INTRODUCTION
CHAPTER - 1
INTRODUCTION

1.0 GENERAL

In recent years, many techniques have been suggested for the estimation of travel demand using link volume philosophy. However, most of these techniques are still in their formative stages, lacking robustness for practical implementation, in spite of the theoretical rigour, some of them enjoy. The object of this study is to conduct a critical review of the recent advances from the point of view of practical implementation and to select one or two of these approaches for further experimentation and development of both spatial and temporal demands that arise in an urban area by bus transportation system. The effect of dynamic changes in urban structure, which changes the travel demand during different times of the day, is a point of investigation in this thesis.

1.1 LINK VOLUME MODELS

The models reported so far in literature can be grouped as those adopting:

i) Gravity formulation approach (Low)
ii) Network equilibrium (Nguyen)
iii) Entropy Maximisation (Willumsen)
iv) Information Minimisation (Van Zuylen)
v) Bayesian statistics (Maher)
vi) Multiobjective formulation (Gothe et al)
In the above listing, the names of the pioneers in respective fields are indicated in the brackets.

None but the first approach seems to have had useful application in real world problems, even though mention may be made of the efforts of Van Vliet and Willumsen (1981) to validate their ME2 model.

The objective of the present exploration is to identify the major bottlenecks in this lack of applications for the many techniques that have been proposed.

1.2 A STATE-OF-ART REVIEW

Some of the findings of the state-of-art review are:

i) Traffic counts alone are not sufficient to estimate Origin-Destination (O-D) matrices.

ii) Because of day-to-day and hour-to-hour variations, it is difficult to measure the true trip matrices and hence, all approaches result only in conjectural estimates.

iii) For most practical situations, all-or-nothing assignment models yield matrices which are only marginally outside the day-to-day variations.

iv) Inclusion of better prior estimates, trip length distributions and total trip ends are likely to improve the estimates far more than adoption of any sophistication in model calibration.

v) Solutions using Maximum Entropy or Information Minimisation can prove counter-intuitive due to
multiple and interdependent link volume counts. Adjustment by trip totals becomes necessary in such cases.

vi) Point estimates that are provided by Entropy or Information theory methods for O-D's and link volumes are only extreme values in the whole range of solutions that can be generated by varying the degree of confidence that are placed on a priori estimates and link counts.

vii) Bayesian statistical approach using multivariate normal distribution for O-D cell entries and link counts can provide interval estimates for travel demand.

viii) The most general approach is to treat the problem of estimating the O-D matrix using link counts as an optimisation problem involving two objective functions, both of them concerning the minimisation of the separation between the estimated and the target values for O-D matrix and link counts respectively.

xi) There are some gaps which have to be filled up to streamline the existing methods.

1.3 NEED FOR GENERATION OF GOOD SEED MATRICES

The review suggests that success of link volume modelling lies in the generation of good guess seed O-D matrices for further updating. An out-of-date survey matrix or matrix generated through either gravity seed or
by a travel demand model calibrated to the old data does admirably serve the purpose. However, the seed matrix chosen must reflect the travel characteristics of the travellers, so that, all that remains to be done by model building is to fine-tune the model to satisfy the observed link counts.

1.4 CONDUCT OF PHYSICAL SURVEYS

The prime consideration in travel demand estimation using link volume philosophy is to reduce the physical surveys to the barest minimum, to those essential for model calibration and validation, splicing together information that may be available through many secondary sources. Unfortunately, there is hardly any literature available, which reports the validation of the travel demand estimation with the actual O-D’s, obtained by primary surveys. It is this lack of experimentation that has resulted in the marginal importance being given to the link volume modelling as a potential technique for travel demand estimation. It is felt that there is absolute need to obtain O-D matrix from primary surveys for the purpose of validation of link volume models in real life. Identification of the links to be used for model calibration is an area not successfully explored so far.
1.5 SPECIFICATION OF URBAN SPATIAL STRUCTURE

Studies reported suggest that good specification of urban spatial structure provides better travel demand models. Even though, there appears to be certain attempts being made, of late, in the introduction of measures of urban spatial description for the travel demand estimation, like the work of Mahmassani et al (1988), such specifications are hardly seen in Link volume methods of travel demand estimation. As many of the data needed for urban structure specification are available through secondary sources, it is felt that it may be easier to incorporate urban structure specifications in Link volume models too.

1.6 ACCESSIBILITY SPECIFICATIONS

Travel by public transport depends on the availability of the bus transport. To generate a useful seed matrix, it is essential that the factors contributing to travel realisation such as the supply accessibility must be taken into account. Hence, further research must address itself towards the development of seed matrices that take the urban structure, vis-a-vis, the transport supply accessibility.

1.7 DYNAMIC URBAN STRUCTURE SPECIFICATIONS

Urban structure, as defined by Hutchinson(1974) has been extensively used by the researchers. But, it is felt from the point of view of transportation planners, that this definition is rather static in nature. Incorporation of
static urban structure may not be sufficient to explain all that happens in an urban area during the period of a day. Day in and day out, the activity system in the city structure breathes and debreathes and depending on the changes in this pulsation, there is a constant change in the spatial travel demand. A dynamic urban structure is a specification which is reflective of the activity system sensitiveness which brings about the changes in the temporal travel demand. Hence, a measure to quantify the pulsating urban structure should be introduced into the temporal travel demand estimation model. This is another area for further experimentation.

1.8 HYPOTHESES FOR TRAVEL MOVEMENTS AND DEVELOPMENT OF COMPUTER PROGRAMS

The success of the link volume modelling for the estimation of travel movement rests squarely on the formulations of appropriate hypotheses for visualisation of the realistic travel movements. Only those types of trip interchanges which are likely to occur must be permitted. Similarly, the activity linkages that are likely to be realised are unlikely to remain time invariant. It is, therefore, necessary that the hypotheses proposed must reflect these stochastic and dynamic tendencies of travel movements. Development of necessary user-friendly computer software becomes all the more important, so that the public transportation management concerns for whom it is intended are in a position to be benefitted.
1.9 SCOPE AND OBJECTIVE OF THE THESIS

Many of the objectives of this thesis directly stem from the needs identified so far. The specific objectives of the thesis are:

i) To review the contemporary research in the field of estimation of O-D matrix through link volume modelling with a view to select technique/techniques suitable for estimation of spatial and temporal travel demand in urban areas, particularly by public transport system.

ii) To select an urban area and conduct appropriate field surveys and collect secondary source information necessary for implementation of the chosen technique/techniques.

iii) To formulate appropriate hypotheses based on field studies concerning urban structure specification and accessibility of the transportation system to enable generation of appropriate seed matrices needed for link volume modelling.

iv) To study the spatial variations in travel demands at different time periods.

v) To quantify the dynamic urban structure and to explore its use in the development of temporal travel demands.

vi) To develop appropriate user-friendly computer software for the above experimentation.

vii) To compare the estimates of travel demand obtained through link volume counts with the actual survey estimates and formulate definite conclusions.
viii) To suggest the possible uses of the model/models developed for the application of the Transport management concern.

The proposed experimentation is suggested to be carried out in the area of operation covered by the public transportation system of Kerala State Road Transport Corporation (KSRTC) at Trivandrum.

1.10 Thesis organisation

Including Introduction, there are seven chapters in this thesis.

Chapter 2 titled 'Estimation of O-D matrix through traffic volume counts' presents a review of the contemporary research leading to the selection of appropriate technique/techniques for the estimation of spatial and temporal travel demands.

Chapter 3 on 'Pilot Studies on Link volume modelling', while giving a brief description of the chosen urban area, describes the various types of travel information, demographic particulars, land-use particulars, details regarding the transport services offered and others that are collected through primary and secondary surveys. This chapter further reports some of the salient findings of the pilot studies carried out in the use of random seed, equiprobable seed, gravity seed etc. for demand estimation.

Chapter 4 on 'Demand Estimation with spatial specifications', presents the various hypotheses formulated, computer packages developed and compares the results of the system
modelling. The validation of these models with the actual O-D studies culminates in the formulation of useful conclusions in link volume modelling.

Quantification of the dynamic urban structure and estimation of temporal travel demand through Bayesian approach are the subject matter of chapter 5 titled 'Demand Estimation with spatial and temporal specifications.'

Chapter 6 on 'Applications of the developed packages' demonstrates the possible uses of the software developed to aid managerial decision-making in Road Transport Organisation.

Chapter 7 concludes the thesis and points out the limitations of the work and scope for further work in this field.