
Contents

Part 1 Introduction to Decision Making

1	Introduction to Decision Making in the Manufacturing Environment	3
1.1	Introduction.....	3
1.2	Decision-making Methods Used.....	5
2	Graph Theory and Matrix Approach as a Decision-making Method	7
2.1	Introduction.....	7
2.2	Machinability Attributes Digraph.....	8
2.3	Matrix Representation of the Digraph.....	10
2.4	Machinability Index.....	19
2.5	Identification and Comparison of Work Materials.....	21
2.5.1	Identification of Work Materials.....	21
2.5.2	Comparison of Work Materials.....	22
2.6	Methodology of GTMA as a Decision-making Method.....	23
	References.....	24
3	Introduction to Multiple Attribute Decision-making (MADM) Methods	27
3.1	Introduction.....	27
3.2	Multiple Attribute Decision-making Methods.....	28
3.2.1	Simple Additive Weighting (SAW) Method.....	28
3.2.2	Weighted Product Method (WPM).....	29
3.2.3	Analytic Hierarchy Process (AHP) Method.....	29
3.2.4	Revised Analytic Hierarchy Process (RAHP) Method.....	32
3.2.5	Multiplicative Analytic Hierarchy Process (MAHP) Method.....	32
3.2.6	TOPSIS Method.....	32
3.2.6.1	Entropy Method.....	34
3.2.6.2	Standard Deviation Method.....	35
3.2.6.3	AHP Method.....	35

- 3.2.7 Modified TOPSIS Method..... 35
- 3.2.8 Compromise Ranking Method (VIKOR)..... 36
- 3.3 Sensitivity Analysis..... 37
- 3.4 Group Decision Making (GDM)..... 38
- References..... 39

- 4 A Logical Approach to Fuzzy MADM Problems..... 43**
 - 4.1 Introduction..... 43
 - 4.2 Method Proposed by Chen and Hwang (1992..... 44
 - 4.2.1 Converting Linguistic Terms to Fuzzy Numbers..... 44
 - 4.2.2 Converting Fuzzy Numbers to Crisp Scores..... 44
 - 4.3 Demonstration of the Method 45
 - References..... 49

Part 2 Applications of GTMA and Fuzzy MADM Methods in the Manufacturing Environment

- 5 Material Selection for a Given Engineering Application 53**
 - 5.1 Introduction..... 53
 - 5.2 Examples..... 55
 - 5.2.1 Example 1 56
 - 5.2.1.1 Application of GTMA..... 56
 - 5.2.1.2 SAW Method..... 58
 - 5.2.1.3 WPM..... 59
 - 5.2.1.4 AHP and its Versions 59
 - 5.2.1.5 TOPSIS Method..... 61
 - 5.2.1.6 Modified TOPSIS Method 62
 - 5.2.1.7 VIKOR..... 63
 - 5.2.2 Example 2 64
 - 5.2.2.1 Application of GTMA..... 64
 - 5.2.2.2 SAW Method..... 65
 - 5.2.2.3 WPM..... 66
 - 5.2.2.4 AHP and its Versions..... 66
 - 5.2.2.5 TOPSIS Method..... 67
 - 5.2.2.6 Modified TOPSIS Method 67
 - References..... 68

- 6 Evaluation of Product Designs 71**
 - 6.1 Introduction..... 71
 - 6.2 Example 74
 - 6.2.1 GTMA 74
 - 6.2.2 AHP Method..... 76
 - 6.2.3 TOPSIS Method..... 77
 - 6.2.4 Modified TOPSIS Method..... 79
 - References..... 79

7	Machinability Evaluation of Work Materials	81
7.1	Introduction.....	81
7.2	Examples.....	84
7.2.1	Example 1.....	84
7.2.1.1	Application of GTMA.....	85
7.2.1.2	SAW Method.....	87
7.2.1.3	WPM.....	87
7.2.1.4	AHP and its Versions.....	88
7.2.1.5	TOPSIS Method.....	88
7.2.1.6	Modified TOPSIS Method.....	89
7.2.2	Example 2.....	90
7.2.2.1	Application of SAW Method.....	90
7.2.2.2	WPM.....	91
7.2.2.3	AHP and its Versions.....	91
7.2.2.4	TOPSIS Method.....	92
7.2.2.5	Modified TOPSIS Method.....	93
	References.....	93
8	Cutting Fluid Selection for a Given Machining Application	97
8.1	Introduction.....	97
8.2	Examples.....	103
8.2.1	Example 1.....	103
8.2.1.1	Application of GTMA.....	104
8.2.1.2	SAW Method.....	105
8.2.1.3	WPM.....	106
8.2.1.4	AHP and its Versions.....	106
8.2.1.5	TOPSIS Method.....	107
8.2.1.6	Modified TOPSIS Method.....	108
8.2.2	Example 2.....	109
8.2.2.1	GTMA.....	109
8.2.2.2	SAW Method.....	110
8.2.2.3	WPM.....	111
8.2.2.4	AHP and its Versions.....	111
8.2.2.5	TOPSIS Method.....	111
8.2.2.6	Modified TOPSIS Method.....	112
	References.....	112
9	Evaluation and Selection of Modern Machining Methods	115
9.1	Introduction.....	115
9.2	Examples.....	117
9.2.1	Example 1.....	117
9.2.1.1	GTMA.....	117
9.2.1.2	SAW Method.....	119
9.2.1.3	WPM.....	120
9.2.1.4	AHP and its Versions.....	120
9.2.1.5	TOPSIS Method.....	121
9.2.1.6	Modified TOPSIS Method.....	121

9.2.2	Example 2	121
9.2.2.1	GTMA	122
9.2.2.2	TOPSIS Method	123
9.2.2.3	Modified TOPSIS Method	124
References	.....	124
10	Evaluation of Flexible Manufacturing Systems	125
10.1	Introduction	125
10.2	Examples	127
10.2.1	Example 1	127
10.2.1.1	Application of GTMA	128
10.2.1.2	AHP and its Versions	130
10.2.2	Example 2	131
10.2.2.1	Application of GTMA	132
10.2.2.2	AHP and its Versions	133
10.2.2.3	TOPSIS & Modified TOPSIS Methods	134
10.2.2.4	Compromise Ranking Method (VIKOR)	134
References	.....	135
11	Machine Selection in a Flexible Manufacturing Cell	139
11.1	Introduction	139
11.2	Example	141
11.2.1	Application of GTMA	142
11.2.2	SAW Method	144
11.2.3	WPM	145
11.2.4	AHP and its Versions	145
11.2.5	TOPSIS Method	146
11.2.6	Modified TOPSIS Method	146
References	.....	147
12	Failure Cause Analysis of Machine Tools	149
12.1	Introduction	149
12.2	Identifying Contributing Events of a Failure Cause	154
12.3	MTFCD and its Matrix Representation	156
12.4	General Machine Tool Failure Causality Function	158
12.5	Machine Tool Failure Cause Evaluation	160
12.6	Machine Tool Failure Cause Analysis	162
12.7	Methodology	163
12.8	Summary	164
References	.....	165
13	Robot Selection for a Given Industrial Application	169
13.1	Introduction	169
13.2	Examples	171
13.2.1	Example 1	172
13.2.1.1	Application of GTMA	172
13.2.1.2	SAW Method	173

	13.2.1.3 WPM	173
	13.2.1.4 AHP and its Versions	174
	13.2.1.5 TOPSIS Method	174
	13.2.1.6 Modified TOPSIS Method	175
13.2.2	Example 2	176
	13.2.2.1 Application of GTMA	176
	13.2.2.2 AHP and its Versions	177
	References	178
14	Selection of Automated Inspection Systems	181
	14.1 Introduction	181
	14.2 Example	182
	14.2.1 Application of GTMA	182
	14.2.2 AHP and its Versions	185
	14.2.3 TOPSIS Method	186
	14.2.4 Modified TOPSIS Method	186
	References	186
15	Selection of Material Handling Equipment	187
	15.1 Introduction	187
	15.2 Example	191
	15.2.1 Application of GTMA	191
	15.2.2 SAW Method	192
	15.2.3 WPM	193
	15.2.4 AHP and its Versions	193
	15.2.5 TOPSIS Method	193
	15.2.6 Modified TOPSIS Method	194
	References	194
16	Selection of Rapid Prototyping Process in Rapid Product Development	197
	16.1 Introduction	197
	16.2 Example	200
	16.2.1 Application of GTMA	201
	16.2.2 SAW Method	203
	16.2.3 WPM	204
	16.2.4 AHP and its Versions	204
	16.2.5 TOPSIS Method	205
	16.2.6 Modified TOPSIS Method	205
	16.2.7 VIKOR	206
	References	206
17	Selection of Software in Manufacturing Industries	209
	17.1 Introduction	209
	17.2 Example	211
	17.3 General Remarks	213
	References	213

18	Welding Process Selection for a Given Application	215
18.1	Introduction	215
18.2	Example	216
18.2.1	GTMA	216
18.2.2	SAW Method	218
18.2.3	WPM	218
18.2.4	AHP and its Versions	218
18.2.5	TOPSIS Method	219
	References	219
19	Geometric Moldability Analysis of Parts	221
19.1	Introduction	221
19.2	Example	224
19.2.1	GTMA	225
19.2.2	SAW Method	226
19.2.3	AHP Method	226
19.2.4	TOPSIS Method	227
19.2.5	Modified TOPSIS Method	228
19.3	General Remarks	228
	References	228
20	Evaluation of Metal Stamping Layouts	231
20.1	Introduction	231
20.2	Example	233
20.2.1	Application of GTMA	234
20.2.2	SAW Method	236
20.2.3	WPM	236
20.2.4	AHP and its Versions	237
20.2.5	TOPSIS Method	238
20.2.6	Modified TOPSIS Method	238
	References	239
21	Selection of Forging Conditions for Forging a Given Component	243
21.1	Introduction	243
21.2	Example	248
21.2.1	GTMA	248
21.2.2	SAW Method	249
21.2.3	WPM	250
21.2.4	AHP Method	250
21.2.5	TOPSIS Method	250
21.2.6	Modified TOPSIS Method	251
	References	251
22	Evaluation of Environmentally Conscious Manufacturing Programs	255
22.1	Introduction	255
22.2	Example	257

22.2.1	GTMA	258
22.2.2	SAW Method.....	259
22.2.3	AHP and its Versions.....	260
22.2.4	TOPSIS Method.....	260
22.2.5	Modified TOPSIS Method.....	261
References	.....	262
23	Environmental Impact Assessment of Manufacturing Processes	265
23.1	Introduction.....	265
23.2	Example	268
23.2.1	GTMA	270
23.2.2	AHP Method.....	271
23.2.3	TOPSIS Method.....	272
23.2.4	Modified TOPSIS Method.....	274
References	.....	274
24	Evaluation of Aggregate Risk in Green Manufacturing	277
24.1	Introduction.....	277
24.2	Example	280
24.2.1	GTMA	280
24.2.2	AHP Method.....	281
24.2.3	TOPSIS Method.....	282
24.2.4	Modified TOPSIS Method.....	282
References	.....	283
25	Selection of Best Product End-of-Life Scenario.....	285
25.1	Introduction.....	285
25.2	Example	288
25.2.1	GTMA	289
25.2.2	SAW Method	290
25.2.3	WPM.....	290
25.2.4	TOPSIS Method.....	291
25.2.5	Modified TOPSIS Method.....	291
25.2.6	Compromise Ranking Method (VIKOR).....	292
References	.....	292
26	Integrated Project Evaluation and Selection	295
26.1	Introduction.....	295
26.2	Example	299
26.2.1	WPM.....	301
26.2.2	TOPSIS Method.....	301
26.2.3	Modified TOPSIS Method.....	302
References	.....	303
27	Facility Location Selection.....	305
27.1	Introduction.....	305
27.2	Examples.....	306

27.2.1	Example 1	306
27.2.1.1	GTMA	306
27.2.1.2	SAW Method.....	308
27.2.1.3	WPM	308
27.2.1.4	AHP and its Versions	309
27.2.1.5	TOPSIS Method	309
27.2.1.6	Modified TOPSIS Method	310
27.2.2	Example 2	310
27.2.2.1	GTMA	311
27.2.2.2	AHP and its Versions	312
References	.....	312
28	Operational Performance Evaluation of Competing Companies.....	315
28.1	Introduction	315
28.2	Example	316
28.2.1	Application of GTMA	317
28.2.2	SAW Method.....	318
28.2.3	WPM.....	318
28.2.4	AHP and its Versions.....	318
28.2.5	TOPSIS Method.....	319
28.2.6	Modified TOPSIS Method.....	319
References	.....	319
29	Vendor Selection in a Supply Chain Environment.....	321
29.1	Introduction	321
29.2	Example 1	323
29.2.1	GTMA	324
29.2.2	TOPSIS Method.....	326
29.3	Genetic Algorithms	329
29.4	Proposed Methodology	330
29.5	Example 2	331
29.6	General Remarks.....	336
References	.....	337
30	Group Decision Making in the Manufacturing Environment.....	341
30.1	Introduction	341
30.2	Example	342
30.2.1	Application of GTMA	343
30.2.2	SAW Method.....	344
30.2.3	WPM.....	344
30.2.4	TOPSIS Method.....	345
30.2.5	Modified TOPSIS Method.....	345
30.3	General Remarks.....	345
References	.....	346
	Appendix Computer Codes	347
	Index	371