CHAPTER III

THE HIGHWAY DESIGN AND MAINTENANCE STANDARDS MODEL (HDM)

3.1 Introduction

The HDM model predicts the costs of different highway design and maintenance options, including different time staging strategies, either for a given road project on a specific alignment, or for groups of links of an entire highway network. It can quickly estimate the total costs for large numbers of alternative project designs and maintenance policies on a year-by-year basis for upto thirty years, and thus be used to search for the alternative with the lowest total cost. In fact, the model can evaluate in the same computer run up to twenty different road links, each with up to ten segments with different design standards and environmental conditions. Each link can have a different traffic volume. Further, up to eight different maintenance policies can be implemented on each segment of the road. Each link or segment can be upgraded at any time in the life-cycle of the project.

Although the model does not provide a formal mathematical optimization, it does provide the results of economic analysis (total discounted transport costs, rate of return, net present value and first year benefits) for the comparison of any two alternatives or groups of alternatives, as desired by the user. Up to fifty pair-wise comparisons of alternatives can be specified in a single run. Furthermore, the model has the capability of analyzing the sensitivity of economic results to changes in key variables such as construction costs, traffic growth rates, discount rates and value of passengers' time. The model, however, does not provide a traffic forecast, which must be specified by the user. Similarly, the model does not itself calculate the regional income or value added benefits of feeder roads, nor the unit value of time saving, nor accident costs, but it does provide a facility for these items to be fed in from separate estimated if desired.

Vehicle speeds and operating costs and road deterioration and maintenance costs are internally estimated by the model as a function of the road design and maintenance standards, traffic, and environmental conditions; costs of construction are not internally estimated in the present model and are to be specified by the user for each alternative. Maintenance and vehicle operating cost components are first estimated in the physical quantities, and then prices and unit costs as specified by the user are applied to determine the total financial and economic costs. The physical relationships underlying these cost estimates have been derived largely from research in Kenya, and relate to low to medium traffic volumes up to about 5,000 vehicles per day.

Coded in Fortran IV, the model required standard library subroutines and functions and basic software features available in most major Fortran IV compilers. At present the model is operational on the Bank's Burroughs B 7700 computer and has been employed in a number of World Bank highway project appraisals in Latin America, Africa and Asia. The model has been converted and installed on several overseas IBM computers, and futher conversions work is currently being undertaken for CDC, DEC, ICL and Honeywell computer.

The applicability of this model is described in section 1.3 in Chapter I.

3.2 Basic Model Operations

The operations of the HDM model basically fall into three phases. The first phase is the input data editing phase in which the input data are examined for possible format and numerical errors and internal inconsistencies. Any input errors detected in this phase would stop the execution of the remaining phases. Error massages generated in the input data editing phase are compiled and described in subsequent section. The second phase is concerned with estimating the costs for each project alternative; construction, maintenance and road user costs and exogenous costs and benefits are each separately calculated. This is done by simulating the lives of the roads from initial construction, through periodic upgrading and through annual cycles of use, deterioration and maintenance for specified traffic volumes. The simulation is performed for each road and each set of construction and maintenance policies or a year-by-year basis throughout a given analysis period. The third phase is concerned with economic analyses and comparisons of alternative construction and maintenance policies, in terms of net present values, internal rates of return, etc., and with generation of management type reports on financial costs, road maintenance quantities performed and related costs, road surface conditions and vehicle operating costs on annual basis or for specified periods.

The following sections provide a detailed description of the simulation and the evaluation and reporting phases.

3.3 Simulation Phase

The sequence of operations of the simulation phase for a given road (or "link") and associated set of road construction and maintenanec policies is shown in Figure 3.1 For each year of the analysis period a series of submodels are applied in the following order :

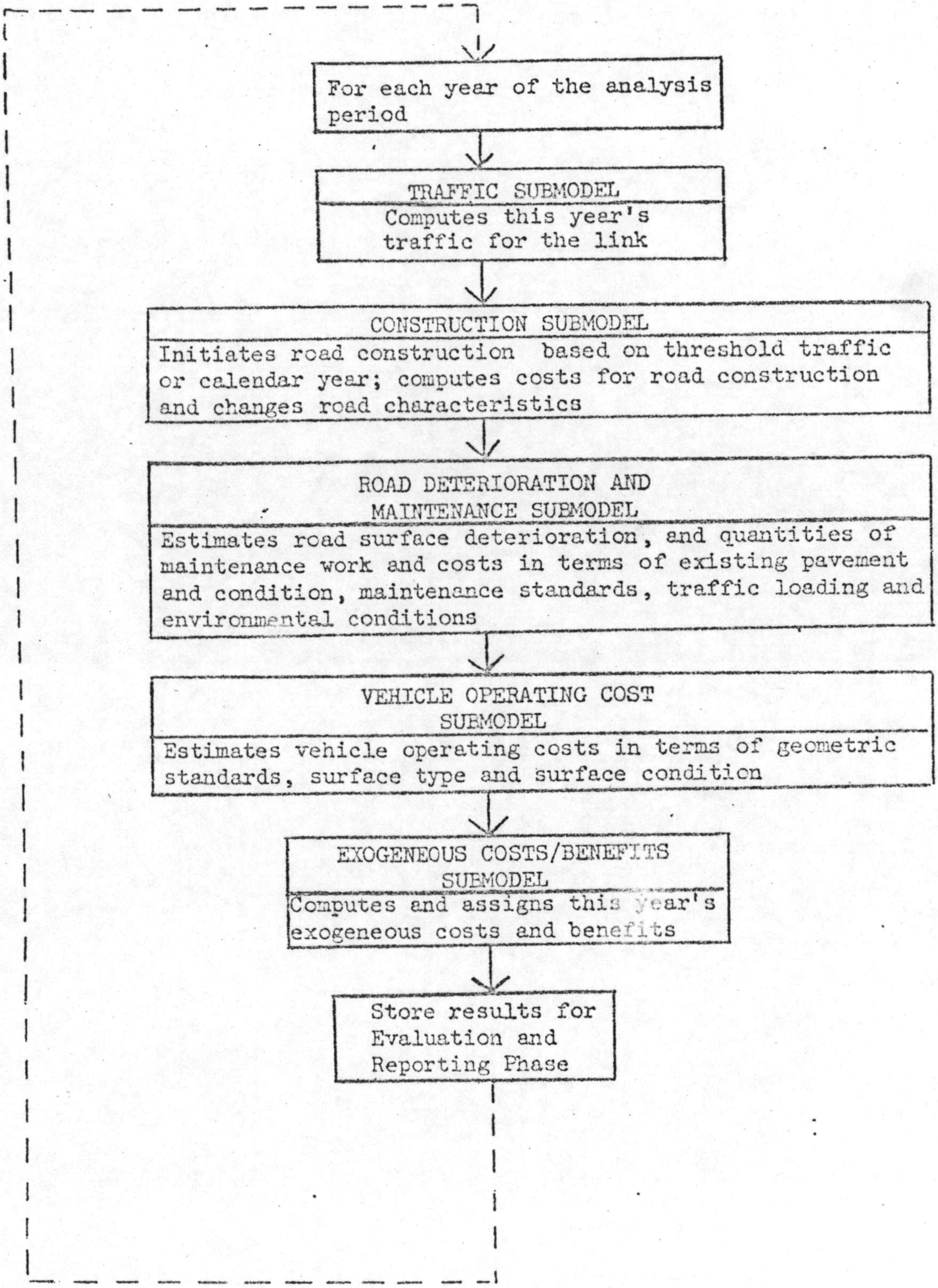
The Traffic Submodel, starting with the base-year traffic and growth rates specified by the user , estimates the current year's traffic volumes based on the previous year's traffic and the specified growth rates, by vehicle type, for both normal and generated traffic.

The Construction Submodel, allocates construction costs , which are specified by the user, to the construction period, updates the status of the road and activates generated traffic and/or exogenous cost/benefits (if any) as projects are completed. The various types of construction projects handled by the submodel included new construction, overlaying, pavement reconstruction, widening, widening,and reconstruction, realignment, and removal of roads from service. Road updating includes the opening of sections to traffic and the abandonment of older sections. All costs are input by the user, in financial, economic, and foreign exchange terms.

The Road Deterioration and Maintenance Submodel estimates the road surface conditions as a function of the initial disign standard, last year's surface conditions, the volume and composition of the traffic in the current year, climate, and the specified maintenance policy .

FIGURE 3.1

SIMULATION OF A LINK-ALTERNATIVE



Surface deterioration may be estimated for both paved and unpaved roads. The surface deterioration of the road is expressed in terms of roughness and rut depth (all roads) cracking and patching (paved roads), and depth of loose material and moisture content (unpaved roads). Typical maintenance activities are specified for paved, and unpaved roads. They may be performed either at specified times during the year or activiated when road surface conditions exceed specified thresholds. In either case, the user decides how and in what quantity they will be performed as well as what is the cost of each maintenance activity in financial, economic and foreign exchange terms.

The Vehicle Operating Cost Submodel estimates the costs of vehicle operation over the road as a function of surface type and condition, geometric design (grade, curvature, and width) and vehicle characteristics. The components of vehicle operating cost include running costs (fuel, oil, tires, maintenance parts, and maintenance labor), annual fixed costs (depreciation, interest crew costs and overhead costs) , and travel time costs (passenger time and cargo holding costs). Cost estimates are made by types of vehicles in traffic volume, in financial, economic and foreign exchange terms.

The Exogenous Costs/Benefits Submodel computes and assigns costs and benefits exogenously specified by the user based on the previous year's costs and benefits and specified growht rates in financial, economic and foreign exchange terms.

The simulation results from each analysis year (including construction, maintenance, and road user costs, maintenance quantities, and road surface condition) are stored for subsequent retrieval in the evaluation and reporting phase.

3.4 Evaluation and Reporting Phase

The last phase of the HDM model performs economic analysis for each link alternative and each pair-wise comparison of link-alternatives from which the results are summarized for group-alternatives. A series of reports are produced, some of which are generated automatically while other are user-specified.

The analysis of alternatives in the HDM model can be summarized in the following steps :

i) For each link alternative, the model assembles financial, economic and foreign exchange annual cost streams including the costs of : construction/capital investment, road maintenance operations, vehicle running passenger and and cargo delays, and exogenous components for each group-alternatives.

ii) The annual cost stream for link- alternatives from step i) are sommarized for each group alternative.

iii) For each pair-wise comparison of link-alternatives the annual benefit and cost streams are computed for one alternative relative to the other in terms of : increase in construction/capital and road maintenance costs; vehicle operating cost and travel time cost savings due to normal traffic; benefits in vehicle operation and travel time savings due to generated traffic; exogenous benefits; and total economic benefits. The total economic benefits are also computed in foreign exchange terms.

iv) The cost and benefit streams from step (iii) are summarized for each group-alternative comparison.

v) The model then computes for each pair-wise comparison of link alternatives : the net present value for five discount rate as specified by the user; the internal rate of return; and the first year benefits.

vi) Step (v) is repeated for each pair-wise comparison of group-alter-natives.

For the sensitivity studies in which the user specifies percentage increases or decreases for certain cost streams, steps (iii) through (vi) above. are repeated with the respective cost streams weighted by the user-specified factors.

3.5 Introduction to Input

Data are input to the model in the form of cards or card images coded in fixed format. The data are organized into eleven parts or series as listed below.

Data Series	Series Name
A	Existing Link Characteristics
B	Construction Options and Costs
C	Road Maintenance Standards and Costs
D	Vehicle Characteristics and costs
E	Traffic Characteristics

Data Series	Series Name
F	Other Costs / Benefits
G	Link - Alternatives
H	Group - Alternatives
I	Specification of Reports
J	Comparison of Alternatives
K	Run Control Information

The preprinted blank input forms are provided, as shown in Figure 3.2 for example. Each line in each form is punched as a separate card. The card are punched in their order of appearance in each input form. In general, information is input to the model in fix fields one to nine columns wide, and can be classified into three types: real number, integer, and alphanumeric. Each field is classified as real number in the input forms unless otherwise indicated as integer or alphanumeric. A real number may be coded anywhere in a field, so long as a decimal point is included. If the decimal point is omitted, the numerical value must be coded right - justified in the field, i.e., the right-most digit must be entered in the right - most space of the given data field. It is strongly recommended that all real-value numerical data be coded with a decimal point, as this reduces the possibility of errors. An integer must, of course, always be coded right-justified. Each alphanumeric item for internal identification and cross-reference purposes, usually of 4 - column width, must by coded in the exact columns indicated. Columns 72 - 80 are reserved for the user to code an identifier, sequence number, etc. A card with an asterick coded in column 1 is treated as a comment card

FIGURE 3.2: EXAMPLE BLANK INPUT FORM

International Bank for Reconstruction and Development

Highway Design and Maintenance Standards (HDM) Model

Input Form: A-2a: SECTION CHARACTERISTICS

Date ____________ Page ___ of ___

Prepared by ____________________

Card Type / Punch Check

A-4 SECTION DATA (2–13)
- Link ID (A): 17–20
- ALL Sections Switch (A): 22–24
- ID Numbers of Sections with Common Characteristics Below (I): 31–34, 37–40, 43–46, 49–52, 55–58, 61–64, 67–70
- 73–80

A-5 ENVIRONMENT (3–13)
- Annual Rainfall (mm): 29–34
- Dry Season Length (Months): 35–40
- Wet Season Length (Months): 41–46
- Altitude (m): 47–52
- AASHO Regional Factor: 53–58
- Subgrade CBR (%): 59–64
- 73–80

A-6 GEOMETRY (3–10)
- Rise/Fall (m/km): 29–34
- Horizontal Curvature (Degrees/km): 41–46
- Carriageway Width (m): 47–52
- Shoulder Width (m): 53–58
- 73–80

A-7 SURFACE (3–9)
- Surface ID Code (A): 13–16
- Carriageway Surface Thickness (mm): 29–34
  - Use wearing-course thickness for paved roads; gravel thickness for gravel roads.
- Structural Number: 41–46
- Deterioration Model (I): 51–52
- 73–80

Deterioration Model

01 TRRL DBST
02 TRRL Asphalt-Concrete
03 AASHO DBST
04 AASHO Asphalt-Concrete
05 TRRL Lateritic Gravel
06 TRRL Volcanic Gravel
07 TRRL Quartzitic Gravel
08 TRRL Coral Gravel
09 Earth (Clay)
10 Earth (Non-clay)

A-8 STRUCTURAL NUMBER (3–19)
- 73–80

A-9 LAYER / LAYER / LAYER / LAYER (4–8)
- Layer No. (I): 28
- Layer Thickness (mm): 35–40
- Strength Coefficient: 41–46
- 73–80

A-10 END STRUCTURAL NUMBER (4–24)
- 73–80

and therefore ignored.

The following sections describe the highlights of individual data series, while the user is refered to the HDM model user's manual for detailed-description of data requirements.

3.5.1 Series A: Existing Link Characteristecs.

In the model, road data are organized in to "links." A link is a length of road for which economic analyses (generation of streams of costs and benefifs-for different alternatives and comparison thereof) are performed. Links are independent of one another with regard to traffic, maintenance, construction, and vehicle operating costs. Up to twenty (20) links may be defined, with each link being divisible into up to ten (10) subdivisions or "sections." Terrain, climate, road geometrics, subgrade, surface type and condition are assumed to be constant over a given section, but may have different values for different sections. Traffic is assumed to be constant over the entire link, while maintenance and construction activities may vary from section to section within the link. A number of "alternatives" may be applied to each link, which may consist of various maintenance " policies ", construction "options ", traffic "sets ", and other cost / benefit "sets ". The input form for this data series is divided into two forms.

Form A - 1 : Link Declaration

Form A - 2 : Section Characteristics.

These forms are used in the following sequence:

Form A - 1 : To provide a general description of any links in the series.

Form A - 2 : To describe one set of section characteristics for any links.

3.5.2 Series B : Construction Options

The geometric, and surface characteristics and condition of any link defined in Series A may be altered by a construction "option" or "project ". The description of a project is very similar to that of a link. In addition, the cost of the project is provided as a lump sum over all the affected sections of a link, in financial, economic and foreign exchange terms, if desired, and may be distributed over one to five years. Generated traffic can be included in the project. All sections in the link need not be affected in the same manner, or at all, by the project. Up to seven types of construction improvements may be performed on any section:

i) new construction

ii) overlaying

iii) reconstruction

iv) widening

v) widening and reconstruction

vi) changing alignment

vii) removal from service

More than one project may be active on a given link at any time, although a project can affect only one link. A maximum of fifty (50) projects may be specified in a run.

The input form for this data series is provided in two forms.

Form B - 1 : Project Specification

Form B - 2 : New Section Characteristics.

Form B - 1	Used to provide a general description of any project specified in the series.
Form B - 2	Used to describe one set of new section characteristics brought about by any project.

3.5.3 Series C : Maintenance Standards and Costs

Maintenance standards are specified in the following hierarchical manner :

3.5.3.1 Operations provide the lowest level of standard specification. An operation is a well-defined road maintenance activity which is associated with a unit cost, such as patching with a unit cost per square meter. Activity levels are specified for an operation in various forms, such as in terms of fixed frequency, traffic - related frequency or condition-responsive action, subject to certain frequency and timing constraints etc. Ten operations are provided in the model.

3.5.3.2 Standards. A standard is a set of activity levels for individual operations, defined as applicable to a specific surface ID code (which must be the same as the surface ID code in Series A or B) and specific traffic range (ADT). Upto 30 standards may be defined for different surface ID codes and traffic volumes.

3.5.3.3 Policies. As the highest level of standard specification, a policy is a set of standards. Up to 8 policies may be defined, and any given standard may be assigned to any one on serveral policies.

This data series provides a declaration of individual maintenance operations, standards and policies, but does not specify their timing and execution for any links. A declared policy in this data series is implemented for a given link in Serie G data, in which the policy identification Code is specified with a starting year. When the link is to be evaluated, the standards comprising the policy applicable to the current year are searched for the traffic range containing the link's present ADT. The link is then analyzed section by section, and the surface ID of each section by section, and the surface ID of each section is checked against those specified in the standards in this policy. If more than one standard in the policy has the same surface ID and has a traffic range containing the link's ADT, the standard with the narrowest traffic range is selected. If there is no standard in the policy which agrees with the section's surface ID and also contains its traffic volume in its traffic ranges, no maintenance will be performed, and a warning message will be printed. Only the standards comprising the policy are searched; that is, the model does not search for another policy if no match of surface ID codes was found in the one assigned.

Five input forms are provided for series C :

Form C - 1 : Unpaved Road Maintenance Unit costs

Form C - 2 : Paved Road Maintenance Unit costs.

Form C - 3 : Unpaved Road Maintenace Standard

Form C - 4 : Paved Road Maintenace Standard

Form C - 5 : Road Maintenace Policies.

3.5.4 Series D : Vehicle Characteristics and Costs

Up to Seven (7) vehicle groups representative of the fleet under study may be defined, with no special requirements for the order of the vehicle groups. However, if less than seven vehicle groups are used, they must be declared in the leftmost available areas. Once the vehicle groups have been defined, all reference to vehicles, either through vehicle data or traffic data (Series D) must be consistent with these original definitions. Vehicles may be differentiated in any manner; e.g., according to type , capacity, design, costs, etc.

Five input forms are provided for this series.

Form D - 1 : Vehicle Characteristics

Form D - 2 : Vehicle Axle Load Distribution

Form D - 3 : Vehicle Unit Costs

Form D - 4 : Vehicle Age Distribution and Fleet Growth

Form D - 5 : Vehicle Utilization

3.5.5 Series E : Traffic Characteristics

Traffic data are organized into "Sets". A traffic set is basically a set of parameters which define a stream of traffic over time for different vehicle groups, in the form of initial ADT and growth rates. Each traffic set is specified with a unique 4 - character ID code which issued in specifying link-alternatires (Series G) and construction options (Series B). Traffic sets are identified either as "normal" or "generated". A normal traffic set provides a base traffic stream for a link, i.e. the existing traffic (if any) plus growth* over time which will be incurred even if the road is not

* Customarily "normal" traffic growth is thought of as a positive quantity (due to growth of the ecomony, etc.), but it can be negative, e.g., where road conditions would deteriorate seriously in the absence of the proposed maintenance program being evaluated. The model provides internally for correction of traffic and benefits estimates due to road deterioration; no other correction by the user is necessary.

improved. Generated traffic is that additional traffic which will be induced, or diverted from the routes, because of lower transport costs due to the improvement on the link(s) being evaluated. Generated traffic may be added to a base traffic stream by scheduling in link-alternative definition (Series G) the year in which generated traffic commences, or by inclusion in a "project" (Series B) where by generated traffic is activated upon project completion. Benefits due to generated traffic are computed in terms of consumers' surplus.

The reason for having generated traffic induced by "projects" or construction "options" is that different design standards or timing might results in various levels of generated traffic, encouraging the user to explicitly consider the effect of various design options or timings in deciding whether or not generated traffic will develop, and at what level. By including an option for scheduling of generated traffic in the "alternative" definition, the user has the flexibility of inducing traffice through ancillary investments other than road construction.

Since each construction option may have different generated traffic volume, generated traffic should be regarded separately from normal traffic, having its own growth characteristics. Growth type can be either incremental percentage-of-existing, or percentage-of-generated. A maximum of 20 traffic sets can be specified.

The order of data entries for individual vehicle groups must be the same as in Series D for vehicle characteristics and costs.

Only one input form, E-1: traffic set, is provided; this form vehicle is used to describe the characteristics of one traffic set, is repeated as many time as there are traffic sets, up to maximum of 20.

3.5.6 Series F: Other Costs/Benefits

The model makes provisions for the user to input exogenously calculated costs and benefits through Series F. Exogenous or "other" costs and benefits are organized into sets similar to traffic sets. Other costs/benefits sets are defined as stream of costs and benefits applicable to specific links, with the streams being either "normal" or "generated". Accident costs may be both normal and generated. Increased agricultural production consumed on the farm caused by provision of an all weather access road should be entered in the model when applicable, as a "normal" exogenous benefit for computational purposes, although conceptually it may be classified as a "generated" benefit. An example of an exogenous costs would be environmental pollution.

Since the cost and benefit growth periods will usually not coincide, each will have its growth periods defined separately. Growth types would be either annual amount, annual increment, or annual percentage increase. The first period for generated costs and benefits cannot be a percentage increase.

A maximum of five growth periods can be input for both costs and benefits for each set. A costs/benefits set is applicable to only one link, and would be applied to that link as indicated in the link-alternative definition (Series G).

Only one input form, F-1, is provided in this series. The form, which is used to describe one costs/benefits set, is repeated as many times as there are costs/benefits sets, up to a maximum of 20 sets.

3.5.7 Series G: Link - Alternatives

Series A through F allow the user to input data insepa-rate parts. Series G allows the user to combine the different parts of data --links, projects, maintenance standards, traffic sets, other C/B sets, and vehicle data -- into "link-alternatives" for policy analysis purposes. A link-alternative is schedule of projects, maintenance policies, and traffic and other C/B sets, proposed for a given link. "Project" or construction "options" are scheduled by giving the starting year, or ADT which will trigger the construction option, and the construction "option" ID (which must be unique and applicable to the link specified). Maintenance "policies" are scheduled by giving the starting year and the traffic "set" ID (which must be applicable to the link). Other cost and benefit "sets" are scheduled by giving the starting year and the C/B "set" ID, which must be applicable to the link.

A provision is made, via the CAPITAL card, to permit the user to inject capital costs, in addition to construction costs, directly into a link-alternative in any year in the analysis period, infinancial, economic, and foreign exchange terms.

Only one input form, G-1, is provide in this series. This form is used to define one link-alternative, and can be repeated up to maximum of 100 link-alternatives. Furthermore, the number of the link-alternatives times the number of analysis years must not exceed 800; however, this limit can be easily increased by re-defining the direct access disk file.

3.5.8 Series H : Group - Alternative

"Group - alternatives" are sets of link-alternatives for which economic analysis results (net present value, internal rates of return, etc.) and various reports (road maintenance expenditures, financial summaries, etc.) are produced. The declaration of a group-alternative automatically declares a "group" which is the set of links in the group-alternative. No economic analysis will be performed for any excluded link-alternatives even if they are defined in series G.

Only one input form, H-1, is provided in this series. This form can be repeated as many times as necessary to define all group-alternatives, up to 20 groups and 100 group-alternatives. Note also that Link ID code must not repeat within each group-alternative. Group-alternatives of the same group ID must contain the same set of links. Finally, at least one group-alternative must be defined.

3.5.9 Series I: Specification of Reports

Up to five hundred (500) reports may be requested at the user's discretion for the various link-alternatives and group-alternatives.

Five (5) types of reports are available:

1) Financial Costs Summary Reports
2) Road Maintenance Summary Reports
3) Annual Road Maintenance Reports
4) Annual Traffic and Road Users Costs Reports
5) Annual Road Conditions Reports

For the annual type reports (Type 3, 4 and 5) one year of reporting is counted as one report. Annual Traffic and Road User Cost Reports (Type 4) and Annual Road Conditions Reports (Type 5) are applicable only to link-alternatives. The remaining types are applicable to both link-alternatives and group-alternatives. No reports need be requested in a computer run.

Two input forms are provided, Form I-1 for requesting reports for one link-alternative and Form I-2 for requesting reports for one group-alternative. These forms can appear in any order and can be repeated as many times as needed, provided that the total number does not exceed 500.

3.5.10 Series J: Comparison of Alternatives

In series G and H the user provides the definition of individual link - and group-alternatives as separate entities. In this series the user specifies what link - and group-alternatives are to be compared in the run, in the form of "sentivity studies." A sensitivity study defined a set of comparisons between group-alternatives, for which various sensitivity factors or "cost parameters" may be provided. Cost parameters cab be specified for individual group-alternatives, in terms of construction, maintenance, travel time, and vehicle operating costs, and other cost/benefits. Up to five (5) discout rates may be specified in a study for computation of net present values. A study may contain as many group-alternative comparisons as desired, as long as the total number of comparisons in all studies does not exceed fifty (50). At least one sensitivity study must be provided in a computer run.

One input form, J-1, is provided for used to specify one sensitivity study, can be repeated for upto a maximum of five (5) studies. The first study is normally a base case in which the cost parameters cards (J-4 and J-5) are omitted.

3.5.11 Series K: Run Control Information

This series provides global run parameters and input/ output options to be used in this run.

One input form, K-1 (in four sheets, K-1a, K-1b, K-1c and K-1d), is provided and must be used once to input run control information.

3.6 Option of Some Relationships Used in the HDM model

3.6.1 Road Deterioration Relationships

There are ten (10) options for deterioration relationships as listed below.

" 01 " = TRRL DBST

" 02 " = TRRL Asphalt - Concrete

" 03 " = AASHO DBST

" 04 " = AASHO Asphalt - Concrete

" 05 " = TRRL Lateritic Gravel

" 06 " = TRRL Volcanic Gravel

" 07 " = TRRL Quartzitic Gravel

" 08 " = TRRL Coral Gravel

" 09 " = Earth - 1 (Clay)

" 10 " = Earth - 2 (Non - clay)

The detail of these relationships are referred to the HDM model user's manual.

3.6.2 Depriciation and Interest - Annual Kilometerage Relationships

Three optional methods are available in the HDM model for computing the average annual depreciation (DEP) and interest (INT).

" 1 " = TRRL - Kenya Method

" 2 " = de Weille's Varying Vehicle Life Method

" 3 " = Constant Vehicle Life Method

Similarly, three optional method are available for computing the "average annual kilometerage". (AKM).

" 1 " = Constant Annual Kilometerage Method

" 2 " Constant Annual Hourly Utilization Method

" 3 " Adjusted Utilization Method

The detailed - description of these methods is provided in the HDM model user's manual.

3.7 Limitation on Parameters and Conditions applicable to the HDM model

Most of the relationships used in the HDM model are derived from field work in Kenya which is typical of developing countries. The user should be aware of the environment in which the model is to be used, it should be similar to that of Kenya. The model cannot calculate the road construction costs for any project and does not also itself calculate the regional income or value added benefit of feeder roads, nor the unit value of time savings, nor accident costs. The model does not provide a traffic forecast, which must be specified by the user. In addition to the several limitations already stated, there are limitations on the number of variables and on the problem size in the HDM model as shown in Table 3.1. These limitations are obtained from many former experiments.

TABLE 3.1

LIMITATION ON PARAMETERS USED IN THE HDM MODEL

Series A	Minimum	Maximum
Number of Link	1	20
Number of section in one link	1	10
Road Rise (m/km)		
unpaved road	0	80
paved road	0	85
Road Fall (m/km)		
unpaved road	0	80
paved road	0	85
Horizontal Curvature (degrees/km)		
unpaved road	0	250
paved road	0	200
Roughness (mm/km)		
unpaved road	2,000	14,000
paved road	2,000	9,000
Moisture (percent) for unpaved only	0	30
Rut depth (mm) for unpaved only	0	75
Altitude (meters) for paved only	0	2,500
Series B	**Minimum**	**Maximum**
Number of Project	1	50
Project Action Period (years)	1	5
Analysis Period (years)	1	30
Series C	**Minimum**	**Maximum**
Number of Policy	1	8
Number of Standard	1	30
Number of Operation	1	10

TABLE 3.1

(Continued)

Seried D	Minimum	Maximum
Number of Vehicle Group	1	7
Series E	**Minimum**	**Maximum**
Number of Traffic Set	1	20
Number of Link as subject to traffic set	1	5
Number of Growth Period	1	3
Series F	**Minimum**	**Maximum**
Number of Growth Period for both costs and benefits in each CIB set.	1	5
Number of Link to which C/B set can applicable	0	1
Series G	**Minimum**	**Maximum**
Number of Link - Alternative	1	100
Number of Link - Alternatives times the Number of Analysis years	1	800
Series H	**Minimum**	**Maximum**
Number of Group	1	20
Number of Group - Alternative	1	100
Series I	**Minimum**	**Maximum**
Number of Requested Report per run	1	500
Types of Report	1	5