

## CHAPTER 7 - SUMMARY AND RECOMMENDATIONS

### MODIFIED MODELS

From the work in this Project new empirical data will be available to develop input parameters for highway planning models. The MIT and TRRL models and combinations thereof will be used as the basic framework for the models coming from this Project.

During the first year of the Brazil study, additional analysis of the Kenya data will be undertaken with the help of TRRL and the World Bank. The model will be applied and tested in Brazil under a variety of conditions. As time and manpower permits we will also undertake sensitivity studies of the model to examine parameters in more detail.

The experience gained using and testing the existing models together with the empirical relationships developed during the Brazil Project will all be blended to produce a modified cost model.

The model resulting from this project will satisfy the basic project objectives of providing Brazil with a planning tool to help them optimize highway transport investments. In more specific terms the model

- 1) Will assist management make investments decisions on highway design and maintenance policies;
- 2) Permits an evaluation of design standards relating to earth, gravel and paved roads at specific locations over fixed time periods;
- 3) Permits an evaluation of alternate construction procedures, stage construction and uncertainties in traffic forecast and interest rates;
- 4) Permits minimization of total transportation costs for available construction and maintenance options over life of alternates investigated;
- 5) Assists in decisions between alternate routes at

- planning and preliminary design levels;
- 6) Can be used in network analysis to investigate the impact of vehicle sizes in the establishment of axle load regulations;
  - 7) Permits the examination of fuel conservation policies and their alternate benefits.

#### Application in Brazil

As pointed out at the beginning of this report our first goal is to develop a model directly applicable to Brazil's roads network. This will be given close attention as the MIT and TRRL models are studied and tested in Brazil. The parameters and data developed here will, of course, be most directly relatable to Brazil. In this regard, users guides and data input guides will relate to Brazil and Brazilian methodology for easy application.

#### General Application Worldwide

In addition to application in Brazil the Project has some responsibility to generalize the models for worldwide application. The background of the MIT and TRRL models, developed for quite different conditions, suggested that general application models can also be developed without conflict with Brazilian versions.

#### Flexibility - Updatability

In all cases attention will be given to flexibility in the models. To this extent it is hoped that the Brazil and worldwide models can have the same basic forms with minimum overall changes. Formats for use of the models for computer analysis will be as flexible as possible as attention will also be given to easy updatability.

#### Using The Models

During 1976, trial applications will be made using the model generated by the Kenya study. Data will be collected in Brazil to be used in evaluating how effectively various sub-models predict quantities for Brazil conditions. The combined

MIT-Kenya model also will be evaluated when it becomes available.

Implementing both the existing models and the version resulting from this Project is important and early efforts will be made to secure the traffic, maintenance, and construction; quantity, composition, standards and unit costs data need for this purpose. Historical data does not always exist so obtaining vehicle data may prove difficult. Therefore, it will be desirable to collect the required data as soon as practical. The first effort will be initiated in 1976 and will continue through 1977 and 1978.

#### Data Requirements and Systems Application

A road network and its traffic load constitute a dynamic system that is constantly but sporadically changing. The method of monitoring and analysing the effects of these changes at the various levels of refinement (nationally, statewide, on a regional basis, or on specific routes) is to adopt a system approach. The models developed here can be applied to any link in this network to compute cost-benefit relationships for that link.

This is a first and vital step in the effective economic analysis of any highway system. To apply the model effectively to any link in the system it is necessary to have data on the whole network. This study does not address the networkwide modelling problem but since the data base and the basic model are common, the outline of the data generating system is presented.

#### A DATA GENERATING SYSTEM DESIGN

The overall system would need to include:

a) a continuously up-dated computer based data bank containing:

I) All the physical characteristics of the road network and environmental factors influencing the cost of transport;

- II) The present and projected traffic on the network with all the necessary details, including its composition (seasonal, daily and hourly) and occupancy of the vehicles;
  - III) Unit cost data or (productivity rate, labour, and plant costs) for construction, maintenance, vehicle operation, time and accidents.
- b) a series of computer programs for a data storage, manipulation, and retrieval.
  - c) simulation models to determine the cost of construction, maintenance and road users developed and validated individually as required.

The network flow diagram (Figure 30) summarizes the information system in conceptual form and shows the logical flow of the systems approach to produce model input. Each simulation model should be constructed in such a way that, given the appropriate input data, it can be used as a separate entity. It will, however, act as an integral part of the overall solution process. It is felt that if each model can be used or run independently, output results will be available more readily and variations can be rapidly tested. This point is important when considering the initial sensitivity checks to be carried out on the models.

#### SENSITIVITY AND USE OF THE MODELS

When complex models are developed, verification and sensitivity should be established prior to using the model. This is true for all types of models, empirical, theoretical or conceptual.

#### Model Verification

In this Project we are dealing with empirical models determined by experimentation and survey techniques. The models must be verified subsequent to development by comparing results to new measurements or observations not used in developing the equations themselves. In this study, data on different pavement sections, different vehicles and different users will be compared

with model predictions to provide verifications. Design of verification studies will be given greater attention in subsequent project reports.

### Model Sensitivity

After models are developed and verified it is essential to test their sensitivity. Such studies can show the relative importance of each input variable to the model and its effect on the predictions or outputs. Ultimately such sensitivity studies must be more detailed than time and funds will allow. However, initial sensitivity studies will be run on each model and reported. Initial experience will be gained by testing the sensitivity of the TRRL-IBRD models.

### Implementation And Use Of The Model

In order to assist with early implementation of the Brazil models every effort will be made to educate potential users early in the study. This can be done by early adaption and use of the TRRL-IBRD models. Furthermore the work will be extended as preliminary results of the Brazil study analysis become available. Early attention will also be given to briefings, meetings and other efforts to educate potential model users to the workings of the Project.

### RECOMMENDATIONS FOR UPDATING

Three years is a short time in the history of a highway facility. It is difficult to predict pavement performance accurately from such a short time data base. This Project will yield in Brazil an organization and a set of research experiments which can overcome this time problem relatively inexpensively. It is proposed that consideration be given to continuing data collection on a portion of the user survey vehicles, and a portion of the pavement test sections for an additional 2-4 years to provide better estimates of the model coefficients than will be available at the end of this study.

Additional updating of the models can be accomplished if

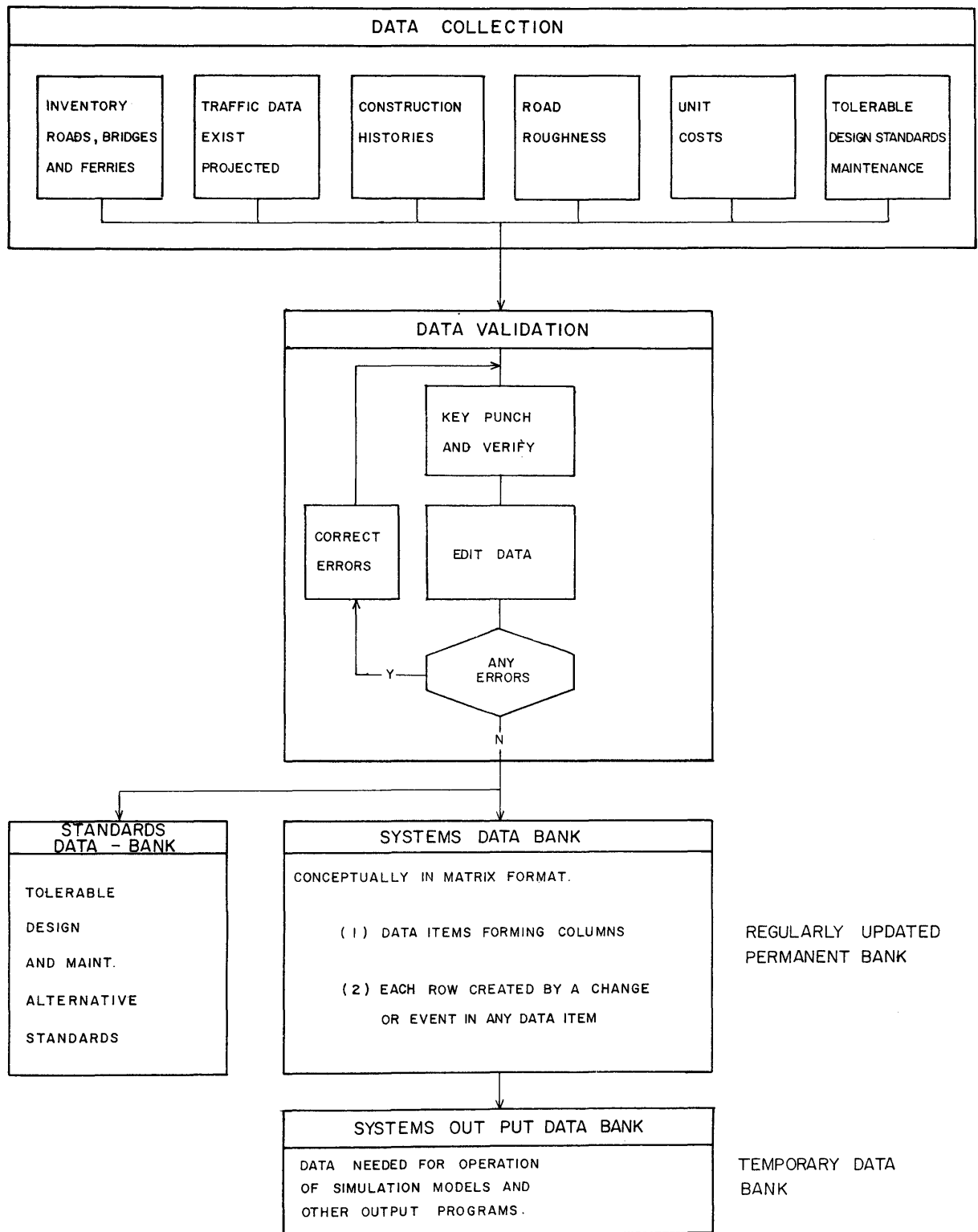


Figure 31 - Data Generating Network Diagram.

and when data become available from other sources such as the similar proposed study in India.

Finally some agency such as GEIPOT and/or the World Bank should serve as a central coordination agency for continued use and updating of these models. Without such continued leadership no additional progress will be made.