

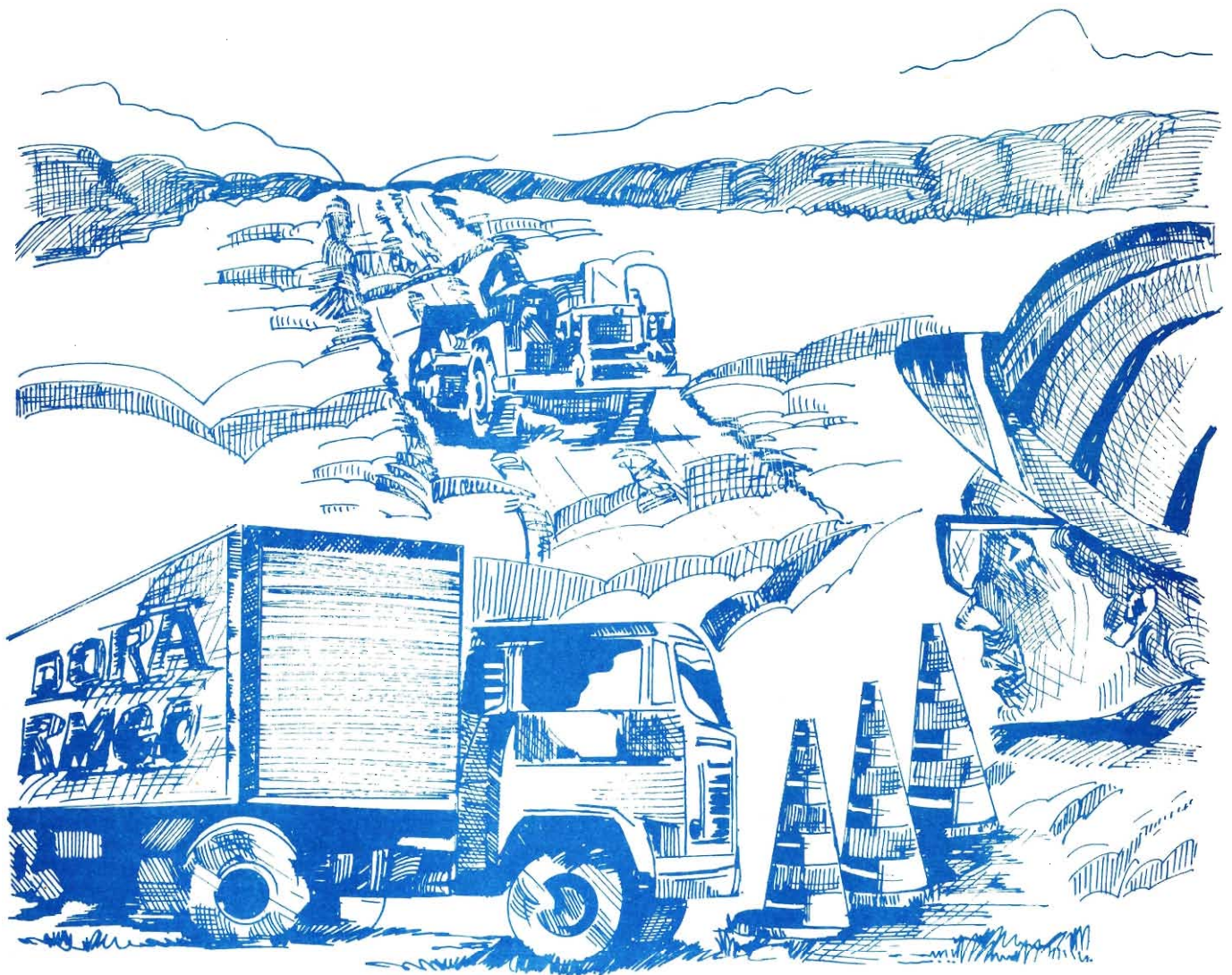
REPÚBLICA FEDERATIVA DO BRASIL

MINISTÉRIO DOS TRANSPORTES

United Nations Development Programme (UNDP)

# Research on the Interrelationships Between Costs of Highway Construction, Maintenance and Utilization

Final Report - 1981



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**Research on the Interrelationships  
Between Costs of Highway  
Construction, Maintenance  
and Utilization**

**Final Report - 1981**

**SPONSORED BY:**

**MINISTÉRIO DOS TRANSPORTES**

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**UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)**

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**Texas Research and Development Foundation - TRDF**

**WITH THE PARTICIPATION OF:**

**Departamento de Estradas de Rodagem de Goiás - DER/GO**

**Departamento de Estradas de Rodagem de Minas Gerais - DER/MG**

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Conteúdo: v.1 Summary of the ICR Research v.2 Methods and organization v.3 Instrumentation v.4 Statistical guide v.5 Study of road user costs v.6 Study of vehicle behavior and performance v.7 Study of pavement maintenance and deterioration v.8 Highway cost model (MICR) v.9 Model of time and fuel consumption (MTC) v.10 Model for simulating traffic (MST) v.11 Fundamental equations v.12 Index to PICR documents.

1. Rodovias - custos - Brasil 2. Rodovias conservação - Brasil  
3. Rodovias - utilização - Brasil - I. Título.

## PREFACE

This research project was funded through an agreement signed in January, 1975 by the Brazilian Government and the United Nations Development Programme (UNDP). The Ministry of Transportation, acting through the Brazilian Transportation Planning Agency (GEIPOT), assumed the responsibility for the project on behalf of the Brazilian Government, and the International Bank for Reconstruction and Development (IBRD) acted as the executing agency for UNDP.

The research was carried out by GEIPOT and the National Highway Department (DNER), acting through its Road Research Institute (IPR). Funding from the Brazilian Government was channeled through the Institute for Economic and Social Planning (IPEA) and the Secretariat for International Economic and Technical Cooperation (SUBIN), along with the Ministry of Transportation.

The World Bank contracted the Texas Research and Development Foundation (TRDF) to organize the international technical staff and to select and purchase the imported equipment needed for the research. The participation of the TRDF continued until December of 1979.

This report is comprised of twelve volumes (each edited in both English and Portuguese) which summarize the concepts, methods and results obtained by December, 1981 by the project entitled "Research on the Interrelationships Between Costs of Highway Construction, Maintenance and Utilization (PICR)". It includes a documentary index volume which will aid researchers in locating topics discussed in this report and in numerous other documents of the PICR. This report contains much detailed analysis which is being presented for the first time, and also incorporates relevant parts of earlier reports and documents produced under the 1975 Agreement, updating them through the inclusion of new results and findings.

A special mention is due the Highway Departments of the States of Minas Gerais and Goiás, the Universities of Aston, Birmingham, Juiz de Fora, Minas Gerais and Texas, and the Western Australia Main Roads Department, which placed some of their best and most experienced personnel at the service of this project to fill many key positions on the research staff.

Finally, thanks are due the Transport and Road Research Laboratory for its assistance during the initial stages of the project, along with specialists from various countries who periodically visited Brazil to discuss the work being done in the PICR and to assist the permanent research staff in conducting analyses.

JOSÉ MENEZES SENNA  
President

VOLUMES IN THIS REPORT\*

- VOLUME 1 - SUMMARY OF THE ICR RESEARCH
- VOLUME 2 - METHODS AND ORGANIZATION
- VOLUME 3 - INSTRUMENTATION
- VOLUME 4 - STATISTICAL GUIDE
- VOLUME 5 - STUDY OF ROAD USER COSTS
- VOLUME 6 - STUDY OF VEHICLE BEHAVIOR AND PERFORMANCE
- VOLUME 7 - STUDY OF PAVEMENT MAINTENANCE AND DETERIORATION
- VOLUME 8 - HIGHWAY COSTS MODEL (MICR)
- VOLUME 9 - MODEL OF TIME AND FUEL CONSUMPTION (MTC)
- VOLUME 10- MODEL FOR SIMULATING TRAFFIC (MST)
- VOLUME 11- FUNDAMENTAL EQUATIONS
- VOLUME 12- INDEX TO PICR DOCUMENTS

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\* Volume 1 contains a brief description of the contents of each volume, while Volume 12 provides a subject index to this report and all other PICR documents, including technical memoranda and working documents.



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## SUMMARY

The Research on the Interrelationships Between Costs of Highway Construction, Maintenance and Utilization (PICR) was carried out in Brazil with 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*.

This Volume 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 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 utility 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.