PART 1 ECONOMICS-BASED PROJECT APPRAISAL TECHNIQUES, 1

1 Decision Making and Project Appraisal, 3
   1.1 Decision making context, 3
   1.2 Techniques for decision making, 4
      1.2.1 Non-analytical decision making, 4
      1.2.2 Analytical decision making, 6
      1.2.3 Reasoned choice, 6
      1.2.4 Classical rational decision making, 7
      1.2.5 Behavioural decision making, 10
      1.2.6 Irrational decision making, 11
      1.2.7 Political involvement in the project planning process, 12
   1.3 Primacy of the rational model, 13
   1.4 Decision-making conditions, 14
      1.4.1 Certainty, 14
      1.4.2 Risk, 15
      1.4.3 Uncertainty, 15
   1.5 Project planning process, 16
      1.5.1 Identifying project options, 16
      1.5.2 Identifying attributes/criteria of evaluation, 17
      1.5.3 Methods for engineering project appraisal, 19
   1.6 Example of a decision process, 22
      1.6.1 Case study 1: Economic analysis of alternative port access routes for a major city, 23
      1.6.2 Case study 2: Multicriteria analysis of alternative waste management strategies for a region, 24
   1.7 Summary, 25
   1.8 Review of succeeding chapters, 26
References, 27
2 Basic Tools for Economic Appraisal, 29
  2.1 Introduction, 29
  2.2 The time value of money, 29
  2.3 The estimation of interest, 30
  2.4 Simple and compound interest, 31
  2.5 Nominal and effective interest rates, 33
    2.5.1 Nominal interest rates, 33
    2.5.2 Effective interest rates, 34
  2.6 Continuous compounding, 34
  2.7 Time equivalence, 35
  2.8 Economic computation, 37
    2.8.1 Symbols, 37
    2.8.2 Formulae for single payments, 38
    2.8.3 Uniform series formulae, 39
    2.8.4 Geometric series formulae, 43
    2.8.5 Calculations involving unknown interest rates, 46
    2.8.6 Calculation of unknown years, 48
    2.8.7 Additional examples, 48
  2.9 Summary, 50

3 Present Worth Evaluation, 51
  3.1 Introduction, 51
  3.2 Present worth – the comparison process, 52
    3.2.1 Comparing options with equal lives, 52
    3.2.2 Comparing options with unequal lives, 53
    3.2.3 Comparing options with infinite lives, 55
    3.2.4 Life-cycle cost analysis, 58
    3.2.5 Payback comparison method, 60
    3.2.6 Additional examples, 63
  3.3 Summary, 65

4 Equivalent Annual Worth Computations, 67
  4.1 Introduction, 67
  4.2 The pattern of capital recovery, 67
  4.3 Modifying annual payments to include salvage value, 69
  4.4 Evaluating a single project, 71
  4.5 The comparison process, 72
    4.5.1 Introduction, 72
    4.5.2 Equal life projects, 72
    4.5.3 Lease or buy? 72
    4.5.4 Projects with different lives, 73
    4.5.5 Projects with infinite lives, 75
  4.6 Summary, 77
5 Rate of Return Computation, 79
  5.1 Introduction, 79
  5.2 Minimum Acceptable Rate of Return (MARR), 79
  5.3 Internal Rate of Return (IRR), 80
  5.4 IRR for a single project, 80
    5.4.1 Calculating IRR for a single project using present worth, 80
    5.4.2 Calculating IRR for a single project using annual worth, 82
    5.4.3 Single projects with more than one possible rate of return, 82
    5.4.4 External Rate of Return (ERR), 83
    5.4.5 Historical External Rate of Return (HERR), 84
    5.4.6 Project balance method, 85
    5.4.7 Unequal lives, 86
  5.5 Incremental analysis, 87
    5.5.1 Using rate of return analysis for ranking multiple mutually
           exclusive options, 89
    5.5.2 Using IRR to analyse options with different lives, 93
  5.6 Summary, 94

6 Benefit/Cost Ratio, Depreciation and Taxation, 96
  6.1 Introduction, 96
  6.2 Costs, benefits and disbenefits, 96
  6.3 Estimating the benefit/cost ratio for a single project, 97
  6.4 Comparing mutually exclusive options using incremental
      benefit/cost ratios, 98
  6.5 Depreciation, 99
    6.5.1 Straight-line depreciation, 99
    6.5.2 Declining balance depreciation, 100
  6.6 Taxation, 102
  6.7 Summary, 104
    6.7.1 Benefit/cost ratio, 104
    6.7.2 Depreciation, 105

7 Cost–Benefit Analysis of Public Projects, 107
  7.1 Introduction, 107
  7.2 Historical background to cost–benefit analysis, 108
  7.3 Theoretical basis for cost–benefit analysis, 110
  7.4 The procedure of cost–benefit analysis, 111
  7.5 Identifying the main project options, 111
  7.6 Identifying costs and benefits, 111
  7.7 Placing valuations on all costs and benefits/disbenefits, 112
    7.7.1 Shadow pricing, 113
    7.7.2 Non-market valuation of costs/benefits, 114
  7.8 Assessing and comparing the cost–benefit performance of options, 115
  7.9 Sensitivity analysis, 117
7.10 Final decision, 119
7.11 Case study: the cost–benefit analysis of a highway improvement project, 119
    7.11.1 Background to cost–benefit analysis for transport projects, 119
    7.11.2 Introduction to the case study, 122
    7.11.3 Data, 122
    7.11.4 Solution, 123
7.12 Case study: water supply scheme in a developing country, 128
    7.12.1 Background to cost/benefit analysis of water projects, 128
    7.12.2 Introduction to the case study, 131
    7.12.3 Solution, 131
7.13 Case study: cost–benefit analysis of sewer flooding alleviation, 135
    7.13.1 Introduction to the case study, 135
    7.13.2 Solution, 135
7.14 Advantages and disadvantages of traditional cost–benefit analysis, 137
7.15 Techniques for valuing non-economic impacts, 138
    7.15.1 Techniques using surrogate market prices, 138
    7.15.2 Contingent valuation methods, 143
    7.15.3 Integrating sustainability into cost–benefit analysis, 147
7.16 Using cost–benefit analysis within different areas of engineering, 148
    7.16.1 Flood alleviation, 148
    7.16.2 Health, 149
    7.16.3 Agriculture/irrigation, 149
    7.16.4 Transport, 150
7.17 Summary, 151
References, 152

8 Economic Analysis of Renewable Energy Supply and Energy Efficient Projects, 154
8.1 Introduction, 154
8.2 Policy context, 154
8.3 Renewable energy supply and energy efficient technologies, 157
    8.3.1 Fossil-fuelled power generation, 158
    8.3.2 Biomass and bioenergy, 159
    8.3.3 Wind power, 160
    8.3.4 Solar energy, 162
    8.3.5 Buildings, 162
8.4 Economic measures for renewable energy and energy efficient projects, 163
    8.4.1 Aspects of renewable energy supply and energy efficient analysis, 163
    8.4.2 Conventional economic measures, 171
    8.4.3 Special economic measures, 176
    8.4.4 Choosing economic measures, 178
8.5 Estimating GHG emissions, 179
    8.5.1 Life-cycle assessment, 179
    8.5.2 Carbon dioxide equivalent, 180
9 Value for Money in Construction, 193

9.1 Definition of Value for Money, 193
9.2 Defining Value for Money in the context of a construction project, 194
9.3 Achieving Value for Money during construction, 194
9.4 Whole-life costing, 195
  9.4.1 Relationship between Value for Money framework and whole-life decision making, 195
  9.4.2 Baseline costs vs. actual performance over ‘whole-life’, 196
9.5 The concept of ‘milestones’, 196
  9.5.1 Value for Money review, 196
  9.5.2 Financial review, 197
  9.5.3 Project management delivery systems review, 197
9.6 Detailed description of the Value for Money framework, 197
  9.6.1 Value Management, 199
  9.6.2 Risk Management, 201
  9.6.3 Project execution plan, 203
  9.6.4 Control procedures, 204
  9.6.5 Project reports, 205
9.7 Value for Money and design, 206
  9.7.1 Maximising business effectiveness, 207
  9.7.2 Delivering effective project management, 207
  9.7.3 Achieving the required financial performance, 208
  9.7.4 Achieving a positive impact on the local environment, 209
  9.7.5 Minimising operational maintenance costs and environmental impact, 209
  9.7.6 Ensuring compliance with third-party requirements, 210
  9.7.7 Assessing the relative importance of the different value drivers, 210
  9.7.8 Concluding comments on achieving Value for Money through good design, 210
9.8 Is there a conflict between Sustainability and Value for Money, 211
9.9 The role of better managed construction in delivering projects on time and within budget, 213
  9.9.1 Establishing effective construction programmes, 214
  9.9.2 Developing and supporting well-focused and capable clients, 214
  9.9.3 Basing both design and decision making on whole-life costing, 214
  9.9.4 Using appropriate procurement and contracting strategies, 214
  9.9.5 Working collaboratively through fully integrated teams, 214
  9.9.6 Evaluating the project’s performance, 215

References, 215

10 Other Economic Analysis Techniques, 216
  10.1 Introduction, 216
  10.2 Cost effectiveness, 216
    10.2.1 Final comment, 219
  10.3 The Planned Balance Sheet, 220
    10.3.1 The relevance of pure CBA to planning problems, 221
    10.3.2 Lichfield’s Planned Balance Sheet, 222
    10.3.3 Layout of the Planned Balance Sheet, 224
    10.3.4 Conclusions, 227
  10.4 Hill’s Goal Achievement Matrix, 227
    10.4.1 Goal Achievement Matrix and the rational planning process, 228
    10.4.2 The basic steps used to form the matrix, 229
    10.4.3 Formulating the objectives, 229
    10.4.4 Evaluating costs and benefits within the Goal Achievement Matrix, 230
    10.4.5 The structure of the matrix, 231
    10.4.6 Uncertainty within Goal Achievement Matrix, 232
    10.4.7 The simplified Goal Achievement method, 232
    10.4.8 An advanced version of the Goal Achievement Matrix, 234
    10.4.9 Concluding notes on the Goal Achievement Matrix, 236
  10.5 Summary, 239

References, 240

PART 2 NON-ECONOMIC-BASED PROJECT APPRAISAL TECHNIQUES, 241

11 Multicriteria Analysis, 243
  11.1 Introduction, 243
  11.2 Multicriteria evaluation models, 244
  11.3 Simple non-compensatory methods, 246
    11.3.1 Dominance, 246
    11.3.2 Satisficing methods, 248
11.3.3 Sequential Elimination Methods, 250
11.3.4 Attitude-Oriented Methods, 253
11.4 Summary, 255
References, 256

12 The Simple Additive Model, 257
12.1 Background, 257
12.2 Introduction to the Simple Additive Weighting (SAW) Method, 259
12.3 Sensitivity testing, 261
12.4 Probabilistic Additive Weighting, 264
  12.4.1 Expected value, 265
  12.4.2 Variance, 266
12.5 Assigning weights to the decision criteria, 270
  12.5.1 Presumption of equal weights, 270
  12.5.2 Ranking system for obtaining weights, 270
  12.5.3 Ratio system for obtaining weights, 272
  12.5.4 Pairwise comparison weighting system, 273
  12.5.5 The resistance-to-change grid, 274
  12.5.6 Hierarchy of weights, 276
  12.5.7 Multiple weighting systems, 279
  12.5.8 Scoring systems for the criteria, 281
12.6 Checklists, 282
  12.6.1 Environmental Evaluation System, 283
  12.6.2 Sondheim's Environmental Assessment Methodology, 287
  12.6.3 Mongkol’s Methodology, 289
12.7 Case Study: Using the Simple Additive Weighting Model to choose
the best transport strategy for a major urban centre, 292
  12.7.1 Assessing the importance weightings for the decision criteria, 293
  12.7.2 Assessment of each option on each of the subcriteria, 295
  12.7.3 Results of the multicriteria assessment, 296
  12.7.4 Sensitivity analysis, 297
12.8 Summary, 298
References, 298

13 Analytic Hierarchy Process (AHP), 300
13.1 Introduction, 300
13.2 Hierarchies, 301
13.3 Establishing priorities within hierarchies, 301
13.4 Establishing and calculating priorities, 303
  13.4.1 Deriving priorities using an approximation method, 304
  13.4.2 Deriving exact priorities using the iterative eigenvector
  method, 306
  13.4.3 Example of the Exact Method for determining priorities, 308
13.5 Relationship between AHP and the Simple Additive Weighting (SAW) model, 316
13.6 Summary, 316
References, 317

14 Concordance Techniques, 318
14.1 Introduction, 318
14.2 Concordance Analysis, 319
14.3 PROMETHEE I and II, 321
14.4 ELECTRE I, 328
  14.4.1 Obtaining a ranking from the concordance and discordance indices, 330
14.5 Other Concordance Models, 331
  14.5.1 Indifference and preference thresholds, 331
  14.5.2 ELECTRE III and PROMETHEE (5th Form), 333
14.6 Summary, 339
References, 342

15 Concluding Comments, 343
15.1 Introduction, 343
15.2 Which project appraisal technique should one use? 343
15.3 Future challenges, 344
References, 345

Interest Factor Tables, 346
Index, 368