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INCORPORATING FEEDBACK LOOP INTO FSUTMS FOR MODEL CONSISTENCY (Volume I)

PROBLEM STATEMENT

Like other travel demand forecasting models, the Florida Standard Urban Transportation Model Structure (FSUTMS) is not immune to under- and over-assignments of trips to individual links or screenlines. Various means of model calibration and validation, therefore, are developed in an attempt to reduce the degree of assignment errors due to numerous causes and to obtain more accurate trip forecasts. Inconsistent travel impedances exist within FSUTMS's four-step traditional demand model. In this model, trip generation, trip distribution, mode choice, and trip assignment are calculated consecutively, the results from one step being used as input for the next, in ascending order. The problem of inconsistent travel impedances arises because travel impedances are a function of network congestion, but the level of congestion is not known before trip assignment. Consequently, free-flow travel impedances are usually used during the trip distribution and/or modal split steps. For demand forecasts involving congested networks, the inconsistency problem can have a major impact on the output, as travel impedances such as travel times and average speeds are more sensitive at high flow rates. Consequently, the overall pattern of travel flows, such as origin-destination trips and/or their purpose-specific breakdown, may be unrealistic.

OBJECTIVE

The main objective of this project is to improve the accuracy of trip assignments in FSUTMS by designing and implementing an automated feedback loop in FSUTMS to achieve consistent travel impedances among trip distribution, mode split, and route assignment.

FINDINGS AND CONCLUSIONS

Based on the feedback procedures that this study has implemented into FSUTMS, the major findings are summarized as follows:

1. In general, the direct feedback method fails to achieve convergence. In the case of small networks, oscillation may occur between two states of link flow patterns and the network never reaches convergence. This problem becomes less pronounced as the level of congestion increases.
2. The Method of Successive Average (MSA) facilitates the convergence behavior. When the level of congestion increases, the advantage of MSA becomes especially pronounced.
3. Due to feedback, link-specific speed in general increases and, consequently, the travel time decreases.

4. The feedback process redistributes the origin-destination trips more evenly over alternative routes on the network than the four-step process without feedback, due to more congested skim times.
5. The trip distance and length are, in general, reduced due to the feedback process. This results in a lower total VMT and VHT on the network.
6. In general, the feedback process improves the overall volume-to-capacity ratio on the network.
7. The model accuracy, in terms of root mean square error (RMSE), improves marginally due to feedback using the friction factor as determined from the pre-assignment scheme.
8. Feedback with on-line trip length calibration using observed trip length as the starting value results in a systematically higher level of assigned volumes and degraded RMSE when compared to ground counts.
9. Feedback with on-line trip length calibration and total VHT (Vehicle Hour Traveled) control through proportional adjustment by iteration (PAI) restores the RMSE and other statistics to level comparable to the pre-assignment scheme.

The results presented in this report do not provide sufficient evidence to support the significant benefit of feedback process to the model accuracy as claimed by previous research works overall. This is partially attributed to the fact that the proposed feedback model has not fully calibrated as in the pre-assignment model. Proper calibration of the friction factor governing trip length and other important model parameters seems to bear more significance with regard to affecting the model accuracy than the feedback process itself.

BENEFITS

This research provides several benefits: (a) the opportunity for transportation planners to understand the bearing of the feedback process to overall model accuracy; (b) the ability to re-evaluate performance of the pre-assignment process currently used in the planning community; and (c) the ability to objectively review a need for feedback process in the traditional four-step planning model. Although these results indicate that there is only a marginal gain in model accuracy due to the feedback process, this research is worthwhile because it has discovered this particular phenomenon and has empirically determined the marginal effects of the feedback process, which will eventually be well learned by the planning community.

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