7 SUMMARY AND CONCLUSIONS

7.1 Summary

Advanced transportation planning and systems analysis are key activities in modern society. Origin-Destination (O-D) trip tables play an essential role in transportation planning. Conventionally, O-D trip tables were obtained through vast amounts of surveys, which are costly, manpower extensive, and time consuming. Since the 1970s, different theories and models have been developed to obtain O-D trip tables based on some easier-to-obtain data. Among them, the Linear Programming model estimates the O-D trip tables by using traffic counts on links (Sherali *et al.* 1994a-b) and has been tested on some practical networks.

This research attempts to enhance the existing LP model so that it better fits the real world situation. In Chapter 3, an enhanced version of the LP model, LPIM(TT), is developed. The model emphasizes the nature of uncertainty in the data and in the problem, and allows the observed traffic counts to have a degree of variation and the least cost travel path to be known only over a confidence interval (range). Chapter 4 investigates a mathematical algorithm proposed for solving the linear programming models LPIM and LPIM(TT) developed in Chapter 3. A Column Generation Algorithm (CGA) is adopted to exploit the special structures of the model. Two other practical problems, assigning costs to links having unknown volumes and prohibiting pass-through-zone paths, are also discussed in this chapter. A simple easy-to-use formula is suggested for estimating the cost of missing volume links. To attempt avoiding unnecessary pass-through-zone paths, the concept of indexed path costs is introduced. An algorithm for solving the indexed-path-cost version of the minimum-path problem is studied, and the issue of how to convert the costs back to the ordinary real costs is also discussed. Chapter 5 presented some guidelines on how to implement the algorithm, focusing on the general philosophy and principle of software design and its application to this research. Chapter 6 addressed some test results using the related models, and demonstrated the efficacy of the LP methodology. Although these results did not directly test the most general models developed in this research, it is expected based on the model structures that these results, or at least their trends, would not change too much for these revised models.

7.2 Recommendations for Future Research

Based on the above discussion, the following research topics might be recommended for future studies.

1. **Implement the general models.** The problem discussed in this research is motivated by real-world transportation phenomena and incorporates realistic uncertainties in data and decision information. Its full implementation based on the coding principles discussed in Chapter 5 is recommended.

2. **Perform further tests.** As discussed in Chapter 6, O-D models can only be evaluated and validated through reasonable testing. Even for the cases tested herein, there still exist issues that need to be investigated. For example, the LP(TT) model was only tested on the Pulaski network for a fixed value of $\sigma = 0.8$ (see Chapter 2 for the definition of σ). It is expected that the reported statistics would vary according to the choice of σ, but it is not clear what the trends of these variations would be and what should be used as a reasonable σ value. These questions can only be answered via a reasonable amount of testing.

3. **Modify the model to involve socioeconomic factors.** The origin-destination distributions for a given study area involve complex social factors, and it is hard to imagine that these distributions can be closely estimated by just using information

regarding link volumes. The current model is based on the user-optimum principle, a principle that itself needs to be justified. Note that for the test results on the Pulaski network in Chapter 6, the performance of both the Linear Programming and maximum entropy models closely depended on the quality of the target table. In cases that no “prior-trip table” is available, a “structural” target trip table may be the only reasonable choice. But the test results show that there are too many zeros in the O-D trip table produced by the LP model for this case. The recent research by Sivanandan *et al.* (1998) tries to improve the results by enhancing the target trip table through some socioeconomic information. It is perhaps more systematic and meaningful if this information could be directly involved in the developed model itself.

4. **Improve the quality of the algorithm.** Previous experience in testing the LP based model shows that this approach is relatively more accurate, but also, more time consuming and computationally extensive for reasonably-sized systems. Although the run-time criterion is not a critical factor for evaluating O-D models, it is still an important factor for practical applications, and could be very critical in the case of testing large-sized networks. There are at least three general approaches to improve the execution time of LP models:

   1) improve the column generation process discussed in Chapter 4;

   2) improve the quality of the computer code, and

   3) investigate an advanced-start method as well as early-termination criteria so that the program may be terminated after a certain measure is attained, such that the interrupted output is not too far from the true optimal output.