Contents

Preface *xiv*

1 Project Management 1

1.1 Learning Objectives 1
1.2 Introduction 1
1.3 Project Management 1
1.4 Project Management Objectives 2
1.5 Basic Steps in Project Management 2
1.5.1 Defining Activities: Work Breakdown Structure 3
1.5.2 Estimation of Time Durations and Resource Requirements 3
1.5.3 Development of an Execution Sequence 4
1.5.4 Project Scheduling 4
1.5.5 Schedule Refinements 5
1.5.6 Project Execution and Related Arrangements 5
1.5.7 Project Controlling 6
1.6 Project Planning 6
1.7 Project Scheduling 7
1.8 Planning and Scheduling Techniques 8
1.9 Conclusion 9
Exercises 10

2 Work Breakdown Structure 11

2.1 Learning Objectives 11
2.2 Introduction 11
2.3 Project Work Breakdown Structures 11
2.3.1 Hierarchical Levels 12
2.3.2 WBS: An Example 13
2.4 The Development of Network Diagrams from a WBS 14
2.4.1 Network Diagrams from a WBS: An Example 16
2.5 WBS: First Step Toward Project Management 17

2.6 Benefits of A WBS 18
2.7 Conclusion 18
Exercises 19

3 Bar Charts 20

3.1 Learning Objectives 20
3.2 Introduction 20
3.3 Bar Charts 20
3.4 Construction of Bar Charts 22
3.5 Calendar Date Scheduling 24
3.6 Shortcomings in Bar Charts and Remedial Measures 26
3.6.1 Lack of Details 26
3.6.2 Controlling Tool 28
3.6.3 Inter-dependencies between Activities 29
3.6.4 Useful for Routine Tasks 30
3.6.5 Planning and Scheduling Together 30
3.7 Milestone Charts 31
3.8 Linked Bar Charts 31
3.9 Bar Charts for Repetitive Projects 32
3.10 Differences between Bar Charts and WBS 33
3.11 Conclusion 33
Exercises 35

4 Development of Network 38

4.1 Learning Objectives 38
4.2 Introduction 38
4.3 Activity-on-Arrow Networks 38
4.3.1 AOA Networks 39
4.3.2 Network Issues 45
4.4 Event Numbering for Identification of Activities 46
4.4.1 Skip Numbering 48
4.4.2 Event Representation 48
4.5 Activity-on-Node Networks 49
4.6 Comparison of AOA and AON Networks 52
4.7 Networks versus Bar Charts 54
4.8 Conclusion 54
Exercises 55

5 Critical Path Method – I: Activity Times 59

5.1 Learning Objectives 59
5.2 Introduction 59

5.3 Activity Time Durations 59
5.3.1 Accuracy of Activity Time Duration 60
5.4 Activity Times 61
5.5 Time Scaled Networks: Calculations of EST And EFT 62
5.6 Time Scaled Networks: Calculations of LST and LFT 64
5.7 Forward Pass Calculations 68
5.7.1 Calculation of EST_{ij} and EFT_{ij} Using Forward Pass 69
5.8 Backward Pass Calculations 70
5.8.1 Calculation of LST_{ij} and LFT_{ij} Using Backward Pass 70
5.9 Conclusion 71
Exercises 72

6 Critical Path Method – II: Activity Floats 77

6.1 Learning Objectives 77
6.2 Introduction 77
6.3 Critical Path 77
6.4 Critical Activities 78
6.5 Total or Path Float 78
6.5.1 Zero-Float Convention 80
6.6 Free or Activity Float 81
6.7 Interfering Float 83
6.8 Independent Float 83
6.9 Simple Method for Calculating Floats 84
6.10 Significance of Floats 86
6.11 Network Development Procedure 87
6.12 Conclusion 87
Exercises 92

7 Crashing: Time-Cost Tradeoff 97

7.1 Learning Objectives 97
7.2 Introduction 97
7.2.1 Shortening Project Time Durations 97
7.3 Project Crashing 98
7.4 Constituents of Total Project Cost 99
7.4.1 Direct Costs 99
7.4.2 Total Indirect Cost 101
7.5 Total Project Cost and Optimum Time Durations 102
7.6 The Process of Cost Optimization 102
7.7 Implementation 104
7.8 Conclusion 107
Exercises 117

8 Limited Time Resource Scheduling 121

8.1 Learning Objectives 121
8.2 Introduction 121
8.3 Resource Profiles 121
8.4 Resource Planning 123
8.4.1 Resource Smoothing (Limited Time Resource Scheduling) 123
8.4.2 Resource Leveling 124
8.5 Resource Smoothing Process 124
8.6 Understanding the Process 124
8.7 Illustrative Example 1 127
8.8 Illustrative Example 2 128
8.9 Resource Leveling vs. Resource smoothing 129
8.10 Conclusion 131
Exercises 131

9 Project Control and Updating 137

9.1 Learning Objectives 137
9.2 Introduction 137
9.3 Project Control 137
9.4 Schedule Updating 139
9.5 Schedule Updating Process 139
9.5.1 Information Required 139
9.5.2 Updating Process 140
9.5.3 Frequency of Updates 140
9.6 Fund Flow Forecasting: Inflow and Outflow 141
9.6.1 S-Curve 141
9.6.2 Financial Planning 143
9.7 Conclusion 145
Exercises 147

10 Programme Evaluation and Review Technique – I: Event Times 149

10.1 Learning Objectives 149
10.2 Introduction 149
10.3 Activity Time Durations 149
10.3.1 Optimistic Time Durations 150
10.3.2 Pessimistic Time Durations 150
10.3.3 Most Likely Time durations 150
10.4 Time Duration Estimation 151
10.4.1 Frequency Distribution Curve 151
10.5 Mean Time Duration 153
10.6 Event Times 155
10.7 Time-Scaled Networks: Calculations Of Earliest Event Times 156

10.8 Time-Scaled Networks: Calculations of Latest Event Times 158
10.9 Forward Pass: Calculations of EET 159
10.9.1 Calculation of Earliest Event Times Using a Forward Pass 161
10.10 Backward Pass: Calculations of LET 162
10.10.1 Calculation of Latest Event Times Using a Backward Pass 162
10.11 Conclusion 164
Exercises 165

11 Programme Evaluation and Review Technique – II: Probability of Completion 168

11.1 Learning Objectives 168
11.2 Introduction 168
11.3 Critical Path 168
11.4 Critical Activities 169
11.5 Probability Distribution 169
11.6 Central Limit Theorem 170
11.7 Normal Distribution For a Project 172
11.7.1 The Concept of Probability Calculation 174
11.8 Probability of Completing a Project 177
11.9 CPM vs PERT 179
11.10 Conclusion 179
Exercises 184

12 Precedence Diagramming Method 187

12.1 Learning Objectives 187
12.2 Introduction 187
12.3 Development of Networks 188
12.3.1 Activity-on-Node Representation 188
12.3.2 Representation of Inter-dependencies 188
12.3.3 Representation of Time Constraints 188
12.4 Development Of Networks: AOA to AON Representation 189
12.5 Development Of Networks: Inter-Dependencies and Time Constraints 193
12.5.1 Finish-to-Start 194
12.5.2 Start-to-Start 195
12.5.3 Finish-to-Finish 199
12.5.4 Start-to-Finish 200
12.6 Activity Times 203
12.7 Forward Pass Calculations 205
12.7.1 Calculation of EST and EFT Using Forward Pass 206
12.8 Backward Pass Calculations 207
12.8.1 Calculation of LST and LFT Using Backward Pass 208
12.9 Critical Paths and Critical Activities 209

12.10 Total Float 209
12.11 Calendar Date Scheduling 213
12.11.1 Finish-to-Start 213
12.11.2 Start-to-Start 218
12.11.3 Finish-to-Finish 219
12.11.4 Start-to-Finish 220
12.12 PDM for Repetitive Projects 224
12.13 Network Development Procedure 226
12.14 CPM and PDM: Similarities and Dissimilarities 227
12.15 Conclusion 228
Exercises 228

13 Line of Balance for Repetitive Projects 233

13.1 Learning Objectives 233
13.2 Introduction 233
13.3 Repetitive Projects 233
13.4 Scheduling of Repetitive Projects: Line of Balance 234
13.4.1 Activities with Different Progress Rates 236
13.5 Work/Resource Continuity 237
13.6 Time and Space Buffers 238
13.7 Types of Repetitive Projects 238
13.8 Activities With Different Productivities 239
13.9 Linear Interpretation of Precedence Relationships 241
13.9.1 Finish-to-Start 241
13.9.2 Start-to-Start 242
13.9.3 Finish-to-Finish 243
13.9.4 Start-to-Finish 244
13.10 Alternate Representation of an LOB Graph 245
13.11 LOB Graph Development Procedure 246
13.12 Advantages of LOB 248
13.13 Conclusion 248
Exercises 250

14 Selection of Planning Techniques 252

14.1 Learning Objectives 252
14.2 Introduction 252
14.3 Selection of Planning And Scheduling Techniques 252
14.3.1 Sample Example 253
14.4 Techniques for Different Levels of Management 255
14.4.1 Network Condensation 257
14.5 Level of Detail 260

14.6 Techniques For Reducing Time Durations 261
14.7 Project Success or Failure 262
14.8 Conclusion 263
Exercises 263

Bibliography (for Additional Readings) *265*
Index *266*