

## TABLE OF CONTENTS

	Page
I. INTRODUCTION	1
II. SOCIAL CHOICE THEORY	10
1. VOTING	10
1.1 Nonranked Voting System	10
1.1.1 One Member Elected From Two Candidates	11
1.1.2 One Member Elected From Many Candidates	11
(a) The First-Past-The-Post System	11
(b) Majority Representation System	11
Repeated Ballots	11
The Second Ballot	12
Note:	12
Case 1 of Dodgson	12
Case 2 of Dodgson	13
Case 3 of Dodgson Modified	13
1.1.3 Election of Two or More Members	14
1.1.3.1 The Single Nontransferable Vote	14
1.1.3.2 Multiple Vote	14
1.1.3.3 Limited Vote	14
1.1.3.4 Cumulative Vote	15
1.1.3.5 List Systems	15
(a) Highest Average	15
(b) Greatest Remainder	17
1.1.3.6 Approval Voting	17
1.2 Preferential Voting System	19
1.2.1 Simple Majority Decision Rule	20
1.2.1.1 Two-Alternative Case	20

1.2.1.2	More Than Two Alternatives Case	21
(a)	Paradox of Voting	21
	Example 1 of Condorcet	21
	Example 2 of Condorcet	23
(b)	The Condorcet Effect	24
	Note: Nonminority Rule	27
2.	SOCIAL CHOICE FUNCTION	29
2.1	Introduction	29
	Condorcet Principle	29
2.2	Notation, Definitions and Basic Properties	31
2.3	Condorcet's Function	34
2.4	Borda's Function	36
2.5	Copeland's Function	37
2.6	Nanson's Function	40
2.7	Dodgson's Function	44
2.8	Kemeny's Function	45
2.9	Cook and Seiford's Function	51
2.10	Fishburn's Function	56
2.11	Eigenvector Function	58
2.12	Bernardo's Assignment Approach	63
2.13	Cook and Seiford's Ordinal Intersection Method	73
3.	SOCIAL WELFARE FUNCTION	79
3.1	Introduction	79
3.2	Notation and Statement of Problem for Social Choice and Individual Values	80
3.3	Arrow's Conditions for Social Welfare Function	83
3.4	Arrow's Possibility Theorem for Two Alternatives	86
3.5	Arrow's General Possibility Theorem	88
3.6	Black's Single-Peaked Preferences	90
3.7	Bowman and Colantoni's Approach	96
3.8	Goodman and Markowitz's Approach	103

3.9	Cardinal Social Welfare Function	107
3.9.1	Value Function for Certainty Case	108
3.9.2	Utility Function for Uncertainty Case	110
3.9.2.1	Additive Group Utility Function	111
3.9.2.2	Multiplicative Group Utility Function	112
3.9.3	Some Applications	113
3.9.3.1	Gymnastics Competitions	114
3.9.3.2	Extended Contribution Rule Method (ECR Method)	120
3.9.3.3	The Selection of Trajectories for the Marine Jupiter/Saturn 1977 Project	130
3.10	Comparison Between Arrow's Conditions for Social Welfare Function and Proper- ties of Social Choice Function.	136

III.	EXPERTS JUDGMENT AND/OR GROUP PARTICIPATION	145
1.	INTRODUCTION	145
2.	BRAINSTORMING	148
2.1	Introduction	148
2.2	Rules and Procedure for Brainstorming Method	149
2.3	Advantages and Disadvantages	150
2.4	Note on Various Modified Techniques	151
3.	BRAINWRITING	152
3.1	Introduction	152
3.2	Procedure of Brainwriting Pool and Its Discussion	152
3.3	Brainwriting and Its Variations	154
4.	THE NOMINAL GROUP TECHNIQUE (NGT)	155
4.1	Introduction	155
4.2	The Nominal Group Technique Process	156
4.3	Advantages and Disadvantages of NGT	157

5.	SYNECTICS	158
5.1	Introduction	158
5.2	The Process of Synectics	159
5.3	Advantages and Disadvantages of Synectics	163
	Note	164
6.	SURVEYS	165
6.1	Introduction	165
6.2	Survey Procedure	166
6.3	Advantages and Disadvantages of Surveys	168
7.	DELPHI METHOD	169
7.1	Introduction	169
7.2	The Procedure of Delphi Method	169
7.3	Advantages and Disadvantages of Delphi Method	172
	Note	173
7.4	Example	174
8.	CONFERENCES	180
8.1	Introduction	180
8.2	Planning and Conducting the Conference	181
	Note	184
9.	SUCCESSIVE PROPORTIONAL ADDITIVE NUMERATION OR SOCIAL PARTICIPATORY ALLOCATIVE NETWORK (SPAN)	185
9.1	Introduction	185
9.2	The Procedure of SPAN Technique	186
9.3	Example	186
9.4	Advantages and Disadvantages of SPAN	189
10.	INTERPRETIVE STRUCTURAL MODELING (ISM)	190
10.1	Introduction	190
10.2	The Procedure of ISM	191
10.3	Digraphs, Binary Matrices, and Computer Implementation	195
10.4	Example: Urban Planning for Dayton, Ohio	202
10.5	Advantages and Disadvantages of ISM	205

11. DECISION MAKING TRIAL AND EVALUATION LABORATORY (DEMATEL)	207
11.1 Introduction	207
11.2 Objectives, Ideas, and Goals	208
11.3 Procedure	210
11.3.1 Framework of the World Problematique	210
11.3.2 Participants	212
11.3.3 Questions Asked	212
11.3.4 Analysis of Individual Perceptions of World Problematique	213
11.3.5 Analysis of the Average Perceptions by Group of the World Problematique	221
11.3.6 Comparison of Individual Perceptions of the World Problematique	221
11.4 Example: Perception of the World Problematique	222
Note	232
12. COGNITIVE MAP	232
12.1 Introduction	232
12.2 Basic Elements of a Cognitive Map	234
12.3 Analysis of Signed Digraph	235
12.4 The Cognitive Map of Collectivities	237
12.5 Inferring the Properties of a Cognitive Map	238
12.6 Example: Building and Analyzing an Energy Demand Signed Digraph	240
12.7 The Limitation of the Cognitive Map	250
13. KANE'S SIMULATION (KSIM)	252
13.1 Introduction	252
13.2 The Procedure of KSIM	253
13.3 Example: Shall We Permit Bird Hunting in Eco Valley?	257
13.4 Advantages and Disadvantages of KSIM	261
13.5 Other Simulations	262
Note	264

14. IMPLEMENTING AND CONTROLLING A PROJECT	264
14.1 Introduction	264
14.2 Gantt Chart	265
14.3 Program Evaluation Review Technique (PERT) and Critical Path Method (CPM)	265
14.4 The Planning-Programming-Budgeting System (PPBS)	267
14.5 DELTA Chart	268
15. GROUP DECISION MAKING UNDER MULTIPLE CRITERIA FOR EVALUATION/SELECTION OF ALTERNATIVES	270
15.1. Introduction	270
15.2. A General Formulation	273
15.3. The Ordinal Approach	274
15.3.1 The Agreed Criteria Approach	274
15.3.2 The Individual Approach	276
15.3.3 Numerical Example	277
15.4. The Cardinal Approach	282
15.4.1 The Agreed Criteria Approach	283
15.4.2 The Individual Approach	285
15.4.2.1 The Additive Weighted Value Approach	285
15.4.2.2 TOPSIS and Borda's Function Approach	285
15.4.3 Example	286
15.5 Note	294
16. A SYSTEMS APPROACH TO EXPERT JUDGMENTS AND/OR GROUP PARTICIPATION ANALYSIS	295
16.1 Introduction	295
16.2 Processes in the Systems Approach	296
16.3 Note	301
IV. GAME THEORY	306
1. INTRODUCTION	306
2. SOME BASIC CONCEPTS	307
The Extensive Form of a Game	307

The Normal Form of a Game	308
The Characteristic Function Form of a Game	309
Cooperative and Noncooperative Games	310
Essential and Inessential Games	310
Zero-Sum, Constant-Sum, General-Sum Games	311
3. THE NORMAL FORM PAYOFF FUNCTION	311
3.1 Introduction	311
3.2 Pareto Optimal Set	312
3.3 The Nash-Harsanyi Arbitration Solution	315
3.4 Compromise Solution	317
4. THE CHARACTERISTIC FUNCTION FORM	319
4.1 Introduction	319
4.2 Core Concept	322
4.3 Shapley Value	331
4.4 The Parametric Approach	336
V. CONCLUDING REMARKS	347
VI. REFERENCES	355