Table of Contents

CHAPTER 1: INTRODUCTION ................................................................. 1

CHAPTER 2: LITERATURE REVIEW ......................................................... 7

2.1 Time-Independent Shortest Path Problem ........................................... 8
   2.1.1 Shortest Path Algorithm for a Network having Nonnegative Costs ...... 10
   2.1.2 Shortest Path Algorithm for a Network having Mixed Sign Costs ...... 13

2.2 Label-Constrained Shortest Path Problem ........................................ 15
   2.2.1 Problem Formulation ............................................................ 16
   2.2.2 Algorithm ........................................................................... 17

2.3 Time-Dependent Shortest Path Problem ........................................... 19

2.4 Description of TRANSIMS ............................................................ 24
   2.4.1 Major Data Inputs ............................................................... 25
   2.4.2 TRANSIMS’ Modules .......................................................... 25

CHAPTER 3: TIME-INDEPENDENT LABEL-CONSTRAINED SHORTEST PATH
            PROBLEM WITH APPLICATION TO TRANSIMS ................................ 29

CHAPTER 4: TIME-DEPENDENT LABEL-CONSTRAINED SHORTEST PATH
            PROBLEM WITH APPLICATION TO TRANSIMS ................................ 42

   Relationship between the Partitioned Shortest Path (PSP), the Dynamic
   Programming (DP), and the Proposed Algorithms for Solving TDLSP ............ 46

CHAPTER 5: IMPLEMENTATION ISSUES WITHIN TRANSIMS ......................... 58

   5.1 Overview ................................................................................. 58
   5.2 Terminology ............................................................................ 60
   5.3 Key Concepts .......................................................................... 64
   5.4 Major Data Inputs and Outputs .................................................. 65
   5.5 Generating Nodes and Links in the Internal Network ......................... 66
   5.6 Generating Travel Time Functions for Each Link in the Internal Network ... 68
List of Tables

Table 1: Currently Recognized Travel Mode Labels…………………………………………… 60
Table 2: Data of a Travel Time Function over the Interval 8.00 A.M.-8.15 A.M…. 71
Table 3: Simple Single-Trip Request for a Traveler…………………………………………... 74
Table 4: Single-Trip Requests for a Traveler………………………………………………… 82
Table 5: Single-Trip Requests for a Traveler………………………………………………… 88
Table 6: Zonal Index for each Land-Use Zone……………………………………………….. 105
Table 7: Parameter Values for the Heuristic Methods……………………………………….. 108
Table 8: Types of Travel Activities Classified into Crossing Zones………………….. 110
Table 9: Admissible Mode Strings Implemented in the Network and Their
  Notations………………………………………………………………………………… 111
Table 10: Admissible Mode Strings for each Class of Problems………………… 112
Table 11: Overall Results…………………………………………………………………… 114
Table 12a: Comparison of the Solution Quality for the Various Heuristic Methods… 115
Table 12b: Comparison of Heuristic Methods in Computational Time………………… 117
Table 12c: Results for method (i) for the case of $\beta = 0.9$…………………………… 118
Table 13: Results Based on Various Values of the Parameter $\theta$ for the Heuristic
  Method (ii): Network Sectioning Technique .............................................. 120
Table 14a: Results for Different $\alpha$ Parameter Values for the Heuristic
  Method (iii)-1: Level-Based Technique Using Equation (6.7a)………………… 121
Table 14b: Results for Different $\alpha$ Parameter Values for the Heuristic
  Method (iii)-2: Level-Based Technique Using Equation (6.7b)………………… 123
Table 15a: Avg. % Opt for Various Parameter Values $\beta$ and $\psi$ for the Heuristic
  Method (iv): Ellipsoidal Region Technique……………………………………... 125
Table 15b: Average Solution Quality (ASQ) for Various Parameter Values $\beta$ and $\psi$
  for the Heuristic Method (iv): Ellipsoidal Region Technique ………………… 125
Table 15c: Average CPU times for Various Parameter Values $\beta$ and $\psi$ for the
  Heuristic Method (iv): Ellipsoidal Region Technique………………………… 125
Table 15d: Detailed Results for the Alternative Method (iv) with Rectangular Accesses versus the Regular Method (iv) and the Exact Algorithm …… 126

Table 16: Tracking Curtailment Results for Heuristic Method (i)…………………127

Table 17: Tracking Curtailment Results for Heuristic Method (ii)………………128

Table 18a: Tracking Curtailment Results for Heuristic Method (iii)-1………………129

Table 18b: Tracking Curtailment Results for Heuristic Method (iii)-2…………… 130

Table 19: Detailed Results for Heuristic (i): Standard Base-Case (β_i = 1 ∀ i)……..133

Table 20: Detailed Results for Heuristic (iii)-1: Level-Based Technique Using an Exponential Decay Function…………………………………………………… 134

Table 21: Detailed Results for Heuristic (iv): Ellipsoidal Region Technique……… 135

Table 22: % of trips that yield anomalies (either the travel time > T or no feasible O-D path found)…………………………………………………………… 136
List of Figures

Figure 1: TRANSIMS Framework………………………………………………………… 5
Figure 2: An Example of a Simple Network……………………………………….. 12
Figure 3: Nonsimple, Nonconcatenated, and Non-FIFO Time-Dependent Network…………………………………………………………………… 22
Figure 4: Flow-Chart For a Rudimentary Procedure to Solve the TILSP Problem….40
Figure 5. Flow-Chart for the Algorithm to Solve the TDLSP Problem…………… 47
Figure 6: Layered Multi-Modal Network……………………………………………. 53
Figure 7: Data Flow Diagram of the TRANSIMS Route Planner…………………..59
Figure 8: A High-Level Depiction of the Various Layers Used by the Route Planner…………………………………………………………………… 64
Figure 9: A Transformation from the TRANSIMS Network to the Internal Network…………………………………………………………………… 67
Figure 10: Layers of the Internal Network Corresponding to Figure 9…………… 67
Figure 11: An Example of a Travel Time Function over a 24-Hour Interval for a Specific Link Defined by a Pair of Specific Nodes…………………………69
Figure 12: Travel Time Function over 7.00-9.00 A.M. Interval Corresponding to Figure 11……………………………………………………………….. 71
Figure 13: A Plot of the Approximation to the Travel Time Function over the Interval 8.00 A.M. – 8.15 A.M……………………………………………… 72
Figure 14: A Plot of the Approximation to the Travel Time Function over the Interval 7.00 A.M. – 9.00 A.M……………………………………………… 73
Figure 15: The Network for the Illustrative Example for TISP………………………75
Figure 16: The Shortest Path Solution for the Example…………………………….. 81
Figure 17: The Internal Network Representation for the Example for TILSP…….. 83
Figure 18: Layers of the Internal Network for the Example for TILSP…………… 83
Figure 19: The Shortest Path Solution for the Example for TILSP………………… 87
Figure 20: The Internal Network Representation for the Example for TDLSP…… 89
Figure 21: Layers of the Internal Network for the Example for TDLSP……………. 90
Figure 22: The Shortest Path Solution for the Example for TDLSP………………… 93
Figure 23: Transformation of Space................................................................. 96
Figure 24: Prescription of $\beta$ Based on the Level Measure.............................97
Figure 25: Ellipsoidal Region $E_1$, $E_2$, and $E_3$ to Curtail the Network.................99
Figure 26: Land Use in the Bignet Network ....................................................102
Figure 27: Pattern of Travel Time Function for Every Arc in the Network..............104