Road Management

Thursday 23 October 2003 (1.30 – 5.00 p.m.)

Session Agenda & Introductory Report

22.06.E

SESSION AGENDA

Opening

Mr. Michel GORSKI (C6 Chairperson/BELGIUM)

1. Presentation of the working groups' principal result results related to the activities of the Committee and centered on the following topics

Mr. Michel GORSKI (C6 Chairperson/BELGIUM)

Topic 1. Asset Management

Practical advices for implementation and use in the context of a road asset management.

Mr. David BAKER(C6 member/UK)

Topic 2. Performance Indicators

The performance indicators insure the best guarantees for the users and communities at a minimum life cycle cost.

Mr. Gabriele CAMOMILLA(C6 member/ITALY)

Topic 3. Predictive Economic Models

The role of predictive economic and socio-economic models in road management.

Mr. Johann LITZKA(C6 member/AUSTRIA)

Topic 4. Maintenance Budgets and Programming

Analysis from a practical angle of the possibilities for road administrations to present maintenance budgets to decision makers.

Mr. Mike WILSON(C6 member/UK)

2. Summary of the papers submitted in the context of road management

Mr. Michel GORSKI (C6 Chairperson/BELGIUM)

3. Panel discussion on the state of road management and future orientations.

Moderator:

Mr. Carl HENNUM(C6 member/CANADA)

External invited panel participants:

Mr. Rick vanBarneveld (National Highway Manager/NEW ZEALAND)

Mr. Tadayuki TAZAKI
(Chief Managing Director, Organization for Road System Enhancement/JAPAN)

Mr. Eric LAYERLE
(Deputy Director for Asset Management of ASF/FRANCE)

Mr. Louw KANNEMEYER
(South African National Road Agency/SOUTH AFRICA)

4. Expectations and recommendations concerning future orientations and priorities at mid and long term related to Road Management.

Moderator:

Mr. Michel GORSKI (C6 Chairperson/BELGIUM)

Assistants:

Mr. Arnold PREVOT (C6 French-speaking Secretary/BELGIUM)
Mr. James SORENSON (C6 English-speaking Secretary/USA)

CONTENTS

FOREWORD

The Strategic Theme 4: Management and Administration of the Road System has set its goal: Improve the performance of road administrations in the provision, operation and management of road infrastructure and its use in accordance with international best practice.

For the Technical Committee C6 on Road Management which is part of the Strategic Theme 4, the Asset management methods should take into account the following factors:

- Transport management,
- Levels of service,
- Management and maintenance quality,
- Economic management/prediction models.

P1, the PIARC/HDM-4 Project Team is linked to this Technical Committee.

In order to comply with the objectives of the Strategic Plan, the activities of the Technical Committee on Road Management were divided into four working groups with the following orientations:

1. Asset management,
2. Framework of performance management,
3. Economic prediction models,
4. Maintenance programming and budgeting.

This report presents the four aspects of the activities of the C6 Committee.

ASSET MANAGEMENT

Sub-Committee Members

D. Baker	Transport for London	United Kingdom
G. Breyer	Ministry of Transport	Austria
O. Gutierrez-Bolivar	Centro de Estudios de Carreteras	Spain
C. van Haasteren	C.R.O.W.	The Netherlands
C. Hennum	Ministry of Transp. Of Ontario	Canada
O. Jakoet	ASCH Civil Transport & Structure Engineers	South Africa
D. Jonsson	National Road Administration	Sweden
W. Kurylowicz	Road Network Development Office	Poland
F. Rizzardo	Emcon Services Inc	Canada
J. Saarinen	Finnish Road Administration	Finland
B. Skoglund	Public Road Administration	Norway
M. Srsen	I.G.H.	Croatia
C. Sylvest	Danish Road Directorate	Denmark

Background

In recent years, Asset Management has become an issue of key interest to many highway administrations around the world. Usually as a result of governmental pressure, increasing road user expectations, and reducing budgets, those with responsibilities for highway networks have sought new and better ways of managing their 'business'. Asset Management has been regarded as a logical and effective development in this quest.

The Sub-Committee's remit has therefore been to confirm, to clarify, and to extend the cumulative knowledge and experience of this new technique. As always, special consideration had to be given to the needs of developing countries, and countries in transition. With this latter point in mind, the Sub-Committee took the view that its work should concentrate on practical guidance for those who might be thinking of introducing Asset Management into their organization, and this now forms the major part of the report.

Abstract of the Sub-Committee Report

Introduction

A very great deal of work has been done in recent years in developing the Asset Management concept. At the forefront have been OECD, PIARC, and highway administrations in the United States, Finland and Australia. Indeed, the US Federal Highway Administration established an Office of Asset Management in 1999. But, as far as we know, no country has yet implemented a fully operational comprehensive Asset Management framework.

We have been particularly keen to investigate the way in which asset management can fit into an organization, what new approaches to communication can be realized, and what new management practices, skills and training might be required. We also wanted to investigate on what basis organizations have been preparing valuations of their assets, which assets these were, and to what level of detail. Our hope is that we can help the achievement of some degree of consistency which, in turn, will lead to the adoption of a consistent set of indicators and more ready comparison and benchmarking opportunities.

What is Asset Management?

A generally accepted definition of asset management is that it combines engineering, finance, economics and best business practice in an effort to enhance investment decisions, as well as the ongoing delivery and management of these investments.

Asset management is basically the institutionalizing of a business-like approach (culture) to managing infrastructure. This implies:

- looking at projects and programmes as investments for specific customers;
- monitoring asset performance and value in order to trade-off project alternatives and investments;
- developing sound and competitive short and long-term investment strategies for current and future assets.

Asset management touches all parts of an organization to some degree, as well as the organization's partners, stakeholders and its customers. As a new business-like approach, asset management needs to spread to all business units in an organization, retrofitting or displacing old practices, procedures and policies. The breadth of asset management in an organization should span:

- strategic planning;
- performance assessment and analysis;
- alternative generation and evaluation;
- investment strategies and programming;
- business planning and funding acquisition;
- engineering and design phases;
- construction and implementation;
- operations and maintenance; and
- monitoring and marketing.

What are the Benefits?

The need for asset management can be separated into two categories:

- general organizational needs;
- the needs of key decision-makers.

General Organizational Needs

For the appropriate fulfillment of its mandate, a transportation organization has the following requirements:

- need to have performance measures that consistently, efficiently and accurately describe infrastructure requirements, support funding requests, demonstrate how well the organization implements and manages its investments, and effectively markets the organization's stewardship of its assets;
- need to monitor and preserve a substantial investment in transportation assets, ensuring that their value is being properly maintained and not being driven to reconstruction or replacement;
- need to be able to defensibly conduct and integrate investment trade-offs at the project, corridor, programme and network levels;
- need to support economic development and manage traffic growth, and to minimise adverse land use, socio-economic and environmental impacts;
- need to ensure and demonstrate that capital and operational funding provides the best outcomes for customers;
- need to be proactive in developing business cases that provide financiers with the quality investment information they need to set their relative priorities, contrast them against competing needs and to leverage incremental funding;
- need to be creative in attracting third party funding for investments, perhaps through funding of planning, design, construction, maintenance and operations of assets, and accommodate varying degrees of participation;
- need to integrate investment decisions across asset categories and improve the speed and efficiency of carrying out investment analyses, and assessing changing investment scenarios and varying funding levels;
- need to have an appropriate long term assessment of future capital and revenue funding needs;
- need to ensure that supportive business needs such as human resources, information technology, and other administrative resources are integrated with core business activities and their ongoing and shifting priorities; and
- need to streamline programmes and organizations to maintain a competitive edge, and to enhance and promote productivity.

Needs of Key Decision-Makers

Key decision-makers need direct and timely access to accurate and consistent data and information in order to:

- make defensible investment decisions;
- make hard choices on investment trade-offs;
- promote the needs of the organization;
- compete for funding and staffing of these needs;

- pursue alternative sources of funding and partnerships;
- inform customers on performance, programmes and projects;
- demonstrate stewardship of assets;
- carry out continuous review of programmes and core activities; and
- market the organization's effectiveness and efficiency.

Key decision-makers need an executive support tool that merges all asset and investment data and information, enabling them to make strategic trade-offs and respond to queries from politicians, customers, communities, special interest groups and stakeholders such as consultants and contractors. This executive support system must be responsive to immediate, day-to-day issues and situations, such as:

- How efficient is the organization?
- How well is the organization meeting its responsibilities, objectives and performance expectations?
- How safe and reliable is the network or corridor?
- Is the organization getting value for money?
- Are road users getting value for money?
- How is funding distributed between urban and rural areas?
- How much has been invested in a particular area?
- How is the work programme distributed between large/medium/small contracts?

- What is the level of public/private partnerships in a given year, i.e. the number of projects with partner funding?
- What is the organization planning to do in a particular area, and when?

- What is the current status of all your projects?
- Why is a project required, why now, and what are the benefits?

- What impact will a given project have on the overall network condition?
- What are the road user impacts?
- What are the environmental impacts?
- Is the project on budget, or delayed?
- What are the impacts of deferral?
- What are the costs, what are the benefits?
- How long will construction delays last?

Principles For Adoption

The adoption of asset management in an organization is likely to represent a fundamental cultural shift, from a technical, project driven, focus to a strategic business oriented focus. As an added complexity the culture also shifts from a silo-based to a team-based operation. A natural result of the cultural shift is a knowledge, experience and comfort gap that can only be reduced through strong visible leadership and change management.

Communication plays a very important role in all stages of an asset management process, from early development, through implementation, to adoption and use. In order to achieve continuous improvement and innovation, it is necessary to establish procedures that encourage the participation of members of the organization and that take into account their comments.

A successful asset management cultural shift requires sound analyses, tools, guidelines and business processes, as well as a well laid out and supported change management framework. Components of the change framework should include:

- the case for change;
- shared values and common goals;
- a sponsorship map with roles and responsibilities;
- a communications plan with education, training, and information milestones;

- an implementation plan, with quick wins;
- an action plan;
- success factors and performance indicators; and
- an organizational feedback tool.

Perhaps most crucial to successful implementation is not to underestimate the time and cost involved. Normally an implementation team would be necessary, employed full-time for many months, if not years. There are other options, of course, but not necessarily quicker or cheaper. For example, the Highways Agency in the UK decided not to set up a dedicated team. Nevertheless, more than 100 staff (internal and consultants) have been involved part- and full-time in implementing new initiatives directly associated with asset management.

Accept that you might not be able to do this on your own. Do not hesitate to ask for help from experts. There are more and more of them available now. It is understood that in the US consideration is being given to asset management academic centers, and perhaps even undergraduate courses in asset management.

The application of asset management requires a horizontally and vertically integrated business structure around core functions and processes that translates business direction, resources and priorities into specific coordinated and iterative analyses and decisions that produce the desired results. Providing new analytical tools alone to a status quo organizational structure will not result in asset management. Evidence of this is seen through the addition of an independent pavement management system, a bridge management system or other management systems to organizations.

Conclusions

The dawn of the 21st century has seen more and more road and highway administrations taking an active interest in Asset Management. Despite this, there remain very few practical examples of successful implementation, and no fully operational comprehensive Asset Management frameworks. Indeed, some are still failing to appreciate a very fundamental point – that Asset Management is not about purchasing or developing a new, sophisticated computer program. But this is not altogether surprising, since all too often one hears reference to Asset Management 'systems'. Asset Management is not a 'system', it is an 'approach' to managing infrastructure embodying a framework within which various 'systems' can be operated.

The Sub-Committee suggests that the four key elements of Asset Management framework implementation should be:

- technical tools;
- owner objectives/Customer needs;
- administrative arrangements/reform; and
- business arrangements/reform.

For those considering implementation, our advice is to plan thoroughly, to resource adequately, to seek expert advice, to maximise use of existing systems and procedures which work well, and not to underestimate the overall impact on an organization.

The ultimate benefits should be improved understanding of asset performance, better organizational integration, and more strategic, effective and efficient management of the infrastructure.

Main References

The Sub-Committee considers that one of the most important documents written to date providing general information on Asset Management is the OECD Report *Asset Management For The Roads Sector* published in 2000. Specific reference was also made to the following documents:

- Asset Management Primer – US Department of Transportation, December 1999.
- Asset Management Peer Exchange – American Association of State Highway and Transportation Officials, 2000.
- An Investment Decision Framework for Road Asset Management (Discussion Paper) – N F Robertson, Queensland Department of Main Roads, August 2001.

FRAMEWORK OF PERFORMANCE INDICATORS

Sub-committee members

G. Camomilla	Autostrade SpA	Italy
P. Alves Pereira	Universidade do Minho (Dep. Genie Civil)	Portugal
G. Norwell	Main Roads W.A. Road Maintenance Strategy	Australia
J. Sorenson	Federal Highways Administration	U.S.A.
K. Inoue	Japan Institute of Construction Engineer	Japan
M. Maruyama	Tokyo Construction Bureau. Metropolitan Expressway	Japan
J.H. Swart	Rijkwaterstaat - Dienst Weg- & Waterbouwk.	Netherlands
A. Garcia Garay	Ministerio del Fomento	Spain
R. Debak	TEB Engineering	Hungary
F. Rizzardo	Encome Service Inc.	Canada
M. Srsen	I.G.H.	Croatia

Stakes

In the new millennium the reduction of investments in primary activities will be firmly established. New jobs and in ever-greater quantities will be created in the service sector. Their number will grow along with the expectations that the clients will have with regard to their quality.

However, in most cases, we are still not used to managing services scientifically. The concept of the product quality connected to the economy of production (and in other characteristics related to marketing) while clearly evident in industry and even in agriculture, is not yet in many countries an integral part of the production of services, and nor has it become, with appropriate modification, a guiding idea or a standard practice for whoever produces or controls them.

This is all the more true in those services related to the management of the so-called "public" facilities, built and run with money from the public purse, such as roads for example. Roads, moreover, do not provide complete and easily assessable transport systems, such as railways or other types of transport service characterized by the management of passenger and goods transport vehicles and thus by timetables to be respected (in addition to modifying them to meet the needs of the users) or vehicles to be kept in aesthetically and technically good conditions.

This shortcoming is, on the one hand, related to the manner in which normally these road administrations are financed (by conferring annual grants whose precise entity is never certain and which are never rationally allocated according to areas of use or the objective needs of the facility to be managed) and on the other to the lack of a definition (as also of systems to measure and control the results) to objectively evaluate not only such needs but also the behaviour of whoever is appointed to manage these facilities. Typically whoever manages them justifies himself when faced with the ever more vocal dissatisfaction of users by blaming the dysfunctional arrangements that lead to these inefficiencies.

However, these services were managed in many cases only from the point of view of the proprietor that acted *on his own* without any systematic control of the expectations of users.

The main developments, instead, were concentrated upon dealing with the enormous growth in traffic - its make-up and its arrangements for the sectors of intrinsic safety and improvement of the infrastructure, with what was later called programmed maintenance or road “terotechnology”.

Quality management

The new trend today is “Quality Management”. This new requirement is the product of the fact that the greater part of the roads needed already exist. Thus the most urgent matter now is not so much how to improve new road construction - even though this is important - but rather how to *improve the possible use of existing roads*, which is precisely the issue of quality management.

To achieve this, it is necessary to identify the problems and the rules of road management from the points of view of all the parties involved.

These matters have been studied in the last four years, especially in the context of PIARC's worldwide studies.

Improving road management in order to obtain quality management calls for a unique basic methodology to be applied to all fields:

- establish the goals to achieve (it is important to know where you want to go),
- verify, at fixed time periods, whether or not they have been reached as well as estimating the costs involved.

This is the principal scope of roads Performance Indicators

These things are easy to propose. Putting it into practice is very much more complex, unless we set out a priori and with precision all the elements of the problem, commencing from the goals to be attained, distinguishing them from those pursued in the past, (that is those referring to "planned maintenance" of infrastructure alone), given that today we wish to achieve "global quality" (intrinsic and recognizable, enduring and economic).

The new element (with a strongly “mutagenic” effect on the traditional operator) consists in the need to take account of all points of view when pursuing these goals.

In other words, not only the single point of view of the owner or operator of the road infrastructure but also that of other parties, that is the users and those (the involuntary recipients of the negative aspects of the infrastructure) who live by the side of the road, the bordering residences.

Once these objectives are established, verified and found to be compatible with all points of view it is possible to establish the measurable indicators that must be surveyed in order to measure them and determine their reference values.

Once indicators and references have been established it is possible to measure the level of quality reached (the verification of the result).

In order to see the costs involved in pursuing these goals, a new method of evaluating company costs is needed as also those of the administrative structures needed to run this kind of infrastructure.

This approach calls for a different kind of accounting, but one that is by now well established (in other industrial sectors), as well as a different type of approach. These aspects have been studied as part of the remit of the C-15 Committee of AIPCR which was set up to evaluate the *performances of road operators/administrations* and determine how to measure them (see the acts of the C15 document of the World Road Congress of Kuala Lumpur).

Not all countries used or prepared these instruments at the same level but we have now and, for the first time in the world, implemented them in a fully comprehensive fashion, with operational consequences and quantifiable results.

The importance of this fact does not lie in the method used, which we shall set out later, and which could have been different but in the fact that the method is based upon systems tried and tested in the course of years of operational use and that it is currently used to improve the capacity to address and check the performance of the operator/ proprietor in terms of the results produced.

Abstract of the sub-committee report

We start from this statement:
Performance Indicators provide the best results for users and community at minimum life cycle cost

We start from structure of items of Coolum questionnaire; we write how many countries have given the answers; we present in synthetic way the answers. With a Table derived from Tallin Meeting: P.I. are divided in main category, category, parameters, way to evaluate and comments. We describe the different ways to collect the parameters and calculate P.I. We describe the different ways to use the P.I. We put some examples of:

1. measuring devices
2. target values

We add a bibliography for the other systems. We put also a table of the previous work of C6/7 Committee. We make a comparison between:

1. the ideas of yesterday;
2. and application of today.

We write the conclusion with the recommendations and possible future development of P.I. use; all the tables with the answers from 14 countries are also reported.

The basic criterion consists in using measurement parameters[1] that are reproductive and objective related to the characteristics and/ or structure being examined, (with limited costs) whose values can be correlated to previously identified states as different levels of quality of the measured structure.

Then it is necessary in the more advanced use of P.I. to identify the road sections, as a percentage of the total, that correspond to the different levels of codification made by the parameter on the present road structure (percentage distribution of sections at an excellent level-A%, the percentage of sections rated as good, B%, etc.)

From the combination of these distributions, and with a specially developed function f, a Performance Indicator I_i is obtained of the characteristic in question.

Every characteristic (or structure) may be described by more than one parameter in which the corresponding indicator I can be the result of a combination of the present levels of the various parameters that come together in a global indicator of that characteristic or structure.

The infrastructure as a whole is then made up of a series of characteristics and structures each with its own indicator and its own weight p_i, which altogether define the state of quality.

With respect to planned maintenance the innovation lies in the fact that it was only important, as regards all its single characteristics, never to fall below the threshold values of user perception (see figure 1) or failure level.

However, by taking other levels into consideration, that is, those above intermediate level, the whole management approach changes: in order to manage quality it is not sufficient to have dispensed with the state of failure or minimum levels. It is necessary to obtain structures that as far as possible come within the optimum or average A, B, C levels.

Definitions Glossary

A significant effort was made to provide a clear terminology, easily useable in the field of numerical (objective) road management by measured indicators. Terms such as

- Technical parameter,
- Plain Performance Indicator,
- Combined Performance Indicator,
- Global performance Indicator,

etc., received clear definitions. A list of cards, with their common designation, and their definition and use was proposed.

[1] As regards the parts of the infrastructure subject to maintenance, the parameter could be the same as that used to define its maintenance requirements. The criteria can, however, be extended to all the features of the management and the other quality areas of more direct interest to clients or roadside residents.

Literature review

More and more research and development actions had been carried out in the world, on technical and socio-economic analysis and useful criteria applicable to road management (not only maintenance's aims). The most important contribution to this field came from different actions conducted under the aegis of the OECD and PIARC and the European Countries. These works were carefully examined by the WG2.

In 1995, the OECD Road Transport Research Programmed established a Scientific Expert Group to investigate Performance Indicators for the Road Sector (OECD ROAD TRANSPORT RESEARCH, *Performance Indicators for the Road Sector*, OECD, Paris, 1997). The report related to this research included the following components:

1. a survey of current method used by member countries' road administrations to assess road performance;
2. a set of performance indicators;
3. procedures for refining the performance indicators to meet the needs of different countries;
4. a basis for tracking important trends, identifying efficient interventions and making country comparisons.

An important statement made by this report was that "*In order to understand why a particular indicator had been used, the role of the road administration in the entire road transport system, and in society as a whole, had to be considered*."

In the previous work period, from 1996 to 1999, the work group C6.6/7, taking into account the recommendations established by the OECD Road Transport Research Programme, dealt with the theme of Performance Measures and Benchmarking.

The research undertaken by the C6.6/7 work group, during the previous period, was mainly related with a wider and qualitative approach than a quantitative one.

Following these two previous research approaches, the work undertaken by the C6.2 work group has considered a more pragmatic approach to help the road administrations, in the field of road management activity, adopting both a qualitative and quantitative approach for the research on Performance Indicators, considering the following items:

- Road Categories;
- Stakeholders.

Questionnaire

We have prepared a first list of question with this settlement of Performance Indicators

The indicators are the measurable numbers starting from defined parameters, and they must refer to the various road characteristics, such as measurement units, and the shortcoming and qualities of the four possible viewpoints of road stakeholders.

- the owner in terms of general strategies (primary responsibility),
- the operator in terms of the intrinsic state of the structure,
- the user in terms of comfort, safety services and travelling time,
- the external road residents in terms of environment.

The use of performance indicators is not widespread in the same manner and level in all PIARC countries; for this reason we made some classification to facilitate the answer to the questionnaire.

We have divided the Indicators as follows:

1. the Road Planning Indicator (High level of road Administration and other related administration for planning of Road Quality like Accessibility, Mobility, Level of Safety etc.);
2. the infrastructure Management Indicators (The Road Management Administration level), often connected to programmed maintenance (structural road quality for pavement, bridges and tunnels, geotechnics, complementary devices such as signs, barriers, etc.);
3. the user's perception of Road Quality connected to the various "services" provided by roads, (road trip quality, time, information);
4. the perception of roadside residents and environment impact (Quality of environment, noise, water, air and soil pollution).

For each indicators it was necessary to define:

- the method of measure and the corresponding parameter/s (one can use a survey machine or visual system based on card form and explanatory Manuals)
- the values (limits) of parameter/s at different levels of quality, used in the responses for different types of road.

The responding country had to indicate its limits for the indicators present in the questionnaire and add other indicators used only in his country.

The original questionnaire has been redesigned based on feedback from members. It is intended to determine the extent and application and how performance indicators are used by road administrations to manage the road network.

The objectives of this second questionnaire were:

1. Collect data from different countries (at least C6 members) related with performance indicators adopted for different road categories and for different stakeholders.

2. Analyse the data collected in order to produce a report on the "state of the art" regarding the present practice in the field of performance indicators.
3. From the previous analysis, produce recommendations on performance indicators related to different road categories considering different perspectives (owner, operator, user, community) with emphasis on the customer perspective.

This work will lead to the development of the following outputs by C6.2.

1. *Report on PIs used by road administrations to monitor performance based on road classification. This includes information on the application of data collected both by high performance road condition survey devices and subjective methods. The road condition survey data may be of interest to C1, and they should be invited to comment.*

2. *Guidelines for the application of PIs by road administrations.*

This project was intended to collect good examples of how performance indicators are being used or how management can be improved through the use of performance indicators in order to achieve better performance based management.

Many countries are using performance indicators in a variety of ways. It is apparent that it is not practical to apply a single set of performance indicators to all types of road. For this project it was proposed that information be gathered for a five-level hierarchy of roads. It is accepted that a road classification system is a fundamental part of road management. While it is appreciated that different countries will have different road classification systems, the questionnaire is based on the following five categories. Respondents are encouraged to provide information based on their own classification system and not be constrained by the following classifications.

Proposed Road Classifications

1. Motorways/Freeways/Expressways - *generally high speed divided roads consisting of 4 or more lanes with no at grade connections. May be publicly or privately owned/operated.*
   Respondents may wish to separate into urban and rural.
2. Primary National roads – *Similar high geometric standards, limited access control, connects major destinations carrying high volume commercial goods and services. May include major urban streets.*

3. Secondary National roads – *Lower geometric standards, distributor roads, free access control to adjacent properties, regional interests, may be jointly funded by the Federal and State/provincial governments. May include city distributors.*

4. Regional/Provincial roads – *local collector roads, generally funded and managed by state/provincial authorities.*
5. Local Roads – *Also known as municipal or residential roads, generally low volume roads that provide access to homes and property. Respondents may wish to provide separate responses for rural and urban roads*.

The stakeholders are identified as owner, operator, user and community like in the first questionnaire. Performance indicators can be divided into four broad groupings which align with these stakeholders, being

1. Road Planning Indicators – These reflect higher level considerations based on desired outcomes or benefits such as safety, accessibility, mobility etc. (owner's view)
2. Infrastructure Indicators – These normally relate to asset condition that is a reflection of the level of maintenance. They reflect the Road Management Administration level and include structural road quality for pavement, bridges and tunnel, geotechnics, complementary devices such as signs, barriers etc. (operator's view)
3 The user's perception of road quality connected to the level of service provided e.g. ride quality, travel time, congestion, signing, information etc. (user's view)
4 The perception of the broader community regarding environment impact e.g., noise, water, air and dust pollution. (environment or community view)

There needs to be a link between the owner's view and the road user perception. The level of service to be provided to the road user needs to be translated into intervention or target standards to be applied by the asset owner.

Recommendations

The actual level reached by the framework of performance indicators represents a very encouraging signal as it indicates that many countries have understood the potentiality inherent to the rational approach to their measurement.

Many countries are measuring them and some are using them at various levels of use – both cognitive and operational.

The validity of the approach is also demonstrated by its flexibility.

It can be used to improve maintenance planning but also to evaluate the need to transform the network at all levels.

Data collection is a crucial aspect for the reliability of economic analysis; it is necessary to put adequate efforts in this activity. Collecting data requires a quite significant budget, especially because data need to be updated on a regular basis. This budget is, in any case, much lower than the money which can be saved on works budget, if these works are planned and designed according to rational methods. But, in order to meet these advantages, quality of the data is a crucial point. Data collection has to be performed according to a complete and well-accepted Quality Plan.

Moreover, it can initially be used in a circumscribed manner and later extended as the various parties involved begin to understand its potentiality.

The most important roads can be managed first, and all the other categories later.

Initially, the pavements can be checked, later all parts of the road, and then the efficiency of all-administrative actions.

We have seen it being used to plan budgets, to verify safety and to correlate toll increases to the qualities achieved in the motorways.

Each improvement planned for the road system, from the actual point to the required goals, on traffic fluidity, reliability of structures and so on, can be monitored in terms of results and costs by means of suitable performance indicators.

Lastly, the roads have codified units of measurement that enable universally verifiable measurements to be made, thus finally freeing them from the decisions made on an approximate qualitative and subjective basis that have hitherto always characterized road management.

This will increase the percentage of roads run along industrial managerial lines, compared to those managed with the still prevalent artisan approach.

Main references

[1] *PIARC Technical Committee CT8* “Flexible roads”, sub-committee 3 “Whole life costs of roads”, 08.09.B, 2000

[2] *Specification RVS-2.21* “Economic Analysis of Pavement Structures” (in German), Vienna, 1999

[3] *OECD Road Transport Research*, Paris
“Pavement Management Systems”, 1987
“Road Strengthening in Central and Eastern European Countries”, 1993
“Road Maintenance Management Systems in Developing Countries”, 1995
“Performance Indicators for the Road Sector”, 1997
“Performance Indicators for the Road Sector”, Summary of the Field Tests, 2001

“Asset Management for the Roads Sector”, 2000

[4] *La manutenzione programmata* G. Camomilla - Autostrade Magazine, January 1981

[5] *Fatigue life of road pavement* G. Camomilla Ann Arbor Conference on Bituminous Pavement, 1988

[6] *MA.P.P.E. Manutenzione Programmata con Programmazione Elettronica* G. Camomilla, Mauro Malgarini e Massimo Fornaci Autostrade Magazine July 1988
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THE ROLE OF ECONOMIC AND SOCIO-ECONOMIC PREDICTION MODELS IN ROAD MANAGEMENT

Sub-committee members

Ph. Lepert	*Laboratoire Central des Ponts et Chaussées*	France
M. Gorski	*Centre de Recherches Routières*	Belgium
W. Pichler	Carinthia Tech. Institute	Austria
T. Kaal	Technical Centre of Road Administration	Estonia
J. Litzka	Technische Universität Wien	Austria
G. Rhode	Transportation Division AFRICON	South Africa
N. Robertson	HDM4 Project co-ordinator	PIARC
G. Woltereck	Autobahndirektion Südbayern	Germany

Stakes

In a context were the Public Administrations experience a stronger and stronger demand on social policy, road budgets tend to be tightened or even scaled back. The economic evaluation and optimization of maintenance policy becomes a recurrent requirement. There is, therefore, a growing need for methods and tools to meet this requirement. The development of such tools implies a number of technical obstacles, including: devising reliable means for monitoring the condition of road networks; forecasting pavement deterioration rates; assessing the level of nuisance caused by pavement deterioration and road maintenance work on users; and quantifying these various phenomena in monetary terms. Such obstacles have already been handled, with differing results. For instance, in the context of developing countries, models were developed and incorporated in the HDM software. For some years, different projects have also been conducted in developed countries, especially in European countries, for instance under the aegis of the European Commission. The COST 324 action, the PARIS and PAVECO projects dealt with the development of technico-economic models for pavement maintenance management. The COST 343 action and the FORMAT project are dealing with reduction in road closure by improved maintenance procedures. At the world level, works were conducted by different countries or international organizations such as PIARC.

Abstract of the sub-committee report

Introduction

Integration of economic and socio-economic analysis frameworks and models in effective and efficient systems requires close cooperation, and direct and fruitful exchanges, between the road managing authorities, which are waiting for such systems, and the experts or research staff who are conducting developments. The Working Group n° 3 “Economic and socio-economic prediction models” of the C6 Committee (thereafter referenced as “WG3”), which is composed of experts and road managers, aims at providing the opportunity to develop these cooperation and exchanges. During the period 2000 - 2003, the WG3 pursued the objective of promoting the development and use of economic analysis framework and models. This was done by applying a work programme organized in five phases:

1. giving clear definitions of the aims of road management ;
2. clarifying the needs and requirements of managing authorities for economic models;

3. conducting an overview of the projects that were or are conducted in the world, and making a synthesis of the results which have been achieved ;

4. finally, providing recommendations to convince road managing authorities to take benefit from using existing tools to improve their practices, and development staffs, to better meet the requirements and expectations of managing authorities. These recommendations were based on the results of the former literature survey and from a specific interpretation of the answers to the questionnaire of WG4.

The action of the WG3 reported in this document contributes to the PIARC strategic theme 4 “Management and Administration of the Road System”, and especially to issues 4.1 “Developing, improving and implementing asset management processes”, 4.5 “Marking more efficient use of the road budget”, and 4.7 “Introduction of road pricing”.

Definitions

A significant effort was made to provide a clear terminology, easily useable in the field of road maintenance management. The so-called *network level* and *project level* of maintenance management were defined and illustrated, according to the proposals of COST 343, itself reflecting previous works. Terms such as

- model
- predictive model
- economic model
- technico-economic model
- statistical model
- technical model
- social model
- socio-economic model
- empirical model
- mechanistic model
- environmental model
- decisions rules

etc., received clear definitions. A list of elementary models, with their common designation, and their definition was proposed.

Literature review

More and more research and development actions have been carried out in the world, on technical and socio-economic analysis and models applicable to road maintenance management. The most important contribution to this field came from different actions conducted under the aegis of the World Bank and PIARC (HDM), OECD and the European Commission. These works were carefully examined by the WG3.

HDM-4, at least the version 1.3, which was examined by the WG3, is strongly 'user oriented'. Typically, it does not involve any model to evaluate pavement depreciation, though this concept is largely used today, in developed countries, to justify maintenance budgets. HDM-4 involves road deterioration and works effect models, but it mainly uses them to calculate IRI, which is the only condition indicator used in the economic models. Most of these models are addressing the 'vehicle costs': consumption, repairs, utilisation, capital costs. These costs generally remain quite constant for small IRI values (< ~5), and increase rapidly beyond. They are important components of the economic balance of maintenance policy in countries where the IRI currently exceeds 5. On the contrary, they do not influence this balance on networks where IRI is almost systematically less or equal to ~ 5. There, the economic balance is governed by the so-called 'other user costs': effects of road works on traffic (thus, on travel time), user safety, etc. On the heavily trafficked networks, the travel time is slightly increased by slowing down, but strongly sensitive to bottlenecks due to road works. HDM-4, version 1.3, does not involve any model for delays due to bottlenecks. Furthermore, road safety is only briefly addressed in HDM-4 guides. It is not related with road condition, which implies that effects of maintenance operations on road safety are not really taken into account. This brief overview supports the conclusion that HDM-4, at least the version 1.3, is appropriate for economic analysis of maintenance policies in developing countries, where the condition of the networks usually implies a major contribution of vehicle costs to the overall balance, but not in developed countries, where pavement preservation, user safety and delays at works zones are the major components (positive and negative) of the benefits expected from maintenance. HDM-4 also illustrates an other important feature, which applies to any PMS: the application of such systems to a specific context require both adaptation and calibration of the models. These tasks are important for the reliability and accuracy of the analysis made with the system. They are also important in terms of amount of works, and should not be underestimated.

The Road Transport Research Group of OECD put specific interest in the performance indicators that road administrations use to gauge themselves. In 1997, a task force was established to field test a selection of 15 of these indicators, with the objectives of assessing their applicability to improve the management of road administrations. This project mainly involved a comparison of the processes in which the indicators were applied by different administrations, including some qualitative assessments on the role and function of these administrations, and whether the execution of their mandates reflects the views of the public and government.

This study suggested that a cultural change was necessary in most cases toward a client focused approach, which enforced the need for socio-economic analysis tools. Another expert group presented, in December 2000, a report on Asset Management for the road sector, defined as "a systematic process of maintaining, upgrading and operating assets, combining engineering principles with sound business practice and economic rationale, and providing tools to facilitate a more organized and flexible approach to making the decision necessary to achieve the public's expectations". The report described experiences of the OECD Members that were moving towards Asset Management. It made some recommendations, such as the need to improve information collection, storage and management procedures, to base maintenance options priority on the basis of life cycle cost analysis. It also encouraged road administrations to adopt a more business-like approach to the management of the assets. It finally promoted the concept of performance monitoring including, for example, Performance Indicators.

The most important R&D effort, in the field of socio-economic approach of road management, in the last 7 years, was conducted under the aegis of European Commission (EC). The development of socio-economic models for road management, applicable in developed and transition countries, has been, for some 7 years, the major objective of a series of European project (COST 324, PARIS, PAV-ECO, COST 343, FORMAT). First, considering that economic analysis can only be performed on the long term, the PARIS project (Performance Analysis of Road Infrastructure) aimed at developing robust models for the European inference space of traffic loading and climate, focusing on flexible and semi-rigid pavements. Some 19 Institutes from 15 European countries participated in the project which produced distress initiation and propagation models. The PAV-ECO project addressed more specifically the question of socio-economic analysis and model. Its first objective was to review European practices in this field. Road Directorate from 15 countries were interviewed, underlining both the need for socio-economic analysis of road maintenance in these countries and the lack of experience and tools. A general Cost Benefit Analysis (CBA) framework was proposed, and some models were at least elaborated, such as the model for estimating user delays due to road works, considering the effect of bottlenecks (at project level). This analysis was pursued in COST 343, which enlarged the framework proposed in PAV-ECO with the aims of evaluating and minimising traffic disturbance due to road maintenance, by selecting lasting, easy-to-implement maintenance techniques, combining maintenance tasks on the same site, and co-ordinating the sites. FORMAT, an on going project, is completing this work. Especially, the 4th Work Package of this project aims at achieving a complete CBA method, including pavement models for pavement depreciation, for user delay in bottleneck (at network level), for agency and environmental costs, etc.

The literature survey, the most important activity of WG4 during the period, enlightened the importance of socio-economic analysis in maintenance decision. It also point out that, if such analysis can be performed in the context of developing countries, thanks to HDM, there is a lack of models and tools, applicable in developed and transition countries. But some recent or on going projects, such as those partly funded by the EC, should rapidly fill this gap.

Questionnaire

There are a lot of questionnaires sent, all over the world, to road managing authorities, road experts and firms. In such a context, issuing one more questionnaire had to be carefully considered. Finally, it was decided that no specific questionnaire will be emitted by the WG3, which will rather examine the answers to the questionnaire prepared and disseminated by the WG4 “Maintenance Planning and Budgeting”, focussing on the questions dealing with the actual and future use of management methods and tools. A limited number (10) of countries provided – often partial – answers to the questions that were directly interesting the WG3. Some answers addressed the regional networks, some other the national. A crosscheck of the answers of the same country to different questions was systematically made, showing that some questions were misunderstood. Most answers were dated on 2001, and the situation could have changed. Therefore, no statistics were derived from the answers. Nevertheless, important observations were drawn from the processing of the answers done by the WG4, and kindly release to the WG3. They were mainly dealing with the implementation of PMS, especially when it aims at performing economic analysis. These observations were very useful to write the recommendations of the WG3 for a good and satisfying implementation of economic evaluation procedures.

Recommendations

The work and discussion within the WG3 made it possible to produce the following recommendations, which are the main conclusions of its activities.

1. *When deciding to implement a PMS, road authorities have to consider all the efforts which will be necessary to get a satisfying functioning*: data collection with adequate means (methods, tools, technicians) and regular updating; model calibration (see 3); modifications in organization; training of people according to their future role; etc.

2. *When implementing a PMS, adapt the organization of the road management service.* The consistency between the role and the activity of each level/person involved in the decision process, must be revisited. For instance, people making decisions do not need to know neither how to operate the system, nor how it works in all details. People operating the system should not take decisions instead of the deciders.

3. *Data collection is a crucial aspect for the reliability of economic analysis; put adequate efforts in this activity.* Collecting data requires a quite significant budget, especially because data need to be updated on regular basis. This budget is, in any case, much lower than the money which can be saved on works budget, if these works are planned and designed according to rational methods. But, in order to meet these advantages, quality of the data is a crucial point. Data collection has to be performed according to a complete and well-accepted Quality Plan.

4. *Calibration of all models required by the system is a key point; although it requires a lot of work, this step is essential and should not be underestimated*. All PMS include some kind of "basic" models, with 'default values' for the parameters. These values are normally provided with the models for people training. Do not systematically use them for real applications. Adjust the models to the network on which they will be used. Although this calibration requires a careful selection of the test sections, a complete and extensive data collection on these sections, the use of rigorous statistical methods to process these data, it is a key step in implementing the PMS. It should never be underestimated.

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MAINTENANCE PROGRAMMING AND BUDGETING

Stakes

Road management is a key element in the process of preserving existing assets and road safety. Budgets allocated for that purpose have, however, often been found inadequate. This may be due to a lack of means, but also to the poor presentation and justification of budget proposals to decision-makers.

Committee 6 has been entrusted with a practical analysis of the various alternatives for road administrations (or offices or agencies) to present maintenance budgets to decision-makers with a view to convincing them to allocate the necessary sums to adequate maintenance. The objective of this work is to define best practice while inventorying the various alternatives for presentation.

Recommendations

Defining best practice does not mean recommending a single method – rather than any other – for use in any case. As a matter of fact, the work undertaken does not allow us to say that one method is better than another regardless of the context. Depending on the desired degree of precision, on the items of road infrastructure that are being analyzed and on the human and financial resources available, the choice will be in favour one method or another. Current practice and future prospects reported in the replies to the survey questionnaire have shown that no method must be rejected. On the other hand, it clearly appears that the use of technical and technoeconomic models will increase in future. Their field of application is, however, not wide enough to cover all the needs for analysis.

In any case, one should be careful about using a single method of presentation. Only by using several methods in combination, with a reasonable estimation of their precision and knowledge of their limitations, will it be possible to convince decision-makers. The latter are, indeed, not a homogeneous group, and each of them should be presented with results suited to his or her individual expectations.

List of members

C. Morzier	Département des Ponts et Chaussées	Switzerland
S. Allen	VicRoads	Australia
D. Thompson	VicRoads	Australia
A. Prévot	Ministère de l'Equipement et des Transports	Belgium
P. de Backer	Ministerie van de Vlaamse Gemeenschap	Belgium
D. Peshkin	Applied Pavement Technology, Inc	USA
A. Laslaz	Ministère de l'Equipement	France
P. Hernadi	Techn. & Infor. Service on National Roads	Hungary
J. Timar	Techn. & Infor. Service on National Roads	Hungary
M. Wilson	The Highways Agency	United Kingdom

Objective

Road management is a key element in the process of preserving existing assets and road safety. Budgets allocated for that purpose have, however, often been found inadequate. This may be due to a lack of means, but also to the poor presentation and justification of budget proposals to decision-makers.

By definition, decision-makers are bodies or persons who approve budgets for maintenance, such as Governments, ministries, financial departments, boards of directors, representatives of road users, etc. They are political leaders, financial managers or road users of various backgrounds, with different sensitivities that require personalized approaches.

That is why Committee 6 has been entrusted with a practical analysis of the various alternatives for road administrations (or offices or agencies) to present maintenance budgets to decision-makers with a view to convincing them to allocate the necessary sums to adequate maintenance.

The objective of this work is to define best practice while inventorying the various alternatives for presentation – from the simplest to the most complex in content.

The study is to result in a report:

- showing the advantages and disadvantages of each method from the point of view of effectiveness: understanding by decision-makers, ease of dialogue, result achieved in obtaining the budgets which the network manager considered to be necessary, etc. ;
- covering the fields of routine maintenance, winter maintenance, structural maintenance, and rehabilitation;
- distinguishing the specific features of developed countries and those of developing countries or countries in transition;
- discriminating between methods with or without consideration of user costs;

- identifying the peculiarities of the various types of decision-maker.

Methodology

- C6 made a list of the methods most commonly used in practice.

- It prepared a survey questionnaire asking for a short description of the method used and including a number of questions that were to allow a quantitative analysis of the replies, as well a number of fields for respondent organizations to state the advantages/disadvantages of their methods and to make comments.
- The questionnaire was circulated to all the First Delegates of PIARC, with a request to forward it to the organizations concerned.

The replies were analysed both quantitatively and qualitatively.

The list of methods described in the questionnaire was based on knowledge among the members of C6. The methods are:

- Method 1: budget based on previous budgets (historical method)
- Method 2: budget based on the value of the network
- Method 3: budget based on an estimate of general needs
- Method 4: budget based on precise needs
- Method 5: use of technical models
- Method 6: use of technoeconomic models
- Other models
- Use of several models in combination.

Recommendations

No method alone allows an effective presentation of budgets to decision-makers. The choice of method depends on the field of activity (e.g. the type of structure) or on the budget item concerned (e.g. winter maintenance).

Method 1: budget based on previous budgets (historical method)

This method of preparing and presenting budgets has been and remains in very wide use. If the means apportioned to maintenance have been well suited to the needs, it may do especially for the short term. If not, and if used alone, it will, of course, not allow any effective correction of resources; nor does it make it possible by any means to relate a budget to topical objectives. In addition, this method is only suitable when the asset to be managed is relatively stable.

On the other hand, the historical method has some effectiveness in handling (budgetary) data from a statistical point of view, and for all activities that result from annual planning.

It can be used among other things for routine maintenance and operation, for winter maintenance, and for certain items of electromechanical installations with a short service life.

Method 2: budget based on the value of the network

This method is often used as a first step in assessing the budgetary needs for maintenance. It is a first approximation that is easy to implement, but also requires a good knowledge of the value of the network. Its relation with this value has some impact on policy-makers.

However, this method cannot take account of the actual condition of the network, and can be applied only at the network level while aggregating all needs. On the other hand, it allows comparison with ratios of expenditure on similar networks.

Committee 6 recommends to use this method as a first approximation, and to combine it with other methods to refine the results.

Method 3: budget based on an estimate of general needs

This method prerequires knowledge of the service lives of infrastructure components. It does not enable resources to be allocated to a given item or object in the network. On the other hand, it makes it possible to define a spread of needs over the years for the entire network.

This method undoubtedly allows a better comprehensive approach to the actual needs than the previous ones, at little cost. It is to be recommended particularly for regular readjustments of the previous two methods.

Method 4: budget based on precise needs

This method can only be considered insofar as maintenance needs are precisely known for all the parts of the network. It often goes with a short- or possibly a medium-term vision of maintenance. However, when used alone, it cannot yield an optimum at the general network level.

The application of this method is generally recognized to require more resources than the previous ones. Its effectiveness in convincing decision-makers is rather controversial, except in sensitive fields (e.g. tunnels).

Committee 6 recommends this method to determine the maintenance needs of road sections and important engineering structures that require a specific approach.

Method 5: use of technical models

The main advantage of this method is the possibility to simulate several scenarios relating to conditions actually encountered on the network. It allows for maintenance objectives and yields long-term forecasts.

This method requires a very good knowledge of the network, and regular monitoring of the condition of structures. As a result, it is expensive to use and sometimes found too technical and difficult to understand for decision-makers.

C6 recommends its use for optimum network management.

Method 6: use of technoeconomic models

This type of model can be considered for use at the level of a sufficiently large network. It allows for maintenance objectives and yields results for the long term. Even more than the previous method, it requires a very good knowledge of the network and regular monitoring of the condition of structures. It integrates an even larger set of input data, such as user costs and the external costs of traffic. As a result, it is expensive to use and sometimes considered complex and difficult to understand for decision-makers. It has the same field of application as the previous method, but with extensions to economic and even social aspects.

Committee 6 recommends its use especially when decision-makers expect such results.

Use of several models in combination

The effect of maintenance activities on the condition of a network is only felt in the medium or long term. Now these activities are closely bound up with budgetary levels. It is, therefore, difficult to assess whether requested budgets (if allocated) will actually produce the announced results. The use of several models in combination finds its first justification in this context. By comparing the results from several approaches, the user can justify the budgets he is asking for on more solid grounds, and possibly be more successful in convincing decision-makers.

Another reason for using several models to determine budgets follows from the preceding discussion of models: it has, indeed, been found that some models can currently be used for certain types of structure or for certain tasks, but are less suitable for others. In this way, the precision of results can be improved by applying the most appropriate method for the specific fields considered.

The consequent recommendation of Committee 6 is to encourage comparison of results from different models. The choice from the latter will mainly depend on the context, the sensitivities of the decision-makers, and the means available.

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