possibilistic Network DEA Approach for Performance Evaluation of Two-Stage Decision Making Units Under Uncertainty](#)” presents a method for evaluating DMUs under uncertainty by using a fuzzy network DEA model.

Subsequent chapters explore the application of DEA in various industries. The chapter “[Managerial Ability in Indian Life Insurance Companies: A Comparison Based on DEA and DEAGP](#)” evaluates managerial abilities in Indian life insurance companies by using DEA and goal programming methods. The chapter “[Efficiency Appraisal and Classification of Flexible Random Factors](#)” proposes methodologies for evaluating the efficiency of organizations incorporating stochastic and flexible elements. The chapter “[Performance Evaluation of Indian Banking Financial Sector by Using DEA Approach](#)” assesses the performance of Indian banks, identifying key factors influencing efficiency. The chapter “[Application of Data Envelopment Analysis in Decision Making of Civil Engineering Problems](#)” provides practical examples of DEA applications in civil engineering.

Further chapters address advanced topics in DEA, such as robust optimization and tri-level decision-making. The chapter “[A Robust Optimization Approach for Estimating the Most Productive Scale Size in Uncertain Data Envelopment Analysis](#)” presents a novel method for estimating productive scale size under uncertainty. The chapter “[Goal Programming Method for Solving Tri-Level Data Envelopment Analysis](#)” extends the DEA model to tri-level structures, demonstrating its application through an illustrative example. The chapter “[Machine Learning Techniques and Efficiency Evaluation: A Survey of Methodological Contributions](#)” surveys the integration of machine learning with DEA, highlighting key methodological contributions. The chapter “[A Literature Review for Nonparametric Frontier Methods Applied to Portfolio Analysis](#)” summarizes research on nonparametric frontier methods in portfolio performance evaluation.

The book also delves into specific decision-making models and optimization under uncertainty, incorporating advanced fuzzy set theories. The chapter “[An Optimization Algorithm to Solve Imprecisely Defined Unconstrained Optimization Problem](#)” discusses a fuzzy optimization algorithm for imprecisely defined problems. The chapter “[Examining Dimensions and Critical Success Factors of Supply Chains Based on the Blockchain and Internet of Things \(B-IoT\)](#)” evaluates critical success factors for implementing a smart supply chain using IoT and blockchain technologies. The chapter “[A Multi-Objective Investment Selection Problem Using Fuzzy and Intuitionistic Fuzzy Approach](#)” develops a multi-objective linear model for investment selection using fuzzy and intuitionistic fuzzy sets. The chapter “[Revolutionizing Education: An Optimal MAGDM-Based e-Learning Approach for Curriculum Beyond the Classroom](#)” proposes a multi-attribute group decision-making model for selecting the best e-learning websites. The chapter “[Balanced Neutrosophic Fermatean Graphs with Applications](#)” explores the application of balanced neutrosophic fermatean graphs in optimizing medical treatment delivery.

The chapter “TOPSIS-Based Entropy Measure for N -Valued Neutrosophic Trapezoidal Numbers and Their Application to Multi-Criteria Decision-Making Problems” develops a multi-criteria decision-making method using N -valued neutrosophic trapezoidal numbers. The chapter “A New Decision-Making Analysis Model Based on the Transformation of Picture Fuzzy Sets into Fuzzy Sets” proposes a transformation method for picture fuzzy sets to enhance their applicability in various industrial contexts. The chapter “An Enhanced Score Function for Quadripartitioned Single-Valued Neutrosophic Sets” introduces an enhanced score function for quadripartitioned single-valued neutrosophic sets, providing a multi-criteria decision-making method.

The book comprehensively explores DMDEA and its applications in various decision-making contexts. By presenting methodological advancements, real-world applications, and future research directions, it aims to equip researchers, practitioners, and decision-makers with the tools and knowledge needed to navigate the complexities of modern decision-making. Through its detailed chapters, readers will understand how DMDEA can be utilized to improve decision-making processes, address uncertainty, and optimize performance across different sectors. By combining DEA with other decision-making models and machine learning techniques, this book showcases the versatility and practical utility of DMDEA. It highlights the importance of integrating advanced fuzzy set theories, such as intuitionistic fuzzy sets, fermatean sets, and neutrosophic sets, in handling imprecise and uncertain data. The practical case studies and empirical applications provide valuable insights into implementing DMDEA in real-world scenarios, demonstrating its effectiveness in enhancing decision-making processes.

Thanks to the dedication and expertise of many individuals who made this book possible. We extend our heartfelt gratitude to the publishing team of Springer Nature for their invaluable guidance throughout the editorial process. We also wish to thank all the contributors for sharing their insights and research, enriching the content of this volume. Additionally, we deeply appreciate the reviewers for their diligent work in evaluating the chapters and ensuring the quality of this book. We believe the chapters presented here will provide our readers with substantial knowledge and inspiration for their studies and research in the field of DMDEA. We hope students and researchers will find this book both informative and enlightening.

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Contents

Merging Data Envelopment Analysis and Structural Risk Minimization: Some Examples of Use of Multi-output Machine Learning Techniques on Real-World Data	1
Nadia M. Guerrero, Juan Aparicio, Raul Moragues, and Daniel Valero-Carreras	
A New Network Data Envelopment Analysis Model for Efficacy Evaluation of Decision-Making Units	33
Hilda Saleh, Morteza Shafiee, and Sara Nakhjirkan	
Possibilistic Network DEA Approach for Performance Evaluation of Two-Stage Decision Making Units Under Uncertainty	59
Pejman Peykani, Mostafa Sargolzaei, Farhad Hamidzadeh, Fatemeh Sadat Seyed Esmaeili, and Amir Takaloo	
Managerial Ability in Indian Life Insurance Companies: A Comparison Based on DEA and DEAGP	81
Ram Pratap Sinha and Bahareh Vaisi	
Efficiency Appraisal and Classification of Flexible Random Factors	103
Monireh Jahani Sayyad Noveiri and Sohrab Kordrostami	
Performance Evaluation of Indian Banking Financial Sector by Using DEA Approach	125
R. Venugopal, C. Veeramani, V. T. Dhanaraj, and E. Kungumaraj	
Application of Data Envelopment Analysis in Decision Making of Civil Engineering Problems	139
Sanaz Razmyan and Azad Yazdani	
A Robust Optimization Approach for Estimating the Most Productive Scale Size in Uncertain Data Envelopment Analysis	165
Pejman Peykani, Farhad Hamidzadeh, Mir Saman Pishvae, Elaheh Memar-Masjed, and Armin Jabbarzadeh	

Goal Programming Method for Solving Tri-Level Data Envelopment Analysis 183
Morteza Shafiee and Hilda Saleh

Machine Learning Techniques and Efficiency Evaluation: A Survey of Methodological Contributions 201
Juan Aparicio, Miriam Esteve, and Qianying Jin

A Literature Review for Nonparametric Frontier Methods Applied to Portfolio Analysis 235
Tiantian Ren, Helu Xiao, and Zhongbao Zhou

An Optimization Algorithm to Solve Imprecisely Defined Unconstrained Optimization Problem 259
Paresh Kumar Panigrahi and Sukanta Nayak

Examining Dimensions and Critical Success Factors of Supply Chains Based on the Blockchain and Internet of Things (B-IoT) 281
Esmaeil Najafi and Hamed Nozari

Leveraging Data Mining Techniques to Render Unprecedented Opportunities for Business Organizations to Survive and Thrive in the Course of COVID-19 295
Pooja Bhakuni and Amrit Das

Optimizing Ecological Development Zone Selection: A Comparative Analysis of AHP and DEA-Modified VAHP Approaches in Geography 319
Mehdi Soltanifar and Saeid Kamyabi

A Multi-Objective Investment Selection Problem Using Fuzzy and Intuitionistic Fuzzy Approach 339
Prabjot Kaur, Nasreen Kausar, Salma Khan, and Dragan Pamucar

Revolutionizing Education: An Optimal MAGDM-Based e-Learning Approach for Curriculum Beyond the Classroom 353
Sumera Naz, Areej Fatima, Shariq Aziz But, and Arooj Ashiq

Balanced Neutrosophic Fermatean Graphs with Applications 413
Said Broumi, S. Sivasankar, Assia Bakali, and Mohamed Talea

TOPSIS-Based Entropy Measure for N-Valued Neutrosophic Trapezoidal Numbers and Their Application to Multi-Criteria Decision-Making Problems 433
Vakkas Uluçay and İrfan Deli

A New Decision-Making Analysis Model Based on the Transformation of Picture Fuzzy Sets into Fuzzy Sets 455
Taiwo O. Sangodapo, Nasreen Kausar, and Mohammad Y. Chreif

**An Enhanced Score Function for Quadripartitioned Single-Valued
Neutrosophic Sets** 465
Akanksha Singh, Said Broumi, S. Krishna Prabha, Assia Bakali,
and Mohamed Talea