volume four
Analytical Framework and Model Descriptions
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This Version 1.0 edition of the Analytical Framework and Model Descriptions describes the analytical framework and the technical relationships of objects within the HDM-4 model. It contains very comprehensive reference material describing, in detail, the characteristics of the modelling and strategy incorporated in HDM-4.

It is to be used by specialists or experts whose task is to carry out a detailed study for a road management organisation. The Analytical Framework and Model Descriptions is one of five manuals comprising the suite of HDM-4 documentation (see Figure 1).

The suite of documents comprise:

- **Overview of HDM-4 (Volume 1)**
  A short executive summary describing the HDM-4 system. It is intended to be used by all readers new to HDM-4, particularly high level management within a road organisation.

- **Applications Guide (Volume 2)**
  A task oriented guide describing typical examples of different types of analyses. It is to be used by the frequent user who wishes to know how to perform a task or create a study.
- **Software User Guide (Volume 3)**
  Describes the HDM-4 software. It is a general purpose document which provides an understanding of the software user interface.

- **Analytical Framework and Model Descriptions (Volume 4)**
  Describes the analytical framework and the technical relationships of objects within the HDM-4 model. It contains very comprehensive reference material describing, in detail, the characteristics of the modelling and strategy incorporated in HDM-4. It is to be used by specialists or experts whose task is to carry out a detailed study for a road management organisation.

- **A Guide to Calibration and Adaptation (Volume 5)**
  Suggests methods for calibrating and adapting HDM models (as used in HDM-III and HDM-4), to allow for local conditions existing in different countries.

**Notes:**
1. Volumes 1, 2 and 3 are designed for the general user
2. Volumes 4 and 5 are only to be used by experts who wish to obtain low level technical detail

**Structure of the ‘Analytical Framework and Model Descriptions’**

The information in the [Analytical Framework and Model Descriptions](#) is structured in nine parts (see Figure 2).
The nine parts in the Analytical Framework and Model Descriptions contain the following information:

- **Part A - Introduction**
  Provides an overview of the Analytical Framework and Model Descriptions.

- **Part B - Traffic**
  Describes the traffic characteristics used in HDM-4, and provides details of the traffic data that is required.

- **Part C - Road Deterioration Models**
  - C1 Modelling Concepts and Approach
    Describes the types of pavements modelled in HDM-4, and the possible combinations of pavement surface types and base types. It discusses the key variables that affect deterioration, which include climate and environment effects, traffic, and pavement history.
  - C2 Bituminous Pavements
    Describes the specifications used in the Bituminous Pavements (Road Deterioration) model. It provides a detailed discussion of pavement materials, surface behaviour, surface distress, pavement strength, and construction quality.
C3 Concrete Pavements

Describes the specifications used to model rigid (or Portland) cement concrete pavements. This includes details of the different types of rigid concrete pavement construction that are modelled in HDM-4.

C4 Unsealed Roads

Describes the specifications used in the unsealed Road Deterioration models. It provides an overview of the HDM-4 Road Deterioration modelling logic, and the relationships and default coefficient values for each of the distresses modelled.

Part D - Road Works Effects

D1 Types of Works

Describes the types of road works and their effects on road pavements, including the calculation of physical quantities of road works and the corresponding costs.

The three types of pavements considered are:
1. Bituminous pavements (see Chapter D2)
2. Concrete pavements (see Chapter D3)
3. Unsealed roads (see Chapter D4)

D2 Bituminous Pavements

Describes the detailed modelling of Road Works Effects for bituminous pavements. This includes methods of defining works activities and intervention criteria, the calculation of physical quantities of road works and their corresponding costs, and the effects of road works on pavement characteristics and road users. Road works are grouped into the following classes:

- Routine maintenance
- Periodic maintenance
- Special works
- Improvement works
- Construction works

D3 Concrete Pavements

Describes the detailed modelling of Road Works Effects for concrete pavements. This includes methods of defining works activities (maintenance and rehabilitation) and intervention criteria, and classification of the road works. The following three types of concrete pavements are analysed:

1. Jointed Plain Concrete Pavements
2. Jointed Reinforced Concrete Pavements
3. Continuously Reinforced Concrete Pavements

The following classes of road works are performed:

- Routine maintenance
- Restorations
- Overlays
- Reconstruction

D4 Unsealed Roads

Describes the detailed modelling of road works effects for unsealed roads, including the methods of defining works activities and intervention criteria, the calculation of physical quantities of road works and their corresponding costs, and the modelling of the effects of road works on pavement characteristics and road users. Unsealed road works are grouped into the following classes:

- Maintenance
- Improvement works
- Construction works

Part E - Road User Effects

E1 Introduction

Provides an overview of the implementation of Road User Effects (RUE) models for calculating motorised vehicle operating costs and travel time, including an overview of the HDM-4 representative vehicle framework and the default representative vehicle types.

E2 Vehicle Speeds and Operating Costs

Describes the implementation of Road User Effects (RUE) models for calculating motorised vehicle speeds, operating costs and travel time. It provides an overview of the modelling concepts and logic, the relationships used, and the default parameter values for each of the RUE components.

E3 Non-Motorised Transport

Discusses the use of non-motorised modes of transport and their effect on the motorised transport. The impact of non-motorised transport on other road users and road characteristics is included.

E4 Road Safety

Describes the implementation of road safety models through a series of look-up tables of accident rates with user defined accident costs.

Part F - Social and Environmental Effects

F1 Introduction

Gives an overview of the modelling logic used to quantify the energy consumed by both motorised and non-motorised vehicles, together with the emissions produced by motorised vehicles.

F2 Energy Balance Analysis

Describes the energy implications of alternative transport projects and policies. The models estimate separately the global and national consumption of non-renewable energy by motorised vehicles, the consumption of renewable energy by non-motorised vehicles, and energy use in roadworks.
F3 Vehicle Emissions

Describes the models used to quantify vehicle emissions. The document presents the emissions models together with default parameters for the 16 standard vehicle types. Details of the input data and the output reports are also given.

Part G - Economic Analysis

Describes how the annual costs streams calculated by the HDM-4 components are compared to determine the benefits and costs associated with a road investment. Standard discounting methods are then applied to calculate key economic indicators such as net present values, internal rates of return and benefit/cost ratios. Investment optimisation methods are also described.

Part H Nomenclature

Provides details of the units and numbering system used within the HDM-4 suite of documents.

Part I Glossary

Provides descriptions of terminology used throughout the HDM-4 suite of documentation.

ISOHDM Products

The products of the International Study of Highway Development and Management Tools (ISOHDM) consist of the HDM-4 suite of software, associated example case study databases, and the Highway Development and Management Series collection of guides and reference manuals. This Volume is a member of that document collection.

Customer contact

Should you have any difficulties with the information provided in this suite of documentation please do not hesitate to report details of the problem you are experiencing. You may send an E-mail or an annotated copy of the manual page by fax to the number provided below.

The ISOHDM Technical Secretariat welcomes any comments or suggestions from users of HDM-4. Comments on the Analytical Framework and Model Descriptions should be sent to the following address:

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This is the first formal edition (Version 1.0) of the HDM-4 documentation.

Related documentation

HDM-4 documents:

The Highway Development and Management Series Collection is ISBN: 2-84060-058-7, and comprises:


Future documentation

The following documents will be issued at a later release:


Terminology handbooks


General reference information

Further details on HDM-4 may be obtained from the following:
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**Note:** Within each Part/Chapter there will be an Acknowledgements chapter. Each listing contains references to specific documentation for the topics described in the Part/Chapter.

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Highway Development and Management Series

The Highway Development and Management system (HDM-4) provides a harmonised systems approach to road management, with adaptable and user-friendly software tools. It is a powerful tool for conducting project appraisals and analyses of road management and investment alternatives.

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Volume five: A Guide to Calibration and Adaptation
Suggests methods for calibrating and adapting HDM models (as used in HDM-III and HDM-4) to allow for local conditions existing in different countries. It discusses how to calibrate HDM-4 through its various calibration factors. It is intended to be used by experienced practitioners who wish to understand the detailed framework and models built into the HDM-4 system.

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Volume six: Modelling Road Deterioration and Works Effects
This volume describes the technical background of theory, observation, knowledge and international practice in which the HDM-4 models for road deterioration and works effects have been developed.

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