ROAD TRANSPORT RESEARCH

# road maintenance and rehabilitation:
## funding and allocation strategies

REPORT PREPARED BY
AN OECD SCIENTIFIC EXPERT GROUP

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

# ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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Publié en français sous le titre :
ENTRETIEN ET RÉHABILITATION DES ROUTES :
FINANCEMENT ET STRATÉGIES D'AFFECTATION

## FOREWORD

The Programme centres on road and road transport research, while taking into account the impacts of intermodal aspects on the road transport system as a whole. It is geared towards a technico-economic approach to solving key road transport issues identified by Member countries. The Programme has two main fields of activity:

-- International research and policy assessments of road and road transport issues to provide scientific support for decisions by Member governments and international governmental organisations;

-- Technology transfer and information exchange through two databases - the International Road Research Documentation (IRRD) scheme and the International Road Traffic and Accident Database (IRTAD).

The scientific and technical activities concern:

-- The management, rehabilitation and environmental assessment of road and bridge infrastructure;

-- The formulation and evaluation of targeted road and traffic safety programmes;

-- The development and management of road traffic technology and advanced driver communication systems;

-- The assessment of urban and inter-urban road transport strategies, freight operations and logistics approaches;

-- The strategic planning and management of research and joint projects as well as technology diffusion, both in OECD countries and economies in transition;

-- The maintenance management of road infrastructure and the evaluation of traffic safety measures and strategies in developing countries.

## ABSTRACT

**IRRD No. 863515**

The study evaluates methods used in resource allocation and distribution for maintenance and rehabilitation works, taking due account of the prevailing political, economic and social context and perceived problems in OECD Member countries. It proposes guidelines for best and flexible practices to be instituted in widely differing institutional frameworks of Member countries. Chapter I describes the technical, social, political and economic factors in the decision making process. In Chapter II road systems, funding practices and organisational structures of OECD countries are surveyed. Chapter III reviews road programme preparation, and funding allocation and Chapter IV discusses the analytical background needed to support an engineering-economic approach to road maintenance. Calculating of benefits and costs are presented in Chapter V, characterisation and measurement of road conditions in Chapter VI, and environment and other externalities in Chapter VII. Chapter VIII presents a recapitulation of best practices, and Chapter IX gives ten "commandments" for implementing effective resource allocation policies for road rehabilitation and maintenance works. Under current budget constraints for new road construction projects, road maintenance and rehabilitation has a key position in preserving the value of the road asset, and ensuring improved service to road users. The Report provides road administration managers and engineers with rational resource allocation methods based on rigorous scientific and technico-economic analysis.



Field Classification: Economics and administration; equipment and maintenance methods.

Field Codes: 10, 61.

Keywords: Maintenance; administration; cost benefit analysis; decision process; pavement management system; road user; environment; financing; repair; distribution (gen).

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# EXECUTIVE SUMMARY

## A NEW CONCEPT FOR REHABILITATION AND MAINTENANCE

The OECD Expert Group on *Resource Allocation for Road Rehabilitation and Maintenance Programmes* was established in 1992 to evaluate methods used in resource allocation and distribution for maintenance and rehabilitation works, propose improvements to these methods and, if possible, seek common approaches for road system management.

Road maintenance and rehabilitation, traditionally viewed as a mundane topic for second rate engineers, operates today in a changed context and with a changed concept. It has now a key position in preserving the value of the road asset, providing improved service to road users and contributing to environmental quality. In fact, during the life cycle of a road the responsibilities and life styles of people, their travel demands as well as communities will change and the road network has to be adapted to the new circumstances.

The objective of maintenance and rehabilitation is no longer to simply keep the road in appropriate condition as a structure. Road Administration management and its analytical procedures need to be broadened toward environmental and aesthetic milieu assessment recognising opportunities for improvements and including affected interests in the early phases of highway studies.

To restate, rehabilitation and maintenance have experienced a change in concept and content: they are meant to preserve the value of the investment and to improve the environment.

## ROAD ADMINISTRATION OPERATES IN A COMPLEX ENVIRONMENT AND FACES CHALLENGING ISSUES

A country's transport system is an enormous national asset. Management of the system is a highly sensitive and complex task, entrusted to a country's Road Administration and shaped by a constellation of political, technical, environmental, managerial and historical forces. In addition to transport sector objectives, roads are often used to achieve social objectives which lie outside the road transport sector, to help implement a vision for the future.

The political environment in which the Road Administrations' managers and professionals work is complex, even hostile. Managers are asked not only attempt to minimise the society's expenditure on transport but also to meet user needs. These user needs range from an acceptable level of service,

to a desire for clean environment and sustained economic development and to a low share of user taxes to provide for the agency's funding. The everyday reality for Road Administration professionals is that they must increase their effectiveness and productivity in accomplishing a mission that grows in complexity while budgetary constraints become increasingly sever. Issues challenging every road manager in every country are elaborated in Chapter I.

Since management practices and organisation structures depend on each other, the study of the Group started with a survey of institutional settings, trends in Road Administrations and resource allocation and funding practices in Member countries. This laid a solid foundation for the Group's work and enables a proposal for a framework that is generic and flexible could be put forward, in spite of the great variety in organisational structures and administration styles in Member countries. The key results of this survey are presented and discussed in Chapter II and III.

## THE CONCEPTUAL APPROACH: A COMPREHENSIVE ASSESSMENT BASED ON LIFE CYCLE COSTS AND BENEFITS

The situation faced by the Road Administrations involves a difficult trade-off between on the one hand, the adverse consequences of traffic on the environment and on the other, the beneficial effects of good roads on the economy and social well-being.

The management needs a conceptual approach which is broad and comprehensive, yet responds to decision-makers' needs and supports the dialogue with the politicians and the public. The management is also required to ensure that most effective use is made of the taxpayers monies to serve the motorists and deter deterioration of the environment. The technical staff, for its part, needs a tool which can be employed to implement the physical works in an efficient manner and which is of course consistent with the managerial directives.

The commonly accepted objective of road resource allocation is the minimisation of administration plus user costs over the life time of the facility or the network. A more restricted objective of minimising only the administration's costs is often employed. This latter objective requires standards which however, imply economic and social choices and should indeed be part of the analysis. For this reason and because the user costs are overwhelmingly large as compared to the administration's cost, the broader objective of minimising the sum of the administration and user costs is adopted as the organising concept in the Report. This scientific approach is described both in technical and non-technical terms in Chapter IV. The operational implementation of the method is dependent on institutional structures, managerial styles, methods of financing and criteria Road Administrations use in formulating their multi-year programmes.

The proposed approach embodies a three-tier hierarchy, network-programme-project, found in every Member country. The network level resource allocation and distribution is done at the highest managerial level and focuses on the network and sub-networks without a specific project in mind. The programme level is an intermediate activity which ties together the network level resource distribution with the project level expenditures. This is a necessary feature of resource allocation and distribution. The hierarchy helps ensure fairness, avoid mis-allocation or mis-distribution of monies, and, over time, ensures a consistent and well-justified level of funding for maintenance and rehabilitation.

The OECD countries and also developing countries, can derive advantages of economies of scale and scope from road maintenance management methods which have common rationale and enjoy widespread acceptance among professionals. International co-operation is desirable to exchange experience, survey the best practices available and identify steps to make major gains in managing resource allocation and distribution in road administrations.

## IDENTIFICATION OF BENEFITS AND COSTS REQUIRES AN EXCELLENT INFORMATION DATA BASE

The Road Administration's information system serves multiple purposes, such as Central Administration's needs regarding planning and investment, rehabilitation strategies, or the Regional Administration's needs for organising routine maintenance activities. The greater the complexity of the objectives, the more elaborate are the management's information requirements.

The main aim of benefit and cost calculations is to enable managers to give informed input to the budget negotiations and political dialogue and to identify the most advantageous rehabilitation and maintenance strategy. A corollary aim is to enable the design engineers, at the project level, to associate with it the most economical maintenance works over the life cycle of the facility subject to policies established at the network level.

Different rehabilitation and maintenance management strategies will have a direct effect on the experienced costs and benefits. Some of these costs and benefits will be of a quantifiable and others of a non-quantifiable nature. Chapter V sets out the various costs and benefits of maintenance and rehabilitation split between those that are internal to the administration and road users and those that are external; some will be quantifiable and others non-quantifiable.

Enumeration of benefits and costs requires an excellent information system *to enable management to strengthen the decision-making process and increase productivity.* Chapter VI of the Report discusses how information Road Administration's systems relate to the road manager's needs in resource allocation and distribution and what approaches may be used in measuring the road network's conditions.

## ENVIRONMENT AND MILIEU: KEY ELEMENTS IN DECISIONS

Environmentally sensitive construction and maintenance of roads provide tangible benefits: cleaner air and more pleasing appearance of road space; protection of neighbourhoods from roads and traffic; increased quality of life; higher value of land and homes; and aesthetic milieu of urban business centres. Access without the visible nuisance due to roads is a highly valued commodity. Environmental investment in the framework of road works is already substantial; presently 5-15 per cent of road costs are environment related expenditure.

Quantitative consideration of the environment is difficult even in the context of new construction, but is the most common theme discussed in public hearings. Take an example from Switzerland; a section of a national highway, 24 km long, currently under construction had an initial cost estimate

US$165 million in 1967. Because the road traverses an ecologically difficult zone on a lake shore, changes in alignment and adaptations to the different environmental obligations pushed the final cost estimate to US$735 million! In this instance the external costs have been internalised in the plan, in the design and construction.

For rehabilitation and maintenance the situation is much more difficult. The status quo is a road in use and the traditionally quantifiable costs of maintenance works may suggest negligible impacts. However, the reality may differ. Indeed, any attempt to construct an index for environmental quality, -- such as a benefit/cost ratio -- will hide the issues rather than bring them out to be discussed.

Public participation is again, recognised as an important element in all transport planning. Actions and measures conceived in this way gain political and public acceptance. The public is willing to pay for the higher costs of the more extensive environmental rehabilitation and, at the same time, the existing road itself can be effectively maintained and rehabilitated.

## TEN COMMANDMENTS FOR RESOURCE ALLOCATION IN ROAD REHABILITATION AND MAINTENANCE

Resource distribution for rehabilitation and maintenance should -- indeed must -- be done with a good understanding about the trade-offs with development investments. Roads and bridges should not be kept in good or excellent condition for their own sake, but for the sake of the users. Thus, there may be instances in which disinvestment, or some lack of rehabilitation or maintenance, may be a wise action, obviously within the legal constraints for safety and environment, allowing for redirecting of these funds to new facilities where they better satisfy the needs of the users. Consistent with this concept, the objective of road rehabilitation and maintenance is to preserve the value of the investment **and** to improve the milieu and the environment. This conclusion sets new requirements for decision-aiding systems.

Regardless of the specific administrative and organisational structure of a country, the survey conducted as part of this Report shows that there is consistency in how road funds are allocated and distributed. For "best practice" (as discussed in detail in Chapter VIII) to accomplish this allocation and distribution, countries have developed -- or should develop -- an integrated Road and Bridge Management System as proposed in this Report.

In outline, the management system should be capable of assessing the physical and operating conditions of the current road network with the accuracy and detail desired by the Road Administration. By using estimates of travel demand -- disaggregated geographically and functionally -- the management system should provide forecasts about future requirements, both in capital and rehabilitation outlays as well as routine maintenance to achieve varying levels of system performance. It should also provide input to allocation of costs among road users to help develop equitable funding of the road network over the long run.

*For 'best practices' in resource allocation and distribution decisions, a unified analytical framework is proposed -- minimisation of user and administration costs. However, a clear distinction is made between network, programme and project level. The first serves policy applications by the Central Administration and the latter two project prioritization and design, normally applied by the regional executing agency. All these applications must be based on the same data.*

*During the course of its work, the Group developed a consensus on 'Ten Commandments' which governments and Road Administrations should observe in developing a method for resource allocation and distribution for road maintenance and rehabilitation programmes and the process to be followed. These 'commandments' are:*

*I.* *Maintenance is an Opportunity for Enhancing the Environment as well as Safeguarding the Road Network Asset.*

*II.* *Road and Bridge Maintenance Should be Pursued for the Sake of the Users. Therefore, Public Participation is an Essential Part of Developing the Road Maintenance Programme.*

*III.* *Road and Bridge Assets Should be Maintained in an Economical Way.*

*IV.* *A Sound Analytical Framework is Important for Delivering an Economical and Environmentally Sound Product.*

*V.* *User Costs Must Be Treated as Important Costs and Included in the Analytical Framework.*

*VI.* *Budget Constraint on the Administration's Expenditures is an Important Feature of the Analytical Procedures. Competitive Maintenance and Rehabilitation Programmes are One Important Means to address these Constraints.*

*VII.* *The Entire Road Budget and Trade-offs Between Alternative Uses Must be Considered when Allocating and Distributing Resources.*

*VIII.* *The Management Systems Used in Allocating a Distributing Resources Must Be Compatible with the Road Administration's Organisation and Management Style.*

*IX.* *The Methods Used at Network, Programme and Project Levels must be Different but Interlocking and Utilise the Same Data Base.*

*X.* *Data Systems which Support the Road and Bridge Management Systems Must be Timely and Reliable.*

# CHAPTER I

# INTRODUCTION

## I.1. BACKGROUND

A country's transport system is an enormous national asset. As the circulation system of the body politic, it facilitates commerce, communication, and economic and social growth. Management of the system is a highly sensitive and complex task, entrusted to a country's road administration and shaped by a constellation of political, technical, environmental, managerial and historical forces.

Despite its complexity, the mission of a country's road administration is typically stated in broad simple terms, e.g.: "*Effectively manage the transport system that serves the country*". In addition "serving clients", delivering "quality products", "environment", "the economy", and recognising the "value of the employees" are increasingly emphasised goals and add to the managerial dimension of a road administration's mission.

In addition to these transport sector objectives, roads are often used to achieve social objectives which lie outside the road transport sector, to help implement a vision for the future. One historical manifestation of this tendency occurred at the beginning of this century when farmers were "pulled out of the mud" by paving roads. Today, environmental enhancement is sought, in part, through effective use of road rehabilitation and maintenance resources. Recently, with the decline of funds available for road management, rehabilitation and maintenance of roads have gained a position of paramount importance.

The objective of the OECD Scientific Expert Group on 'Resource Allocation for Road Maintenance and Rehabilitation Programmes', a component of the OECD's *Road Transport Research Programme* was two fold. First, the Group set out to examine the operational dimensions of managing a country's road system. Second, its aim was to provide a framework of analysis for road administration managers and engineers. This framework should incorporate both the vision for the future as well as the verifiable facts and details about roads as an engineering product, and -- most importantly -- be flexible and general enough to serve the different administrative circumstances prevailing in the OECD countries.

It might appear on the surface to be a contradiction, but in fact the "big picture" -- the vision of a country's road system -- can only be implemented by attending to a multitude of small details. The central question of the operational aspect of road management is the way in which allocation and distribution of resources for various purposes accomplish the road administration's mission.

At the outset it is useful to define several key terms as they are applied in this report. The term (resource) 'allocation' in this report is used to mean apportioning of funds to road purposes by an elected body, such as Parliament, often on the basis of a recommendation by the road administration. The term 'distribution' is used to mean the apportioning of (politically) allocated budgets between programmes, objectives, and projects in the road sector. This distribution is normally done by a road administration (agency). The word 'agency' is used nearly interchangeably with the word 'administration'. If there is a difference it is the following: 'agency' is associated with the execution or management of road improvements, while 'administration' with the discharge of duties specified in the country's laws.

Another set of definitions which recur throughout this report concern 'development', 'rehabilitation', 'periodic maintenance', and 'routine maintenance'. The definitions of these terms are: (1) 'development' means construction of new roads, capacity increases by means of adding lanes, and substantial realignment of a road which may or may not increase capacity; (2) 'rehabilitation and maintenance', or simply maintenance, means reconstruction or rehabilitation of existing roads and periodic maintenance, such as surfacing or resurfacing, of these roads; and (3) 'operations' means keeping roads passable every day. These activities are often called 'routine maintenance' and include snow and ice control (if applicable), upkeep of traffic signs and markings, road side care, and patching and sealing road surface.

The operational objectives to which road administrations' professional staffs attach importance are among the following: traffic safety, capacity increases to sustain or enhance current operating speeds as well as respond to changing traffic demand, rehabilitation of existing roads, and environmental amelioration. In some countries and States improved farm to market accessibility, congestion management, and promotion of carpooling and public transit are also important objectives.

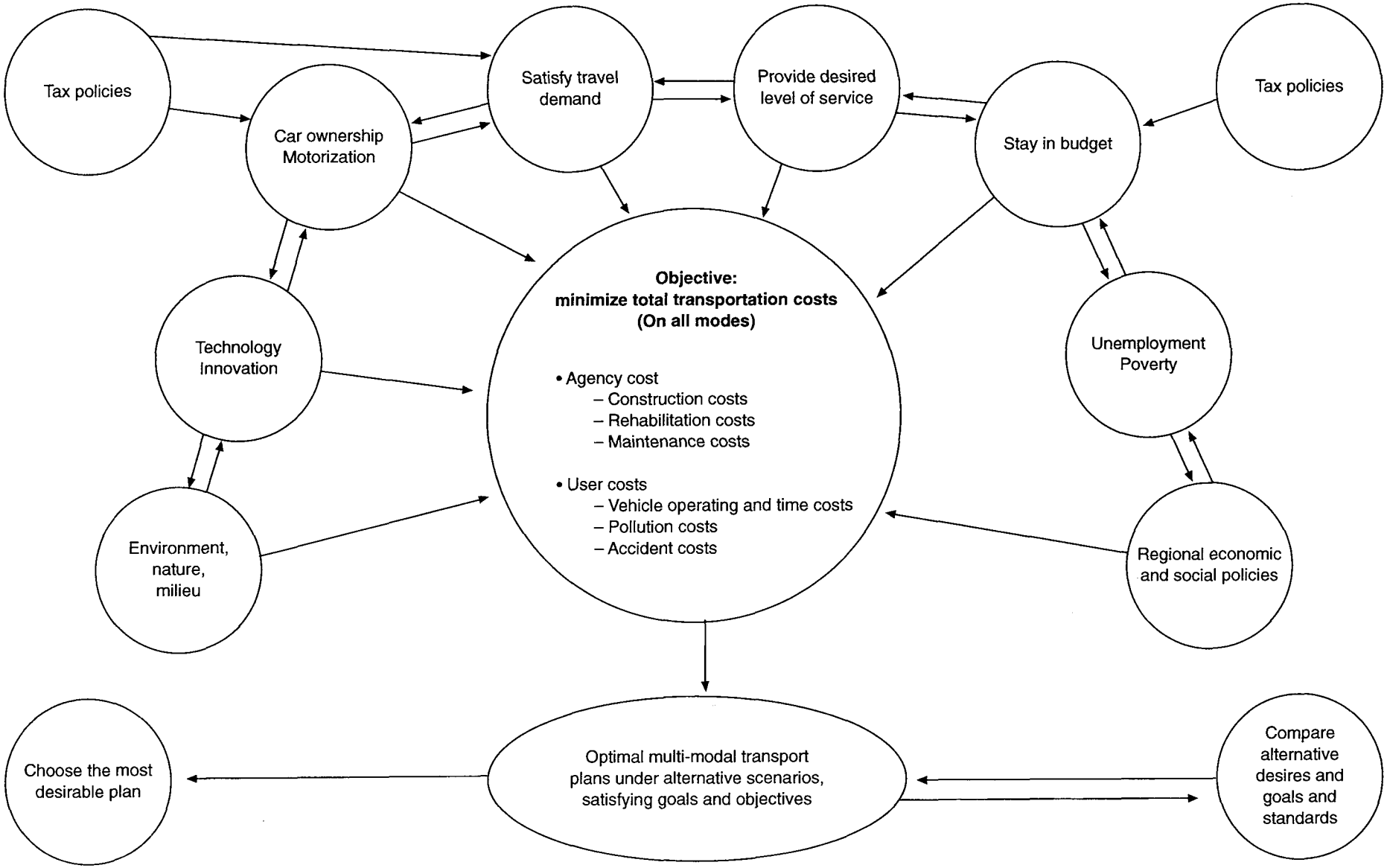
The issues and problems surrounding these objectives constitute a familiar, well trodden ground for road professionals in every country, and most transport managers anticipate them in the normal course of their work. However, what makes dealing with them technically difficult is their intricate relationship with a full range of socio-economic parameters and nearly every facet of life, and the complications they introduce to decision-making in road management.

The political environment in which the road administrations' managers and professionals work is complex, even hostile. Managers are asked not only to attempt to minimise the society's expenditure on transport but also to meet user needs. These range from an acceptable level of service, to a desire for clean environment and sustained economic development, and to a low share of user taxes to provide for the agency's funding. The everyday reality for road administration professionals is that they must increase their effectiveness and productivity in accomplishing a mission that grows in complexity while budgets constraints become increasingly severe. Figure I.1 portrays the constellation of often competing and contradictory forces and demands which the transport decision-maker faces.

In this complex 'universe' in which everything depends on everything else, the road administrations are called upon, and used by others, to serve multiple objectives. A 1984 survey of the U.S. State highway professionals (1) led to the conclusion that transport is perceived and used by State (country) policy makers as means to ends other than those directly impacting transport, "sometimes to the discomfort of transportation professionals."

Larson and Rao (2), who undertook a comprehensive study of the U.S. State Highway Agencies' capital programme management practices, describe the complexity of these practices and venture to guess that "in a more competitive environment for resources, highway capital programmes will likely

Figure I.1. **Decision making considerations in road rehabilitation and maintenance**



require a new focus and broader ranging goals". They claim that there is no "right way" to manage the highway capital programme and argue for "directed autonomy" to allow creative approaches to be developed by individual States. Larson and Rao suggest, further, that the best results are achieved when there is a balance between the need for direction and control on the one hand and freedom and flexibility on the other, depending on the political, cultural, and demographic circumstances of each State.

## I.2. AIM

The present report is part of a long-standing series of OECD Road Transport Research reports on maintenance and rehabilitation issues of road infrastructure[1]. The report, dealing with fund allocation and distribution for road and bridge rehabilitation projects seeks to be sensitive to overall political, economic and social circumstances in Member countries. Its starting point was a survey of current practices and perceived problems. The report discusses issues, concepts and methods involved in the processes of critical concern to the road agency management and key ministerial officials and politicians.

The orientation in the document is a managerial one. It seeks to address three central questions. First, of what service can a systematic model be -- a road and bridge management system model, that offers a basic conceptual structure but can be adapted and quantified to suit each country's unique needs? Second, what kind of information can managers expect from their policy staff? And finally, what kinds of questions can and should managers ask and expect adequate responses to?

## I.3. ROAD ASSET

The highway network of any country, but especially of a developed country, is a major public investment designed to support the national economy by enabling industry, business and commerce to transport goods and people. The investment itself is usually undertaken as a result of balancing the various competing costs and benefits. When developed, the road network is expected to meet the national objectives for road transport and at the same time minimise whole life costs (or life cycle costs) of facilities and the transport costs of goods and persons.

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1 Previous OECD studies addressing a range of technical, economic and management aspects include: *Maintenance of rural roads* (1973), *Road strengthening* (1976), *Maintenance techniques for road surfacings* (1978) and *Catalogue of road surface deficiencies* (1978), *Road surface characteristics: their interaction and their optimisation* (1984), *The maintenance of unpaved roads in developing countries* (1987), *Freight vehicle overloading and load measurement* (1988), *Pavement management systems* (1987), *Traffic management and safety at highway work zones* (1989), *Road monitoring for maintenance management: Manual and damage catalogue for developing countries* (1990), *Dynamic loading of pavements* (1992), *Road strengthening in Central and Eastern European countries* (1993), *Road maintenance management systems in developing countries* (1994).
Likewise, on bridges and engineering structures, the following OECD reports are noteworthy: *Bridge inspection* (1976), *Evaluation of load carrying capacity of bridges* (1979), *Bridge maintenance* (1981), *Bridge rehabilitation and strengthening* (1983), *Durability of concrete road bridges* (1989), *Bridge Management* (1992).

Road infrastructure is thus a significant economic asset. The replacement values range from US$ 0.1 million per km for minor roads to US$ 1-7 million per km for interurban multilane motorways. The asset value of a road network is in the order of one half to three times the annual GNP (Gross National Product) of a country (3). The costs borne by road users are typically 10 times that amount, so the share of all road transport costs in the economy is in the order of 2-17 per cent of GDP (Gross Domestic Product): in advanced industrialised economies this may be as low as 2 per cent, but in developing countries it ranges up to 17 per cent of GDP. These costs are reflected in the prices of commodities and services.

Equally striking, and giving concrete meaning to a road agency's objective of 'serving the clients', is the significant share of user costs of total transport costs, the latter being the user costs plus the agency costs. As shown in Figure I.2 when the volume on a road is as low as 300 vehicles per day, a volume level exceeded on an average road in every OECD Member country, the road agency's maintenance and rehabilitation costs are merely a fourth of total transport costs. This statement is conditional to a big IF: if the resources committed to rehabilitation and maintenance are adequate to permit "optimal maintenance". This is an elusive concept and will be explored later in this report.

The development of a road infrastructure is a complex, multi-layered, high-stakes endeavor for any country. At each turn, crucial decisions must be made, and each involves expenditure of valuable resources. What can a Road Administration manager do to achieve economic efficiency in the provision of road infrastructure and in road user costs? How is he to determine priorities in highway improvement programmes? What road should be improved? When should the improvement take place? What should be done -- routine maintenance, resurfacing, or reconstruction? What is the benefit to society of another ECU or dollar spent on maintenance or rehabilitation, compared to another spent on new roads or improving alignments? Is it more economical to build a stronger pavement and spend more initially, thereby permitting the use of larger vehicles and saving on maintenance? Or, should the construction be done in stages, economising on the initial construction and paying more for maintenance and upgrading later on, when uncertainties about traffic growth will have been resolved? How much, or how little, should be spent to maintain paved roads, and how much to maintain and upgrade gravel roads? How long can maintenance be deferred in times of financial stringency? In short, what should be the highway budget for various purposes, where should the money be spent, and what exactly should be the road improvement action?

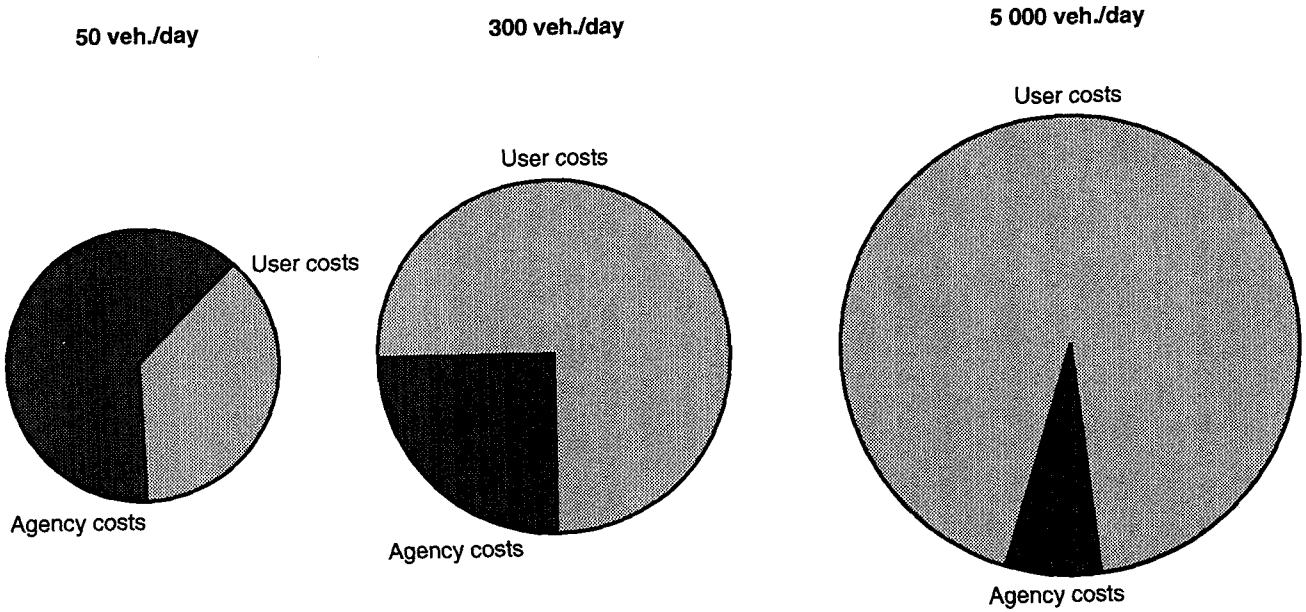
These are difficult but important questions. They are difficult not only technically, as is implied above. But because of the sophistication of the transport system, the extent of the road network, the complexity of relationships, and the political realities which are always present in road system management and decision-making, these are difficult questions from managerial point of view.

## I.4. MANAGEMENT ISSUES

### I.4.1. Three main activities and three levels of decision-making

A Road Administration's work encompasses the management, planning, and execution involved in the development, rehabilitation and routine maintenance of the road system.

Figure I.2. **Cost-shares under optimal maintenance**



From a managerial perspective and as pointed out in Section I.1, 'development' consists of new investments or marked improvements in road level of service; 'rehabilitation' denotes periodic resurfacing or strengthening of structural capacity; and, 'operations' means routine maintenance, snow and ice removal (in certain countries), care of roadside and service areas, guardrails, upkeep of traffic signs and markings, and other minor repairs -- potholes, shoulders -- to keep pavements smooth and safe to the motorists.

These three main activities are shown as columns in Figure I.3. This three-part division corresponds to the policy and budget making practices of most public infrastructure agencies. It also corresponds to the time horizon of decisions: development for long range ("new constructions"), rehabilitation for intermediate range, and operations for the short range and emergency interventions. In general it has been very difficult to make transfers of funds between operations, rehabilitation and investment budgets.

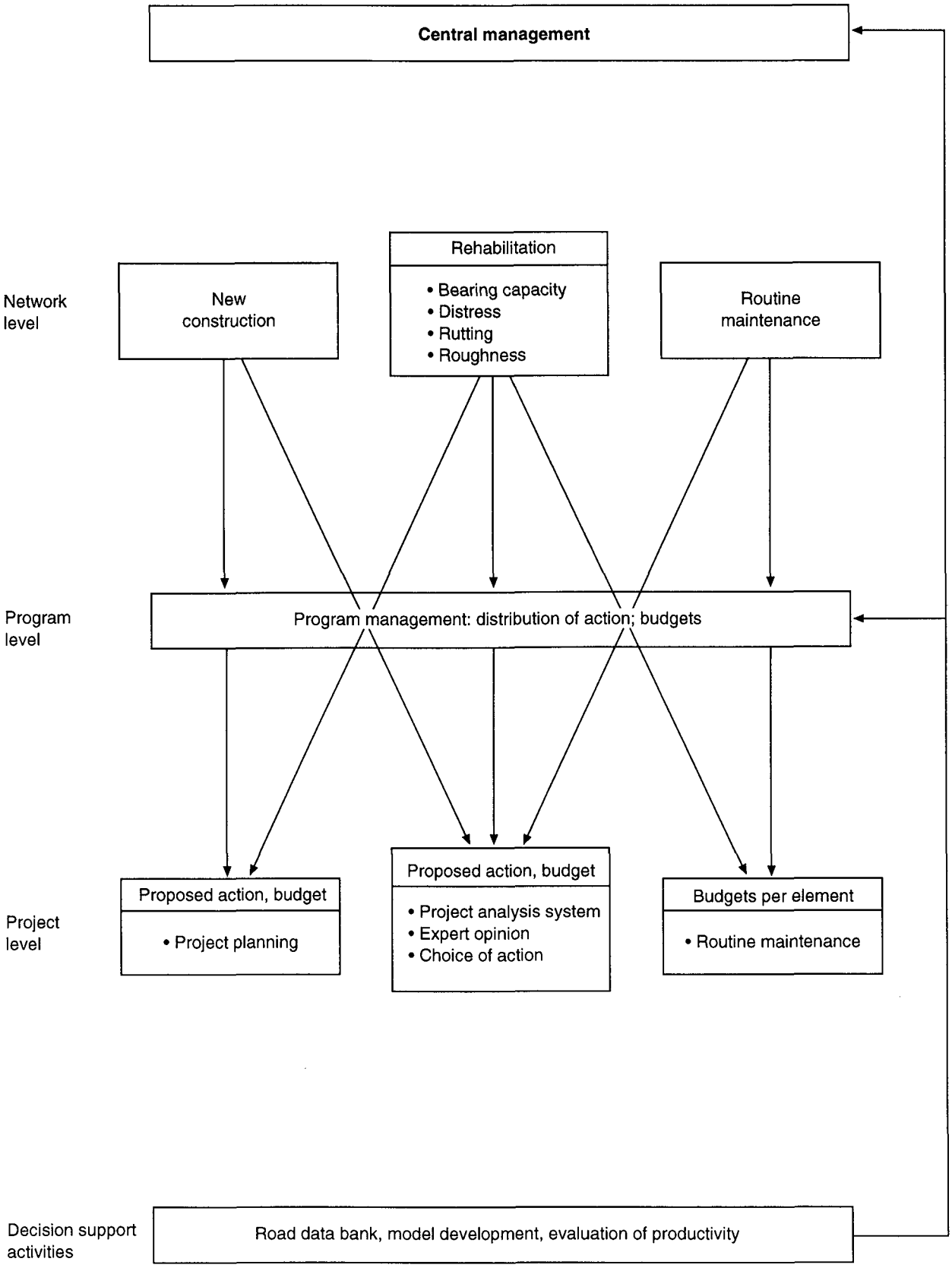
There are three administrative decision making levels in each road programme area. They are shown as rows in Figure I.3; this Figure illustrates in compact form the domain of resource allocation and distribution in a road administration. The first level -- the network level -- deals with policy and is usually exercised by the central management in the Administration or the Ministry. The third -- the project level -- is normally performed by the district office's engineers charged with execution of the policies including project design. The second level -- the programme level -- lies between the network and project levels; its function is to programme the actions over years to implement the policies set at the network level, in the form of a multi-year road programme.

### I.4.2. Road and Bridge Management System (RBMS) - An integrated comprehensive management tool

Road agencies routinely face both important policy questions and increasing demands upon the monies allocated to them. Among the most pressing policy questions confronting road agencies are road rehabilitation and maintenance:

- What is the optimal level of rehabilitation and maintenance funding nationwide, and what is the corresponding level of road surface condition;
- What choices of rehabilitation and maintenance actions and budgets will most effectively bring pavement conditions toward an optimal level in long term (in 5 years?, in 10 years?);
- How are limited funds best distributed between geographical areas of a country and functional classes of roads;
- What will happen to road surface conditions and structural capacity considering the present budget level;
- What is the excess user cost linked to the present level of highway budget;
- What is the excess cost to users and/or to the agency of the present maintenance/condition standards;
- How are funding requirements and user costs affected if certain roads are allowed to meet standards less than, or different from, the optimal.

Figure I.3. **The road agency - levels of decision-making and main programme areas**



Road agencies do not grapple with these questions in a vacuum; Central and District Administrations (or their equivalent) interact with the road agency in a variety of ways. To address some of these issues, some countries and organisations have implemented Pavement and Bridge Management Systems (4,5,6,7). However, as the environment surrounding road management has become more complex, various inputs, actions, outputs and decisions must be accounted for at all levels. Thus, an extension of these systems, the concept of a Road and Bridge Management System (RBMS) has emerged. It is based on an approach to determining road and bridge standards and expenditure priorities which is different from the often practised conventional management and planning approach.

As a decision-making tool, the RBMS has been designed to include all the components (boxes) of Figure I.3; development, rehabilitation, operations at the network and project levels. The RBMS is thus a modular system which includes pavement management, bridge management, (routine) maintenance management systems, and so forth. It provides decision support from management to engineering. An important feature of this system is that it uses **the same data source and the same overriding objective** (minimisation of total transport costs) in all modules even when the immediate purpose of the decisions is different (e.g. to apportion monies or to choose the most appropriate rehabilitation action).

From the management's point of view a useful Road and Bridge Management System would accomplish the following objectives:

(i) The system should assist in both long term and short term decision making in managing roads in all traffic classes[1] and with all kinds of surfacings;

(ii) The system should be both integrated and differentiated, capable of being separately applied at three different levels of highway management: policy (network), programme (project selection, prioritising, and timing), and project (specific action, design); the degree of detail should vary between the three levels;

(iii) The system should include actions from routine maintenance to resurfacing to rehabilitation to additions of new capacity[2];

(iv) The system should recognise the agency management style. For example, many agencies practice management by objectives (MBO). This means that goals, policies, standards and guidelines are issued from the Central Administration and decisions relating to choice of specific design, mode of execution, etc. are made at the local level;

(v) The system should have connections to other relevant agency functions (e.g. manpower planning, equipment, etc.);

(vi) The system should also serve the overriding goals of the agency relating to environment, economy, safety, technology, accessibility, and management accountability;

As these guidelines imply, the Central Administration is most interested in the policy (network) level and the Regional Administrations are most concerned with the project level. The programme level is of interest to both, but from different perspectives. For the Central Administration the road

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1 Road classification systems - administrative and functional - will be discussed later.

2 The framework to capacity addition decisions should ideally be multimodal.

programme is blueprint for achieving national goals; its performance will be evaluated on the basis of delivering promised services to users with the allocated monies. For Regional (or district) Administrations the road programme is a plan for execution; its mission is to deliver the products at minimum agency costs. In practice this means that the Central Administration is occupied with policy goals, and distribution of actions and budgets by functional road class[1] for each District Administration. The districts are occupied with the engineering and efficient implementation of these policies.

## I.5. RECOMMENDED APPROACH TO ROAD MANAGEMENT AND ROAD STANDARDS

As distinct from other management and planning approaches, the RBMS approach might be called an *engineering-economic approach*; its defining aim is to quantify and analyse the trade-offs between alternative courses of actions.

A comparison with two other prevalent approaches to analysing needs and priorities will dramatically demonstrate how the engineering-economic approach differs from other methods. With some variations within each, the other methods allocate and distribute resources on the basis of condition and available funds or when crisis occurs:

(i) **Needs based approach**: A road system is designed and built in accordance with physical standards set in relation to: a) perceived technical requirements for the life of the pavement structure; b) acceptable service levels for users (of riding comfort, safety, and speed); and c) affordable budget levels based on historical trends;

(ii) **Zero-maintenance approach**: A road system is designed and built with capital financing, and then operated with little maintenance until a failure occurs, when the road condition causes complaints, structures begin to disintegrate, or service is obstructed. Then expensive reconstruction work is undertaken to reinstate the facility under special programmes and financing arrangements. This is akin to crisis management.

In contrast the engineering-economic approach can be defined as follows:

(iii) **Engineering-economic approach**: A road system is designed and built in light of functional and technical standards that minimise total road transport costs to society, comprising the life cycle costs of facilities to the agency, the users and society. Standards, therefore, are viewed as an economic choice of what can be afforded rather than an imposed technical requirement, without sacrificing safety levels or environmental quality. When budgets are constrained, the tradeoffs between relaxing either design or maintenance standards are evaluated on the basis of long-term consequences of future higher costs for more expensive treatments such as reconstruction.

Existing management styles have often been typified by the first two approaches; the third is viable only after research work is done and applied. The aim of the engineering-economic approach is to

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[1] Sometimes by administrative road class, this issue is clarified and discussed from several viewpoints in Chapters II and III because it is intimately tied with how road administrations are organised and road funding arranged in different countries.

minimise the total road system costs, including user costs, within constraints as to technical characteristics and standards, and funding. It must be emphasised, as will later be explained in detail, that this optimisation process determines both the optimal agency budget and the optimal road standard.

The total transport costs comprise five interacting sets of costs: (1) construction, (2) rehabilitation and periodic maintenance, and (3) routine maintenance and system operation costs spent by the road agency, (4) the road user costs (which are primarily vehicle operating costs but also include some accident costs and time delay costs), and (5) external costs to society (including pollution, societal costs of accidents, and development and production benefits).

This discussion amplifies the earlier observation that making transfers between maintenance and investments budgets is extremely difficult. This suggests an important conclusion which was arrived at in the Group's deliberations and which need to be made explicit in the outset:

> *Resource distribution for "rehabilitation and maintenance"[1] should - indeed must - be done with a clear understanding about the trade-offs with "development investments". Roads and bridges should not be kept in good or excellent condition for their own sake, but for the sake of the users. Thus, there may be instances in which disinvestment, or a lack of rehabilitation or maintenance, may be a wise action, obviously within the legal constraints for safety and environment, allowing for redirection of these funds to new facilities where they better satisfy the needs of the users.*
>
> *Today, road maintenance operates with a new concept. According to this concept, the objective of road maintenance is to preserve the value of the road investment in the changing environment which includes the road, the road milieu, the processes by which roads are improved; simply put: the objective of road rehabilitation and maintenance is to preserve the value of the investment* ***and*** *to improve the man-made and natural environment.*

This conclusion sets new requirements, discussed and elaborated in this report, for decision-aiding systems such as the RBMS, the Road and Bridge Management System.

## I.6. ORGANISATION OF THE REPORT

Chapter I has opened this report with an introduction to the increasingly complex universe of road management. That both management as well as technical, social, political and economic factors enter into the decision making process within road administrations at three levels -- network, programme and project -- mandates the application of a more effective Road and Bridge Management System as an analytical approach.

In Chapter II includes a brief survey of road systems, funding practices and organisational structures found in several OECD Member countries. The results show a variety of practices but also marked similarities, enabling the concepts presented in the report to have validity independent of national borders.

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[1] Routine maintenance, which also can be analyzed in the framework proposed, was seen to lie outside the Group's mandate and is not addressed in the present report.

Chapter III reviews the road programme preparation, allocation and fund distribution processes. It explores the delicate issues of equity in funding, of competing geographic areas, and competing classes of roads. Present methods of financing are also reviewed in this context because they are intimately tied to the distribution of funds between regions and types of roads.

Chapter IV contains a discussion of the analytical background needed to support the engineering-economic approach to road management. Simple graphs are used to illustrate the most important concepts involved in optimising road rehabilitation and maintenance objectives and associated budgets.

Chapters V-VII examine the components for making the engineering-economic approach operational: calculation of benefits and costs in Chapter V; characterisation and measurement of road condition in Chapter VI; and, in Chapter VII, a discussion of environment and other externalities for which there exist no market at present but which yet exert a decisive influence on the road fund distribution process.

Finally, Chapter VIII presents a recapitulation of the 'best practices' in the resource allocation/distribution process for road rehabilitation and maintenance, and Chapter IX gives the 'Commandments' for implementing the 'best practices' in resource allocation for road rehabilitation and maintenance works.

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# CHAPTER II

# INSTITUTIONAL SETTINGS OF ROAD ADMINISTRATIONS

## II.1. BACKGROUND

In order to provide the background for the Expert Group's deliberations, a survey was undertaken of Member countries' road organisation, management, and resource allocation/distribution processes. This Chapter presents the Institutional settings in Member countries as reference for the findings presented in Chapter III "Allocation and Distribution of Funds between Road Classes and Road Improvements" and Chapter VI "Characterisation and Measurement of Highway Condition". The data included in this Chapter are based on replies to a questionnaire sent to OECD countries participating in the study.

All of the data set out in this Chapter are considered in light of three distinct frames of reference.

The first frame of reference deals with the allocation and distribution of the total resources available within the road sector for investments, rehabilitation and maintenance.

The second frame concerns the decision levels at which the allocation and distribution of funds are made. In spite of the differences between countries, this is a general issue relevant at overall **governmental level** (allocation between different public sectors and between different transport sectors) and at the various **road administrative levels**. The individual allocation and distribution methods reflect the political and administrative organisation prevailing in each country. Subsumed in this discussion are the methods through which resources are distributed by the responsible administrative department, i.e. to regions, subnetworks[1] or specified road or bridge projects. In the latter case the distribution will be influenced by the road classification system used in each country.

The third frame of reference, finally, takes into account the influence of the structure of financing road investments, rehabilitation and maintenance on the resource allocation and distribution process.

Key actors in the allocation and distribution process are: Central and District Administrations (or their equivalents); Ministries of Finance and Transport (or their equivalents); and applicable local

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[1] A subnetwork is a well-defined part of a national network. For example, a subnetwork could be all Main Roads, or all Local Roads, or a network of a region, etc.

government organisations. These actors interact in matters dealing with highway resource allocation and distribution with consequences for, or imparted by:

- -- Transport (or Construction, Equipment, Public Works) Ministry obligations and its relation to the Road Administration;
- -- The Road Administration;
- -- Definition and classification of the road network and the distribution of responsibilities;
- -- Skill and competence within the planning unit responsible for the preparation of multi-year plans for maintenance and rehabilitation;
- -- Criteria and models used for preparing the multi-year plans;
- -- System used for monitoring (and evaluating) the maintenance and rehabilitation activities;
- -- Restrictions, financial and legal, in distributing resources.

## II.2. MAIN ISSUES

The common base for the presentation of data in this Chapter is the road classification in Member countries and a description of the road network system.

Road classification can be made in a number of ways. In this study the basic classification is made from a **functional** point of view. Roads are classified as serving international, national, regional or local functions; in some cases classification is also influenced by existing road standard (for instance, motorways). A second method of classification is based on **administrative criteria** (for instance federal roads versus State, county or city roads).

Based on the road classification a description and use of the road network is presented. The description is made in terms of:

- -- **length of the subnetwork** in each classification (in km),
- -- **traffic volume** (vehicle km travelled by car and truck on different road classes),
- -- **traffic growth** (actual and forecast), again by road class.

The traffic growth figures are given as actual growth (in most cases for 1990 or 1991) and forecast for future growth (1992 - 1996). Consistent with the traffic load data, traffic growth is given for cars and trucks separately (Figures II.1-4). From this basic information on roads and traffic, an outlook is made towards the two main issues of this Chapter, **administration and organisation**, and **funding and taxation**.

The first issue, then, deals with the organisational structure in Member countries and the delegation in decision making, regarding allocation and distribution of resources for road maintenance and rehabilitation. The question of delegation in decision making is in this case presented in terms of planning responsibilities at different levels in the organisation as well as for different road categories.

The second issue, dealing with funding road maintenance and rehabilitation, is closely related to the issue of taxation which in this case concentrates on the influence resource collection may have on the way resources are allocated and distributed.

## II.3. BASES FOR RESOURCE ALLOCATION AND DISTRIBUTION IN OECD COUNTRIES

The source for findings regarding resource allocation and distribution is a compilation of answers to a questionnaire from fifteen OECD Member countries involved in the project. The fifteen countries are:

- Canada (Ontario only)
- Finland
- France
- Germany
- Great Britain
- Italy
- Japan
- Netherlands
- Norway
- Portugal
- Spain
- Sweden
- Switzerland
- Turkey
- United States

### II.3.1. Road lengths and traffic

The public road network in a country can be concisely characterised by its length and usage. The numbers in Table II.1 give a clear overview of the magnitude, scale and variance among participating countries. The public road network length in OECD countries varies from 3 million kilometres to 20 thousand kilometres, and the overall average traffic volume on that network from one thousand to five thousand vehicles per day. This wide variance explains the -- expected and understandable -- variant road management practice, but is at odds with the surprising communalities.

The road lengths in the fourteen countries for functional and administrative road classifications are given in Annex A along with the traffic volumes.

### II.3.2. Traffic growth

The actual annual traffic growths (in 1991) have only in a few cases been estimated for each functional road class. In many cases figures pertain to selected functional road classes. In other cases traffic growth figures are related to a slightly different classification. In Sweden, for instance, the traffic growth is related to "European roads" (E-Roads); "National roads", "Primary County roads" and "Other County roads", i.e. an administrative classification.

The traffic growth in 1991 for the road network as a whole is shown in Figures II.1 and II.2 for cars and trucks, respectively, in the OECD countries.

The forecast figures for annual traffic growth, requested for the period 1992-1996, are in fact for many Member countries predictions for somewhat different time periods; the forecast traffic growth trends in Member countries were annualised and are shown in Figures II.3-4 for cars and trucks, respectively. These forecasts are often accompanied by reservations about their reliability and the dependency of predictions on the economic situation is noted. Nonetheless, there is a convergence of traffic growth trends at 3.5 per cent per annum.

Table II.1. **Road length and traffic loads (1990 or 1991)**

| Country | Length of the road network (1000 km) | Vehicle kilometres of travel (million) | Average daily volume (veh/day) |
|---|---|---|---|
| Canada (Ontario) | 156 | 73,000 | 1280 |
| Finland | 77 | 28,000 | 1000 |
| Germany | 226 | 360,000 | 4360 |
| Great Britain | 360 | 412,000 | 3100 |
| Italy | 602 | 327,000 | 1490 |
| Japan | 1,123 | 629,000 | - |
| Netherlands | 118 | 96,000 | - |
| Norway | 89 | 28,000 | 900 |
| Portugal | 20[1] | 19,000[2] | N.A. |
| Spain | 156 | 110,000 | 1930 |
| Sweden | 206 | 62,700 | 830 |
| Switzerland | 28 | 43,000 | 4210 |
| Turkey | 360 | 26,000[3] | N.A. |
| United States | 3,048 | 3,375,000 | 3030 |

1. Urban, private and some of the local roads (rural) not included.
2. Only about 9,500 km of State roads data available.
3. on Main roads I

In general it is known from travel trends folklore that traffic growth or decline follows the growth or decline of the Gross National Product (GNP). As shown in Figure II.5, car traffic appears to grow a bit faster than GNP and truck traffic a little slower. Besides the macroeconomy, car traffic is also strongly influenced by car ownership which is expected to show a continued upward trend in the OECD countries (Figure II.6).

The dilemma of increasing car ownership and traffic, economic growth and the diminishing resources available to the road and traffic sector culminates in dilemmas managers experience in relation to resource allocation and distribution. This situation is aggravated by increasing consumer expectations with regard to traffic safety, road condition, and other user services (Figure II.7).

### II.3.3. Administration/organisation

Distinctive administrative structures in Member countries provide the mechanisms by which resources are allocated and distributed to a country's road system. The great variety of organisational structures among OECD countries have understandably evolved in response to the needs embedded in the history of the country. No taxonomy or analyses of these often unique organisational structures are

Figure II.1. **Traffic growth (cars) 1991 (%)**

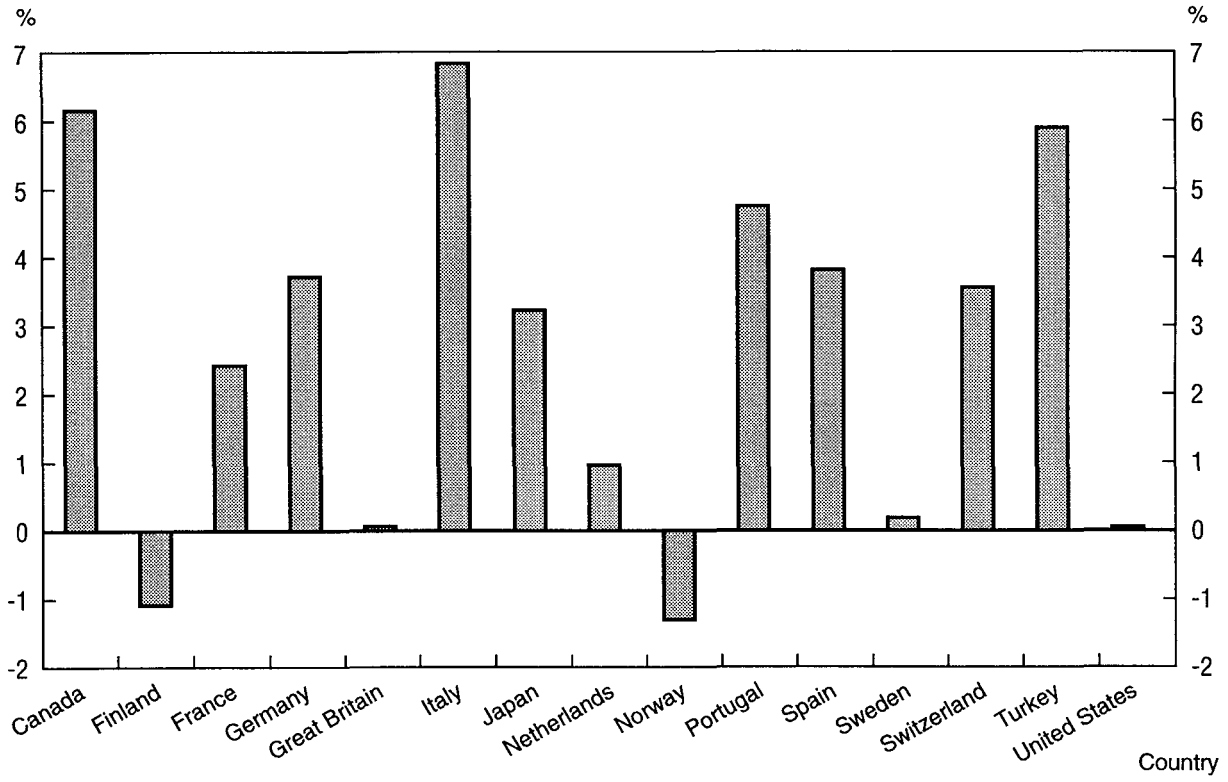



Figure II.2. **Traffic growth (trucks) 1991 (%)**

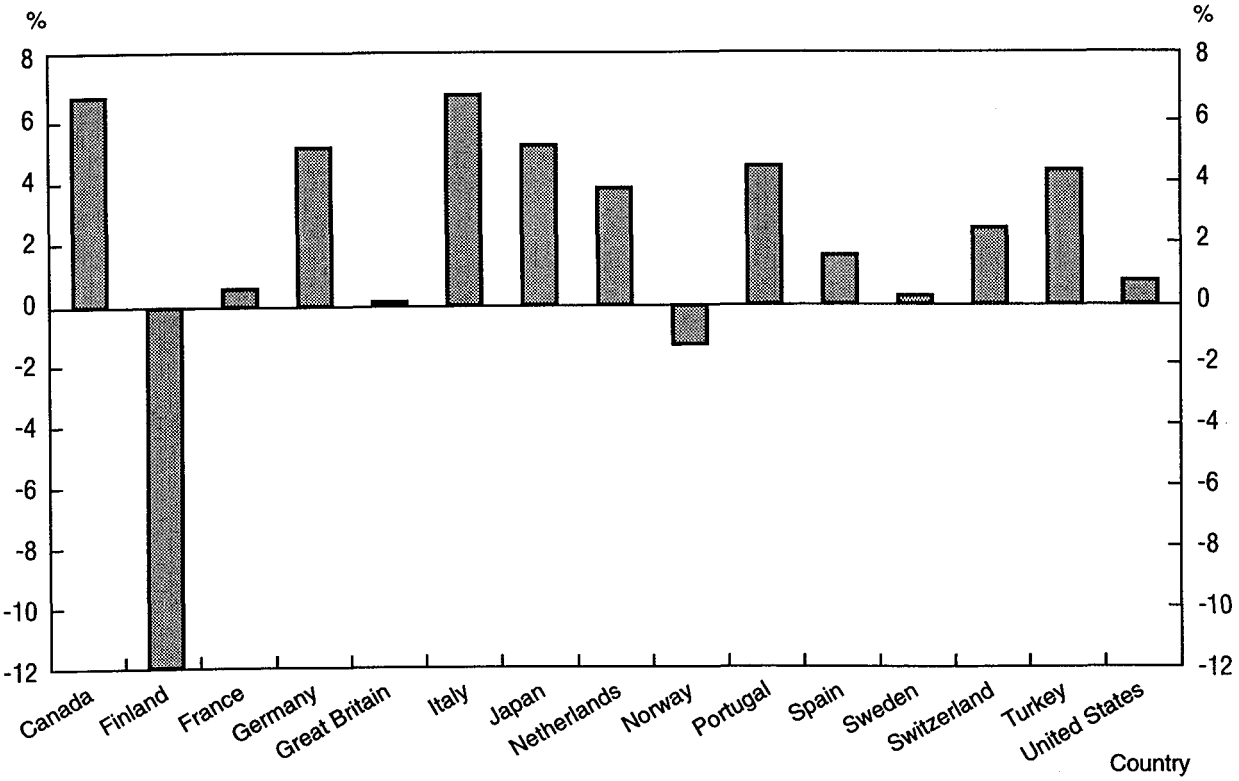


Figure II.3. **Estimated annual traffic growth (1992-1994) (cars, %)**

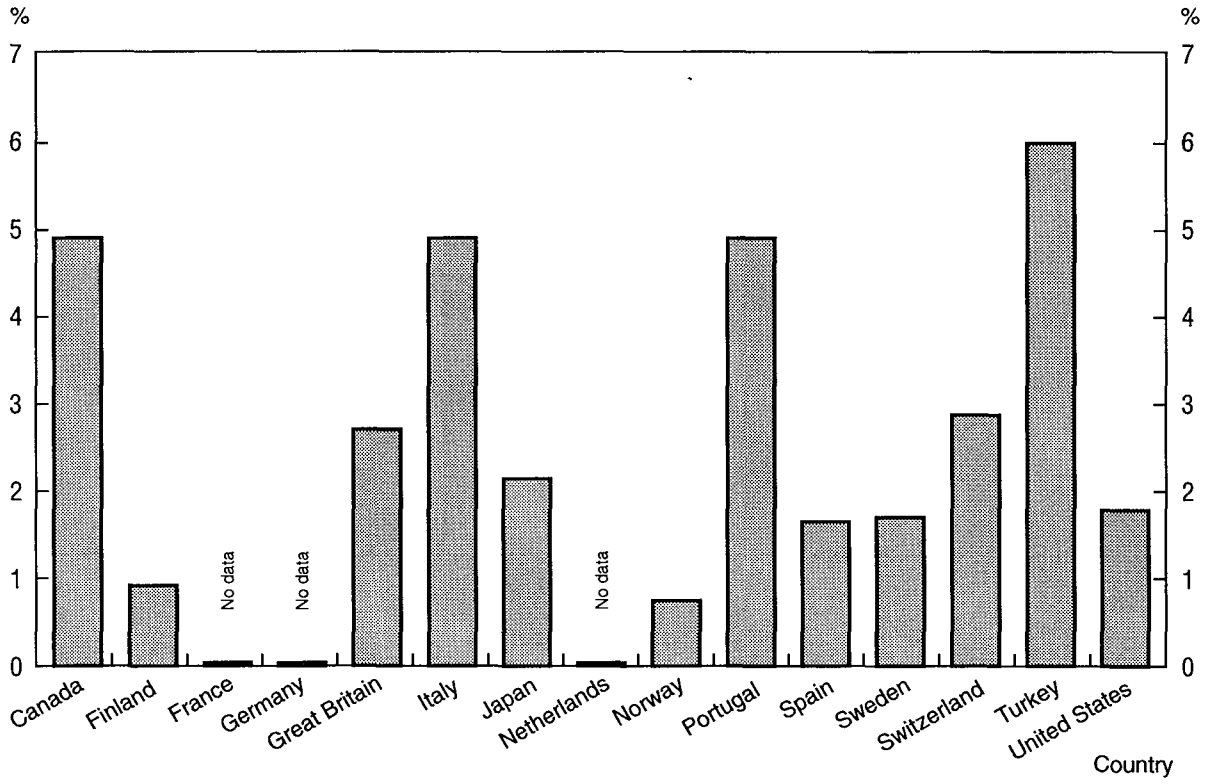



Figure II.4. **Estimated annual traffic growth (1992-1994) (trucks, %)**

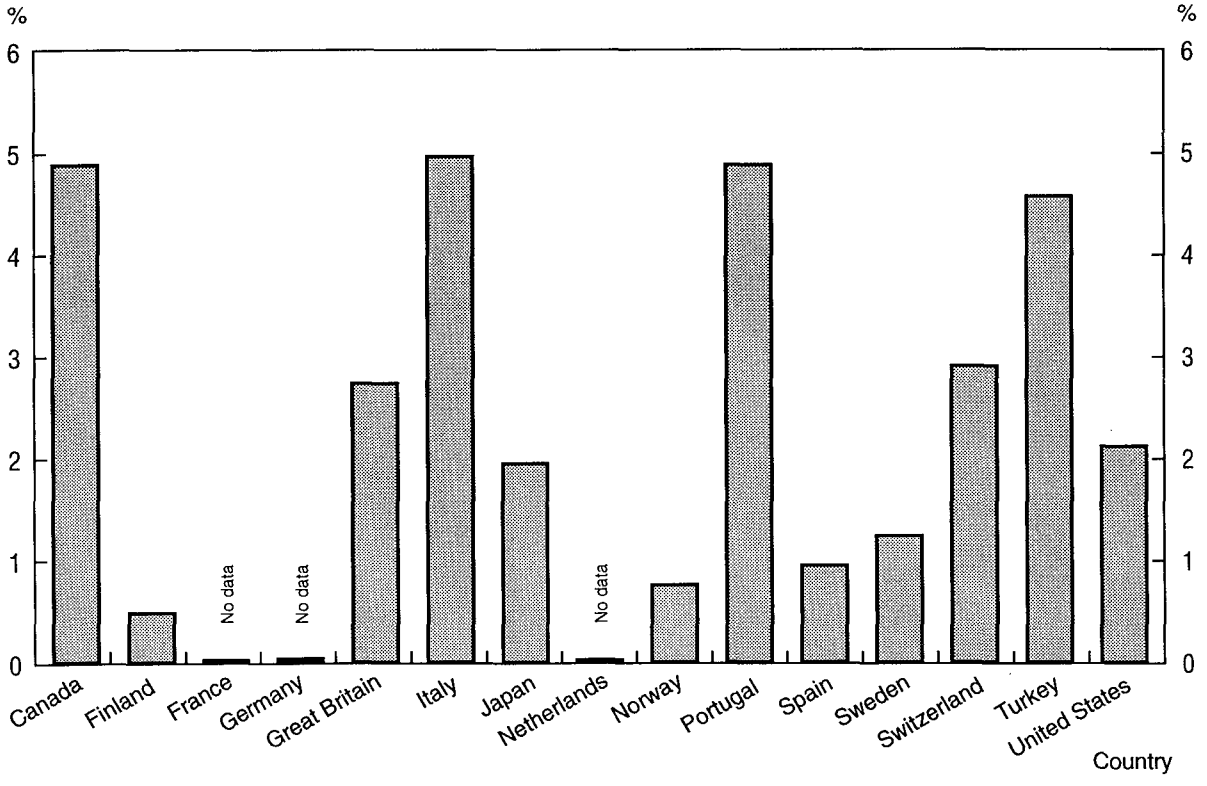


Figure II.5. **Typical relationship between GNP and traffic growth (USA)**

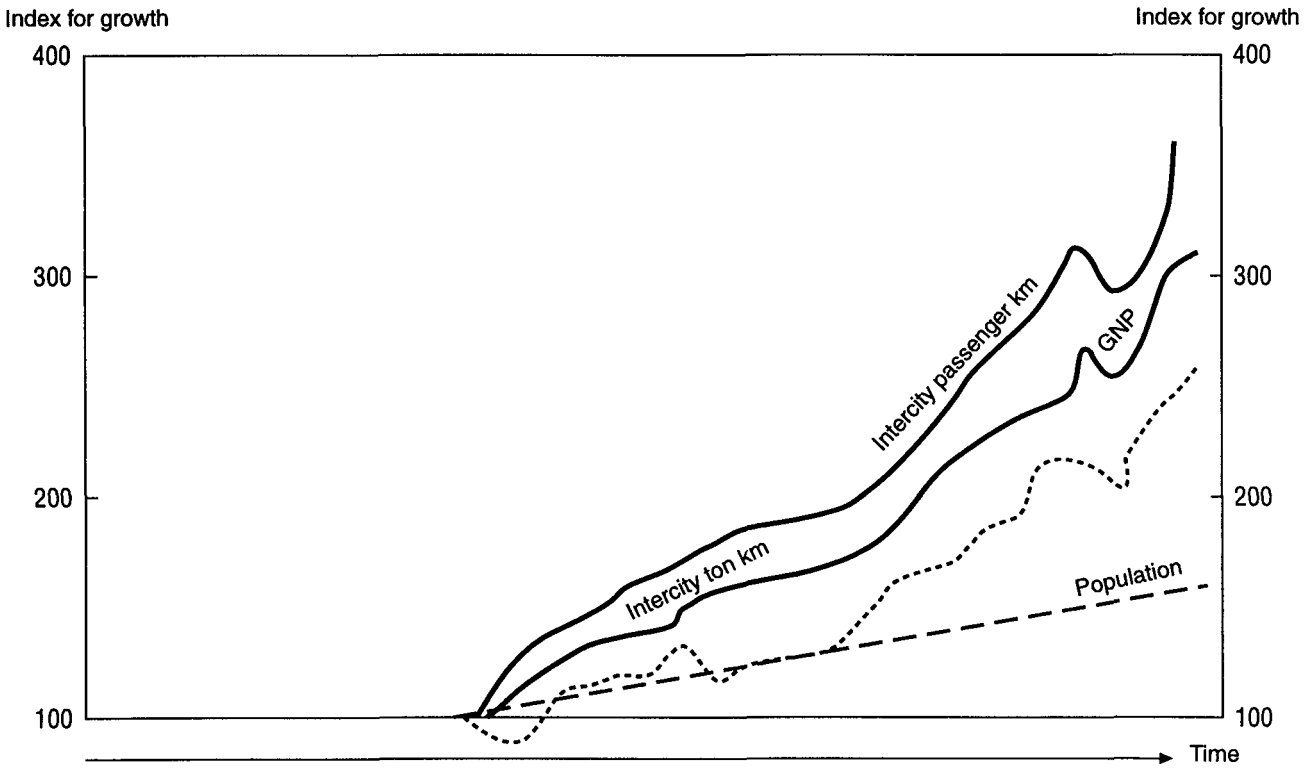



Figure II.6. **Projected growth in car ownership in selected countries**
Number of four-wheeled vehicles per 1000 persons

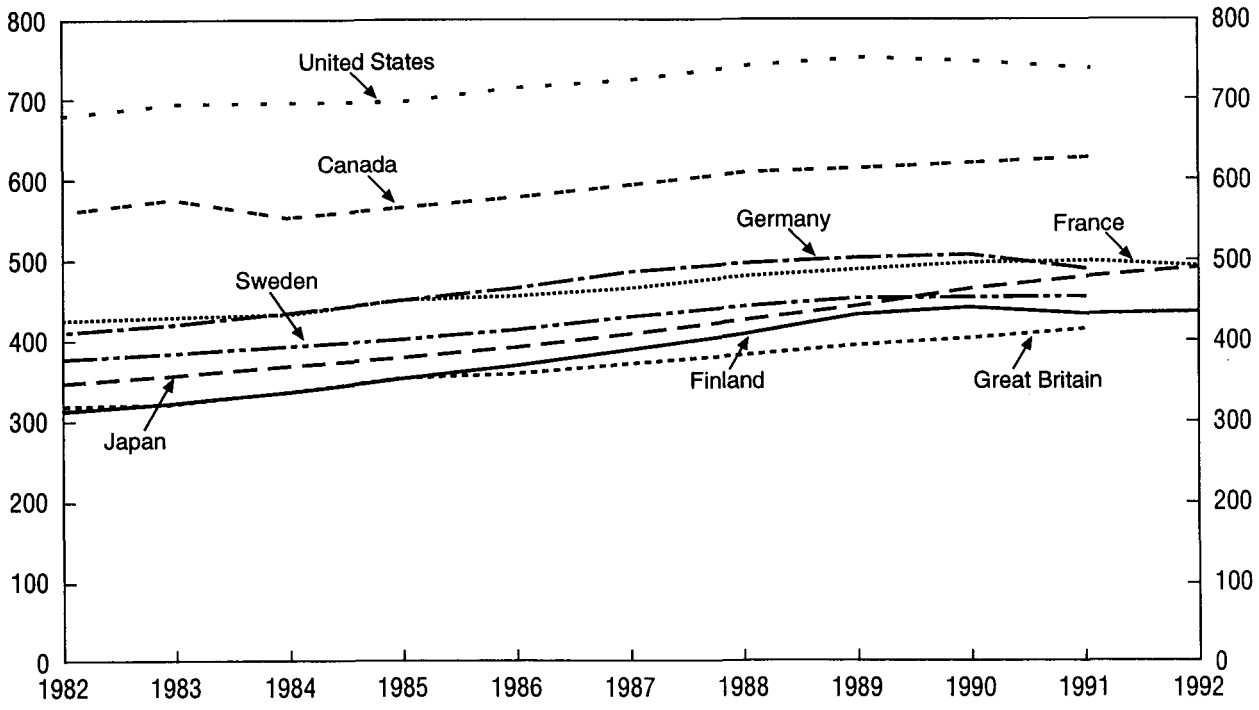
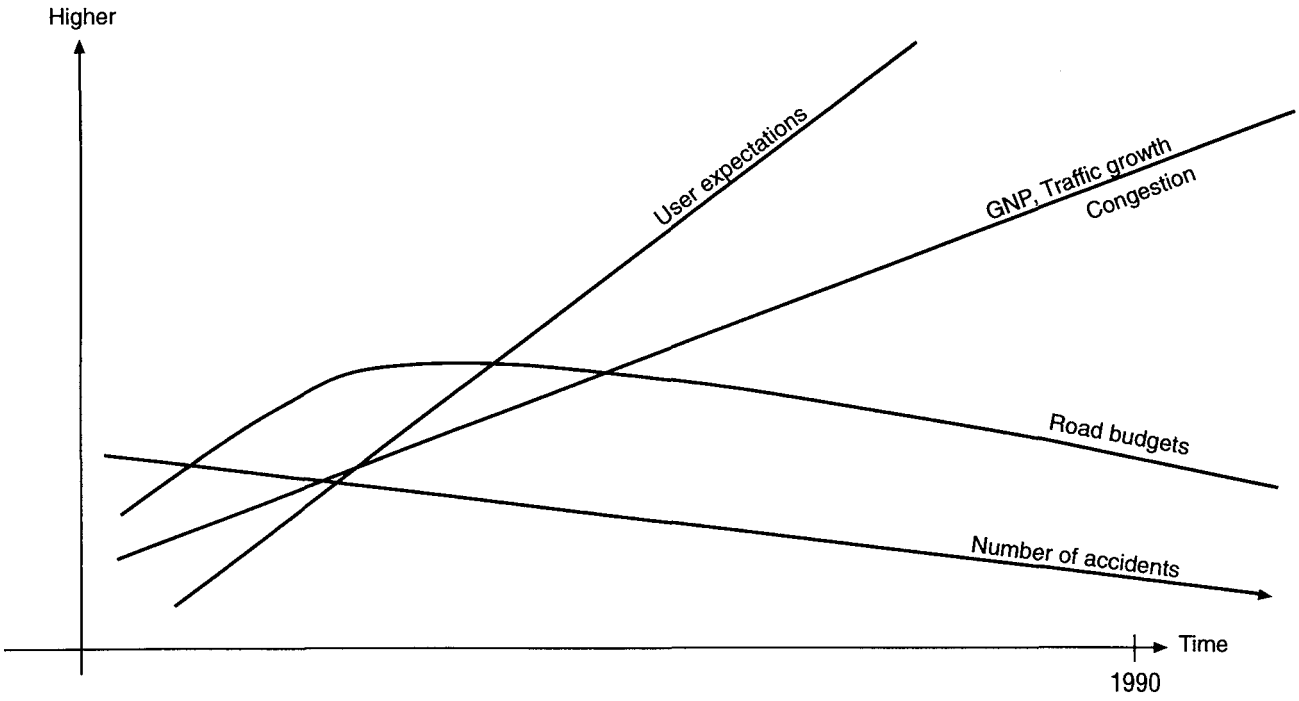


Figure II.7. **Diagrammatic Representation of Past Trends - Reality vs. Expectations**




attempted[1]. Suffice it to say that in each country there exists a hierarchy of decision-makers and decision levels. A more detailed description of this hierarchy follows in Chapter III.

From a road manager's point of view the important distinction between structures is whether each functions at network and project levels. At the former level, funds are allocated and distributed to subnetworks and to a range of actions on that network; at the latter, funds are allocated and distributed to support project specific action decisions. The former have wide political, social, environmental and economic impacts, and are often impinged upon by limited interests (economy vs. environment); the latter have limited social, economic, environmental and political consequences, and are often accompanied by wide and consuming interests (e.g. the 'nimby' -- not in my backyard - phenomenon).

In order to gauge and understand the allocation/distribution procedures in Member countries a number of questions were formulated and put forward in the questionnaire. These questions and the responses to them dealt with:

-- Allocation of road budget;
-- Division of road budget;
-- Choice of road sections and type of actions;
-- Responsibility for road maintenance and rehabilitation;
-- Responsibility for multi-year plans;
-- Criteria in preparing the multi-year plans.

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[1] Present organisations of road administrations in the participating countries is shown in Annex B.

These dimensions of the resource allocation/distribution process will be elaborated later in this chapter and the other chapters that follow.

### II.3.4. Present funding

Allocation and distribution of road funding is often -- and this study is no exception -- related to functional and/or administrative road class and type of action. The road class related information presented below refers to 1991 data (in most cases and to forecasts for the five year period 1992 - 1996).

The funding in the participating fourteen OECD Member countries is illustrated in Table II.2, in Million US dollars per 1000 km by administrative road classes in 1991 (Italy 1989 and the US 1990). It is seen that there is a wide variance. This may be due to the differences in road classification, terrain, costing and extent of environmental protection, or be merely a reflection of some country specific unusual circumstances in 1991.

Table II.2. **Funding and road length (millions US$ per '000 km)**

| | Federal | State | County/City/ Rural&Other/ Prefecture | Total |
|---|---|---|---|---|
| "Canada" | | 29.1 | 9.4 | 12.2 |
| Finland | -/- | 15.6 | 12.0 | 13.9 |
| Germany | 105.7 | 71.3[1] | 39.9[2] | 88.4[1,2] |
| Great Britain | -/- | 253.9[3] | 14.4 | 23.9 |
| Italy [4] | 366.7 | 26.1 | 7.7 | 12.7 |
| Japan | -/- | 483.0 | 41.0 | 49.0 |
| Netherlands | 100.0 | -/- | -/- | -/- |
| Norway | -/- | 56.4 | 14.6 | 27.1 |
| Portugal [5] | -/- | 43.5 | -/- | -/- |
| Spain | 21.4 | 5.1 | 4.6 | 7.1 |
| Sweden | -/- | 48.6 | 6.0 | 9.4 |
| Switzerland | 600.0 | 72.2 | -/- | 56.3 |
| Turkey | (Total for all categories 10.1) | | | |
| United States | 2.4 | 34.2 | 20.1 | 24.5 |

" " Canada stands for Ontario
1. Data refer to Lower Saxony
2. Data refer to Lower Saxony and City of Munich only
3. Motorways and trunkroads
4. "Federal" for Italy concerns "motorways"
5. Figures only given for Federal roads

A summary of funding by type of action, (Million US $ 1991, the US 1990) is shown in Table II.3 and the distribution of funding for New Construction, Rehabilitation, Periodic and Routine Maintenance and Miscellaneous is shown in Figure II.8 for thirteen of the fourteen countries. The total road funding as a percentage of GNP is shown in Figure II.9 for twelve countries.

Table II.3. **Funding by type of actions (millions US$)**

| | New construction | Rehabilitation | Periodic maintenance | Routine maintenance | Miscellaneous |
|---|---|---|---|---|---|
| "Canada" | 54 | 234 | 11 | 220 | 158 |
| Finland | 411 | 196 | 234 | 120 | 238 |
| Germany[1] | 4 194 | 2 419 | - | 146 | 211 |
| England & Wales | 3 480 | 1 414 | 845 | 529 | 640 |
| Italy | no data available | | | | |
| Japan | 28 961 | 3 507 | -[2] | -[2] | 829 |
| Netherlands | 390 | 320 | -[3] | -[3] | 80 |
| Norway | 1 169 | 133 | 33 | 156 | 308 |
| Portugal[4] | 705 | 83 | 14 | 23 | 44 |
| Spain | - | 459 | -[5] | 364 | 224 |
| Sweden[7] | 397 | 172[6] | 323 | 351[8] | 187[8] |
| Switzerland | 985 | 1 065 | 505 | 1 138 | 360 |
| Turkey | 2 128 | 33 | no data | 46 | 24 |
| United States | 5 810 | 12 117 | -[9] | 7 001 | 6 772 |

"" Canada stands for Ontario
1. Federal trunk roads only
2. Periodic and Routine maintenance are included in Rehabilitation.
3. Periodic and Routine maintenance are included in Rehabilitation.
4. Figures for ferries (63 M US $) are included.
5. Periodic maintenance is included in Routine maintenance.
6. Rehabilitation includes measures for increasing bearing capacity.
7. Figures include only funding for state roads (national roads and county roads).
8. More than half of the budget is related to new wearing courses/new pavements. The main part of the rest is for winter road operation.
9. Preventive maintenance is included in the first two categories.

Figure II.8. **Distribution of road funding**

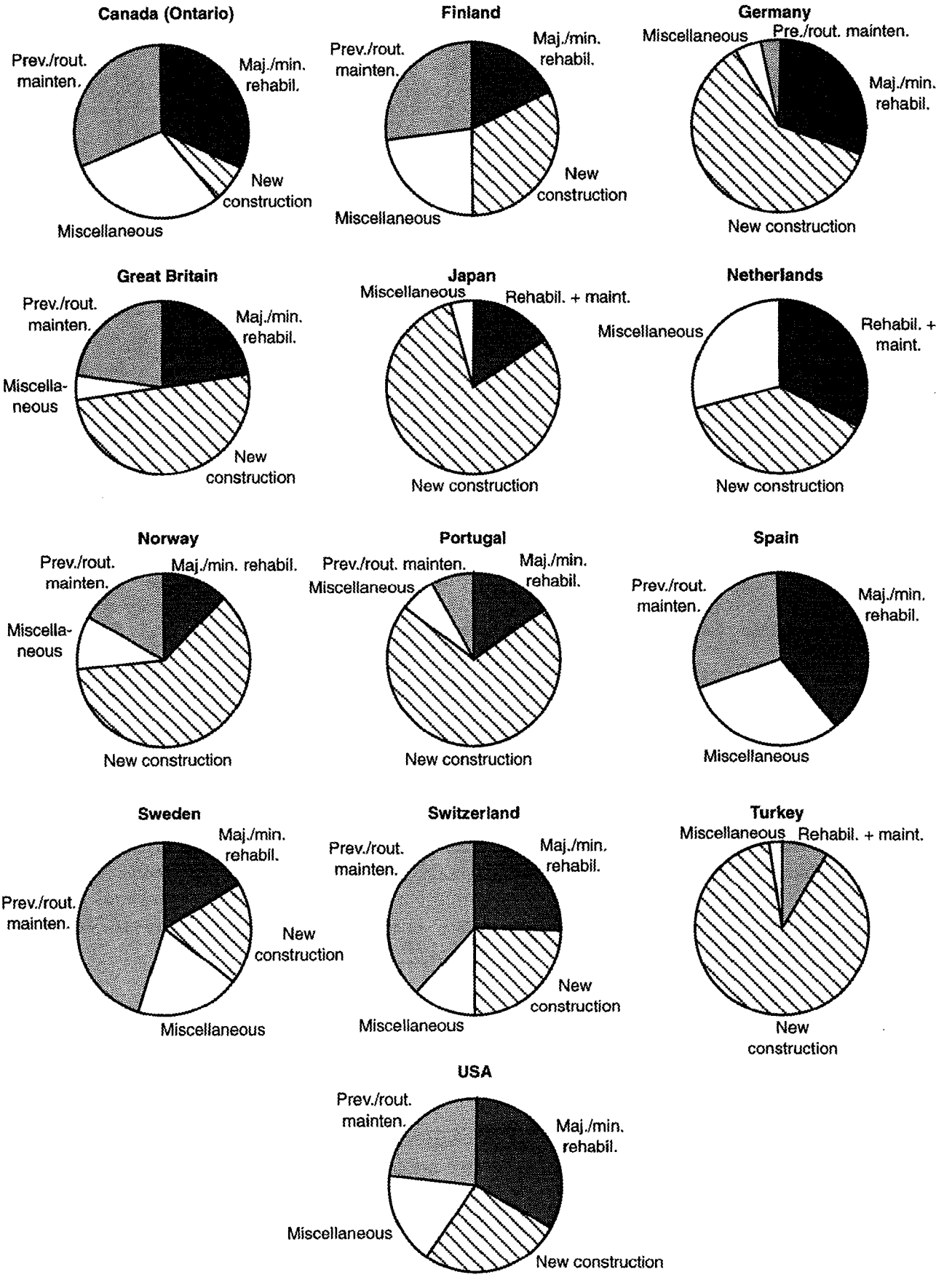
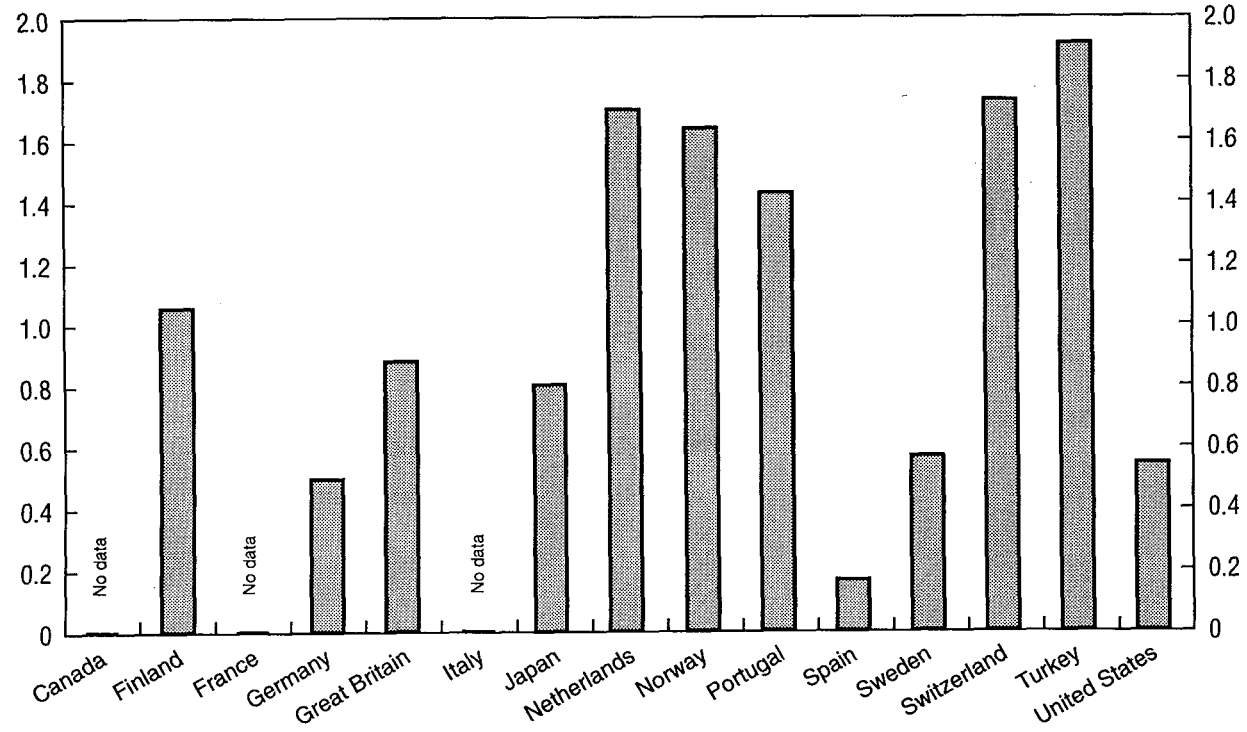


Figure II.9. **Total road funding - % of GNP**




Again, the pie-charts in Figure II.8 confirm what already was known from the preceding tables and graphs: the OECD Member countries have different kinds of road organisations, apparently face different specific issues, and tackle these issues in their own distinct fashion. The basic data shown in this Chapter generate the following conclusions:

i. the OECD Member countries practice different policies in distributing road monies to road classes;
ii. the OECD Member countries have different criteria and different policies in distributing road monies to activities (investment, rehabilitation, operation) and actions;
iii. the OECD Member countries allocate a different portion of their GNP to roads.

It was observed that the necessary prerequisites for a detailed scrutiny and analysis do not prevail for the judicious examination of data and comparison of information from different countries. The main obstacle is the lack of data from some important European countries and the conspicuous differences in data accuracy for the participating OECD countries. In this respect the differences between countries could give an impression that the differences are greater than they in fact may be.

It would be beneficial to OECD Member countries if rules for classifying roads **functionally** (not administratively, because of widely differing administrative structures in the Member countries) were compatible and consistently applied, and data collection was based on similar principles to permit comparisons between countries.

The substantial differences in resource allocation and distribution in Member countries raise the question of whether the conclusions proposed above are the result of calculated actions on the part of the decision-makers and are a true reflection of the differences between the countries, or, if the numbers and figures merely reflect historical trends and not rational decision-making in response to real world problems.

The information collected also raises the question of whether or not the Member countries would benefit from improved resource allocation and distribution methods of road funds between road classes, between major activities of investment, rehabilitation and maintenance[1], and between regions of country. In order to accomplish this, consistent but parsimonious methods of data collection need be agreed upon and developed to be used together within a flexible but common analytical framework.

The proposal in this report for "best practice" in resource allocation to road rehabilitation and maintenance aims to contribute toward such an ambitious objective, in addition to reporting on the current practices in Member countries.

## II.4. TYPES OF ROAD CLASSIFICATIONS AND ROAD ORGANISATIONS

Although the fifteen countries did not present fully conclusive and comprehensive answers to all questions, the information they did provide can be used for some analysis. Combined with data on population and population density, and GNP, extremely useful data on road classification, road organisations, resource allocation and distribution methods in different countries can be presented. The comparisons will be made on aggregated data and in general terms rather than focusing on each country individually, excepting to illustrate a point or principle.

Of particular use is an examination of the road classification system and the types of road administration organisations used in OECD countries. These impact upon the resource allocation/ distribution methods used and discussed at length in Chapter III.

### II.4.1. Road classification

Most of the countries use a functional as well as an administrative road classification. The most common **functional road classification** divides the roads into the following classes:

- Motorways;
- Main roads (sometimes divided into two sub-classes I and II);
- Collector roads;
- Local roads;
- Urban roads (not considered in this report);
- Private roads.

Some countries aggregate two or more classes in the presentation of funding and of other data. Canada, for example, presents interpretations of each functional road class and thereby creates a link between the functional and administrative road classifications. Thus, in Canada, "Motorways" are understood as "Provincial Freeways", "Main roads" as "Provincial Arterial Highways" and "All other Provincial Highways"; "Collector roads" as "County roads"; "Local roads" as "Township roads"; and "Urban roads" as "Roads for separated Cities, Towns and Villages". Turkey uses a classification which can be seen as a combination of a functional and an administrative classification. Thus roads there are

[1] Or "development", "rehabilitation and maintenance" and "operation", as defined in Chapter I.

classified as motorways, state roads, provincial roads, tourist roads, village roads, forest roads and urban roads.

The **administrative road classification** most commonly used has the following classes:

-- Federal (national) roads (when relevant);
-- State/Provincial roads;
-- County roads;
-- City roads (not considered in this report);
-- Rural community roads;
-- Other roads (when relevant).

Data on funding are more often based on an administrative classification than on a functional one. This may be due to the way funds are either collected or distributed. Federal-State classification is relevant only in countries where Federal and State governmental levels exist. In Italy an autonomous body (ANAS) is responsible for national roads and motorways. Consequently Italy presents "Motorways" as the highest road administrative class.

As already mentioned it would be desirable for the OECD countries to establish consistent and compatible concepts and procedures for functional classification of roads. A generic model is shown in Table II.4.

Table II.4. **A functional classification of roads: percentage ranges of vehicle kilometres of travel and kilometres of roads in each system**

| SYSTEM | RANGE (%) RURAL | | RANGE (%) URBAN | |
|---|---|---|---|---|
| | **Veh-kms** | **Kms** | **Veh-kms** | **Kms** |
| PRINCIPAL ARTERIALS (motorways and principal arterials) | 40 - 60 | 3 - 4 | 40 - 60 | 5 - 10 |
| PRINCIPAL ARTERIALS plus MINOR ARTERIALS | 45 - 75 | 7 - 10 | 60 - 80 | 15 - 25 |
| COLLECTOR ROADS | 20 - 35 | 25 - 30 | 10 - 15 | 10 - 15 |
| LOCAL ROADS | 10 - 20 | 60 - 75 | 10 - 30 | 60 - 80 |

## II.4.2. Road network description

The road network description, in terms of road lengths for different road classes, is given by almost all the countries. The descriptions allow for comparisons of funding related to road lengths. The funding comparison was best made on an aggregated level (total funding compared to total road length).

Most countries presented data on annual traffic growth. The differences between the countries are tangible. While declining tendencies are noted in Finland and Norway, growth is noted for Canada, Germany, Italy, Japan, Netherlands, Portugal, Spain, Sweden, Switzerland and Turkey. Great Britain and the United States present almost unchanged levels.

Official forecast figures, in terms of expected annual traffic growth, are presented by twelve of the fourteen countries. The differences between the twelve countries may be of only limited interest. More noteworthy is the fact that all the eleven countries expect a traffic growth - despite the present economic recession in Europe.

### II.4.3. Administration structures

The description of administration/organisation and the responsibility for allocation/distribution of the road budget can easily develop into a battle of words. To avoid this we put forward the general notion that it is the politicians in democratic societies that have the ultimate responsibility for funding/taxation and the allocation of resources. They purposefully use structured administrations for the distribution and transfer processes. These structures are basically the same in the Member countries, although they differ in terms of the number of administrative levels (federal, state, etc) and in the interaction and delegation of authority between levels.

Even though organisations have wide variety in their structures (see Annex B) two main types can be detected: the line organisation and the fractal organisation. In the former responsibilities are divided functionally -- construction, maintenance, planning and design, administration. This is the most common type of organisation. In this model the Road Agency has a centralised line organisation and decision making structure. The regional organisations, also organised along functional lines, are executing arms of the programmes made by the central planning and programming staff. In the fractal organisation model, delegation of responsibility is comprehensive; both the Central Administration[1] and the Regional Administrations, which again are responsible for executing the national programmes and policies, have *comprehensive responsibility regardless of the size of the region* to creatively manage all their outputs. These latter types of organisations are found in Sweden and Finland.

### II.4.4. Methods for allocating and distributing road budget

As noted, the responsibility for resource allocation for road maintenance and rehabilitation rests with politicians within national, regional and local governmental jurisdictions. On the national level the main responsibility for preparing the budget proposal traditionally lies on the Ministry/Department of Transportation. This allocation responsibility may also to a variable extent incorporate the concept of *shared power* between several governmental bodies. That is especially the case when the "managing by objectives" (MBO) philosophy is adopted and when funding is totally or in part achieved by road pricing or tolls.

The responsibility for the resource distribution normally rests with each governmental jurisdiction having authority over roads. In as many cases as not, this responsibility is transferred directly to the (Central) Road Administration which, based on needs studies, distribution formulae or criteria budget-frames, may further delegate the responsibility to regional road administrations, which in cooperation with local general purpose governments distribute the monies to projects.

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[1] In Belgium there is no central administration.

To this "standard" procedure variations can be added, especially when there are more than one source for funding road maintenance and rehabilitation. Some countries, consequently, have adopted special allocation/distribution models for tolls or earmarked fuel taxes.

The allocation/distribution methods may also differ with the type of functional or administrative road class. Thus detailed multi-year plans normally are the bases for distribution of funds for the national road network while the distribution may be less specified on regional or local levels, and depend on criteria which have only local significance. In some countries resources are distributed to subnetworks as lump sums based on rough parameters as number of kilometres of road and/or number of vehicle-kilometres travelled.

This brief summary of methods used in allocating and distributing resources, which are further examined in the next chapter, shows clearly the 'ad hoc' nature of the present procedures. It is precisely in this area in which the Group sought to make a contribution by proposing a comprehensive and consistent, yet flexible method for approaching the resource allocation/ distribution issues.

### II.4.5. Funding levels

An important question in resource allocation/distribution is the impact which different sources of road financing may have on the way fund allocation and distribution is made. The answers to the questionnaire show, for instance, that there is a strong interest in adding "earmarked sources" to the traditional financing in the national budgets - and destined directly for road investments, maintenance and rehabilitation. Another question of interest is how resources can best be distributed to different road classes or different types of actions and in what way Federal and State governments should be involved in this more detailed division to lower levels.

Comparisons between countries in terms of total funds spent on roads on a per kilometre basis, show significant differences between countries. While Switzerland annually spends approximately US$ 56 000 per km of road, the corresponding figure in Spain is only US$ 7 000 per km of road. Most countries spend between US$ 15 000 and US$ 45 000 per km of road.

Comparisons between countries as to the division of funds for different kinds of action show that Portugal in 1991 spent over 80 per cent of the total funds on new construction. The United States spent (1990) less than 20 per cent of the total funds on new construction. Canada (Ontario) spent less than 10 per cent of the funds on new construction as far as Motorways and Main Roads under Provincial jurisdiction are concerned. The other countries' expenditures for new construction represent 25 - 65 per cent of the total budget.

## II.5. GROUPING OF STRUCTURES: ALLOCATION/DISTRIBUTION METHODS AND ADMINISTRATION/ORGANISATION

The issues of finding communalities and grouping existing structures are examined thoroughly in the next chapter, and only two general and a third not-so-general observation are made here.

The first observation is that, although most countries present similar administrative/organisational structures, the governmental levels and the road administrative bodies do not have a similar distribution

of responsibilities. However, one thing is common to all the countries: elected officials and their trusted civil servants, have the main responsibility for resource allocation. This responsibility is reflected by the fact that most of the resources for allocation emanates from the State budget -- in Great Britain, from Her Majesty's Treasury.

The second general observation is that administration/organisation structures for resource allocation and distribution reflect the governmental structures prevailing in each country. Thus a Federal as well as a State level for resource allocation for road maintenance and rehabilitation are relevant in Germany, Italy, Spain, Switzerland and the United States. Canada also has a Federal governmental level, but this level is not involved in allocating road budgets. In other countries the Federal-State hierarchy is missing or replaced by another administrative organisation or procedure.

The third not-so-general observation, and one which seems to generate keen interest in many countries, is that pervasive traffic problems in many countries are a motivation for creating totally new kinds of administrative structures. A good example are the motorway concession companies in France (Box II.1)

## II.6. INTERNATIONAL TENDENCIES

This Chapter on "Institutional Settings" presents the State of the Art for Road Classification and Road Administration/Organisation. These classifications tend to persist. Internationally, changes of tendencies are not ordinarily expected in these areas because -- almost as a contradiction -- they develop slowly but occur suddenly.

The functional and administrative road classification in use has generally been in effect for several years and will probably prove to be relevant for many years to come. In spite of the "healthy inertia" it would be good to keep the classification system current and tuned to the macroeconomic directions of the country.

In the administrative/organisational structures, on the other hand, changes can be noted in spite of the same inertia against change. Different actors play defined roles in the process of change. Thus, the politicians will formulate the overall objectives, while Road Administrations may be given wider executive responsibilities. This is to say that the Management by Objectives (MBO), Planning Programming and Budgeting System (PPBS), or Zero Based Budgeting (ZBB) philosophies may be beneficially adopted and further developed in many of the Member countries.[1]

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[1] MBO, ZBB and PPBS are strategic planning tools developed in the 1970' to integrate programme and budget development and programme delivery.

MBO: Management by Objectives is a "top-down" management tool that requires the development of programme goals, objectives, and milestones. Every agency activity is monitored for achievement of goals and objectives in terms of chronological interim milestones of all agency activities.

ZBB: Zero Based Budgeting is a "bottom-up" management tool that requires agencies to begin the programme budget development process at "0". The agency must define until an overall budget and programme is defined. "Sunset provisions" are an outgrowth of ZBB with the goal to discourage creation of programmes that cannot be abolished once they have outlined their usefulness.

Another trend is the growing participation of additional funding sources, particularly private investors, in the road maintenance and rehabilitation arena. Insufficient resources for new investments, and for maintenance and rehabilitation make it necessary to adopt new funding strategies. Private investors and sponsors on the scene -- in the road market -- make it important to define the roles of different actors. Specifying objectives for different road classes and for different types of actions will gain increasing importance. It is to be expected that functional classification of roads also grows in importance.

At the same time the traditional role of the Road Administrations is changing. One influential force in the process of change is the international wave of privatisation. Duties outside planning and control do not any longer have to stay within the Road Administration itself. On the other hand the participation in financing from private enterprises will require for the creation of new partnerships and new autonomous administrations. Inevitably, before long, questions will arise as to how planning will or should be done in this new environment.

While the responsibilities in each transport sector might be transferred to Road Administrations having substantial autonomy, the government jurisdictions will have to focus on multi-modal transport planning based on politically defined objectives.

In concluding this Chapter three more significant international tendencies can be pointed out:

-- In characterisation and measurement of highway condition there is an overwhelming national preference being expressed to develop Pavement Management Systems -- which is a component of the Road and Bridge Management System. This system is the essential backbone for improved engineering practices in rehabilitation and maintenance; it is essential that it is framed in the terms described in this Report. There is significant potential for international cooperation; substantial benefits from the economies of scale, and in data collection can be obtained in producing these systems.

-- Significant developments and changes are also occurring in staff and labor relations owing to increased demands for accountability and commercialisation of the road agencies.

-- The same is true in contracting practices and methods and in the usage and improvement of initially substandard materials.

In time, these trends will be reflected in how road agencies are organised and organise their work.

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PPBS: Planning Programme Budgeting System integrates programme and budget development with a "critical path method" (CPM) of evaluation for implementing programmes and tracking expenditures. The use of CPM chart represents a complex project as a series of interconnected jobs that must be accomplished in specific sequence to minimize wasted assets or redundancy.