

CHAPTER 5  
OVERVIEW OF THIS REPORT



This Final Report on the ICR Research is composed of 12 main volumes, each published in both Portuguese and English, which provide a full description of the activities of this research project - its creation and organization, its data collection, methods and techniques, and its results and conclusions.

In addition to these main volumes, both the user's manuals and the documentation of the computer programs for the models developed by the PICR are available as appendices (bound separately and printed in limited editions).

As complementary information for technicians and planners, all the documentation produced during the research, under the form of progress reports and technical memoranda, has been grouped into 53 volumes termed "Working Documents", which are also listed in this chapter.

The following pages present a summary of each of the 12 volumes of the Final Report, as well as a list of the Working Documents with a synopsis of their content.

5.1 VOLUME 1 - SUMMARY OF THE ICR RESEARCH

5.1.1 *Structure of Volume 1*

CHAPTER 1 - Background, Objectives, Organization

CHAPTER 2 - Methods, Instruments and Basic Data

CHAPTER 3 - Equations and Models

CHAPTER 4 - General Evaluation

CHAPTER 5 - Overview of this Report

### 5.1.2 *Summary of Volume 1*

This volume describes the objectives of the Research on the Interrelationships Between Costs of Highway Construction, Maintenance and Utilization (PICR), as well as the data and variables covered by its surveys and experiments. It contains a brief description of the work carried out during the PICR, its organization and the basic data surveyed, and also indicates where this information can be found in the different volumes of this report, evaluating the tasks performed.

The principal objective of the PICR was the development of methods and models which would minimize the cost of highway transportation in Brazil, particularly on non-urban highways characterized by a low volume of traffic. To reach this objective, wide-ranging field research was performed - one of the largest projects of its type ever carried out in Brazil or abroad - with the objective of determining the costs of the three major components of the *total cost of highway transportation*, namely: the costs of highway construction, maintenance and utilization. In short, an effort was made to determine the influence of highway characteristics on the cost of vehicle operation. As major factors, highway geometry and surface quality were studied, to quantify their influence on operating cost. Traffic-provoked highway deterioration was also studied, as well as the behavior of highway users.

This Final Report is composed of 12 volumes, 6 appendices (in the form of Manuals for the three models developed) and 53 Working Documents (containing all of the documentation produced during the research project).

5.2 VOLUME 2 - METHODS AND ORGANIZATION

5.2.11 *Structure of Volume 2*

CHAPTER 1 - Introduction

CHAPTER 2 - General Method

CHAPTER 3 - User Costs Survey

CHAPTER 4 - Methods of Gathering Data on Traffic Behavior

CHAPTER 5 - Pavement Deterioration Studies

CHAPTER 6 - Analytical Procedures

CHAPTER 7 - An Evaluation of Methodology and Organization

### 5.2.2 *Summary of Volume 2*

This volume describes the objectives of the Research on the Interrelationships Between Costs of Highway Construction, Maintenance and Utilization (PICR), the data and variables included in PICR surveys and experiments, and the procedures followed in data collection and analysis.

The principal objective of PICR was to develop methods and models to minimize the cost of transportation on both paved and unpaved low-volume roads in Brazil. To obtain this objective, one of the largest highway research projects ever undertaken, here or abroad, was initiated to determine the interrelationships of the three main components of highway transportation, namely, road construction costs, road maintenance costs, and the operating costs incurred by the users of these roads. It was assumed that the variables which characterize a road, such as riding surface quality, and vertical and horizontal geometry, affected significantly the operating costs of vehicles which used the road. If mathematical functions could be obtained to describe the impact of each variable on vehicle operating costs, it would be possible to evaluate the effect of different construction and maintenance standards on the total cost. The ICR Research developed a model to depict the interrelationships of the highway costs, termed the Highway Costs Model (MICR). This Model includes these equations and was designed to allow planners to choose, among a given number of design and maintenance alternatives, the one that minimizes the total cost of highway transportation.

During the research it was noted that other results and applications would be very useful as a means of improving the MICR equations or for independent applications. The information obtained is useful as an aid in developing energy conservation policies, and furnishes new concepts for establishing the dimensions of flexible pavements, as well as correlations on the capacity of roads, permits the calculation of the benefits resulting from improving the design of a road and the determination of the speed where minimum fuel consumption occurs for different types of vehicles. The PICR has also developed one of the most complete studies on user costs presently available.

On the basis of the models and studies previously developed by the Massachusetts Institute of Technology and by the Transport and Road Research Laboratory, the PICR staff sought to perfect the specifi-

cation of the interrelationships of costs in Brazilian conditions. The basic information consists of (1) data furnished by road users and by highway authorities; (2) physical measurements; and (3) experiments with the major variables under control.

To analyse the effects of different highway characteristics on maintenance and utilization costs, a factorial matrix was designed whose cells represent different combinations of roughness and levels of horizontal and vertical geometry on Brazilian roads. Pavement structures were characterized through *in-situ* measurements and laboratory tests. At selected sections, the PICR applied several different maintenance levels and observed the subsequent deterioration of these sections.

The researchers and supporting personnel were divided into three groups:

The User Costs Group was responsible for surveying the different components of transportation costs by interviewing company representatives and owner-drivers operating on the routes studied. This Group sought to obtain the costs for routes of different characteristics, by systematically collecting data on fuel, oil, grease, spare parts, maintenance labor, tires, operating labor, travel time, kilometers run, etc. It also made an inventory of the routes used and measured their riding quality.

The Traffic and User Cost Experiments Group sought to determine experimentally, using its own vehicle fleet, the influence of road characteristics on fuel consumption and travel time, in order to develop the Model of Time and Fuel Consumption (MTC). Subsequently, it studied the possibility of extending the potential usefulness of the PICR to the analysis of roads with a higher level of vehicles, where traffic congestion occurs. The Model for Simulating Traffic (MST) was thus developed to analyse the effects of traffic congestion on fuel consumption and travel times.

The Pavement Performance and Maintenance Studies Group analyzed the effect, over time, of alternative standards of construction, maintenance and traffic volume on road surface roughness.

To accomplish these tasks, the PICR called on the expertise of statisticians and specialists in data processing and analysis, along with technicians in instrumentation maintenance. The personnel respon-



sible for the maintenance of the measuring instruments came to modify the instruments acquired at the outset of the research, since almost all of them had to be adapted to PICR requirements, and also developed new instruments to meet unanticipated needs. The knowledge thus gained is documented in detail in technical memos, and constitutes an important advance in technical and scientific knowledge not envisioned at the beginning of the research.

Doubts and questions also arose as to the nature of the postulated interrelationships, the precision and adequacy of the concepts, and the quality of the measuring instruments. For some of these a satisfactory solution has already been obtained, while additional studies and experiments were required for others and are presently being carried out in Brazil.

5.3 VOLUME 3 - INSTRUMENTATION

5.3.1 *Structure of Volume 3*

CHAPTER 1 - Introduction

CHAPTER 2 - Road Surface Roughness Measurement System

CHAPTER 3 - The Survey Vehicle

CHAPTER 4 - Traffic Behavior Measuring Equipment

CHAPTER 5 - Pavement Deflection Equipment

CHAPTER 6 - Fuel Consumption Measurement Equipment

CHAPTER 7 - Traffic Counters

CHAPTER 8 - Vehicle Weight Measurements

CHAPTER 9 - Data Conversion Equipment

CHAPTER 10- Measurement of Road Surface Conditions

CHAPTER 11- Meteorological Measurements

CHAPTER 12- Conclusions and Recommendations

### 5.3.2 Summary of Volume 3

The Research on the Interrelationships Between Costs of Highway Construction, Maintenance and Utilization (PICR) was carried out in Brazil included the objective of providing a fundamentally new data base for the economic cost/benefit evaluation of alternative standards of highway construction and maintenance. To form this data base, measuring instruments with a total cost of more than US\$750,000 were utilized. The most important of these instruments were manufactured in the U.S.A. specifically for this Research and, therefore, cannot be considered as either completely developed or tested. A major share of the work of the Instrumentation Group of the PICR consisted of developing these instruments and adapting them to the operational conditions found in Brazil. Due to the dimensions and innovative aspects of the Research, it was necessary to design and build highly original apparatuses *in loco*.

Volume 3 presents a brief description of the instruments used in the PICR, explains what they measure, the reason why they were chosen or built, their precision, how they were employed and their degree of trustworthiness. The text also contains bibliographic references, providing the reader with access to the technical and operational details of the equipment described. Manufacturers are also indicated.

Taking into account both the technical problems which arose, as well as the significance and usefulness of the data produced, an evaluation of the performance of each instrument is also presented.

The conclusion in the final chapter is that, in projects of limited duration, such as the PICR, one should avoid the use of instruments which have not been fully tested. Should this prove impossible, it is recommended that sufficient time be dedicated to the development and refinement of the instruments in the environment in which they will be utilized, before initiating actual data gathering.