

## Contents

### Preface *xiii*

<b>1</b>	<b>An Overview of the Art of Decision-making</b>	<b>1</b>
1.1	Introduction	1
1.2	Classification of MADM Methods	5
1.2.1	Preference Evaluation Mechanism	5
1.2.2	Attributes' Interactions	7
1.2.3	The Mathematical Nature of Attributes' Values	8
1.2.3.1	Deterministic Vs. Nondeterministic	8
1.2.3.2	Fuzzy Vs. Crisp	8
1.2.4	Number of Involved Decision-makers	8
1.3	Brief Chronicle of MADM Methods	9
1.4	Conclusion	10
	References	12
<b>2</b>	<b>Simple Weighting Methods: Weighted Sum and Weighted Product Methods</b>	<b>17</b>
2.1	Introduction	17
2.2	The Weighted Sum Method	20
2.2.1	Step 1: Defining the Decision-making Problem	20
2.2.2	Step 2: Normalizing the Elements of the Decision-matrix	21
2.2.3	Step 3: Aggregating the Preference of Alternatives	21
2.3	The Weighted Product Method	21
2.4	Conclusion	22
	References	22
<b>3</b>	<b>Analytic Hierarchy Process (AHP)</b>	<b>25</b>
3.1	Introduction	25
3.2	The Hierarchical Structure	27

- 3.3 The Pairwise Comparison 30
- 3.4 Inconsistency 33
- 3.5 Quadruple Axioms of the AHP 35
- 3.6 Stepwise Description of the AHP Method 36
  - 3.6.1 Step 1: Defining the Decision-making Problem 36
  - 3.6.2 Step 2: Performing the Pairwise Comparison Through the Hierarchical Structure 37
  - 3.6.3 Step 3: Estimating the Preference Value Vectors 37
  - 3.6.4 Step 4: Synthesizing and Computing the Overall Preference Value of Alternatives 38
  - 3.6.5 Step 5: Evaluating the Results' Rationality and Selecting the Best Alternative 38
- 3.7 Conclusion 39
  - References 39
  
- 4 Analytic Network Process (ANP) 43**
  - 4.1 Introduction 43
  - 4.2 Network Vs. Hierarchy Structure 45
  - 4.3 Stepwise Instruction to the ANP Method 48
    - 4.3.1 Step 1: Defining the Decision-making Problem 48
    - 4.3.2 Step 2: Conducting a Pairwise Comparison of the Elements of the Decision-making Problem 49
    - 4.3.3 Step 3: Forming the Supermatrix 52
    - 4.3.4 Step 4: Computing the Weighted Supermatrix 53
    - 4.3.5 Step 5: Computing the Global Priority Vectors and Choosing the Most Suitable Alternative 53
  - 4.4 Conclusion 54
    - References 54
  
- 5 The Best–Worst Method (BWM) 59**
  - 5.1 Introduction 59
  - 5.2 Basic Principles of the BWM 62
  - 5.3 Stepwise Description of the BWM 63
    - 5.3.1 Step 1: Defining the Decision-Making Problem 64
    - 5.3.2 Step 2: Determining the Reference Criteria 64
    - 5.3.3 Step 3: Pairwise Comparisons 64
    - 5.3.4 Step 4: Computing the Optimal Weights 65
    - 5.3.5 Step 5: Measuring the Inconsistency of Decision-Makers Judgments 66
  - 5.4 Conclusion 67
    - References 67

<b>6</b>	<b>TOPSIS</b>	<b>71</b>
6.1	Introduction	71
6.2	Stepwise Description of the TOPSIS Method	72
6.2.1	Step 1: Establishing the Formation of the Decision-making Problem	73
6.2.2	Step 2: Normalizing the Element of the Decision-matrix	73
6.2.3	Step 3: Computing the Weighted Normalized Preference Values	74
6.2.4	Step 4: Defining the Reference Alternatives	74
6.2.5	Step 5: Calculation of the Separation Measure	75
6.2.6	Step 6: Computing the Relative Closeness to the Ideal Solution	76
6.2.7	Step 7: Ranking the Alternatives	76
6.3	A Common Misinterpretation of TOPSIS Results	76
6.4	Conclusion	77
	References	78
<b>7</b>	<b>VIKOR</b>	<b>81</b>
7.1	Introduction	81
7.2	Stepwise Description of the VIKOR Method	84
7.2.1	Step 1: Modeling the Decision-Making Problem	84
7.2.2	Step 2: Normalizing the Element of the Decision-Matrix	85
7.2.3	Step 3: Compute the "Group Satisfaction" and "Individual Regret" Parameters	85
7.2.4	Step 4: Computing the VIKOR Parameter	86
7.2.5	Step 5: Ranking the Alternatives	86
7.2.6	Step 6: Determining the Compromise Solution	86
7.3	Conclusion	87
	References	88
<b>8</b>	<b>ELECTRE</b>	<b>91</b>
8.1	Introduction	91
8.2	A Brief History of the ELECTRE Family of Methods	93
8.3	ELECTRE I	94
8.4	ELECTRE II	96
8.5	ELECTRE III	99
8.6	ELECTRE IV	104
8.7	Conclusion	105
	References	106
<b>9</b>	<b>PROMETHEE</b>	<b>111</b>
9.1	Introduction	111
9.2	Common Ground of the PROMETHEE Family	112

- 9.2.1 Stage 1: Construction of the Generalized Criteria 113
- 9.2.2 Stage 2: Mapping the Outrank Relation on the Set of Feasible Alternatives 116
- 9.2.3 Stage 3: Evaluation the Relation Among the Feasible Alternatives 116
- 9.3 PROMETHEE I 117
- 9.4 PROMETHEE II 118
- 9.5 PROMETHEE III 119
- 9.6 PROMETHEE IV 120
- 9.7 Conclusion 121
- References 121
  
- 10 Superiority and Inferiority Ranking (SIR) 125**
- 10.1 Introduction 125
- 10.2 Foundational Bases of the SIR Method 126
- 10.3 Stepwise Description of the SIR Method 129
- 10.3.1 Step 1: Establishing the Formation of the Decision-Making Problem 129
- 10.3.2 Step 2: Computing the Superiority and Inferiority Scores 129
- 10.3.3 Step 3: Forming the Superiority and Inferiority Matrices 132
- 10.3.4 Step 4: Superiority and Inferiority Flows 133
- 10.3.5 Step 5: Ranking the Set of Feasible Alternatives 135
- 10.4 Conclusion 136
- References 137
  
- 11 PAPRIKA 139**
- 11.1 Introduction 139
- 11.2 Stepwise Description of PAPRIKA 140
- 11.2.1 Step 1: Defining the Decision-Making Problem 141
- 11.2.2 Step 2: Identifying the Nondominated Pairs of Alternative 141
- 11.2.3 Step 3: Ranking the Pairs of Nondominated Solutions 142
- 11.2.4 Step 4: Calculating the Complete Ranking of Alternatives 144
- 11.3 Conclusion 145
- References 146
  
- 12 Gray Relational Analysis 149**
- 12.1 Introduction 149
- 12.2 Gray System Theory: The Foundation and Basic Principles 150
- 12.3 Gray Relational Modeling 151
- 12.4 Gray Theory in Relation to MADM 153
- 12.5 Conclusion 155
- References 155