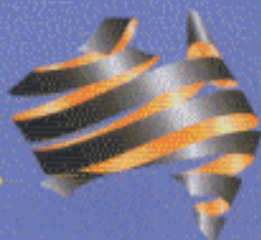


AP-133

NEW ANALYSIS TECHNIQUES FOR
MULTI-CRITERIA EVALUATION



AUSTROADS
Delivering Best Practice

TABLE OF CONTENTS

	EXECUTIVE SUMMARY.....	ES-1
1	INTRODUCTION.....	1
1.1	OBJECTIVES OF THE STUDY.....	1
1.2	FUZZY LOGIC	1
1.3	APPROACH.....	2
1.4 OUTLINE OF THIS REPORT.....	4
2	APPLICATION OF FUZZY SET THEORY TO ROAD INVESTMENT STRATEGY DEVELOPMENT.....	5
2.1	INTRODUCING FUZZY SET THEORY INTO THE CONVENTIONAL ROAD PLANNING PROCESS.....	5
2.1.1	Steps in the Road Planning Process.....	5
2.1.2	Crisp Techniques Used in Road Planning	8
2.1.3	Optimality in Road Planning: Concepts And Practice	9
2.1.4	Issues That Can be Addressed Using Fuzzy Methods	11
2.1.5	Some Examples of Fuzzy Methods in Project Planning.....	13
2.2	FROM PROJECT PLANNING TO STRATEGY PLANNING	14
2.2.1	Penetration of Fuzzy Methods into Strategic Road Planning.....	14
2.2.2	Road Strategy Planning Guidelines, Responses and Tools.....	15
2.3	EXAMPLES OF FUZZY METHODS IN A ROAD STRATEGY PLANNING CONTEXT.....	17
2.3.1	Application of Fuzzy Logic to Selection of Maintenance and Road Enhancements.....	17
2.3.2	Application of Fuzzy Logic to Development of Network Performance	18
2.3.3	Application of Fuzzy Logic to Government, Industry and Community Requirements	22
2.4	THE ROLE OF CONSULTATION	23
2.4.1	On Consensus	23
2.4.2	Impediments to Achieving Consensus.....	25
2.4.3	Consultation in Strategy Selection.....	25
2.4.4	Group Decision-Making in Queensland	26
2.4.5	Consultation in Evaluation and Decision-Making	26
2.4.6	A Method for Reaching Consensus.....	27
2.5	CONCLUSION.....	27

TABLE OF CONTENTS (CONT'D)

3	PROPERTIES AND CONTEXT OF THE NOMINATED CASE STUDY	29
3.1	AIM OF THE CASE STUDY	29
3.2	INFORMATION PROVIDED.....	29
3.3	DESCRIPTION OF THE QUEENSLAND GAM INDEX PRIORITISATION PROCEDURE.....	30
3.3.1	Origin and Purpose.....	30
3.3.2	Formal Specification of the Optimisation	31
3.3.3	Description of the Spreadsheet	33
3.4	COMMENTARY.....	35
3.4.1	Analogy with Cost-Benefit Analysis	36
3.4.2	Responsiveness to Queensland Goals and Procedures	36
3.4.3	Building Blocks for Optimisation.....	36
3.4.4	Choice of Criteria.....	37
3.4.5	Control of Compensatory Effects	37
3.4.6	Valuation of Criteria.....	37
3.4.7	Application of Weights	38
3.4.8	Valuation of Weights	38
3.4.9	Normalising Weights.....	39
3.4.10	Methods of Aggregating Value.....	39
3.4.11	Choice of Decision Rule.....	40
3.4.12	Consultative Arrangements.....	40
4	CONDUCT OF THE CASE STUDY	41
4.1	TERMS OF REFERENCE.....	41
4.2	APPROACH.....	42
4.2.1	Information Sources.....	42
4.2.2	Choice of Fuzzy Optimisation Methods.....	42
4.2.3	Choice of Computer-Based Procedures and Methods	42
4.3	CALCULATION OF FUZZY GAM INDEX FOR EACH LINK VISION	43
4.3.1	Steps in the Calculation	43
4.3.2	Prepare Membership Functions.....	44
4.3.3	Conversion of GAM Scores to Fuzzy GAM Scores.....	46
4.3.4	Interpretation of the Fuzzy GAM Scores.....	46
4.3.5	Calculation of Fuzzy GAM Index for each Link Vision.....	48
4.4	OPTIMISATION METHODS.....	49
4.4.1	Method 1: The FWA Method.....	49
4.4.2	Method 2: The Fuzzy Coefficient Method	49
4.5	MODELLING THE FUZZY COEFFICIENT METHOD.....	52
4.6	RESULTS OF OPTIMISATION METHODS.....	53
4.6.1	Comparison on the Basis of Link Visions Chosen	54
4.6.2	Comparison on the Basis of Funds Allocated	56

TABLE OF CONTENTS (CONT'D)

5	TOWARDS FUTURE PROCEDURES FOR ROAD INVESTMENT STRATEGY DEVELOPMENT.....	57
5.1	LIMITATIONS OF THE GAM PRIORITISATION PROCEDURE.....	57
5.2	EVOLUTION OF FUTURE PROCEDURES.....	57
5.3	PURPOSE OF ANALYSIS AT EACH LEVEL.....	58
5.4	APPOINTING A REFERENCE PANEL.....	59
5.5	ESTABLISH PLANNING PARAMETERS.....	60
5.5.1	“Building Blocks” of A Road Investment Strategy.....	60
5.5.2	Choice Of Criteria.....	61
5.5.3	Choice of Measures for Use in Monitoring Process.....	61
5.5.4	Other Parameters.....	62
5.6	THE LEVEL 1 PROCESS.....	62
5.6.1	Formulation Of Candidate Actions.....	62
5.6.2	Evaluation Procedures.....	64
5.6.3	Identifying Level 1 Preferences.....	64
5.7	THE LEVEL 2 PROCESS.....	65
5.7.1	Refining the Selection and Evaluation of Candidates.....	65
5.7.2	Identifying Level 2 Preferences.....	66
	BIBLIOGRAPHY.....	68
	DEFINITIONS.....	75
	APPENDIX A: TOWARDS FUZZY METHODS IN ROAD INVESTMENT STRATEGY DEVELOPMENT.....	A-1
	APPENDIX B: REQUIREMENTS OF ROAD INVESTMENT STRATEGY PLANNING IN QUEENSLAND.....	B-1
	APPENDIX C: OPTIMISATION WITH FUZZY NUMBERS IN THE OBJECTIVE FUNCTION.....	C-1