Chapter V

CONCLUSIONS AND RECOMMENDATIONS

The Road Transport Investment Model (RTIM) was developed by the British Transport and Road Research Laboratory which conducted field work in Kenya between April 1971 and July 1973 to derive relationships that could be applied to the investment analysis of developing countries. The Model was designed to be an efficient tool for senior administrators, engineers and transport planners, and those responsible for developing improved techniques for road investment appraisal. The Model enables study of the inter-relationships between road design and construction standards, road maintenance policy, vehicle characteristics, traffic flows and growths, environmental factors and road deterioration. These relationships were derived as empirical formulas. If the calibrated limits of these formulas are exceeded, the Model prints warning messages to draw to the user's attention situations in which program assumptions have been exceeded during the execution of the program. The present research was conducted to study certain problems arising from the application of the Model to a feeder road which had been designed but not yet been constructed. Thus, the following conclusions have been reached.

Regarding construction items, as costs or quantities calculated by the Model, the results obtained were quite close to those estimated by the consulting engineers, the pattern conformed to the results obtained by SINTHUSARN (1976). This application of the Model depends entirely on the quality of the input data to produce results at a given level of accuracy. It is believed that this function of the Model is reliable and usable; its application by road planners could save time and enable effective comparison of alternative designs.

The parameters used to indicate the physical characteristics of the condition of the road in terms of cracking, roughness, and rut depth have been related to the amount of traffic travelling along the road. These parameters affect components of vehicle operating cost and the maintenance policy. The Model can investigate the road and predict its condition at any future time, not in terms of an average condition, but in terms of specific values of the various parameters which together represent road condition.

In the present study it was found that parts of the vehicle-age spectrum formulated in the program were not realistic. After the Model had distributed the first-year traffic in the form of a vehicle-age spectrum, the portion of the traffic in subsequent years which was greater than the previous-year traffic was taken entirely as new vehicles. Although the Model does not consider diverted traffic nor generated traffic as separate components, generally all growth traffic is assumed by the Model to be constituted entirely of new vehicles. This assumption results in new vehicles dominating the vehicle fleet, and consequently the average age of vehicles is unrealistically low. This effect becomes apparent if the increment traffic in given year were equal to or greater than the traffic in the previous year, as it happened with passenger cars in the 4^{th} year of analysis of the study road.

The vehicle-age spectrum has effects on depreciation, spare parts and maintenance-labour costs. For depreciation, the Model did not assume a linear reduction over the productive life of the vehicle, as used by most engineering consultants in Thailand. Instead, the Model used 22-percent reduction for vehicles of one year's age, 14 percent reduction for vehicles of two years' age, and 8 percent reduction for vehicles of between three and nine years' age. It is obvious that the depreciation cost of new vehicles was rather high. If the average age of vehicle tended to be low, depreciation on the average value would become high, compared with values generally used by consultants in Thailand. As depreciation cost has been found to be the highest value (T.P.O'SULLIVAN, 1973) of the several components of vehicle operating cost, this predisposes the Model to have high vehicle operating costs.

From the same reasoning as above, the results for spare parts cost and vehicle maintenance-labour cost obtained from the Model would be low values, as new vehicles normally require less expenditure for repairs and maintenance than older vehicles.

Care should be taken in using the vehicle-age spectrum. If some specified vehicle type were to be lately introduced on the road, the Model would predict that all vehicles of this type were new. Thus, vehicle depreciation cost for the year that this type of vehicle was introduced would be very high. Also, the Model would predict that spare parts and maintenance costs would be zero at the same time, as happened with the semi-trailers (ST) introduced in the 8^{th} year of analysis. If constant traffic were specified (ie, growth rate equals to zero), those old vehicles which the Model ascribed to wastage and scrapping would be replaced entirely by new vehicles.

From this study, the high value of vehicle operating cost would have come from the following factors:

1) High value of depreciation resulted from the incremental traffic being entirely defined as new vehicles.
2) Vehicle crew time was used as an component of vehicle operating cost, whereas VALLENTINE, LAURIE & DAVIES (1976) attributed this component to occupants' time cost.
3) Overhead and standing costs suggested by the Model were taken as a percentage of vehicle operating cost (ie, 10

percent for passenger cars and 25 percent for all other types of vehicles), but VALLENTINE, LAURIE & DAVIES (1976) limited this component to be not greater than 5 percent and applied it only to heavy commercial vehicles.

4) The vehicle speeds predicted by the Model were all higher than average lifetime speed, a representative value for analysis used by VALLENTINE, LAURIE & DAVIES (1976); thus, more fuel would be consumed by the vehicles specified in the Model.

5) The representative type of light commercial vehicles used in the Model had a greater engine size than the typical type used in Thailand; this resulted in a high value of vehicle operating cost for this vehicle type.

For this study, combination was made of the different types of pavement designed by VALLENTINE, LAURIE & DAVIES (1976) --with adjustment of the thickness of pavement layers--to produce an equivalent representative pavement for Section I. The Model specified the pavement strength in terms of the modified structural number. The equivalent thickness of each pavement layer in Section I, in combination with an average value of CBR of subgrade weighted by length of each sub-link, were used to determine the structural number of pavement. This index in combination with the cumulative standard axles was used to determine the roughness. Results from the Model showed that Section I needed to be overlaid in the 14^{th} year as the roughness would then exceed 4,000 mm/km. Checking was made of sub-links 2A, 2B, 2C, 3A, and 3B as originally designed by VL&D to ascertain whether an overlay was needed. Calculation of individual roughness values by the use of cumulative standard axles was made throughout the analysis period. Values which exceeded 4,000 mm/km were found for sub-links 2A, 2B, and 3A which together constituted 11.5 km (Section I was 16.0 km). Thus it was deemed reasonable to specify overlaying for the entire Section. This showed that roughness determined from the equivalent thickness of pavement layers was a reasonable representative value.

The Model had an additional facility which enabled the economics of different stage construction options to be examined. This study tried to apply a stage construction program starting with an unpaved road and upgrading to a paved road, but the program terminated at the middle of the first year of traffic. It was found that the number of standard axles in the first year of traffic led to values of roughness in excess of the maximum limit (14,000 mm/km for unpaved roads). It is recommended that a review should be made of the amount of first-year traffic, in terms of cumulative standard axles, that would result in roughness not exceeding the limit. Without this initial inspection, one can be led to confusion due to the possibility of mistakes in the input data. Besides, another precaution that should be kept in mind -- if checking were not done throughout the analysis period -- is to specify overlaying in the Model to avoid the termination of the program during the analysis period because the roughness might exceed its limit. By first checking on the amount of first-year traffic, stage construction could be reasonably obtained and by the use of the second precaution (checking the roughness throughout the analysis period to ascertain whether or not overlay is needed), the Model would continue to the end.

It is recommended that further study should be made of the Model parameters to ensure that they are in the range appropriate for Thailand. To do this, field work must be carried out and considerable money would have to be spent; thus, it would be difficult to conduct successfully. So, it might be reasonable to try to correct the parameters in another way by using the available Model and adjusting the inappropriate parts of the program. During the course of this study, some impractical parts of the Model were found; these should be remedied as follows:

1) There is a peculiar form in the maintenance cost analysis in which zero was spent in the last year of analysis. Generally, maintenance money would be spent in every year, including the last, during the analysis period. During the last year traffic

will still travel along the road, so maintenance should be carried out to maintain the road in good conditions. This expenditure should appear at the end of the last analysis year in accordance with period-end accounting.

2) For minor river crossings, extension of the Model should be made to enable a larger number of them to be specified. The limit of minor 10-river crosiings is too low for conditions in Thailand, and twice that number would be preferable.

3) The Model is aimed strongly at heavy commercial vehicles, and only two types of light vehicles may be specified. In Thailand, light vehicles play somewhat the same role as the heavy ones elsewhere, so extension of the light-vehicle category to include four-wheel drive vehicles, light buses, taxis, and so on would be helpful. This would not necessarily entail correcting the formulas derived for these type of vehicles, only to provide more computer storage space to allow more kinds to be specified.

4) More space should be provided for additional components of vehicle operating cost as to be specified by the user, Also, space in the program provided for average vehicle age and average lifetime speed.

Thus, further useful research could be done by one who has highway sense and is competent with FORTRAN IV as the Model is quite complicated.