IV-232 Effect of data-size and configuration of networks on the estimation of a trip matrix

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1.Introduction

Estimating a trip matrix by means of updating an old trip matrix on the basis of limited road side survey is an useful technic for transportation planning in an urbanized area in developing countries, because such efforts are less expensive than having a huge survey, e.g. the person trip survey. When the sample size is limited, however, it is obvious that the estimated trip matrix will have an error. Therefore, it will be very useful to study the error variation according to the sample size and the influence from network size and configurations on this error variation. In this paper two different network configurations and six different network sizes are analyzed.

2.Model formulation

A method for updating trip matrix direct from road side survey data, was proposed by VAN ZUYLEN (1980), using information minimizing theory. Another model, based on entropy concept was proposed by WILLUMSEN (1980), where this model did not require information about an old trip matrix. The accuracy of the results from these two models are greatly influenced by assignment model specification. Therefore, HALL et al. (1980) proposed an updating strategy using the feed back effect between trip distribution and traffic assignment.

A combined distribution assignment model, which combines Willumsen's entropy concept and travel cost minimizing concept for traffic assignment, was suggested by FISK and BOYCH (1983). However, the complexity of direct solution was realized in their study and alternative solving methods were recommended for further research.

In this study, a similar basic concept of combining these models is considered. The objective function can be formulated as follows:

$$Min\ \alpha \sum_i \sum_j \int_0^{f} t_{kl} \cdot f_{kl}^{ij}\, \partial f + \sum_i \sum_j T_{ij} \ln T_{ij}, \qquad (1)$$

subject to,

$$\sum_i \sum_j f_{kl}^{ij} \le C_{kl} \qquad (2)$$

$$\sum_l \left(\sum_j f_{kl}^{ij} - \sum_j f_{lk}^{ij}\right) = \begin{cases} -Tik & for\ k \ne i \\ 0 & for\ k = i \end{cases} \qquad (3)$$

$$\sum_j T_{ij} = O_i, \quad \sum_i T_{ij} = D_i \qquad (4)$$

$$f_{kl}^{ij},\ T_{ij} \ge 0, \qquad (5)$$

where,

T_{ij} :Trip from origin i to distination j,

f_{kl}^{ij} :The cell volume which represents the volume through a link kl produced by trip T_{ij},

t_{kl} :Travel time in the link kl,

C_{kl} :Capacity in the link kl,

α :A free parameter combines both models.

The direct solution of the above model is very laborious. As such, it is desirable to develop a heuristic procedure for updating a trip matrix.

3.Heuristic approach for solution

In this study imaginary network configurations are analyzed. Fig.1 depicts the methodology of updating trip matrix which is to be adopted here. It can be explained in the following steps.

1.Assume appropriate capacity to each links.

2.Apply a suitable assignment model to the old trip matrix and obtain the old link volumes.

3.Adjust the capacities, hence volume-speed curves so that the estimated old link volumes match with the old observed data.

4.Formulate a three dimentional contribution matrix, which consists of origin i, destination j and cell volume f_{kl}^{ij} as the three dimentions. Hence evaluate the proportion between cell volume in each link and T_{ij}.

5. Determine the incremental volumes for the available current links volume data.

6. Distribute this incremental volumes δf_{kl}^{ij} in proportion to cell volumes f_{kl}^{ij}.

7. Calculate the incremental cell trips δT_{ij}^{s} corresponding to each cell volume described above using the proportion evaluated in step4.

8. Find the arithmetic mean values of δT_{ij}^{s}, i.e. $\overline{\delta T_{ij}} = \Sigma_{s} \delta T_{ij}^{s} / n^{s}$, where n^{s} = total number of cells for each O-D pair. Thus find the new trip matrix $T_{ij}+\overline{\delta T_{ij}}$.

9. Assign the new trip matrix and return to step 4 until a reasonable matching is reached between observed link volumes and estimated link volumes.

4. Conclusions

Fig.2 and 3 show a gradual decrease in the accuracy until the traffic volume data on links is limited to 20% of the total links in the network. The similarity in this trend was observed in the two types of network configurations tested. The further limitation in the traffic volume data caused escalation in the decrease rate in accuracy. This is mainly because, when the traffic volume data became insufficient to estimate trip matrix, the supplementary information was obtained from old trip matrix. This particular information cannot reflect the present change in traffic volume.

In addition, three different sizes correspond to the two different types of networks were analyzed. It was found that, as the network size increases, the accuracy curve lowers. But it is difficult to suggest a relationship from this analysis. Extensive analysis is required to propose such relationship between the size of the network and accuracy curve.

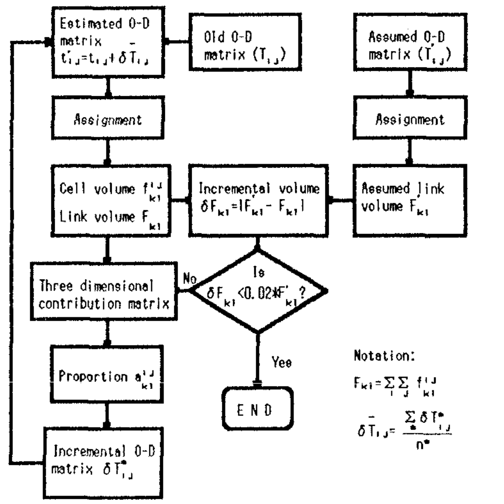

Fig.1 Flow diagram for updating trip matrix

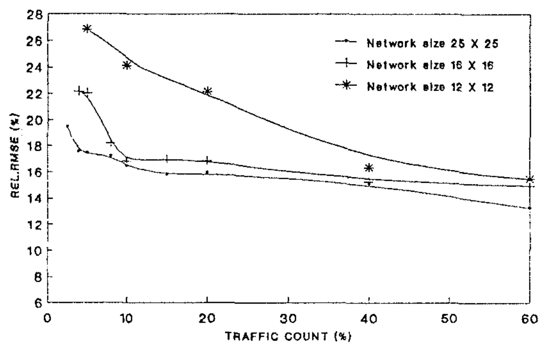

Fig.2 Influence by network size on accuracy variation (Grid Type)

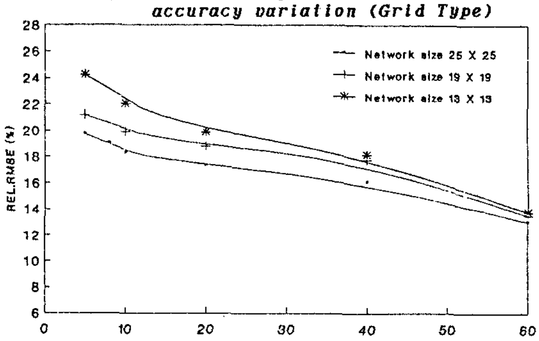

Fig.3 Influence by network size on accuracy variation (Radial Type)

References

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