

## 7.0 Conclusions and Recommendations

### 7.1 Summary Findings

In this research, the evaluation of THE and LP models' were performed in the context of two target tables : (1) structural table (the results of which were available through the earlier study), and (2) TG-TD table, which was established through the use of the traditional planning approach. THE and LP model results were also compared against each other. These models were evaluated on the Pulaski network for three cases of available link volume information. The test results were judged by two criteria: (1) the closeness of the model output tables to the VDOT-surveyed tables, and (2) the replication of observed link volumes by the models. These two criteria were measured by percentage Mean Absolute Error (%MAE) and Percentage Root Mean Square Error (%RMSE) (for both criteria) and 'PHI' (for criterion 1 only) statistics. Since these are measures of error rates or closeness, the lower the values, the better the results.

The Pulaski case study provided a more credible case for validation of the model results, since a surveyed table was already available for comparison purposes. This surveyed table was assumed to be "true/correct". In addition, the availability of the structural target case results provided an opportunity for gauging the improvements in performances of these models' when a more realistic target/seed table is provided. Both the 24-hour and peak-hour cases were investigated. The summary findings of the evaluation are presented below.

- Trip Table Comparisons

For the 24-hour case, the LP model with the TG-TD target table (derived through MINUTP) shows a consistently improved performance in terms of the closeness of the output tables (as

measured by %MAE, %RMSE, and PHI statistics) to the VDOT-surveyed table, as compared to the structural target table case. This is true for all three cases of available link volumes. A noteworthy observation in the case of LP is that the provision of the TG-TD table as target greatly reduces the error rates as compared to the structural target case. The magnitude of improvement is particularly notable for the PHI(Trip Table) statistics, where the values are dropping by more than 70% for the 24-hour case and around 50% for the peak-hour case, as compared to the structural target case. Thus, the use of the TG-TD table has proven to be valuable in enhancing the performance of the LP model. THE model, on the other hand, shows mixed results. While the PHI statistic decreases, %MAE and %RMSE increase for all the cases of available link volumes.

Comparing the results of LP with those of THE, LP results are significantly superior (in terms of closeness of modeled tables to the VDOT-surveyed table) when the TG-TD target table is used. This inference is true for each of the three cases of volume availability. This inference further endorses the value of providing superior target table information to the LP model.

The above conclusions are based on the assumption that the VDOT-surveyed table is a representation of a “correct” or “true” trip table for the region. It must also be noted that this surveyed table was established through sampling.

- Link Volume Comparisons

As for the link volume replication criterion, the LP model’s ability to replicate observed volumes is clearly superior to THE for all cases of available link volumes, on using the TG-TD target table. However, in general, for both the models’, the link volume replication errors are only in the lower ranges, and hence may not be of major concern. With regard to the behavior of the models’ in replicating observed volumes with varying levels of volume information, mixed trends are noted for both the models’. These may be attributed to the

inconsistencies of the surveyed trip table with the observed volumes and/or to inconsistencies/errors in observed volumes.

Inferences on the test results of peak-hour case for both the models' also lead to generally similar conclusions as for 24-hour case, with some exceptions and differences in improvement ranges.

The sensitivity analysis of the  $\sigma$  parameter in context to the LP model's behavior was also studied. Accordingly, values of 0.9, 0.8, 0.7 and 0.6 were used for  $\sigma$ , both for the 24-hour and peak-hour cases. The modeled trip tables were then tested for their closeness to the target/seed tables, using the %MAE, %RMSE and PHI statistics. It was noted that for both the 24-hour and peak-hour cases, LP modeled trip tables yielded high PHI values for low  $\sigma$  value. This trend was as expected, since a decrease in the  $\sigma$  value signified lesser belief in the target/seed trip table, and accordingly, the LP modeled trip tables showed greater deviations from the target/seed. This sensitivity analysis has confirmed the influence of  $\sigma$  on the output tables. It has also led to some guidance on the use of  $\sigma$  value.

## **7.2 Conclusions**

This research effort was an attempt to enhance the performance of the LP and THE models to estimate trip tables using link volumes. Based on the above findings, it can be concluded that the use of a superior target/seed table information as input clearly improves the performance of the LP model in terms of trip table replication. A similar conclusion, however cannot be reached for THE model, which showed mixed trends in the results. This improvement is in comparison to the case when a structural target table is provided, in the absence of a old/prior trip table. The methodology presented in this research can be employed for situations when a old/prior trip table that is superior to the structural table is unavailable. With the easy and ready availability of socio-economic data, a target table that is more realistic than a structural table can be established by adopting the conventional steps of the four-step planning process.

Since the synthetic models rely primarily on the link volume information in the process of deriving the solution trip table, the purpose of the target table is only to guide the synthetic models. Thus, the objective in this research effort was only to derive a start table that will be superior to the structural table. Hence, assumptions and approximations in the application of trip generation and trip distribution steps in the process of establishing the target table was acceptable. It should be noted that alternative ways of establishing this target table can also be adopted. The test results indicate the general superiority of the LP model over THE on using a superior target/seed table. In addition, the tests indicate that LP results improve greatly when a superior target/seed table is used. This further stresses the desirability of using a good and complete target table, in conjunction with complete (or as close to complete as possible) link volume information for yielding better output trip tables.

In general, it must be kept in mind that these conclusions are based on tests on a specific network, and under the assumption that the data used in testing and evaluation were accurate enough. The adaptability of these models' and the use of one model versus the other must be decided based on the above facts, and in the context of error rates reported in this study. Although these models' can easily be used for any real-life network, their performance has to be judged on the basis of available data for an area. However, this study has highlighted the value of indirectly incorporating travel behavior characteristics (in the form of a target table generated through socio-economic data) into such theoretical models' for trip table estimation without performing conventional surveys.

The LP model was also investigated in the context of  $\sigma$  value variations. This has shed some light on the selection of suitable  $\sigma$  value by the user, based on the relative belief placed in the target/seed table. The user can input a low value of  $\sigma$  if less belief is placed in the target/seed table, and a high value of  $\sigma$  if considerable faith is placed in the target/seed table.

The methodology of deriving O-D trip tables without carrying out conventional surveys can be a very advantageous and desirable approach for many situations. In these times of budget constraints and manpower limitations, techniques such as these are very useful. However, the validity of these models' must be verified before they can be used with confidence. This research effort was a validation attempt. The ready availability and easy accessibility of socio-economic data will be another incentive for transportation agencies to look favorably to this approach.

### **7.3 Recommendations for Further Research**

Further tests and validation of the models' and ways to establish even more superior target tables can be potential areas of further studies. The model results were encouraging for the Pulaski network. Further tests on more real networks will help confirm the findings presented in this thesis. Other ways of establishing target tables can also be tested in the context of the methodology presented in this research. For a credible validation, the model results must be compared with tables that are known to be correct or reasonably good. Further investigation of using the appropriate sigma ( $\sigma$ ) value for LP model runs is also worth pursuing. More time and resources are worth investing in continuing this research due to the potential benefits, in terms of money, time, and manpower, that this approach can offer.