23rd WORLD ROAD CONGRESS
PARIS 2007

GENERAL REPORT

World Road Association

Contents

Preamble

The general report for the 23rd World Road Congress was prepared under the aegis of the PIARC Strategic Planning Commission.

The draft has been assembled by Jean DETERNE (Ponts et Chaussées Advisory Council - CGPC/S4), with contributions from Jean-Louis DURVILLE (CGPC/S3), Didier GILOPPE (CETE Normandy-Center Region), Jean-Michel PIAU (LCPC), Jean-Charles POUTCHY-TIXIER (CGPC/S3), Kristen REED-DROUARD (CETE de Lyon), who also acted as technical secretary and Jean-François CORTE and Leanne GRANT for the PIARC General Secretariat.

The final version was produced after taking into account remarks issued by Strategic Planning Commission members and the PIARC Technical Committees after the Congress.

Foreword

In 1908, Paris hosted the representatives from 33 countries invited for the very first International Road Congress, an event that led to the creation of the World Road Association (PIARC), whose aim was to develop a worldwide community in the roads sector. A full century later, the Association's membership now extends to 110 countries, a considerable number of which are emerging nations. Through the organization of international forums and events, the Association provides a framework for fostering exchanges that lead to the dissemination of good practices and efficient tools to enhance decision-making capabilities among actors in the field, thereby contributing to raising both the level of economic growth and social welfare.

It has been a proud moment for Paris to hold the 2007 Congress, which by the same occasion marks the 100-year anniversary of PIARC World Road Congresses. This event has been built around the theme of sustainable development, which is not a new preoccupation for PIARC as evidenced by the prominence this topic has been given on the Association's Technical Committee work calendars over the past ten years. During the 2003 Congress held in Durban, the Ministers had already been asked to compare their approaches on how to go about applying this concept, which had undeniably become the leading concern at the dawn of the 21st century among road and road transport professionals.

Road networks play and will continue to play a fundamental role in stimulating the economy and shaping society, although the international road community today faces increasingly-complex problems in a world experiencing fast-paced changes. As opposed to a period 100 years ago, when the community placed emphasis on improving road design, construction and maintenance techniques, the focus over time has broadened to incorporate issues related to safety, the environment, facility operations, driving assistance systems, risk analysis, optimized financing schemes and network management performance. In addition, PIARC has directed its strategic efforts towards finding ways for roads to most effectively contribute to achieving regional development goals, on evaluating their social impacts and integrating them in the logistic chain through intermodality and spatial planning without weakening competitiveness.

The impetus now lies in coping with a whole new set of relevant issues, such as fossil fuel scarcity, global warming and an aging population. This change in direction has led to other questions being raised in relation to the road's optimal status within overall transportation systems. This is especially true with respect to resource waste prevention when the resource – in this case, road traffic capacity – has become more precious and limited than what would have been forecast during the major periods of urban and interurban development during the second half of the 20th century. How then can the demand for transportation be accommodated or altered despite its consistent growth over the years within an expanding global economy, whilst preserving the planet's equilibrium and without compromising the well-being of either current or future generations?

This question has been addressed at the Paris Congress through the assembling of more than 3,500 participants, including over 50 Ministers in charge of road networks, engaged in debating the key issues of current and future relevance in the field of roads. Moreover, this event underscores the level of awareness and responsibility gained by public authorities

and road industry professionals, who are confronted with the task of satisfying mobility needs while at the same time mitigating adverse impacts on both the population and the environment.

Introduction

In a century and a half, the mobility demands of the human population have substantially increased. More than any other mode of transportation, road use has grown to a point of becoming the world's dominant mode, accounting for over 80% of all passenger km traveled within any given country and over 50% of all freight km[1]. The number of motor vehicles has been increasing by nearly 3% per annum and industrialized nations spend above 1% of their GDP on roads and the road transport sector. Consequently, roads constitute the basis for a country's economic development, and this is particularly true for countries in the developing world.

Society's rising mobility demands, while stimulating economic development, influencing regional planning policies and affecting social trends, have created a new set of concerns for the 21st century that necessitate a more rational and intelligent "consumption" of the road resource.

Throughout the world, economic relations and commercial exchanges have been evolving rapidly and serve as the core of newly-created international trade routes and industrial relocations. Many nations are experiencing demographic changes that in time will be exerting a sizable impact on transportation infrastructure. Along the same lines, some of the structural trends shaping modern society, such as the aging of the population, will be felt in many areas, chief among them being road safety, which remains especially poor in emerging countries, where the number of road casualties continues to mount. In conjunction with these trends, the inevitable scarcity of petroleum resources and the corresponding rise in energy prices will encourage reflection on how best to adapt the transport sector and thus to structure the roads sector.

As a widely-known international association specialized in the sector of infrastructure and road transport, PIARC is intent on fostering and promoting efficient solutions, well suited to the key stakes of the period and compatible with sustainable development constraints. By creating its 2003-2007 Strategic Plan, the Association oriented Technical Committee work around four topics considered to be of strategic importance:

- Governance and management of the road system;
- Sustainable mobility;
- Road safety and operations; and,
- Quality of road infrastructure.

The 23rd World Road Congress has taken these four topics as its basic framework, and then expanded the analysis with the aims of both disseminating the results of the last four years' work of the Association and generating a work program outline for the next cycle.

[1] Source: The World Bank

Various types of sessions have been organized for this purpose:

- the traditional Ministerial session, which examined the topic of road pricing and in particular the use of roads as an intermodal policy tool for promoting sustainable development;
- strategic direction sessions, which were developed from the national reports prepared by member countries and were devoted to a prospective assessment of key issues affecting the road industry with respect to the four strategic topic areas;
- technical sessions, drawn from the work conducted by Technical Committees and individual contributions;
- special sessions, focusing on specific or cross-disciplinary topics involving other international organizations;
- poster sessions, during which the selected individual contributions were presented; and
- workshops, including the one on terminology to highlight the lexicographical work and tools developed by PIARC over the past eighty years.

The key objective of this document is to outline the main lessons from work completed by the various Technical Committees since the Durban Congress in 2003 and to set forth conclusions from the sessions held at the Paris 2007 Congress.

To streamline your reading of this document, it has been structured into two parts: the first contains the general report and summarizes both the stakes and goals of each strategic theme, along with the main subjects discussed during the Congress and the medium-term outlook. The major themes developed in this report were presented by France's Director-General for Roads during the closing session of the Congress. The second part of the report comprises the detailed conclusions from the different sessions. The reader can navigate this part of the report by referring to a particular area of interest.

General report

Governance and management of the road system

What are the challenges facing the sustainable development of road transport systems?

Introduction

Use of the term "governance" in the title of this discussion, as formulated by the Strategic Planning Commission, obviously refers to the corporate world and already offers a clear indication of the orientation and goals adopted for strategic assessments.

This topic focuses on determining how more conventional, administratively-driven management evolves into a dynamic management style, with a truly transparent decision-making process and a responsible attitude towards citizens and society's road networks, seen as an important tool of industrial production. Such evolution implies above all being able to explain and justify the decisions taken, and then to account for the effectiveness of action plans implemented in pursuit of the objectives set.

Within this framework, the following have been examined in detail:

- **economic aspects**, as a device for modeling overall strategy and making it possible to: elaborate a road policy as an integrate component of general transportation policy, quantify objectives and their respective priorities, determine the best adapted rate structures to apply, and select the most worthwhile network development and modernization projects;
- **investment financing** protocols, which provide the keys to road development and maintenance given the magnitude of the sums involved;
- **road administration performance**, within a context of decentralization, outsourcing, ethical concerns, changing professional demands, and the need to better evaluate efficiency in connection with stated objectives; and
- network **management and operations**, with the aim of preserving existing facilities, maximizing the use of available capacities and satisfying worthy demands to improve the quality of services.

Economic aspects associated with road networks

These issues were initially raised during the forum of the **Ministerial Session on road pricing** and included as an agenda item for **Technical Committee 1.1 entitled "Economic aspects of road networks"**, devoted to road system economics as part of the overall transportation system and to road project evaluation methodologies.

The road constitutes a fundamental element of the transportation system, particularly for ensuring end journeys and a more refined level of regional coverage. However, for medium and long distance trips or for urban mass transit, the road takes on a complementary, or even competitive, role with respect to other modes.

The basic strategy employed by transport authorities must be aimed at ensuring mobility under the most efficient conditions and highest level of service, while respecting both the financial constraints and general objectives established by nations in order to improve safety and mitigate adverse environmental impacts.

The economic approach yields a valuable tool in the search for a satisfactory compromise between these constraints. The technical report produced by Committee 1.1 on "**user recommendations for applying a multimodal evaluation system**" describes practices employed in 28 countries. A follow-up report discusses "**the use of monetary valuations in the assessment of socio-environmental impacts due to road projects**". This approach is to be pursued, in particular to engage in tradeoffs among objectives only directly quantifiable through relative expenditures or quality of service restrictions that the local authority is ready to grant in order to achieve its goals (environment, safety, traffic congestion, regional planning, etc.).

Ex-post socioeconomic evaluations are not yet widespread enough to draw conclusions on the relevance of these methods, whose implementation is not always straightforward. Until these techniques become more consistent, projects can be compared on the basis of directly-accessible ratios, by measuring financial data and physical characteristics of features exogenous to transportation production, as expressed in vehicle-kilometers traveled.

Before seeking to meet road transportation demand by means of heavy capital investment, decision-makers must first examine the extent to which they would be able to **reorient demand**, in terms of volume, mode, time slots, route or traffic control measures.

The levers available to decision-makers consist for the most part of spatial planning, regulatory actions and **road pricing**. We will narrow our discussion herein to road pricing, which was the subject of the ministerial session and has **three main goals**: **environmental preservation**, **balanced spatial development** and **infrastructure financing**.

Road pricing targets and levels will naturally vary from one country to the next, depending on the political, geographic and economic situation. Nonetheless, the

strategic reflection carried out on road pricing principles and fee-levying tools is common across borders.

The authorities in charge of road transportation systems are already equipped with a panoply of tax and fee-levying capacities tied to the purchase/possession of motor vehicles and to their overall use. They also possess more targeted instruments, such as road tolls and parking charges, which generate public revenues from infrastructure according to use by certain types of vehicles at certain places and times. Such instruments are especially beneficial when a portion of infrastructure is used by a larger group with quite different characteristics from the group of taxpaying residents within the locality (i.e. transit trips) or when users are competing with one another for scarce transportation resources (i.e. congestion).

These instruments cannot be applied universally without also considering the impacts caused by the implementation. Therefore, prior to implementation, careful consideration, comparison and evaluation should be given to impacts such as user behavior, undesirable effects, potential losses, their collection costs efficiency, and financial returns.

For purposes of illustration:

- taxes levied on vehicle purchase and possession are simple to implement, yet the impact declines with use intensity and such taxes are usually not standardized from one country to the next;
- taxes on fossil fuels are also easy to introduce and correlate well with CO_2 use and emissions, yet they remain independent of the place and time of use. They do not account for the introduction of new fuels, and are not standardized across countries. In free trade areas this can create market distortions and a waste of fuel, whilst increasing risks due to large fuel tanks on lorries.

Another system directly charging on road usage is applied to arterial high traffic volume roads (mainly access-controlled roads) and is gaining higher popularity. Several developed countries have adopted the toll road system for a long time. More recently many countries including developing countries have introduced the system.

The tolls for actual road use and parking taxes provide effective revenue-generating policies, even though they could be hindered by collection difficulties and costs. The rapid popularity of electronic collection techniques (i.e. ETC - electronic toll collection) has opened up new possibilities for road authorities to more easily achieve objectives. Although ETC systems offer new possibilities, there are enforcement issues that must be sorted out. Implementation of these modern road pricing and collection tools enabled more flexible road charges according to the time, day, place, etc. Although it is still too early to draw conclusions regarding their effectiveness on both overall transportation demand and modal transfer; however, effects on urban traffic congestion management have been observed.

Other modes of indirect revenue generation also exist, such as real estate capital gains induced by road improvements. To a certain extent, this situation can back-fire, as it is an incentive for urban sprawl and plant relocations, while at the same time public authorities have to compensate neighboring residents or protect them against newly-created nuisances.

Financing capital investments in road networks

The issue of road financing in most countries is considered a major problem given the huge sums of money involved. This topic, examined by **Technical Committee 1.2**, was also examined in **strategic direction session ST1 "Challenges for the sustainable development of road systems**" that dealt with "road financing", and also in the **special session SP5** titled **"Financing investments in the road sector through comprehensive long-term contracts"** that dealt with comprehensive long-term contracts.

The road network is essential for human activities and for logistic chain efficiency. Safe, smooth, efficient and environmentally-friendly road transportation systems are crucial for sustainable development.

But in many countries, there exists a financial gap between road investment demand and affordable resources. In developing countries and countries in transition, road development and maintenance have even more significance because of the lack of other transport systems. But, as a whole, the road revenue source is not enough to accommodate the road investments needed in those countries. Secured stable road funds especially maintenance funds, including the dedicated tax revenue, toll from road pricing systems, international aid and private investments, serve the regional stability and security and support the country's development.

If the road sector in a country is to develop in a sustainable manner, it is vital to secure funds for the construction, operating and management of roads. The methods used to secure these funds vary from one country to another and according to the social and economic circumstances of the country. Certain countries, by allocating part of the general budget to road financing, adopt direct financing by the government. Other countries that are faced with urgent road development or heavy budgetary constraints to secure stable revenue or needs to seek more beneficiary-paid fair revenue, have secured financing through dedicated funds or direct tolls etc.

Historically speaking, in the majority of countries, road-financing resources originate from either direct or indirect taxation. In return, use of road networks has not given rise to any kind of designated use tax. Funds stem either from the general budget (with the disadvantage of a lack of medium and long-term visibility and risks for the level of maintenance funding) or from dedicated revenues, such as fuel taxes (having correlation with driving distance and efficient collection).

Specific road-related taxes are based on the concept that the owners and drivers of automobiles, which get more benefit from roads and damage roads more, should pay more for roads development and maintenance by means of fuel taxes and/or automobile acquisition/ownership taxes etc. These charges can be dedicated, which make tax acceptance by users higher; nevertheless there are shared views among economists about dedicated funds, some arguing that the best allocation of resources could be hindered, others arguing dedicated funds, based on beneficiary pay principle, have functional aspect to reflect users' choices and demands.

It should be pointed out that in emerging countries, traffic levels and the capacity to pay (which is not the willingness to pay!) are not sufficient enough to finance the bulk of capital investments and road operations by means of a direct toll. In these cases, international aid from the developed world (which would indirectly benefit from the growth stimulated in this manner) channeled through international financing bodies is necessary.

Over the past few decades, some of the developed countries experiencing sizable medium- and long-distance traffic volumes have introduced an alternative means of financing the construction of modern, high-service infrastructure with a directly-applied toll. There are a wide variety of road pricing systems, encompassing toll rates, means of toll collection, objects to be charged, character of toll road organizations, risk sharing, scope of organization’s works, etc. None of them are universal. The introduction of road pricing is a highly social, economic and political issue. A system that fits to one country, might not work at all in another country. Not only the traffic volume or traffic characteristics, but a variety of issues including political or even cultural aspects, must be considered.

In summary:

- positive government participation is essential including supports if necessary;
- involvement of private sector according to the situation could help higher efficiency; and,
- experiences of other countries are helpful and could inspire better solutions.

When a public-private partnership (PPP) is applied, the construction and/or maintenance and/or operations components generally give rise to long-term contracts, which stipulates an advance for capital investments (with allowance for eventual subsidies) by the concessionary companies and an annual remuneration for work performed on the basis of contractual conditions. This may cover some risks and not others (construction risks, traffic intensity and type, weather conditions, inflation, major repairs, etc.).

All of these long-term contracts, in particular the full-service concessions, raise specific problems, which were cited during the **special session SP5 devoted to "road investment financing"**. The following received substantial attention:

- risk analysis and risk sharing;
- contractual conditions;
- renegotiation and rate adjustment mechanisms;

- regulatory principles and mechanisms; and,
- governance and balance between cooperation and competition.

In this case, the transportation regulatory authority delegates the entire sequence of construction, maintenance and operations of a portion of its road network (including all of the associated risks) to a private partner in comprehensive long-term contracts. The private partner either is paid by the public authority according to availability and performance or is entitled to directly collect a toll from network users for a period lasting several decades in order to cover the costs and risks incurred.

This arrangement has proven to be quite effective and has made it possible, during the most recent tendering procedures, to considerably curb reliance on public funds, albeit by accepting higher toll prices than on previous concessions, since the newer rates are tied to concessionaire profitability. This trend also indicates that the advantage users derive from modern, high-performance infrastructure is much greater than the toll rate paid on older motorways. Users are thus drawing a benefit that could lead to transportation resource waste or induce undesirable effects (urban sprawl or plant closings/relocations). This comment is even more applicable on toll-free motorways.

Between the two extremes of 100% public financing and 100% concession, intermediate financing formulas have been implemented in some countries. Such strategies feature the collection of tolls or taxes on some or all vehicles and on some or all road networks (especially on the most heavily-traveled networks and/or those accommodating large volumes of transiting traffic) as a means of complementing the budget or a special fund, along with the transfer of certain risks (typically those not related to traffic trends) onto the road-building contractors or operations firms.

These financing schemes allow road authorities to ensure improved resource durability, particularly for network maintenance and development. In addition, they enable them to define their own road pricing policies based on objectives not necessarily linked to just covering costs (see discussion on supranational economic aspects), without meddling in concessionaires' financial results. Moreover, such schemes limit the bonuses paid out to concessionary companies for absorbing risk.

Road administration performance

Nearly all the national-level reports prepared for the **strategic direction session ST1 on "Road network governance and management: What are the challenges facing the sustainable development of road transport systems?"** refer to the challenges faced by road network management organizations to improve their efficiency.

This topic, at the heart of **Technical Committee 1.3's** work, was examined within special sessions entitled: **SP1 "Evolution of road administrations"**, **SP2 "Governance and integrity"**, **SP3 "Responding to human resources challenges**

in the road sector", and SP4 "Evaluation of public policies in the road sector" and also examined within the **Strategic direction session ST1**.
From an organizational point of view, two main trends are observed in most countries: **decentralization**, and the **outsourcing** of various missions and assignments.

Regardless of their geographic size, many countries have **transferred road management and** decision-making powers to local and regional authorities, or to other public or private designated organizations. This obviously requires that they possess the capacity to assume such responsibilities, which is not often the case in the developing world. This therefore raises the fundamental question as to how such capacities can be generated at the local level at a time when central administration resources have been cut back considerably. In such cases, central government remains responsible for national road policy, but manages only a small strategic part of the total network, accommodating high traffic levels.

This decentralization theoretically enables regional authorities to control all local network links throughout their jurisdiction and to assume direct responsibility for consistency with local spatial planning and the demands expressed by both citizens and elected officials, regarding economic and social development, with special emphasis on rural areas.

This modification of roles between central and local authorities seems to be gaining in popularity. Switzerland, for example, is to recentralize management of its national road network, a responsibility it had previously delegated to the local level.

In conjunction with this trend, the tendency towards clearly distinguishing roles has been confirmed: the responsibilities of project owners, or internal project **decision-makers**, are differentiated from those of **operational production** staff and the project architect/management teams. This separation formalizes production responsibilities in terms of objectives and prepares for the possibility of transforming the corresponding bodies into independent public or private-sector companies, or prepares for the outsourcing of other responsibilities.

As for any sector in which sizable sums of money are involved, **integrity** becomes an essential component of good governance: this was the topic examined during **special session SP2.** The prevention of corresponding risks entails implementing an entire series of measures: building ethical awareness and encouraging authorities to adopt a universal code of ethics in addition to adequate remuneration scales (associated with a performance-based bonus program), adoption of a quality process that includes internal and external controls and a well-adapted auditing system.

The evolution in road administration missions and their organization also requires a **change in jurisdictional competence**. This topic was the focus of **special session SP3 "Responding to human resources challenges in the road sector"**, which also examined the techniques involved in keeping road sector professions attractive to younger generations, which is of equal importance to both the public and private

sectors.

In simple terms, a hundred years ago, road agencies needed a solid corps of design engineers, draftsmen to translate the plans, and a large number of field agents to ensure regular maintenance. In the future, there will still be a need for engineers as well as lawyers, managers and auditors (with a comprehensive set of skills to incorporate environmental, financial, safety and operational considerations), but also for technicians familiar with both computer-assisted design and computer-assisted drawing (CAD), purchasers, managers, auditors, operating system technicians and multi-skilled teams to handle network intervention and maintenance. Quantitatively, these staffing requirements result in fewer personnel (the size of the reduction depends on how heavily outsourcing is being pursued), and qualitatively by the creation of **new professions**. **Road administrations need to prepare** for such a major alteration in personnel trends, by planning for the training of specialists at different levels of competence, through basic vocational or in-house training schemes.

No effective organizational management can do without **a performance evaluation** focusing on both objectives and the resources employed to achieve them. This discussion formed the subject of **special session SP4 "Evaluation of public policies in the roads sector"**.

All administrations assess, to varying degrees, the economic, social and environmental impacts caused by their large-scale road network development and modernization projects. On the other hand, a significant number of them do not yet have a clear picture of the total resources consumed in reaching their objectives. Accomplishing this step entails an organizational evolution towards a "client-supplier" relationship in order to compare suppliers among one another (internal/external), disseminate best practices, and introduce performance improvement incentives.

Management of network operations

In recent years the environment in which national road authorities operate has been changing. Traffic volumes are growing at rates that cannot be accommodated by increases in capacity through construction. Congestion is worsening, making journey times both unpredictable and unreliable. Furthermore, there is growing environmental awareness and an expectation that in addition to dealing with traffic incidents, national road authorities should broaden their responsibilities and take into account spatial planning issues. These trends can be observed in most developed countries, at different rates depending on local circumstances, policy, organisation, level of implementation and expertise.

These are the issues that were raised and discussed by **Technical Committee 1.4**, the primary objectives being to improve safety, enhance accessibility, improve reliability, handle incidents and accidents rapidly, achieve effective control of road

works without closing roads to traffic, and provide the speedy and efficient dissemination of user information.

Congress presentations examined experiences and innovations introduced in several countries. Currently, it is stakeholder requirements, citizen and business needs and the following critical success factors that stand out as being the most important for road authorities within this field over the next few years:

- clarification of the role and responsibility of road authorities;
- development of policy frameworks and decision-making tools for network operations;
- greater understanding of operational requirements;
- better understanding of socio-economic benefits;
- clearer incentives for the development of services for road users;
- better quality in digital infrastructure and services to support network operations; and,
- greater cost efficiency and effectiveness.

Several international sources in Japan, the US and Europe report that ITS (Intelligent Transport Systems and Services) applications have a significant potential to reduce accidents, shorten travel times in urban areas, assist travellers and business and reduce the negative impact of traffic on the environment. Road authorities have often initially introduced ITS to solve localized problems such as road safety or congestion black-spots. However, it has become increasingly clear that these problems require more than just local solutions; they require a network-wide approach.

Committee 1.4 has developed an interactive manual on network operations, available on CD-ROM, to complement the PIARC Handbook on Intelligent Transport Systems, which is now published in English, French and Chinese.

Special session SP16 "**New concepts, new ideas to face the issues of sustainable development**" explored the role that ITS can play and the investment that vehicle manufactures are making to harness the full potential of new communications technologies. Roads authorities also need to play a part in shaping these developments.

Conclusion

The presentations of Technical Committees work and the various session roundtable discussions highlighted the following points, which merit mention:

- The road network is essential for human activities and for logistic chain efficiency. Safe, smooth, efficient and environmentally-friendly road transportation systems are crucial for sustainable development.

- In many countries, there exists a financial gap between road investment demand and affordable resources.

- There is increasing use of tolls and user charges, but there is still a fundamental role for taxes, especially specific road-related taxes based on the user-pays principle.

- Dedicated taxes are working well to secure stable revenue and make tax acceptance by users higher ; nevertheless there are shared views among economists about dedicated funds, some arguing that the best allocation of resources could be hindered, others arguing dedicated funds, based on beneficiary pay principle, have functional aspect to reflect users' choices and demands

  Road pricing offers a powerful instrument **for channeling demand** and **providing financing through methods other than taxation**. Recent trends in toll collection techniques should be utilized to develop this instrument further.

- In developing countries and countries in transition, road conditions are inadequate both qualitatively and quantitatively, but resources for road investments are very limited. Especially insufficient maintenance budgets are causing serious problems. There exists an urgent necessity to establish stable resources managed in a manner not to be influenced by short-term financial or political affairs, utilizing dedicated taxes and other means. Road pricing is also a useful tool in arterial roads with a certain amount of traffic volume when modified and adopted properly according to the situation of the country. For this purpose, **efforts to establish second generation road funds** must be encouraged. The developing countries with weaker economies can not afford investments for roads to satisfy even the very basic human needs and they must be supported by international aid organizations. Decision makers have to recognize the needs for road improvement and maintenance, which are essential not only for the economy but also for health, education and the elimination of poverty in these developing countries.

- The financing of road infrastructure, its maintenance and operations must all be secured by means of **greater visibility over both the medium and long term**, in seeking at the same time to share responsibility for managing risks with the private sector, notably when PPP is utilized. For emerging nations, procuring investments (whether dedicated for major travel corridors or the local grid, both of which are vital in satisfying mobility needs) still depends heavily on supranational financing arrangements. In contrast, experiences with second-generation road funds offer a promising prospect as a tool for guaranteeing the implementation of a benchmark maintenance policy.

- The road network constitutes an essential component of the overall transport system but neither an exclusive nor independent component, its development and operations must be planned within the scope of **a multimodal socioeconomic approach**;

- All road administrations are assessing the resources required to improve network performance through **a more industrial and less bureaucratic approach to** their working procedures. A trend towards decentralization and outsourcing has been detected. This has favored: objective-based work programs to optimize social benefits, conducted in a "client-supplier" mode, the search for uncompromised ethics, an adaptation of personnel skills (which requires efforts in terms of training), and an objective performance evaluation. In several countries, issues tackled extend beyond performance characteristics and include administration-related missions and coordination between policy-makers and administration;

- The incorporation of new, more ambitious objectives, especially in terms of safety, the environment and quality of service, requires **adapting and enhancing our economic and engineering tools for forecasting and evaluation**;

- All countries consider that the importance of road operations, information and driving assistance features via **intelligent transport systems** will grow in the future and that it is important to prepare for this evolution, which will enable optimized network use, improved quality of service and will generate savings on infrastructure capital investments.

- In conclusion, it is important to stress the need for **a more comprehensive approach to road transport in coordination with other transportation modes, sustainable spatial planning and environmental issues**. The development of road networks must be consistent with spatial planning and integrated into regional, nation and international development schemes.

Sustainable mobility

Introduction

Throughout the world, economic relations are progressing steadily. The fast-paced development of some regions is linked to both economic and trade expansion. Intense competition has caused the relocation of production sites and, at the same time, a whole new set of mobility needs. On a global scale, increasing numbers of international transport corridors are appearing, involving all transportation modes.

The historical seminar entitled **"Road civilizations of the 20th century" (Sessions SP18 and 19)** effectively illustrated these trends along with the corresponding economic and societal considerations.

Mobility needs are also influenced by the demographic changes: increased life expectancy, migration flows and strong demographic growth in developing countries.

Within this context, how can the concept of sustainable mobility be integrated into the roads sector?

Since the last Congress, the Technical Committees assigned the **Strategic Theme of "Sustainable mobility"** have sought to provide responses to this question through their work completed on **urban mobility**, **interurban mobility**, **freight transport**, and **rural roads and accessibility**.

For this Congress, the **strategic direction session ST2 on "Sustainable roads – part of the transport chain in a globalized world"** emphasized:

- transport chains and corridors within a context of globalization;
- consequences of demographic change on road infrastructure; and
- road-related impacts on quality of life, here especially the role that the road and road transport can play to cope with the world energy demand and its consequences on global warming.

Special session SP16 "New concepts, new ideas to face issues of sustainable development" presented an outlook on future energy sources, the evolution in automobile use and vehicle emissions, and the contributions of modern positioning systems and driving assistance techniques, the development of which calls for more efficient collaboration on regulatory and organization aspects.

Sustainable mobility

Strategic direction session ST2 emphasized how to cope with the demands of an economic globalization and the effects of demographic changes in a sustainable way. On the one hand, economic development requires building road networks and organizing road transport systems to enable growth. On the other hand, the urgent need for development – especially in developing countries – could lead to the neglecting of the sustainable development concept. It is important that the different transport modes are handled in a well-integrated way throughout the whole strategic planning process. The distribution of the traffic demand on different modes within a corridor is one of the challenges of sustainable planning. The “Climate Change” has reached a new level of public awareness across the world. The issue of CO_2 reduction is already a major aspect of environmental sustainability. Road transport needs to contribute to that goal too. Some countries fully aware of this necessity, have already listed environmental protection among their priority objectives and adopted procedures for consulting with the population when building new infrastructure. The sustainability of mobility and democracy thereby go hand in hand.

Despite these obstacles, the notion of sustainable development has been gaining ground. Through various case studies, the **Technical Committee 2.1 session on "Sustainable development and road transport"** examined how to integrate the notion of sustainability into road transport, whilst respecting the social, environmental and economic objectives of society. This session demonstrated that different contexts call for different priorities.

In order to encourage the integration of sustainable development, **international institutions** such as the World Bank now include this criterion when evaluating the projects they finance. Moreover, industries in the northern hemisphere are increasingly likely to incorporate sustainable development concepts under the heading of their **"social responsibility"** obligations, which in some countries gives rise to a public audit. In addition, firms are enforcing such concepts upon their partners and subcontractors in the southern hemisphere. This dissemination of standards is still at an early stage and unequally applied across regions, although progress is being made in this area.

Interurban mobility

In order to respond to the objectives of increasing economic wealth whilst also providing access to mobility for all social categories in an equitable manner while striving to reduce environmental impacts, a **comprehensive approach,** encompassing both **transport and spatial planning** is indeed.

Some countries have presented how this comprehensive and intermodal approach has been integrated into their National Transportation Plans. Such an approach may be supported by methodologies, such as the **four-stage so-called "cube" process** currently employed in Scandinavian countries and studied in detail by **Technical**

Committee 2.2 "Interurban roads and integrated interurban transport systems", who focused on **network management optimization**, **transportation planning from a regional perspective**, **the socioeconomic evaluation of infrastructure** and **intermodality**. Transposing this comprehensive approach to the context of developing nations warrants further investigation.

An efficient and sustainable planning of transportation services requires coordination between a sectoral view and a spatial view, in addition to ensuring balanced development. In emerging countries, priority actions involve connecting production zones, consumption zones and logistics processing sites, their link to intermodal facilities (seaports, rail stations), and improving access to rural areas. The constructions of major thoroughfares without complementing other modes of transportation would be pointless unless such projects had been assigned a supranational function and benefit from financing dedicated to this very purpose. In industrialized countries, the need to provide efficient road accessibility to remote regions at a considerable distance from major multimodal corridors constitutes another key issue.

One notes increasing attention being paid to the **social impact of road projects and policies**. The tendency is to evolve from a more technical rationale based on the production of transport services to a **socioeconomic rationale of transport use**. In regards to road transport, maximizing the use of existing equipment is a perennial concern, yet is now experiencing evolution at the international level. During its session, Technical Committee 2.2 notably examined issues relating to **Optimized network management** and **the best use of existing equipment,** by focusing in particular on **“Congestion management”,** which was also dealt with in **special session SP8.**

Confronted with increasing interurban traffic, greater road capacity does not always represent the best response to rising mobility demands, especially at a time when public-sector financing is becoming increasingly scarce. Within major conurbations, urban planning measures and the control of access to interurban routes must obviously be closely linked. The advantages associated with access control techniques must be promoted through a greater sharing of experiences and by encouraging creative initiatives.

Some countries, such as the United States or Spain, encourage carpooling by dedicating lanes of roadway to vehicles containing several occupants, or even by prohibiting access altogether to vehicles with no passengers other than the driver. Speed limits designed to enhance vehicle flow while improving safety and reducing nuisances, are also increasingly favored. Tolls are becoming more widespread, with an array of modulation possibilities over time and space, and based on vehicle characteristics (e.g. more or less polluting), for both interurban routes (Swiss RPLP or German LKW Maut, to cite just the European examples) and city itineraries (London, Stockholm, Singapore, Oslo). **“Pay as you go” tolls** will in the future be essential to encouraging **more rational and reasoned road "consumption"**. An optimized use of existing resources necessitates therefore as much effort as building a new piece of infrastructure.

Urban mobility

Technical Committee 2.3 "Urban areas and integrated urban transport" targeted its analyses on **urban congestion**, **megalopolises**, and **non-motorized mobility**. **Special session SP6** on **"Urban intermodality"** presented strategies and solutions for the mobility of persons, either under study or already deployed in various conurbations throughout the world, (Beijing, London, Madrid, Buenos Aires), within a wide range of economic development situations.

A number of countermeasures to reduce congestion have proven feasible, yet these require a comprehensive approach to the "urban planning/mobility /intermodality" system. Regulatory measures, such as parking policies, road pricing, traffic management, time management and the differentiated use of existing infrastructure capacity, lead to sensitive and efficient results if they form part of consistent overall policy. The "Strategy Guides for Sustainable Development in Transportation and Urban Planning", produced by the European Commission, propose excellent methods for use by decision-makers, project owners and technical experts.

Mobility and sustainability problems within the world's major metropolitan areas (i.e. cities with over ten million population) are raised on each occasion under specific conditions. Four studies conducted on Tokyo, Mumbai, Paris and Mexico City revealed that while two of them are slowly advancing towards more sustainable transport systems, none can at present make the claim of actually being sustainable.

Non-motorized mobility often gets ignored during statistical compilation and analysis. This vast form of mobility is considered quite differently from one place to another. Wealthier countries are rediscovering the virtues of such modes, whereas poorer countries are instead looking to gain access to motorized forms of mobility. Surveys show that non-motorized modes are typically listed independently of the other (motorized) modes, though it would be worthwhile to undertake a study of their overlap and interface. Such a course of action becomes possible when integrating non-motorized trips from the very outset within any project involving reassigned land use, which then leads to effective and economical improvements that also help to reduce urban congestion. Emphasis is now being placed on the unique needs of the mobility-impaired and the elderly, as well as on safety measures that rely upon multiple sensory devices. A Congress **special session SP9** was specifically devoted to "the **Mobility of vulnerable users**".

Programs like "Shared Space" in Northern Europe or "Accessibility for All" ("*Une Voirie pour Tous*") in France offer a comprehensive approach to mobility and services for all population segments and for users of urban public spaces. However, research still needs to be extended in this field.

Freight transport

International trade routes are channeled onto an increasing number of national and international corridors suitable for various modes of transportation, yet all situations lead to the same observation: road-based freight transport is constantly on the rise, especially over long-distance routes. **Technical Committee 2.4 "Freight transport and intermodality"** focused on the changes in logistics and non-road solutions, with emphasis on the issue of intermodal terminals, the handling of adverse consequences from road-based freight transport, and the elaboration of best practices when moving freight in developing nations and/or remote areas.

Developing countries often still face the problem of insufficient freight transport systems that lack good infrastructure and freight management systems but also cross-border freight issues and over-loading.

Over long hauls, rail and maritime transport (perhaps also in the future large airships capable of handling heavy loads within zones poorly served by land infrastructure) offer a viable alternative to road transport. Along these lines, support is required for multimodal projects that enable the **use of road transport only when its utility is greater than other modes**, quite often in cases where it is the only mode available (i.e. pre- and post-routing), and ensure in-depth service area coverage. **Intermodal terminals** play a strategic role within the distribution network.

Special session SP10 "Combined transport for freight" examined the requisite conditions to ensure the success of combined transportation modes, along with the role public authorities play in encouraging such an approach. This session also presented examples of good and innovative practices for logistics in urban settings although the discussion highlighted difficulties of pursuing transport efficiency while protecting roadside environment in residential areas at the same time.

One limitation when combining modes however, stems from extending travel itineraries and travel times (thereby generating waste), which may be due to excessive concentration of loading and unloading points. To lessen use of the road for transporting freight, one possible solution calls for a reduction in the actual volumes being transported, based on consumer tendencies to rely more heavily on local suppliers with a more local organization.

Special session SP11 "Providing for the operation of very heavy vehicles on roads" studied how to obtain increased capacity to accommodate heavy vehicles without sacrificing on stringent safety requirements nor adding to environmental nuisances, while maintaining impacts on the physical state of infrastructure within acceptable limits. This session analyzed various solutions during the course of the discussion, including the definition of performance-based standards and heavy vehicle certification measures. The key herein consists of knowing if it is preferable to have slightly fewer yet heavier or longer trucks.

Accessibility, safety, energy savings and nuisance mitigation constitute the main preoccupations that now guide development of a network, both multimodal and intermodal, in which the road will continue to play a vital role.

Rural roads and accessibility

Developing countries are confronted with the difficulty of allocating major capital investments for building strategic thoroughfares (especially to better connect hinterland regions) and at the same time for making large-scale improvements to rural zone accessibility. The latter challenge remains fundamental to winning the fight against poverty, by facilitating access to services while ensuring the flow of local industrial output and reducing transportation costs. **Technical Committee 2.5 "Rural roads and accessibility"** assessed the criteria used to evaluate accessibility needs, which serve to define planning policy. More in this vein than other road infrastructure components, local population involvement in the planning process and in the management and maintenance of roads and rural paths proves essential to ensuring investment durability. A wide array of experiences over the past several years has been observed with the backing of non-governmental organizations. The approaches attempted in various countries are worth sharing in order to draw lessons from the failures or successes, whose sustainability remains to be proved.

Conclusion

While a consensual point of view regarding sustainable mobility and transportation has yet to be reached, **the road transport system has nonetheless entered a period of profound change**.

The transition has been relatively quick from a technical rationale based on the production of transportation supply, towards a **socioeconomic rationale centered on transport use**. Supply and demand interact in a complex manner, especially given that decision-making authorities also take into account the exogenous effects of transportation, positive as well as negative, exerted upon the physical and social environment. The engineer must now work hand in hand with the economist, the facility manager, the elected official, and "civil society". This broader approach encompasses all of a project's environmental, social, cultural and socioeconomic consequences. From this perspective, transport must not be valued at a rate below its economic utility, so as to avoid waste or undesirable effects.

Among the paths towards progress, an **optimal use of existing resources** should be given as much importance as the building of new infrastructure, whether through controlling access and speeds, modulating tolls over time and space, disseminating information, etc. As for improved **planning** of future engineering structures, innovations are still needed in preliminary project evaluation methods and *ex post* assessments, through comparisons and experimentations of various approaches, or the installation of observation stations, etc. Each mode must be appropriately placed

within a multimodal combination for both passengers and freight. The main factors behind successful planning practices include: intersectoral cooperation, creative citizen participation, transparency in the relationship between the evolution of local authority missions and the function of strategic routes on the one hand, and on the other hand authorities, firms and miscellaneous interests. A shared vision of coordinated implementation over time also stands out as a key factor.

Over the long term, the inevitable **scarcity of petroleum resources** and, at the same time, a **general increase of energy prices,** are now accepted as fact. Consequently, more detailed investigations are required in terms of energy sources and vehicle consumption, improvements to **logistics management** and **co-modality** (i.e. multimodality where each mode is used in its most suitable context). The definition of an ambitious energy management policy and the reinforcement of legislation and fee levying practices are also necessary.

Since the trend cannot be reversed over the short term, it is also important to find ways of dealing with **mobility increases** on a global scale during the upcoming years. For roads, which will continue to play a vital role in both passenger and freight transport, the search for innovative technical and organizational solutions takes on even greater significance.

Sustainable mobility requires a judicious implementation of Kyoto and post-Kyoto commitments, by introducing the entire panoply of technical breakthroughs, **standardization schemes**, **regulations**, **pricing**, and **fiscal measures** at the global scale, which is the only relevant scale for such considerations. The transportation sector is naturally concerned by efforts to reduce greenhouse gas emissions. In this regard, sizable **discrepancies** can be noticed between countries, especially **between the northern and southern hemispheres**, with the former already concerned by the post-oil era and the latter barely able to access the mobility potential offered by the road. Yet the spreading of concern is sometimes faster than what one is led to believe.

Pursuing such efforts is necessary in the move towards sustainable road transport, the aim being to "do more – with less – for longer ".

Road safety and operations

Introduction

Road safety is a worldwide issue and has become a major concern shared across a growing number of countries. Road accidents account for nearly 1.2 million deaths each year throughout the world, with strong disparities between industrialized and developing nations. In emerging countries, the number of motorized vehicles in use is increasing rapidly without being accompanied by the required complementary set of regulatory measures, educational programs, health service actions and infrastructure renewal efforts. Road-related death rates in developing countries are rising dramatically, whereas they have been declining for several years now in Western Europe and North America. Due to the presence of other more devastating causes of mortality, such as AIDS, and given the wide array of actions that need to be coordinated in order to significantly improve road safety results, it is unlikely that road safety will be placed on the political or medical priority list in poorer countries in the near future. Sharing knowledge at an international level and bolstering the efforts undertaken by these countries are thus essential to achieving a worldwide reduction in road casualties.

Over the past few years, various natural disasters have caused widespread casualties and massive infrastructure damage, reaching complete destruction in some cases. In Sri Lanka for example, following the 2004 tsunami that claimed 35,000 victims, it has been estimated that structural rehabilitation work will last between 3 and 5 years, at a total cost of 1.8 billion euros.

The risks incurred on roads and the structural integrity of local infrastructure in need of repair are subjects treated with great attention the world over, as user safety constitutes a key to any transport system. The **strategic theme ST 3** deals with road **safety improvements** by means of **more effective risk management**, in focusing on all aspects regarding infrastructure and related facilities, at both the design stage and during the construction/operations period. The term integrated risk management is used to describe such an approach.

For the four fields lying within this strategic theme (**road safety**, **management of road-related risks**, **road tunnel operations** and **winter maintenance**), discussions held within the Technical Committees have stressed ways of upgrading evaluations, processes, design techniques and procedures relating to safety issues, with special emphasis on information systems and information sharing.

Road safety

While mortality rates within wealthier countries are expected to drop 27% by the year 2020, the worlds other countries are projected to experience an 83% increase in their rates as a result of: a rapid rise in the numbers of vehicles in circulation, inadequate infrastructure, road traffic congestion, and a shortfall in medical services. These countries are also more heavily affected by the human and economic impacts associated with road accidents, given that in financial terms the cost of accidents represents between 1% and 3% of their annual gross national product.

A **special session SP7** of the Congress was therefore devoted to **"Road safety issues and policies in developing countries"**; in order to identify the chief difficulties encountered and countermeasures taken to successfully implement a sustainable road safety improvement policy on a national scale.

The commitments undertaken regarding road safety, which have now become more prevalent in many countries, often encompass a political dimension manifested by setting objectives. Since introduction of the "Vision Zero" concept in Sweden, quite a few other countries have adopted similar objectives and action plans.

While human error had for a long time been the primary factor attributed to road accidents, the current trend calls for adopting an integrated approach to reducing accident frequency through incorporating all factors capable of influencing the user / infrastructure / vehicle relationship in a way that minimizes the consequences of human error. Significant safety gains are indeed possible by working to modify these elements. **Special session SP20 "Road safety audits and inspections"** focused on conducting road safety audits within the scope of designing safer roads, and on safety inspections, which have also been performed proactively to help overcome deficiencies in existing infrastructure. The recommendations forwarded by **Technical Committee 3.1** on these topics complement the guidelines in PIARC's **Road Safety Manual**, published at the conclusion of the previous cycle.

In measuring operations performance, it must be highlighted that some countries have achieved considerable safety improvements by taking systematic repressive action against motorists caught breaking the speed limit, which suggests that discrepancies in objective achievement are not solely attributable to road characteristics. Speed limits must also be adapted to road conditions and the appropriate enforcement measures implemented.

The availability of coherent data is obviously essential when carrying out analyses and comparisons of various practices indicate that improvements in this field require efforts in terms of standardizing accident-related information. It is the effort undertaken with databases, such as CARE (European Community Database on Road Accidents), CODES in the United States and IRTAD at the worldwide level, and others at national level.

It is also necessary to single out the higher-risk user populations and enact appropriate measures. The majority of road casualties in developing countries are not in fact vehicle occupants, but rather pedestrians, motorcyclists, bicyclists and the occupants of non-motorized vehicles. It is not altogether certain that these countries are able to benefit from the experience of industrialized nations, which adopted safety improvement strategies in favor of these road user categories by introducing specific technical features (double guardrails, dedicated lanes, traffic separators, etc.). It is likely that it would be more effective to encourage the creation of specific programs, adapted to the situation of each country and intended to build user awareness of the risks induced by combining very different types of traffic and the speed limit requirements that such road sharing requires.

In the world's wealthier countries, life spans are lengthening and a new segment of the population, which until now had not experienced high accident casualty rates, has become exposed to risk (e.g. 40% of road deaths in Japan lie in the 65+ age category).

Special session SP9 "Mobility for vulnerable users" opened a forum to collect feedback from various user categories (pedestrians, the elderly, the disabled, cyclists) in order to better understand their perception of needs. The session also presented solutions applied to various contexts with the aim of improving safety and facilitating mobility. The priority is often given to motor vehicle flow in the design of road infrastructure, particularly in urban environments. A shift in focus is required now where the quality of life and mobility needs of the various categories of road users are given serious consideration.

Some technologies of **intelligent transportation systems** (ITS) have revealed a very positive impact on **road safety** and must be employed or at least tested on a wider scale: seat belt reminders, intelligent automated speed limiters, collision prevention and vehicle stability maintenance systems, and "e-call" systems, etc. Research on navigation and driver assistance systems has shown promising results; in particular, the dissemination of live information on the state of road conditions, the proximity of special traffic zones or upcoming bottlenecks can potentially avert the accident-causing error that the uninformed driver would have committed. In the long term, communication systems between infrastructure and vehicles or between vehicles will provide additional assistance to drivers. However, their development calls for improved collaboration between the various players, in order to tackle organization, regulation and standard-related issues.

Special session SP16 on **"New concepts, new ideas to face issues of sustainable development"** examined several of these new technologies.

PIARC has issued a report on ITS addressed to road administrations that details the effects of such systems on road safety. The Association recommends implementation of a medium-term ITS action plan. The report should assist authorities in shaping their individual strategies in terms of deployment and cooperation with suppliers and operators. Developing countries can also take advantage of these systems, whose

costs are not necessarily prohibitive and whose cost/benefit ratio remains very attractive.

Risk management

Risk is defined as man's encounter with danger. It represents the probability of a prejudicial or negative result that deviates from the desired or programmed outcome. This notion of risk is associated with the prospect of sustaining material losses, damages, loss of life and uncertainties regarding the negative consequences of a given event.

Attaining a zero risk state is, in most instances, simply not possible. However, minimizing the consequences of risks, which must first be identified, offers an objective worthy of consideration within a typical risk management approach. By means of a structured process, this approach entails minimizing human casualties and infrastructure damage in light of the possibilities available within a given technical, administrative and financial framework. The road safety concept must be extended throughout the infrastructure life cycle, from the planning stages until removal from service, which yields a truly **integrated management approach for reducing risks**.

The **strategic direction session ST3 entitled "Risk management: new approaches to improving safety",** examined this concept which is neither well understood nor widely applied in the road sector. Practical examples of risk management as a new approach towards upgrading road safety were presented by Canada, the United States, the United Kingdom, Japan and the Netherlands. **Special session SP14 "Disaster mitigation: road authorities preparation and response to emergencies"** sought to draw lessons from recent cases (hurricane Katrina, earthquake in Japan in 2004) in order to analyze how authorities reacted or organized their response.

Technical Committee 3.2 "Risk management for roads" focused its work on introducing risk management techniques into the road sector, adopting risk management practices in major projects and improving road network safety. The results provided by 23 countries following a survey, enabled Committee 3.2 to assemble a **"toolbox"** in the aim of identifying and sharing best risk management practices at the international level. The database used is intended as **risk evaluation and reduction tool**.

Land available for building infrastructure is becoming scarcer, especially in urban and suburban zones where projects often have to be developed in zones recognized as difficult and risk prone, by adapting to the construction constraints. The strategy often entails limiting land use by: consolidating unstable slopes, running infrastructure underground, which leads to risks of both soil and potential water infiltrations, positioning structures on soils with limited load-bearing capacity, or encroaching on flood zones.

Landslides are **natural risks** which warrant considerable attention. A series of prevention methods were presented by a number of participant countries. Japan, for example, has developed a monitoring strategy that involves strain gauge measurements connected to a warning system. In order to plan its preventive maintenance program, New Zealand has adopted an exhaustive risk evaluation and risk ranking system for embankment instability, on a specific itinerary. Vietnam has also developed proactive risk management strategies as part of a system to protect against landslides and pavement damage caused by typhoons.

Revised seismic standards for engineering structures in Japan following the Hyogo earthquake in 1995, from the analysis of damage observed on bridge piers, call for improved design computation methods for future projects and served to launch a three-year campaign for reinforcing existing bridges. Japan also implemented emergency procedures for quickly restoring service continuity on its road network.

Risks relative to human activity may be of either a deliberate or accidental nature. **Strategic direction session ST3** provided a reminder that transportation equipment can be used by terrorists as a weapon, a target or for weapon conveyance. The United States has undertaken a synthesis for evaluating the management of risks related to terrorism aimed at road infrastructure. In a straightforward manner, critical resources are identified along with their vulnerability.

While **public health** effects related to **automobile pollution** cannot necessarily be qualified as accidents, they do constitute a key concern. Megalopolises of several million in population generate major traffic volumes and quite often in increasing proportions, which account for a considerable production of noxious particles and gases. In some cases, pollutant concentrations surpass the standards widely accepted by the World Health Organization.

Use of quantitative models to study the potential consequences of **transporting hazardous goods** through residential zones or areas sensitive to pollution offers an example of **a risk management tool**.

Road tunnel operations

Tunnels create confined spaces; fires, secondary accidents and faulty human reactions when confronted with crisis situations are difficult events to manage, whilst their consequences are often very serious. They have therefore particularly been under scrutiny for the past several years. A European Union directive, greatly inspired by the work program of **Technical Committee 3.3 "Road tunnels operation"**, set forth in 2004 the minimum safety requirements applicable on the Trans-European road network (tunnels over 500 m long, whether newly-built or existing). In particular, this directive stipulates creating safety documentation, appointing an independent safety agent and in numerous cases, performing a risk analysis. Application is well underway in many countries, not only in terms of

improved operating measures and the organization of safety measures, but also in terms of infrastructure improvement programs.

Committee 3.3 also investigated the main operational issues associated with road tunnels, and notably dealt with human and organizational aspects, the importance of which has been highlighted in the last decade. In addition to conducting an analysis of user behavior and related consequences, the Committee has published reports on operations organization, staff recruiting and training, the management of the interface between operators and rescue services and the specificities of urban tunnels with heavy traffic. Recent advances in technical equipment were studied, notably incident detection by means of video image processing, the best ventilation operation strategies and fixed firefighting systems (especially water mist systems), the use of which has considerably increased in recent years, but calls for clarification.

Special session SP15 "Management of safety in road tunnels" studied several initiatives for improving safety, launched at both national and international levels, some of which have involved automobile clubs. During its technical session, Committee 3.3 presented a recent report which promotes an **integrated approach** towards tunnel safety, developed in collaboration with European research projects, and which spans the entire system composed of: infrastructure, operations, emergency response, users, vehicles. This systematic approach is based on risk analysis, whose benefits and methodology have been examined, and on a clarification of the responsibilities of the various players and their collaboration, which has led to a series of recommendations.

User behavior is a relatively recent field of study and needs to be better incorporated into tunnel design and operations, including the organization, hiring and training of operations personnel.

Winter maintenance

Wind, heavy rainfall, snow and ice are common meteorological occurrences, yet still deserve considerable attention from road managers. The Snow and Ice Data Book, published in 2006, summarizes winter maintenance operations in 21 countries. Winter maintenance provides a good example of an objective-based level of service, which enables establishing an acceptable degradation threshold and designing the production tool, anchored within a risk management rationale. The focus lies in: determining risks from a climatological analysis, monitoring weather patterns and the state of pavement surfaces, and taking action that under icy conditions often necessitates prevention. One of the reports issued by **Technical Committee 3.4** offers an analysis of the **weather-road condition information systems** utilized during the decision-making process.

A key to success is gaining a complete understanding of the weather and its impacts on the roadway. This is achieved by collecting and quality-controlling as much road weather data as possible and disseminating it widely. However, doing this requires

good collaboration across the technical departments of the meteorological and road management organizations. The bringing together of these two fields creates new possibilities. It is essential to continue further development and integration of road weather information systems and winter maintenance management systems together with other systems and data sets.

Administrations are striving to minimize salt consumption and to optimize their winter road maintenance operations. It is important to continue to test innovative approaches against a socio-economic model to assess the consequences of changes in maintenance strategies. There is a need to consider winter maintenance requirements at every stage when planning a road.

It is also necessary to continue considerations relating to the outsourcing of winter maintenance operation contracts in order to ensure user satisfaction and the optimal use of financial resources.

Winter maintenance services for pedestrians and cyclists are urgently required in order to increase the use of these modes of transportation during the winter months. The potential decrease in short car trips would also be beneficial for the environment.

Finally, the impact that climate change has upon winter maintenance should also be analysed.

Conclusion

Reducing the risks associated not only with road accidents, but also with natural and human disasters affecting roads, is of tremendous importance for both developed and developing countries.

Although it is impossible to reconcile with nature or man in such situations, the risk management process can still provide responses, even if the residual risk can be significant. Making the most reasonable decisions regarding resource allocation constitutes the basis of any risk management strategy, which looks to replace intuition with a scientific approach.

Road infrastructure quality

Introduction

The road infrastructure making up road networks constitute assets of considerable monetary value that need to be preserved. During the Congress, the various sessions of this strategic theme (road asset management; road/vehicle interaction; road pavements; road bridges and related engineering structures; earthworks, drainage and capping layers) examined how efficiently-managed road assets, coupled with new design and building/maintenance techniques, can extend infrastructure durability, while minimizing the nuisances experienced by users and adverse environmental impacts.

Road asset management

Road agencies are assigned to build, operate, maintain, improve and preserve road assets through the allocation of financial and human resources, which often are in short supply. At the same time, road users are placing greater demands on the road network in terms of safety, level of service, reliability, comfort and environmental impact, while government agencies are seeking greater transparency in the approach towards the management of road facilities.

For this reason, many countries are studying how best to introduce the concept of global road asset management in order to offer a better organized and more flexible process for making the decisions necessary to meet the growing expectations of both the public and government.

While the need to efficiently manage road assets is well understood, the social and economic context within which management functions are performed varies considerably from one country to the next. The most industrialized nations are now focusing on an optimal use of existing roads, whereby reducing congestion sometimes takes precedence over road asset preservation efforts, while countries with emerging economies are pushing first and foremost to rapidly expand their road network. Road infrastructure also lies within highly diverse natural environments, with some countries facing the difficulty of extreme climatic phenomena. In addition to this, some road agencies are currently confronting major reorganization challenges, with management responsibility for certain infrastructure or activities being transferred to other administrative entities.

The roles and responsibilities of each decision-making actor (technical experts, public-sector managers and political leaders) and the interactions required to perform efficient road asset management were the centerpiece of the **strategic direction session ST4 entitled: "Road asset management: integrating best technical and management practices with political responsibilities".** This session clearly emphasized that good road network management is based on two key elements:

detailed knowledge of the state of the network and efficient communications between technicians, road administrators and political decision-makers.

It is necessary to highlight the importance of links created between the technical and political levels. In most cases, politicians determine the financial resources allocated to maintaining road assets and developing new facilities. Road infrastructure management requires a long-term vision, while political imperatives often lie within a much shorter horizon. Road facility managers therefore play a vital role in clearly explaining to political decision-makers the long-term effects of their decisions regarding works programs and investment schedules. The facility manager can heavily influence investment flows into the roads sector. Countries with an established road asset management system acknowledge the utility of such "systems" which help to justify requested budgets and convince decision-makers of the profitability of their investment plan. Other countries have stated that lack of commitment on the part of facility managers is a major obstacle to establishing a road asset management system.

As is the case with public-sector facility managers, technical experts play a key role in implementing these systems. They are responsible for collecting **reliable, accessible and high-quality data**, used for **decision-making** and day-to-day infrastructure management practices. They must also regularly consult with managers to evaluate needs and ensure the relevance of technical information. These experts are required to **convey the information** collected in terms understandable to both the operational managers and elected officials. Along these lines, **Technical Committee 4.1 "Management of road infrastructure assets"** emphasized the **prioritization of performance indicators**, which allow monitoring and predicting road infrastructure state of repair, and to adapt indicator levels to the decision-making hierarchy. One attractive solution to facilitate communication with public-sector financial managers entails converting technical information into equivalent costs. This approach is particularly widespread in Sweden, where a road asset accounting system has been based on the notion of "road capital", in which technical data is input into the quality indicators.

On the whole, national reports have confirmed the utility of road asset management assistance systems, which rely upon periodic data recordings, technical inspections, diagnostic assessments and guides for selecting the best-suited maintenance and repair methods.

These systems consume resources that can still be optimized through automating and adapting diagnostic frequencies, yet their mobilization remains essential (especially if budget allocations become scarce), in order to avoid diverting funds from the maintenance budget.

In an approach where the "road user" is increasingly considered and treated like a "client", it is crucial to incorporate their point of view into management practices. Some countries have conducted public surveys, whose results have served to shape road network intervention policy.

Although many countries are actively working in the area of road asset management, yet at present none has actually implemented a complete system. These systems, all too often, are still perceived by decision-makers as computer tools and not as comprehensive management processes capable of explaining the consequences of a particular investment strategy, justifying the need for additional budget allocations, or demonstrating to political decision-makers the result of infrastructure neglect. To progress further, technicians need to learn how to express their needs with greater clarity to audiences who are not experts, and explain in simple terms the rationale behind past successes and failures.

The issue of road management within developing countries was raised in **special session SP12**, which focused on the durability of road maintenance budgets and emerging conditions affecting local contractors responsible for these works, as road administrations have been required to forego conducting works through in-house management and dismantle their resource base.

In several regions throughout the world, climatic changes would already appear to be the cause of phenomena capable of undermining road infrastructure durability. **Special session SP13** on **"Vulnerability of road systems to climatic changes"** presented various examples (e.g. permafrost melt, coastal erosion, drainage and instability problems). Study methodologies have previously been devised, and network managers should be taking these hypotheses into account during the design phases of new infrastructure and when possibly adapting existing infrastructure.

The road/vehicle interaction

In this domain, **Technical Committee 4.2** "**Road/vehicle interaction"** has developed an inventory of equipment and techniques for monitoring the effect of traffic on roads.

This Committee continued its work program on standardizing methods for studying pavement skid resistance, by using the test tyres specially developed for PIARC; this measurement campaign has established a good level of representation.

Advice on good practices for measuring and managing road surface skid-resistance and evenness has been collected. The Committee has compiled a set of methods in practice throughout the world for measuring, interpreting and utilizing data, in the form of contemporary guides. Within the developing world, evenness is often expressed in terms of ride quality, yet its impacts on time-related costs, excess fuel consumption and vehicle maintenance can also be considerable. The priorities in industrialized countries are quite different; while ride quality remains important, greater emphasis is placed on the safety and dynamic load effects of road profiles. More recently, increased attention is being paid to fuel consumption, given its impacts on the environment.

Other efforts deal with evaluating the performance of devices for automatically detecting surface cracking as well as the methods and instruments for inspecting unsurfaced roads.

Lastly, in order to shape a vision over the next 20 to 30 years on the impact of changes in vehicle characteristics and road surfacing, Technical Committee 4.2 organized a workshop during the Congress proceedings to enable the automakers, tyre manufacturers, facility managers, road designers and researchers present to share their perceptions. PIARC should now aim to strengthen ties with the automobile industry so that the vehicle and road sectors understand each other's projects and constraints. For the upcoming cycle(s), onboard vehicle techniques for monitoring road/vehicle interactions should be receiving special attention.

Road pavements

Research over the past four years has been oriented around three topics: long-life pavements, pavement recycling, and the impact of road construction and maintenance activities on users and local residents.

Designing **long-life pavements** is indeed possible. The approach may prove beneficial in reducing both direct construction- and maintenance-related costs and indirect costs borne by users (i.e. less traffic disruption, given the lower magnitude and frequency of maintenance work).

The potential of using long-life pavements is now on display, moving from the conceptual phase to the actual demonstration stage. Though difficulties often arise in assembling comprehensive information capable of explaining the outstanding performance of such a pavement, the main factors are: the need for quality material, construction homogeneity, drainage, quality and bearing capacity of the subgrade, compliant thicknesses, bonding between layers, and compaction quality.

The introduction of long-life pavements implies providing more solid and well-documented technical bases, in order to demonstrate their effectiveness and cost/benefit advantages.

Pavement recycling is considered among the techniques contributing to sustainable development, by making it possible to save on non-renewable resources. In 2003, Committee 4.3 had already published three technical guides devoted to: *in situ* cement recycling, *in situ* recycling using emulsion and bitumen foam, and hot in-plant recycling. Even though several industrialized countries have already demonstrated the relevance of these recycling techniques, the practice has not yet reached its full potential and its credibility is not yet universal. Several factors still prevent the use of recycled or alternative materials, chief among them being the lack of client awareness, the complexity of regulations on the reuse of waste material, the absence or scarcity of technical standards covering alternative materials, and overly rigid contractual requirements that do not encourage innovation. To create an attractive

market for recycling activities, advance planning and coordination among the various actors is of paramount importance. Economic incentives, rules mandating recycling and enhanced client awareness could all promote such a market.

The focus on **mitigating the impacts of road works** on users and the environment varies widely between emerging nations and the most industrialized countries. The latter place substantial importance on this issue, particularly in urban areas. Though innovations aimed at reducing the impact from building sites have already been introduced into practices in a number of countries, additional technological progress would be facilitated if contractors were given more freedom to innovate. The testing of performance specifications is one step that would foster greater innovation.

Road bridges and related structures

A significant operating flaw or capacity loss on a bridge often exerts a major effect on the regional economy. It is thus essential that road administrations allocate necessary resources to maintaining the level of service and safety on all bridges under their responsibility.

The session organized by **Technical Committee 4.4 "Road bridges and related structures"** highlighted that in numerous countries, there have been changes in concerns. Whereas designers previously focused on the resistance of structures, they are now more concerned with the **durability** of engineering works, although they are faced with different environments, materials, construction methods and maintenance practices. Feedback has underscored durability problems, which may be explained by design choices that minimize the initial cost instead of reasoning on the basis of overall structural cost.

As regards the durability and life cycle of existing structures, new materials or solutions have been implemented to reduce repair costs and traffic disruptions. It is hoped that the library of examples set by the committee can be of use to administrations, consultants and contractors in efforts to determine the best maintenance or repair strategy.

A number of countries now possess integrated systems for structure management that prioritize works carried out on a network. Even though the underlying philosophy and prioritization methods vary from one country to another, each country recognizes the need to generate **homogeneous, reliable and up-to-date data** on its engineering structures. By planning well ahead for easy-to-access systems, linked to sensitive elements of structures, the monitoring and maintenance of these engineering structures can be considerably facilitated.

Besides durability, other topics of **interest for the future** merit attention by PIARC during its next cycle, notably **the evaluation of existing structures**, **structure instrumentation**, **management of historic bridges** and **bridge aesthetics**.

Earthworks, drainage and subgrade

The use of soil treatment techniques has risen substantially over the past two decades, yet too many emerging countries are unable to access these techniques due to cost considerations, the absence of binders or suitable equipment, etc. Soil treatment, by reusing local materials and improving their performance, satisfies the constraints imposed by a sustainable development policy. It is necessary to study the possibility for the development of reliable implementation techniques adapted to developing countries that rely upon local labor and simple equipment instead of imported, intricate and infrequently-used instruments.

With respect to the reuse of wastes and industrial byproducts as building materials, there is a considerable difference between the northern and southern hemispheres. In the industrialized world, two contradictory policies are in place: conditional reuse, and strict application of the precautionary principle via systematic disposal. The need for technical benchmarks therefore is strong, in order to define conditions for the reuse of these materials.

Only a few recommendations have been published on managing geotechnical structures in road projects, whereas their defects can have severe impacts on the network and its operations. Establishing methods for evaluating geotechnical structures along with proactive structural management approaches does warrant PIARC support.

Conclusion

Road user expectations regarding network level of service are constantly rising. At the same time, road agencies are being more heavily scrutinized and are required to improve communication about the way they manage the road assets under their responsibility.

Road administrations must therefore develop very clear strategies for the development, modernization and maintenance of road infrastructure, based on the need to ensure comfort and safety of road users and overall transport efficiency.

They must promote modern and efficient means of communicating with the public, so as to ensure transparency in decision-making and the promotion of road infrastructure projects.

Integrated road asset management systems offer the tools for road administrations to better respond to these demands and move towards optimal resource use. No system of this type is as yet fully operational. However, many countries have already set up a solid base for building such a management system in the future.

In all cases, it is beneficial to compare resources devoted to maintaining the various road components with their replacement value, their life cycle and the traffic intensity they bear.

Within a sustainable development context, the durability and recycling of pavements and engineering structures, in addition to the use of waste matter and industrial by-products as building materials are becoming increasing concerns for road designers. The efficiency and the cost/benefit ratio of long-life roads are starting to be acknowledged and several industrialized countries have demonstrated the benefits of recycling techniques. However, these practices have not yet reached their full potential, in part due to the significant need for technical reference documents detailing their use.

Finally, interactions between the vehicle/driver/road are constantly increasing due to the development of intelligent transport systems that enable information exchange between these elements. Improved consultation between road administrations, driver assistance system designers and vehicle manufacturers would enable these new technologies to be optimized and used to their full potential. In the next cycle(s), it is in particular recommended to keep a close eye on the development of on-board systems enabling the monitoring of vehicle/road interactions.

In conclusion, the design and construction of roadways and engineering structures can incorporate the principles of sustainable development provided that consideration is given well in advance to the financial and technical aspects of their maintenance and if technical innovation is encouraged.

General report conclusion

The road constitutes a vital asset that needs to be developed and used reasonably within the context of sustainable development all over the globe. Though the road *is* and will continue to be indispensable, especially at the beginning and end of the transport chain, at present it is not always used in the most effective or pertinent manner, and management practices are not always the most optimal.

In the future, road use must be considered as a consumable resource not to be needlessly “wasted". Road infrastructure must be managed with the kinds of quality and profitability criteria widespread in modern industry and with high governance standards.

Faced with the obvious signs of climate change, sustainable transport planning, which is underway in many countries, is now imperative and necessitates effective coordination between the sectoral and the spatial views, in order to positively affect mobility without curbing it. Achieving this goal entails a spatial planning policy that aims to reduce greenhouse gas effects due to needless or undesirable trips (e.g. subsequent to industrial site locations or urban sprawl), along with modal redistribution, for both passengers and freight, backed by the construction of multimodal terminals and the development of intelligent transport systems in order to offer a seamless flow. Realizing emission reductions in the transport sector is often a co-benefit of addressing traffic congestion, too. On the other hand, the non-negligible impacts of climate change on road infrastructure must be identified and related risks assessed and taken into account in road design, operations and maintenance. PIARC has an important role to play, by anticipating these changes and enabling the continued sharing of knowledge and experience.

Mobility is a need and fundamental right of all societies, yet will only be **sustainable** if exercised judiciously. Without systematically curbing demand, decision-makers must aim to impact on it in time and space, as well as upon supply of the most appropriate modes for each mobility need. Spatial planning, telecommunications developments (telecommuting), and the modes for producing and distributing goods, in particular the just in time process on one hand and the concentration of hubs and gateways on the other hand, all lie in close interaction on this topic.

There is increasing use of tolls and user charges, but there is still a fundamental role for taxes, based on beneficiary-pay principle as far as possible. Road networks including arterial roads and large amounts of feeder roads must be improved and maintained continuously but secondary roads are fundamental for alleviation of poverty as well. It is necessary to secure stable resources for development and maintenance of the networks from taxpayers, or road users.

Dedicated taxes are working well for securing stable revenue in those countries that adopted the system. They should be used for road users’ benefit, because the stability and equity are the key of the road financing system.

Road pricing, not only at the cost price of transport (including externalities) but rather at its utility price (should it be higher), as is the case for all scarce resources, offers a valuable tool that guides the choices of economic players and individuals without reducing competitiveness. It enables choices such as whether to travel or not, the mode of transportation, itinerary and time of travel, etc. All these choices in combination will help to alleviate congestion on roads while contributing to environmental protection. Nevertheless road charging must be socially and economically sustainable: willingness to pay and ability to pay must meet. Another issue is to determine if these resources must be dedicated.

Road investment financing must be designed as an industrial investment even though it is generated from tax revenues and the long life cycle costs have to be optimized by efficient asset management. Choices must be made on the basis of economic and social profitability and not only because of financial considerations although this is a constraint that must be considered. Funding and management tools should be coordinated and be consistent with each other. Partnerships with the private sector can improve efficiency but private financing doesn't generate "new money". Comprehensive long term contracts create new governance challenges and the role of government remains fundamental, but the skills needed to manage these challenges must change significantly. Alternative provisions for road infrastructure and services must not be a matter of dogma; efficiency should be the key driving force.

The efforts of developing countries and countries in transition to secure stable revenue for road development and maintenance including second generation road funds should be encouraged.

Road administrations must function like industrial firms, with respect to objectives, organization, human resource management and quality and performance measurement criteria.

Actions conducted in the realm of **network operations,** whose field of application still needs to be developed, often provide an effective economic alternative to heavy capital outlays for new facilities.

Road freight transport capacities are vital, especially for end-journeys. However, alternative modes should be examined on longer-distance routes, (without excluding the use of pricing levers), although not systematically since break-of-load during transport extends travel distance and time, which in turn causes waste (even more so on road trips). The segments where road transport proves most efficient will require modern, clean-burning trucks that may even be longer or haul bigger loads than those in circulation today.

Accessibility comes into play at various scales: from the issues raised over connecting isolated regions or even entire countries, all the way to the very local level, which for rural settings in many developing countries constitutes a real aim for

a society directly pursuing poverty reduction objectives. For the industrialized world, the local level problem has less to do with transport than with quality of life and spatial organization. On this feeder road network, vulnerable users must be given priority and medium and long-distance routing must be dissuaded, in particular by measures applied to route geometry, road operations and regulations (speed). Within countries in transition however, where network specialization is not easily possible, the conditions that allow different types of traffic to coexist must be examined on a case-by-case basis.

Road safety should be treated as a priority objective throughout the world and the full scope of consequences needs to be assessed. In a confined economic space with a fragile environment and limited financial resources, building motorways (considered the safest means of road transport) would be impossible to imagine everywhere, which is why priority must be placed on modifying behavior and controlling speeds.

Risk management consists of a conventional industrial approach that should be gaining prominence in the roads sector. This Congress has provided helpful illustrations of some aspects, such as tunnels or meteorological risks. From a more general perspective however, this approach offers the possibility of dosing to just the right extent the probability of occurrence and seriousness of consequences associated with a given risk.

The efficient application of **road asset management** techniques must be adopted as a priority objective by road administrations. Once again, the network is seen as a production plant, and no rational industrial manager would avoid maintaining production machinery. It is important to evaluate the network's condition and the actual effect of maintenance operations. These data are then matched with their impact on the overall economy (safety, fuel consumption, vehicle wear, noise, dust, loss of competitiveness or tourist appeal, etc.), in order to provide decision-makers with all elements necessary to make objective choices.

Infrastructure **quality and durability** must remain an ongoing concern of designers, along with design and maintenance costs and technical expertise. Without going as far as making reference to the Egyptian pyramids, Roman roads and medieval bridges, it can still be asked why the life span of some of our infrastructure is so short and what the cost would be to extend it.

Moreover, road and vehicle operating costs must be incorporated into infrastructure design and maintenance policy.

Both now and into the future, **vehicle/road/driver interactions** will become a major technical topic area. Closer cooperation between road administrations and vehicle designers will serve to optimize the use of the road space and, in particular, to benefit from the opportunities offered by new driving assistance and intelligent road technologies, for the purpose of improving the safety and comfort of road trips.

PIARC, in proposing a forum of international exchanges for the world's road community and through its interdisciplinary approach that helps the various disciplines understand one another thanks in part to the work completed on terminology, will continue to make valuable contributions to economic growth and social well-being.

"*VIA VITA*": Roads are life!

Detailed conclusions

Strategic direction sessions

TS1 CHALLENGES FOR THE SUSTAINABLE DEVELOPMENT OF ROAD SYSTEMS

This session dealt with two major themes to improve the governance and management of road administration: “Road financing” and “Efficient road administration”.

Recommendation for decision-makers

As everyone present here agrees, road transport will continue to play a key role as the main mode of surface transport in the 21st century and will be supporting socioeconomic development. Through our discussions today, we, the road administrations, reconfirmed the significance of securing the funds for road system development, operation and maintenance.

In order to secure funding, we need to make every effort to gain user’s support and understanding; they are the ones who are bearing the cost by means of taxation and tolls.

We should further undertake efficient operation by outsourcing and privatisation to use our financial resources more effectively, and at the same time, we should meet the needs of users by improving accountability for mobility, safety and the environment.

Technical aspects

More efficient operation is needed to use our financial resources effectively. Outsourcing a part of the business or privatisation is progressing. Governance for road development, operation and maintenance becomes important. With regard to the performance management making use of performance measurement, great results were attained by technical committees including the collection of data for performance measurement indices during this mandate. It is highly desirable that many countries will apply performance measurement and indices to the targets for road development, operation and maintenance to improve accountability to our stakeholders.

Also, with regard to road operation, many countries are applying ITS technologies as a solution for improving mobility, safety and the environment. There still exist various difficulties; nevertheless, we should make continued effort for promoting their deployment.

Recommendation for PIARC

PIARC should publicize to the world the needs for road financing, taking into consideration the outcomes gained from the studies in this four-year term. In particular, for developing countries, there is a pressing need for road financing for maintenance and repair works. Further study on PPPs is necessary as a new method for procuring funds and for risk sharing between the public and private sectors, as it is an important field.

Also, it is important to reinforce our activities for the promotion of improving governance. The data collected on performance indicators during this term is very interesting. As our future challenge, we need to further develop performance measurement for social and environmental aspects to work towards more efficient operation and management.

TS2 SUSTAINABLE ROADS - PART OF THE TRANSPORT CHAIN IN A GLOBALIZED WORLD

Although many countries have already included the goal of sustainability into their planning, construction and operation of roads today, there are many requirements still to be tackled on the route to environmentally respectful and socially just development.

In particular, the idea of a comprehensive intermodal approach for strategic transport planning should be followed up with and introduced, especially in regard to developing countries.

Road transport is definitely one of the major transport modes but it can be said today that sustainable development does not only start with the question of how to make road transport sustainable. This means that the different transport modes should not be dealt with separately in the strategic planning process. The identification of transport needs and the definition of transport corridors to fulfil these needs are a first step in sustainable transport planning. Within those identified corridors, different transport modes can carry the load of traffic. The distribution of the demand on the different modes in a corridor is one of the challenges of sustainable planning. Furthermore, the experience of combining different modes of transport in a corridor has shown some beneficial effects in terms of mitigating the negative impacts of traffic as a whole, such as noise pollution.

Transport chains and corridors in a world of globalisation

The establishment of economic treaties and trade agreements all over the world has had major impacts on the foreign goods trade – already today and even more so in the future. These developments give clear evidence of the increasing importance of the interregional and international transport networks to economic development. There is an eminent need for all countries to work together.

It had been shown that the planning of priority transportation corridors is an approach to deal with the development of increasing trade relations within and between major economic regions.

Nevertheless, there is a need to highlight some open issues necessary to be addressed in the future in greater depth. These are:

- ☑ Balancing development between high priority networks and hinterland regions;
- ☑ Upgrading local distribution networks;
- ☑ Strengthening of nodes within a strategic transportation network;
- ☑ Tackling upcoming demand in developing countries;
- ☑ Making networks reliable in operation; and,
- ☑ Financing these measures

It can be noted that countries that are just about to enter the global market attach greater importance to a fast upgrading of their road networks in order to cope with traffic demand while industrial countries make a greater effort with tackling congestion on the existing networks within the limits of social and environmental requirements.

Consequences of the demographic process on road infrastructure

All regions of the world are facing major demographic changes although there will be differences in development. There will be high birth-rates in developing countries that go along with high rates of migration. On the other hand, populations in industrial regions are likely to decrease and there would be increases in life expectancy rates – if there weren't migration. But it must be noted that an accurate prognosis of the demographic changes can only be done in short and medium term. Long term trends (50 years and more into the future) can only be estimates based on assumed scenarios. A sustainable transportation planning must consider these developments for example:

- ☑ monitor and analyse specific mobility indicators;
- ☑ include elderly-friendly aspects into the planning process; and,
- ☑ analyse the safety impact of an ageing population

Impact of roads on quality of life

The mitigation of the impacts of roads on the quality of life will create a challenge also for the next several years. Measures taken to help cope with the world’s energy demand and its consequences will need to be focussed on in future.

Many countries have already set a target on the reduction of CO2 emissions by implementing comprehensive transportation strategies. Technical, organisational and monetary measures are discussed as contributions of the transport and road sector to that goal. The new structure of the technical committees at PIARC for the next 4 year's working period has already addressed the issue of climate protection and bears good prospects to deal with all of these questions.

TS3 RISK MANAGEMENT: NEW APPROACHES TO IMPROVING SAFETY

Every day, roadway users, operators, and workers face risks that can threaten the safety and security of life and public assets. Although there is a strong awareness of these risks, it is only recently that transportation managers have been taking a more systematic approach to identifying, evaluating, and addressing this theme. From this respect, the World Road Association's sponsorship of this session was very timely since it provided an understanding of the fundamentals of risk management, as well as examples on how those principles can be applied in the roadway community to improve safety. The audience of nearly 150 participants well as their engaging questions was a testimony to the interest in this topic.

Risk is a reflection of the uncertainty of what may or may not occur in the future. However, by systematically assessing both the **likelihood** and the potential **consequences** of those risks we can make better decisions regarding the prioritization of needs as well as investment decisions. This was demonstrated very well by Quebec's evaluation of the risks associated with waterway crossings. Using a 10-step process, it was demonstrated how multiple factors can be simultaneously considered as a tool for making decisions. This process also demonstrated how both objective (quantitative) and subjective (qualitative) factors can be considered in this process.

The presentations from the United Kingdom and the United States highlighted the concerns that terrorists actions posed to safety and security, but also noted how planning and preparing for natural disasters had many of the same characteristics. Although the likelihood of such events may be fairly rare, a systematic consideration of the vulnerability of transportation systems can help identify opportunities for cost-effective actions to mitigate that potential. One of the points that all these presentations emphasized was the need to take an integrated approach to looking at risks. It was apparent that looking at just one category of risks or only one range of issues, did not fully reflect the context of potential solutions.

The application of risk management to roadway safety issues very much reflected these same themes. The global impact of roadway crashes is staggering and the World Bank made a very compelling argument for the need to bring the principles of safety and risk management to developing countries where these issues were only expected to grow in the decades ahead. In addressing these roadway safety issues, it was also recognized that although there was much we could learn from each other, each jurisdiction needed to determine what the right approach for their roadway system was. Specifically, developing countries needed tools that were appropriate for the unique challenges they faced in collecting and analyzing traffic and crash data.

One theme that emerged was the importance of taking a "holistic" approach to addressing roadway safety risks. Both Japan and the Netherlands showed how they had been able to reduce fatalities by looking at the driver, the roadway and the highway together, and identifying new opportunities to create an integrated response. The Netherlands also recognized that changing public attitude and behaviors was extremely difficult, but needed to be part of any systematic approach to safety. This meant that a whole new group of stakeholders and partners were needed if a significant impact was to be made. It is also

important to break down the “walls” that keep us from looking at these issues using multiple disciplines. As an example, health care professionals, judges, community outreach specialists, and teachers all have the potential to help address roadway safety issues, but we need to look beyond engineering to embrace those roles.

The importance of data was also clear. Data is not only extremely valuable for assessing past trends, but is also the means through which performance can be evaluated after changes are instituted. The value for using data to evaluate the technical aspects of risks was fairly well recognized, but there is also a need for better information/data regarding less technical areas such as assessing public opinions, values and priorities. This is an area where further research could be beneficial. Likewise, it is important to continue to support efforts to develop more meaningful performance measures that can be used to evaluate success and opportunities for improvement.

In summary, this session highlighted the importance of risk management, but also the fact that it is a concept that is neither well understood nor applied in the roadway sector. PIARC could play an important role in this by:

- Charging the Risk Management Technical Committee to look across all disciplines for opportunities to help identify and share best practices. In this regard it should be clear that the scope of the Committee extends beyond simply “operations” since the panel clearly showed the broad potential benefits of risk management. Likewise, the Committee should work towards developing a “primer” on the fundamental principles of risk management and how those might be applied in the roadway community;
- In cooperation with the Technology Exchange and Development Commission and other international organizations (e.g. the World Bank), encourage the development and application of tools that would be appropriate for Developing Countries and those with Economies In Transition; and,
- Urge all of the PIARC Technical Committees to look at ways to integrate Risk Management concepts into their work.

TS4 ROAD ASSET MANAGEMENT: INTEGRATING BEST TECHNICAL AND MANAGEMENT PRACTICES WITH POLITICAL RESPONSIBILITIES”

Recommendations to Decision makers

The diversity of road system stakeholders and their often divergent demands, combined with the obligation to ensure the mobility of citizens at all times, are powerful incentives for road authorities to design asset management systems that facilitate decision-making. The aim of this way of doing things is to facilitate decision making for all stakeholders involved in this process. Such systems have, in several countries, proven to be a premium tool in forecasting the budgetary resources that are required to develop and maintain road assets. To ensure that this implementation becomes possible and profitable, it is clear that decision makers and network managers must assume the leadership for such a move. In this spirit, road authorities must recognize the true scope of sound management in regards to the road assets and encourage this way of doing things by giving preference to this approach rather than to more empirical, established methods or management habits. Their commitment, in terms of both financial and human resources, must carry over a long period of time.

Because of their central position—between elected politicians and the population—network managers must overcome the challenge of communication on several levels. They must both foster communication within their own administration and translate technical information so that it can be understood by elected officials and the population.

Technical aspects

Technical developments associated with the management of road assets and in particular with the development of management systems are progressing and must continue to progress in several respects.

In terms of data, it is clear that assets management systems must be fed with reliable data, useful for both day-to-day management and strategic decision making. This implies that technical officers must put in place the appropriate mechanisms to ensure this quality and also to increase the effectiveness of data collections. Furthermore, we must aim for the integration and structuring of the information drawn from such data so that they may be synthesized using adequate indicators and shared between the various levels of road authorities. Finally, the means of disseminating this information to network administrators, elected officials as well as to users and frontages must continue to be improved, in order to foster communications between all stakeholders in the management of road assets.

Efforts are also being made in the modelling of the evolution of the condition of infrastructures and the prediction of the needs the latter will generate. This aspect becomes all-important in the management of road assets, since the reliability of investment scenarios are largely dependent on the system’s capacity to correctly model future behaviours.

In a broader sense, the technical authorities are and will continue to be called upon to quantify the benefits generated by the development of technical means, including the development of road assets management systems.

Recommendations to PIARC

It is important that international organizations continue to promote the implementation of asset management systems within road authorities. Discussions between the various stakeholders and the latter's experience during this session highlighted the importance and necessity of these systems and the means used to increase their efficiency. The highlights of this session are presented below.

An effective asset management system must at the very least provide decision makers with a number of investment scenarios along with their impacts on the state, value and long-term functionality of all transportation infrastructures. The needs of road users as well as good knowledge of the environment are key elements that must be taken into account by decision makers. Economic indicators and concepts relating to engineering and safety must accordingly be integrated into the system. The resulting reports must be presentable in a way that is able to be understood by all stakeholders, be they engineers, managers or politicians, no matter their hierarchical level. The challenge with the implementation of such a system is even greater given that there is no organizational model applied to all road authorities. The more accessible and comprehensible the information, the more decision makers will be informed and inclined to support the implementation of such systems, for the greater good of society.

Within this context, simple visual tools, integrating the aggregate information relevant to the people concerned, are of the utmost importance. For example, using maps, charts and histograms, certain road authorities have established links between values of importance to decision makers based on the investments made. The economic aspects (traffic congestion), value of the assets, safety (state of infrastructures), user satisfaction (surveys of the population) and the optimization of investments (budget provenance and use) are but examples used by speakers at this session to convince and properly inform the various decision makers and other stakeholders.

These illustrated communication tools are one of the main elements of decision making and constitute a basis for discussion shared by the various stakeholders. Therefore, it is important that organizations make the most of the experience of certain road authorities in this area and continue developing the methods used to represent and aggregate the various data required in decision making.

Technical committee sessions

C1.1 ROAD SYSTEM ECONOMICS

Recommendations to Decision makers

Try to address the issue of sustainability at each stage in the planning and operation of the transport system. For those projects which are subject to economic evaluation, the discount rate is a critical parameter, of which the value must be kept at a reasonably low level so as to take into account the interests of at least the next generation of population.
Do consider the specific qualities of each transport mode when designing a transport policy package:

- The performance in speed, access, traffic capacity; and,
- The social and environmental impacts.

The policy can be evaluated ex-ante by using a simulation model. The evaluation must be made with respect to a set of criteria that cover a wide range of aspects. The technical and economic approach to modelling and evaluation has a classical form, which was typified as a reference evaluation framework by TC 1.1.
Transport should be considered as a service for which the users have to pay. When developing a frame transport network, a local or national government has to consider subsidizing the infrastructure in order to achieve an adequate network structure and pace of development. Once a satisfactory frame network is established, the costs of its maintenance, completion and usage may be covered by the users, thus complying with the user pays principle.
Road pricing is the right instrument to charge the users with the costs induced by their traffic. This may be less appropriate in the context of building out the frame network, but once the frame network is established it is fair to tariff a trip with respect to its space and location, in accordance to its own impacts on the environment, safety and congestion. There is a wide range of rate-setting tools; some caution is required about the cost of the charging system, which must be low relative to the expected revenue. Caution should also been exerted about the toll rate, since very expensive rates on high-capacity facilities might lead to much traffic diversion on alternative facilities with lower level of equipment and service, at the risk of yielding more of undesirable impacts.
The implementation of a road pricing scheme may well raise an issue of acceptance by the car users and the population. Here some recommendations are in order:

- to design a transport policy package including not only the road pricing scheme, but also a set of actions such as improvement of travel alternatives by other routes, modes or time of day, improvement of the townscape and urban amenities, toll reduction for residents. To the trip-makers that keep using the car despite paying the toll, the main potential benefit lies in traffic reduction and speed increase.
- to involve the public and the various interest groups in both the design and implementation of the pricing scheme. Much information has to be delivered throughout the process. Monitoring is also required to identify people’s requirements with the system operation and make adjustments to it.

- to facilitate the payment by providing several ways for that, including toll devices, phone-based and web-based.

To implement road pricing on a region or country network, a wise strategy is to begin with trucks, for three sets of reasons. First, truck traffic exerts relatively high impacts in terms of road wearing, congestion, noise and pollutant emissions. Second, as road freight transport is an economic sector of activity, an increase in cost will turn into an increase in price for its customers, thus creating a signal for them to make the right choices. Third, the issues of privacy and public acceptability are less crucial than for private car traffic.

Technical aspects

Concerning the methodology of project evaluation:

- The rational approach to project evaluation for aiding decision-makers makes a mature, consistent framework.
- This evaluation framework is well-suited to accommodate multimodal transport projects as well as considering social and environmental impacts.
- The evaluation can also be targeted at a specific actor or interest group involved in the transport system. Then it enables an analysis of the benefits and disbenefits as incurred by this actor in order to identify his/her position relative to a transport policy. The consideration of the various interest groups is key to understanding the issue of equity among users and non-users etc.
- The main features of multimodal transport must be taken into account in the traffic model that is used to simulate the supply-demand equilibrium. The supply-side features for multimodality include the intermodal facilities in terms of time and money cost and the elaboration of door-to-door transport chains as sequences of one or several modal legs. The demand-side features for multimodality pertain to the trip-makers' valuation of time expense, comfort and financial expense.
- The impacts of economic, social or environmental significance can be modelled on the basis of the outputs of the traffic model, notably the traffic flow and level-of-service by network link.
- Indicators of impacts can be evaluated in physical units. For many of them several methods of economic evaluation have also been developed in recent years. On reviewing various national evaluation frameworks, the committee found that for important impacts such as noise and greenhouse gas emission, the national values make out a wide range of values (from 1 to 10). A potential explanation, which needs to be studied further, is that each country has its own strategy to address that kind of impact (through avoidance, reduction or money compensation to those impacted) which would result in varied costs.
- The impacts on economic activity and land values are yet not fully understood. Recent research projects yielded significant findings that remain to be included into the classical evaluation toolbox.

Concerning road pricing in its objectives, instruments / tools and case studies:

- Various objectives of transport policy may be pursued by use of road pricing, from funding the network development to regulating traffic and demand.

- Conversely, several instruments including road pricing may have to be used jointly as a “transport policy package” in order to achieve a transport policy targeting the full range of impacts.
- Road pricing is one instrument for having the customer pay for the service, along with a set of taxes and charges. Each instrument has a given scope of relevance. These have to be assessed in an integrated way prior to designing a wide-area road pricing scheme.
- There are many tools to implement road pricing, from vignettes and fixed tolls to link/lane pricing and area pricing, passing by distance-based tolls and parking fees. The choice of the tools must take into consideration the objectives (spatial scale, time and location of capacity scarcity or impact severance), the tool implementation and operating costs, and the interoperability of the pricing systems that apply to the same set of users (notably at the regional and national level, sometimes also at the international level).

Recommendations to PIARC

The PIARC Committee on Road System Economics has the following recommendation for future work to be undertaken within PIARC and also in cooperation with other international bodies:

- To perform ex-post evaluation of transport projects and policies, on the basis of case studies. In each case study, each kind of impact should be evaluated separately, first in qualitative or quantitative scale, then in monetary units on the basis of an explicit evaluation method.
- To assess the monetary evaluation methods associated to social and environmental impacts, in relation to the strategy for impact compensation.
- To consider the impacts of the transport system on the economic activity and performance on the basis of models from microeconomic theory as well as econometric studies. To develop related evaluation methods for inclusion in the evaluation toolbox.
- To address the particular issues of developing countries in a specific manner, by taking account of their specific needs, objectives, current state of development and solvency. Their need for transport demand should be assessed primarily on the basis of (1) the opportunity for them to achieve scale economies in the provision of basic public goods such as education, health and administration; (2) their comparative advantages for trade. Their need for transport supply should be assessed on the basis of both the demand objective and their ability to develop and maintain a given amount of equipment of a given modal technique.
- To take an economic approach to the very long-term issues of sustainability, which have been already addressed in a prospective manner. The existing systems for asset management present a risk of maintaining the current technology which might prove inefficient in the future. The transport system and mobility ways of the next generations have to be thought of on their own: an in-depth economic analysis would be useful, starting from scenarios for trip requirements and quota systems.

C1.2 FINANCING ROAD SYSTEM INVESTMENT

The core conclusions of the three working groups have been confirmed by the panel discussions. There is a fundamental linkage between organizational trends towards corporatization and unbundling policy making, transport management, financing strategies, cost management and procurement strategies, in particular public private partnerships (PPPs). Moreover the challenge is no longer to provide road infrastructure but rather transport services.
The shortage of financial resources implies a need for more efficient road asset management and financial procurement. It is also the reason why PPPs and user charging seems to be a solution to bring new money. Nevertheless user charging and financial strategies are only a partial solution. Another alternative in the drive for efficiency is corporatization of road developments with an arms length relationship, leading to increased transparency.

Several conclusions can be derived from this examination.

- There continues to be significant gaps in revenues versus country needs.
- Financial procurement strategies used by different organizational structures are heavily dependent upon a country's objectives in road transport and the road system that it is trying to support.
- There is increasing use of tolls and user charges, but there is still a fundamental role for taxes, especially earmarked taxes.
- Cost management for road system management is a tool for efficient application of funds for maintenance, operations and investments. The use of asset management systems, including accounting and valuation of assets, should be an essential element of cost management.
- For effective cost management it is essential to recognize the responsibilities of the organizations and the network (main, regional, local etc.) they controlled.
- Long term contracts, including PPPs, can be effective tools to assist countries in the procurement of finance and provision of road infrastructure and services. For effective long term agreements, performance based contracts, which predefine service outputs and remuneration, should be adopted.
- Private sector participation is useful to the extent that it serves to overcome possible inefficiencies of traditional procurement of finance and provision of road infrastructure and services. It can overcome budgeting and resource constraints and bring innovative delivery of infrastructure and services.
- The additional costs of private borrowings must be offset by efficiency gains. Alternatives for the provision of road infrastructure and services must not be made on a strict policy basis only, rather on the basis of effective value for money.
- In considering the drivers for PPP, it is important to balance the needs that occur between public and private interests. The public interest also needs to be protected through a strong legal and regulatory framework that encourages transparency and accountability.
- Solid policy, legal and regulatory frameworks are essential to guide the use of PPPs and can assist in ensuring that projects are implemented on the basis of specific principles of good governance.

- The allocation of risk remains a major challenge that can be addressed through a clear understanding of roles, the implications of those responsibilities and a willingness to have an equitable distribution of risk.
- The new financial procurement strategies, including corporatization, that are being adopted, create new governance challenges. Appropriate competences are required in both the public and private sectors and the necessary expertise might take a long time to develop.
- There is an essential role for government no matter what model is employed. In devolving or outsourcing the financing and provision of road infrastructure and services, government must strike a balance between the pursuit of new efficiencies and the need to oversee the maintenance and the development of key public assets. The role of government remains key, what ever model is adopted.

Some of the areas for continued research are:

- The continuing difficulties in finding necessary funding resources to build and maintain road infrastructure encourages further study of alternative financing options.
- Some have noted there is a decline in private sector investment for transport. The truth of this premise should be determined and if it is occurring, what are the factors behind this issue.
- Regional, rural and local roads are not able to attract sufficient private finance. These roads very often cannot be effectively tolled. A review should be made on how these roads can be funded.
- How willing is the political sector to move completely to a user pays environment? In all parts of the world, insufficient maintenance and investment in the road system are being impacted by increasing levels of traffic. Some countries are going to off-budget financing and others are moving towards user pays principle. An examination of the political and institutional issues from the perspective of various countries could provide additional input on this issue.
- New long term contracts invariably will require changes from time to time due to new government regulations, standards etc. A study of appropriate compensation mechanisms for the private sector partners which protect the public interest should be explored.
- Cost management systems for minimising budget overruns of individual infrastructure investment projects

Financing road system investment will continue to have importance for all countries as they strive to obtain economic sustainability, continued vitality and strength. Adequate funding is necessary to invest, maintain and operate a network that serves the needs of a country. There can be a mixture of financial procurement strategies including long term contracts and public private partnerships to meet this need. Without clear objectives, understanding risks and realistic expectations, the drive to sustainability will continue to be a difficult one.
TC 1.2 worked in co-operation with OECD/ECMT (European Conference of Ministers of Transport) Transport Research Centre Working Group on “Transport Infrastructure Investment, Funding Future Needs”. The OECD/ECMT report “Transport Infrastructure Investment: Options for Investment” will be published in a near future.

C1.3 PERFORMANCE OF THE ROAD ADMINISTRATION

1. Integrity is of prime importance in good governance in all economies and PIARC should promote global awareness of this.

If integrity is not assured, road administration (RA) performance will always be endangered. Given the large sums involved and the long worldwide history of collusion and corruption in the road sector, awareness of the integrity issue and measures to guard integrity always should remain a major element of the governance architecture of RAs all over the world. The negative impact on road organisations, economy and democracy cannot be underestimated.

2. The governance of a road administration should be tailor-made for their assigned responsibilities and circumstances.

The performance of RAs depends on a fit between its governance architecture and the environment within which it operates. It is a key finding that to enhance RA performance, its governance and structure, the use of human resources and the use of performance indicators should be tailored to the main activities that the RA performs and does not perform.
Three categories of activities typically executed by RAs require different governance architecture:

- strategic planning & policy making;
- capital investment, that is the (re) construction and upgrading of roads; and,
- service level delivery, mainly consisting of maintenance and operations.

3. Stakeholder/user influence is increasingly important and will shape the aims, values and management of Roads Administrations.

A strong customer influence on the priorities and standards of the RA is becoming a basic value in governance in the Scandinavian countries.
Managing RAs with customer influences is described as a good practice for mature road networks. Here, the government and its administrations decide in general and on a strategic level and the customers involved decide on the level where they have the very best knowledge and for their own good.
The influence of customers on administration at operational and strategic levels provides the administration with a deeper understanding of how needs and problems are composed which enables the authorities to efficiently utilise their sometimes limited resources. It also gives customers more realistic expectations of authorities.

4. Management of road administrations should focus on its external interfaces with all stakeholders.

This comprises for instance the relation between a RA, road users, private contractors and other road network managers.
It starts with a clear understanding of its role and responsibilities (tasks) within the chain, translated into governance design and organisation structures.
Suppliers must exhibit the same values as RA's for efficient service delivery under an outsourced model.
As a consequence, staff skills should be oriented not only on the ability to perform internal

tasks, but even more so on managing relationships and partnerships within the value chain. The RA should be a professional procurer, contractor as well as a professional supervisor. This also extends to the usage of performance indicators, performance monitoring and measurement. Alignment of performance management systems in the value chain is crucial for creating the needed public value and the sustainability of authority to act as a RA.

5. **An imbalanced, ageing workforce is a major threat for the continued, successful operations of road administrations and PIARC should promote a mitigation strategy to avert this threat.**

Based on survey responses, over 40% of RA staff are over the age of 50. As these employees move towards retirement, much of their experience and knowledge will be lost to the RA if adequate measures are not taken.

6. **An innovative, coordinated approach for engaging young people has to be found in order to attract them to the engineering profession and, in particular, to the road sector.**

Surveys have identified low levels of enrolments in university engineering courses resulting in an inadequate number of graduates to replace the aging workforce. Furthermore, there is increasing competition from other professions for bright young people.

7. **Effective strategies for the recruitment and retention of staff, as well as maximising their productivity are the core human resource management elements needed for the continued successful operation of road administrations.**

Experiences shared at workshops indicated that the majority of HR departments in RAs were looking at holistic methods of managing the somewhat complex challenges related to Human Capital management. Engagement of employees from initial recruitment and throughout the various stages of the employment cycle needed to be actively and proactively managed in order to ensure that the organisation maintains the capability to achieve its present and future goals.

8. **Road administrations moving to outsourcing should undertake it in a carefully planned way that appropriately develops the revised competencies of the road administration and its industry partners.**

Experience to date has indicated that ignoring this advice has lead to inefficiency and in some instances failure and inability for road administrations to deliver their goals and objectives.

9. **When establishing a performance measurement regime, road administrations should have a clear understanding of its functions, its deliverables and processes and should impart this to all its stakeholders.**

Performance indicators can be used in many different ways, e.g. as a strategic evaluation tool, an incentive based system or as raw data. Indicators have a best fit for one or more purposes, depending on the position of the RA in the value chain. Deviation or ambiguity of these purposes and agreements on indicator usage, can lead to a misunderstanding or even a breach of trust between the parties involved.

10. Road administrations should apply the tests of good governance when selecting performance indicators and should have regard to effective alignment of the complete set of indicators and the efficiency of their application.

Good governance organisation and structures, identified by the Committee, have been incorporated in a software tool called the Performance Indicator Navigator. This can assist in the selection of performance indicators in accordance with the principles of good governance.

Before the final suite of performance indicators is implemented it is important to ensure that performance indicators are well targeted, relevant, understandable and achieve balanced coverage to avoid distorting behaviours developing within the road administration.

As for all governance instruments, the administrative burden of performance indicators should always be kept in mind. Therefore, before introducing new performance indicators sanity checks should be performed to check whether the information is already available or can be included in an existing indicator.

11. Road Administrations must review their performance measurement regime periodically or when circumstances dictate.

The environment within which Road Administrations operate is unlikely to remain constant. It is important that the measurement of performance continues to be relevant to the political and societal demands made of it. To ensure this is achieved, periodic reviews of the performance measurement regime or reviews when there is a radical change are necessary.

OVERARCHING CONCLUSION

Technical Committee 1.3 (Performance of Road Administrations) identified some serious challenges facing road administrations:

- The need to improve integrity;
- Ageing workforce;
- Shortages in key competencies, particularly to meet the needs associated with outsourcing;
- The need to identify and manage the complex interfaces it has with its stakeholders;
- The need for road administrations to establish effective performance measurement systems that:
    - o demonstrate to our increasingly demanding stakeholders that we are delivering what they want, when they want it and at the least cost, and
    - o motivates staff and suppliers to improve their performance.

The Committee believes that its reports describe the means to start meeting these challenges and points the way forward for Road Administrations and PIARC.

C1.4 NETWORK OPERATIONS

Recommendations to decision makers

There is a continuing need to develop the policy and practice of Network Operations as it evolves, incorporating Intelligent Transport Systems where appropriate. Increasingly, the need is to integrate road network operations across regional and international boundaries. Specifically, Technical Committee TC1.4 sees the need to develop good practice in the following areas as a real challenge:

- Managing the operational, jurisdictional and other administrative interfaces
- Inter-modal operations at international airports, ferry terminals and ports
- Management of cross-border road-freight and transit traffic
- Novel approaches to Network Operations
- Interface of network operations with other major stakeholders: commercial vehicle fleet operators, servicing of local markets, city transport, just-in-time deliveries, etc
- Accommodating the increased need for maintenance of the road infrastructure
- Bringing capital investment and asset management of the network together with network operations
- Strategic planning and modelling for network operations purposes
- Good practice on peak-spreading and demand management
- Role of ITS and new technologies in network operations
- Exchange of information between road authorities, police and emergency services
- Security of network operations against disruption from man-made or natural causes
- Opportunities for co-operative vehicle-highway systems

Technical aspects

Roads authorities are required to justify their budgets for network operations against a background of growing traffic demands and increased public and stakeholder expectations. This is in the context of increasingly scarce public funding. Established evaluation and assessment methods need examining from a network operations perspective. The issues differ from those involved in justifying capital investment in roads infrastructure, but similar methodologies and benefits/costs values can be applied. The committee recommends that PIARC continues to work on the assessment methods collaboration with the International group working on ITS Benefits, Evaluation and Costs (IBEC). These methods include:

- Methodology for ante- and post-evaluation of new methods of network operations (ITS tools and systems)
- Effective inter-agency working: partnerships and contracts between the roads authorities and other stakeholders in network operations
- Risk assessment in network operations, including inter-agency working, corridor management, operating frameworks and contingency plans
- Evaluation of the impact of personal and in-vehicle telematics, information and communications devices on network operations
- Cost-effective procurement of ITS projects and systems

Recommendations to PIARC

1. Involvement of developing countries

PIARC needs to find active committee members or expert advisers who can assist the network operations committee with first-hand knowledge of network operations in developing countries and countries with economies in transition. This is to compensate for a shortcoming in previous cycles.

2. Involvement of Stakeholders

The committee needs greater contact with the public or private sector stakeholders in network operations – especially those that are major users of the road network (public transport and freight haulage companies), or are highly depending on it for completing the offered intermodal chain (railroad, inland waterways or ferry terminals) is needed in PIARC, e.g. by including them as co-opted expert advisers or invited on an ad hoc basis to help TC members on specific agenda topics.

3. Outreach and Education

The combination of PIARC deliverables from this and the previous two cycles now provide PIARC with a rich resource for outreach and education for students and young transportation professionals through workshops, seminars and training sessions. The current committee, TC1.4 recommends that outreach and training in network operations is built in to the next PIARC Strategic Plan in order to maximise the benefit of PIARC committee work that has been done over the past decade.

4. Manual on Network Operations (CDROM)

We recommend that the work done in the current cycle to develop an on-line manual and information library on network operations is continued and expanded in the next cycle to support outreach and education.

5. Joint working with the motor industry

An opportunity exists for joint working with the motor industry under the umbrella of the recently-signed PIARC FISITA memorandum of understanding.

Specifically, in response to the presentation and discussion made in Special Session 16 at this Congress we recommend formation of a sub-committee of Network Operations with the following terms of reference:

A task force (PIARC sub- committee) convened within the context of the PIARC / FISITA MoU involving:

- the motor industry; and,
- the road authorities

This is in order to develop recommendations for the deployment of roads infrastructure to support cooperative systems

Individual members by invitation/ nomination from FISITA and PIARC; PIARC nominees to come from the network operations and road safety committees, with representation from Japan, USA, Canada, EU, South Africa, S. America, Australia and developing countries leading in ITS (e.g. China, Malaysia, Chile)

Main deliverable to be a report providing a strategic overview targeted at Roads Directors identifying:

- ➔ Deployment paths for Vehicle Infrastructure Integration (VII) and Co-operative Vehicle-Highway Systems (CVHS) in context:
  - Expressways and motorways
  - Rural roads
  - All-purpose arterial roads
- ➔ A commentary on the role of VII and CVHS in relation to the generic issues of
  - Road safety
  - Emissions
- ➔ Options for pragmatic incremental deployment:
  - Options and costs
  - Funding: Public funds; commercial case; consumer value
  - Specification and standards
- ➔ Trade-offs
- ➔ Low-cost measures
- ➔ Quick wins
- ➔ Options for developing countries

C2.1 SUSTAINABLE DEVELOPMENT

Can road transport contribute to the goals of sustainability at all? According to the responses given by countries participating in the Committee's survey, this question has to be clearly answered with “yes”. In order to resolve a transport problem, road infrastructure is mostly just one of several options evaluated in an intensive discussion with a strong political dimension.

Recommendations to Decision makers

Member countries need to integrate environmental and social considerations into their decision-making and activities. The concept of sustainable development requires a change of mindset to bring about full integration of the needs for economic and social development while still conserving and enhancing the environment. The integration becomes possible by the means of a debate, which brings a synthesis emphasizing the essential function of governance and of local democracy. Public involvement is the key to social acceptance, and guarantees that all stakes have been expressed and taken into account. Such a debate is all the more efficient if it occurs at the earliest stages and at the main steps of the design and implementation of the project, infrastructure or transportation system.
A process based on priority given to a single main objective (usually economics or the environment) inevitably creates conflicts, usually leading to stopping or suspending the project, going against collective needs and interests, and basically against sustainability. The existence of an explicit legislation about sustainable development, inscribing its principles in law, always shows to be very helpful to implement sustainability in transports.
A thorough financial analysis of the specific projects that implement the transportation plan will help to ensure that projected costs are realistic and affordable. Unless transportation projects are tied to reliable funding sources, the recommended solutions that are developed for environmental and social aspects can easily become a "wish list."
Overall, based on the importance of social and environmental objectives in transportation plans, integrating mitigation into program level funding does not generally serve as a barrier to project budgets. In fact, integrating mitigation into the program level funding will not only provide a more collaborative, well-coordinated decision making process, it can save money by shortening the project development process and eliminating obstacles early on.
The methods and instruments used at present seem to allow a sophisticated approach towards the goal of sustainable road transport, yet there also appears to be a great potential for improvement and refinement. Whether or not a sustainable solution for a road project or road transport in general is actually achieved will always remain with future generations for final judgement. The continuous effort to optimize every single dimension of sustainability, however, seems to be a promising strategy towards sustainable road transport. This strategy should consist of always “getting more – from less – for longer”.

Technical aspects

Fragmentation effects have been identified as very relevant negative impacts of road projects on the environment. There is growing awareness in a lot of countries of the need to mitigate fragmentation effects of roads and road transport in the urban environment. The key to success consists of a holistic approach and interdisciplinary work between road

planners, urban architects and public involvement throughout the project development and evaluation.
In construction and maintenance, the focus is generally on technical and, to some extent, traditional environmental concerns, especially mitigating such negative impacts that may arise during works. The link to the sustainability concept is fairly weak. Developing the kind of specific targets and, especially, functional requirements that would fully utilise the opportunities of the production process, is a sizable task that still remains. The administrations need to co-operate closely with contractors and operators.
Sustainability evaluation of road transport is in most countries based on methods originating from the environmental perspective such as Strategic Environmental Assessment or Environmental Impact Assessment. Few countries apply additional methods, which would give a broader view of impacts or an overall perspective on all three dimensions of sustainability. The development of such methodological instruments on the level of project and plan evaluation seems to be an open field for research.
The key to assessing sustainability of road transportation in the long run appears to lie in the continuous collection of relevant data connected to the impacts of the road network. This monitoring of crucial indicators covering all three dimensions of sustainability is an essential requirement to analyse the progress of impacts along the life cycle of the infrastructure and to allow sustainability evaluation in the future.
In order to make effective environmental assessments as well as meet all funding requirements and objectives, it is important to maintain the rigor of plan and program level appraisals. Although training programs and incentives are good tools, a routine assessment or review process is recommended to ensure that the guidelines are properly followed in all plans and programs and that key objectives are met. One should consider developing regulations or incentives to keep environmental and other mitigating factors as priorities in projects rather than allowing them to be among the first components to be compromised.

Recommendations to PIARC

Sustainability is a core issue for the whole of PIARC and all of its Committees. In developing PIARC's strategy, we need to remind ourselves of this. At present, this aspect is not totally successfully expressed within the organisation's practice.

C2.2 INTERURBAN ROADS AND INTEGRATED INTERURBAN TRANSPORT

Roads are fundamental for society and their development requires good cross sector coordination and cooperation.

The goal of transport planning is to support sustainable community development and the transport system in such a way that people and goods can travel as needed safely and economically. Client-oriented transport planning can integrate the various needs of clients and society in different types of travel environments. The purpose of this type of analysis is to ensure that all the main issues are included, that their links and contradictions are identified, and that the attention is turned from the construction of roads to people's everyday mobility needs and the transport needs.
A multi-stage principle is suggested as a general approach to develop the road transport system.
In the first stage, measures are sought which affect land use, traffic and transport needs and choice of travel mode in order to control traffic growth and its consequences. Greater focus needs to be directed towards creative methods that integrate the technically rational level with the political, strategic level.
Intermodal terminals play a critical role in permitting the most appropriate mode of transport to be used, combining the flexibility of road operations with the line-haul efficiency of rail transport. The integration of transportation modes is an important element of this stage.
In the second stage, measures are sought which enhance the use of the existing road network to keep transport route capacity utilized as fully as possible. In this stage, operational and access management will be important considerations:

- Operational Management is about using the infrastructure as efficiently as possible. Currently, most of this is accomplished by installing infrastructure on the road-way (such as signals, signs and other control devices) that relies on drivers responding appropriately. The natural extension to this trend is likely to involve taking information directly to the vehicle and possibly, ultimate control out of the driver's hands.
- Access Management is "the systematic control of the location, spacing, design, and operations of driveways, median openings, interchanges, and street connections to a roadway". Access Management aims to manage and mitigate the relationships of roadway operations and the side impacts through the control, design, and location of the interactions.

In the third stage, minor road improvement measures for solving the problem are studied. This stage comprises investments in the existing transport route network to improve safety, or load-bearing capacity, or modest traffic capacity enhancement.

Options in these first steps must be exhausted before resorting to improvements particularly those involving substantial investment

Only in the fourth stage are new investments and major renovations considered. This stage comprises projects for expanding the transport route network.
Public participation, the coordination of transport planning and land use and spatial planning as well as cooperation between the public sector and private interests needs, is essential in attempting to influence the demand for road transport.

Road administrations need to recognise their wider operational role, carefully planning their

resource strategy and new skill needs.

Recommendations

Interaction between the development of road and integrated transport and regional and land use planning requires more attention for the future. There is little point in adding new capacity if this is quickly absorbed with more movement and the congestion just returns to previous levels. The conventional sectorial system is not enough; smarter methods in transport planning are needed.
More focus needs to be directed towards creative methods; methods that integrate and create a bridge between the technical-economical issues and the political-strategic dimension. This is a field that needs to be developed in PIARC. It relates to emerging methods in business management, negotiations, decision-making, planning and design. It is a necessary complement to the sectorial analysis.

C2.3 URBAN AREAS AND INTEGRATED URBAN TRANSPORT

Recommendations to Decision makers

Human powered transport
To promote the use of human powered forms of travel, there needs to be a more effective integration between transport and land use policies. Although in western countries, more attempts are made to provide dedicated cycle and pedestrian facilities, this may not be the case in developing countries where the provision of more road space for car users is seen as a better way of managing the congestion.
Education, better land-use planning policies and design guidelines are some of the main areas which should be considered for further investigations. Other incentives such as funding for improved walking and cycling infrastructure should also be seriously considered as an incentive to authorities in developing countries.
Mega-cities
All sampled mega-cities have different elements of sustainability in their transport systems; walking and some forms of public transport, together with cycling. Their transport systems may be contributing to an improved standard of living collectively, but it is not being shared equitably by all sections of the community. Nevertheless, whilst transport policies and plans have elements which head towards sustainability, the development in reality is still heading in the wrong directions.The environmental indicators also demonstrate that they are not generating the greatest possible improvement in the quality of life. Further studies should be carried out to learn lessons from the existing mega-cities and to share the knowledge with other cities which might become a mega-city in the future.

Congestion
In the developed countries, congestion preventive measures (regulatory, soft/technical measures or infrastructure construction) should be mixed in order to develop a consistent and effective set of traffic and transport policies. In developing countries, the infrastructure construction is an important way to mitigate congestion. In order to ensure effectiveness and sustainability, land use and modal shift policies should be integrated.
The adequacy of such mixed traffic and/or transport policies may differ significantly from city to city and from country to country. Because individual cities and countries have different socio/economic/political backgrounds, different demographic sizes and characteristics, different nature/degree of congestion problem, different level of existing infrastructure provision, and deferent level of economic development, the cities/countries may therefore require their own unique sets of traffic and transport policies in order to develop effective measures which are able to combat traffic congestion.

Technical aspects

Human powered transport
To encourage a higher share of travel mode by walking and cycling, it is important that land use planning policies are complemented by effective measures. It is important to have a combination of measures including contra flow system for cycle lanes, traffic calming measures, facilities for bike and ride, cycle parking facilities, safety and comfort measures in roads and at intersections and appropriate signage and marketing. Knowledge sharing and transfer of good design examples to developing countries needs to be given a high

priority status.

Mega-cities

All sampled mega-cities have urban development and transport plans, but all cities are behind target in their implementation of transport plans to varying degrees.

Does this mean that sustainability cannot be achieved by intervention in transport systems? Will change occur in other ways, for example as Tokyo's population declines as a result of Japan's falling fertility rate? Will personal motorised mobility decline as fossil based fuels become more scarce and expensive? We have not been able to manage it so far.

Congestion

Congestion can be managed in many ways including infrastructure provision and regulatory measures. In cities and countries with high levels of infrastructure, regulatory measures tend to show more effective control of congestion. They should be supported by soft and technical measures such as: road telematics, mobility management and reallocating road space for public transport and non-motorised transport modes.

Regarding infrastructure provision, it has been frequently stated that an increase of road traffic capacity may induce additional traffic and thus on the long run the level of congestion would be no better than before. This notion, however, may not undermine the necessity of infrastructure provision by itself, because expanded road transport capacity may well contribute for example to regional economies.

As a long term measure, it is advisable to concentrate new land uses in the vicinity of good public transport connections.

Recommendations to PIARC

From the points raised above, the following research and studies are recommended:

In the field of mitigating congestion in urban areas, a better understanding and deeper knowledge is needed to ensure the sustainability of traffic and transport policy. In the long term, it is necessary to enhance research on the relationship between land use/development pattern and transport systems including the road and public transport networks:

- Efforts should be continued in developing an understanding of the profile of non-motorized users in urban areas both in developing and developed countries. Good design practices in western countries should be shared with authorities in developing countries.
- There is a need to study optimum land-use development strategies that balance the need for economic development with the need to reduce congestion and to save the environment from harmful effects of traffic and transport.
- Study strategies and new initiatives in the use of parking policies to limit urban congestion.

There is a further need to exchange information, experience and views on measures to alleviate, prevent and manage urban transport problems. In spite of the diversified problems, information on and experience in certain cities or countries may well be informative and may present a good reference for other cities/countries.

C2.4 FREIGHT TRANSPORT AND INTERMODALITY

There has been increasing importance of freight transport for building sustainable transport systems from the viewpoint of the global supply chain. Efficiency of freight transport is required for providing a higher level of service to customers. However, there is concern about the negative impacts on the environment generated by existing freight transport systems. To overcome these complicated problems, new technologies including ICT (Information and Communication Technology) and ITS (Intelligent Transport Systems) as well as appropriate public policies are needed.

Freight transport is crucial for developing countries in terms of economic development and the creation of good quality of life. Experience and knowledge on transport and logistics in industrialised countries may be helpful for developing countries to promote freight transport initiatives

The research work by Committee 2.4 focused on the current status of freight transport in member countries and how the variety of challenges relating to freight transport and logistics should be tackled. These include, but are not limited to, the efficiency of logistics, the environment and safety, as well as the differing objectives of the stakeholders in freight transport such as shippers, freight carriers, administrators and residents.

Technical views

Our main areas of work and findings can be summarized as follows:

- Promoting intermodality in freight transport;
- Mitigating the negative impacts of freight transport growth; and,
- How developing countries can build a sustainable transport system.

Measures Promoting Intermodal Terminals and Alternatives to Road Transport

Promoting intermodality as an alternative to the use of roads in transporting freight can have a variety of benefits. The freight transport sector is growing, causing a number of environmental and societal problems, not to mention increasing the congestion on the road network. More collaboration between road and other transportation administrators, as well as government measures that supported intermodality would not only improve the efficiency and safety of the roads, but would have positive benefits on the environment and all freight transport.

Mitigation of Negative Impacts Caused by the Increase in Freight Transport

Due to their size, behaviour and routes taken, freight vehicles can have a negative impact on the environment, the society and the economy and as the amount of freight increases, so do these negative impacts. Therefore, strategies must be developed to mitigate these deleterious effects. Technology can play a role in mitigating these effects, as can improving the overall transport infrastructure and implementing measures that regulate freight access away from certain roads and areas.

Guidance for Developing Countries in Building a Sustainable Freight Transport System

Each country has a unique history and pattern of economic growth to which the transport system makes a distinct contribution. When an individual transport system is developed,

necessary aspects of sustainable development must be considered; and yet it is also imperative to pay due attention to the individual characteristics and overall growth of the given economy and society. Developing countries, such as those in Africa and Asia, often face the problem of inefficient freight transport systems that lack good infrastructure and freight management systems. The committee makes recommendations on the way to tackle these problems, as well as raising the issue of how international cooperation and support can be organised to promote sustainable freight transport systems in developing countries.

Future perspectives

Further research on following topics will be needed to fully understand the characteristics of freight transport and intermodality and build up appropriate public policies to promote sustainable freight transport systems for both developed and developing countries.

1) Reliability of freight transport on the road - understanding the reliability of freight transport on the road is needed in terms of connectivity of road network, travel times, safety and costs for freight carriers for promoting sustainable freight transport systems.

2) Behaviour characteristics of freight vehicles and carrier responsiveness for freight transport management - strategies for successful consensus building in implementing freight transport management schemes are needed for best practice of policy making and execution.

3) Measures to smoothen border-crossing freight transport - investigation on the international trunk network of freight transport is needed especially focusing on the smoothness of border-crossing of countries and regions.

C2.5 RURAL ROADS AND ACCESSIBILITY

The meeting of TC2.5 examined 2 topics from which the following lessons were drawn;

Rural roads are a factor in the development of the local economy in the fight against poverty.

The construction of rural roads constitutes a method of reducing rural poverty, primarily due to the employment that is generated. The experiment nearing completion in Nepal showed the impact of the mobilization and the implication of the local populations in carrying out this work. The problem remains though that to overcome the noted issues surrounding quality and the difficulty to ensure future maintenance was also illustrated in the debate for similar experiments in Africa.

A new approach for the identification of rural roads in Morocco based on the rate of accessibility considers the criterion of access to a practicable road at any time, with less than 1 km for a population living in a locality of more than 50 households. This new approach aroused great interest among decision makers of developing countries and meets an important need to find an alternative to the economic justifications by a criterion of financial profitability for internal road projects (TRI, VAN) in countries where the traffic is weak.

It is recommended aid agencies should be associated to the application of such an approach in the poor countries in order to better understand the local specificities of rural roads, note their interest and accept their financing.

The multicriterion analysis is an alternative to the traditional financial justification of the projects whose example of application in Bangladesh was presented. This method however poses a problem of subjectivity in the determination of the weighting of the coefficients of the various criteria.

Involvement of the local population

This involvement can intervene at several stages including the planning of the roads, their construction or their maintenance. The keys to success which arise from the experiments of various countries are:

- The financial participation or in kind of the population increases the feeling of appropriation of the infrastructure. The rate of 10 % was mentioned as minimal level of this participation.
- The population adhesion is a factor of the permanence of the infrastructure.
- The involvement of the population at the time of planning, but also at the time of implementation, allows facilitation of the acquisition of land, of supply, the installation of the construction site, etc
- The diaspora of the region can constitute an important source for the financing of the road projects (i.e. Haiti, Tiznit)?

- An analogy was proposed to assimilate the service of road accessibility to an access service to drinkable water or to electricity, which allows consideration of invoicing the cost of the infrastructure to the users.
- To involve the local population, it is essential to develop communication adapted to the rural road projects.
- The contractualisation of the partnership is also a factor of success.

C3.1 ROAD SAFETY

Recommendations to Decision makers

There are effective and efficient measures to improve road infrastructure safety and all countries and road operators are encouraged to deploy them over their network. These include **road safety audits** (RSA) for roads during the project phases and regular **road safety inspections** (RSI) on the whole existing network as well as **accident accumulation location ("black spot") treatments**.

Road safety audits can be put into practice immediately in every country. They are very inexpensive to implement and the return on investment is significant. Countries in transition in particular should focus on RSA for their numerous projects. They may be looking for cost effective returns as well and should therefore also invest in **accident accumulation location ("black spot") treatment**.

Accident data is required to target measures to where they are most needed. Each country absolutely needs to define a national accident data collection strategy and needs to enforce it with the various partners involved (police forces etc.).

Developed countries usually have comprehensive accident data and have deployed accident accumulation location treatment measures. They would find it beneficial to complement these measures with RSA and certainly RSI.

> All road users (drivers, pedestrians, cyclists…) have their physiological and psychological limitations. Efforts should continue so that **human factors** are taken into account in road infrastructure and equipment design and operations whenever possible, at the design stage as well as during operations.

A policy framework for road safety

- Many legal and policy issues are real impediments to full deployment of appropriate measures: Who is in charge of ordering a road safety audit? Who is responsible if an audit's remarks are not properly taken into account? How are inspectors or auditors certified? What is their liability level? Such questions need to be clearly answered in each country so that road safety practitioners can act in full confidence.
- Road planning and operation is often in conflict with other interests, road safety measures can be viewed as delaying projects, or impacting traffic volumes. How is road safety defended against these influences?
- Road safety related measures are numerous and involve emergency services, the police, road engineers, schools etc. Coordination among them is essential. Priorities among these logically vary from country to country.

All stakeholders must get involved in road safety and their actions must be prioritised and coordinated. This requires commitment at the highest local political level, so that road safety priorities can be coordinated and clearly defined.

These topics should continue to be discussed and best practices among countries shared. This can be particularly helpful for countries in transition, where having appropriate policies in place early on can foster a network of safety professionals as well as encourage the inclusion of safety in all policy decisions.

Technical aspects

Accident accumulation location ("black spot") treatment

Accident data, even if it is rudimentary, makes it possible to identify accident accumulation locations. Accident accumulation location treatment is a well known process to identify, investigate and suggest solutions for accident accumulation locations with significantly high number of accidents.

=> A PIARC guideline on accident accumulation location ("black spot") treatment would be very useful. This especially applies for countries in transition with clearly identifiable accident accumulation locations.

Network safety management (NSM)

NSM is a comparatively new comprehensive procedure on the road network in operations. It identifies corridors where accidents occur at a high frequency, and aims at understanding the specific local reasons behind this and then making cost-effective recommendations for remedies. NSM goes beyond accident accumulation location treatment and takes a wide perspective on the infrastructure and the driving procedure, so that it is able to take into account all factors affecting the drivers on a given corridor.

=> Continued knowledge exchange and a guideline on NSM would be very useful.

Recommendations to PIARC

- The road safety technical committee's founding principle is taking a systems approach that involves drivers, vehicles and roads simultaneously. Improving road safety thus requires a systematic approach which involves tackling all three subsystems. The TC addresses roadway issues, but topics outside its usual scope such as enforcement and driver's education are generally regarded also as effective ways of improving road safety overall. PIARC should clarify its position on addressing the behavioural aspects of roadway safety, and cooperate more comprehensively with other organizations that are addressing this important topic.
- PIARC produced a Road Safety Manual in 2003 and a catalogue of low cost countermeasures for road safety in 2007. Both should be regularly reviewed and updated as more knowledge becomes available. Adoption by individual countries and adaptation to local conditions should be pursued.
- Donor organizations should set the example. They should make RSA a compulsory condition for the funding of all road projects. They should also continue making funding available for road safety measures on the existing road network, such as RSI, accident accumulation location ("black spot") treatment and accident data collection.

C3.2 RISK MANAGEMENT FOR ROADS

Recommendations to Decision makers

In order to reduce the loss of life, injury and damage caused by disasters, each country should:

- Adopt comprehensive and integrated risk management strategies considering the balance between safety and security. Such an integrated strategy should be underpinned as a context of integrated disaster risk management which is closely related to the policies and practices for land management and the reduction of damages by all relevant stakeholders. Specific recommendations are:
  - Integration of structural and non-structural measures, such as hazard mapping, zoning, disaster proofing, disaster fighting, forecasting and warning, training and rapid response actions.
  - Strengthening of the framework of disaster policy and organization, laws and legislation regarding preventative measures and emergency management from the viewpoint that disaster can never be totally eliminated.
  - Promoting information sharing, compilation of necessary data and capacity building for proper maintenance and optimum operation of disaster control facilities based on the recognition that improper management of such facilities may aggravate disasters.
  - Development of guidelines/manuals of risk management to implement and operate risk management in the road sector for the purpose of inducing the effective and appropriate countermeasures for the mitigation of essential social loss.
  - Development of educational methods including capacity building to risk management for roads
  - Giving importance to public participation and community based local cooperation in raising awareness regarding the impacts of disaster through appropriate policies and related activities.
- Allocate adequate resources to implement the necessary disaster management projects in accordance with the above recommendations.
- Cooperate with neighbouring countries and with all relevant intergovernmental and non-governmental programs aimed at mitigating the effects of disasters including participation in the network systems and the opportunity of dialogue such as the international seminar organized by PIARC.

Technical aspects

Technical Toolbox

TC 3.2 has developed a technical toolbox, which is a database of useful technologies for the risk management phase, i.e., planning, design, construction, operation (maintenance) and consists of the inventory sheets and their appendices. The inventory sheets aim to assist budgeting and road management application of risk management technologies/tools. The technical tool box can be applicable to show the series of qualitative analyses such as the risk matrix for the risk evaluation and risk assessment. This tool box can be useful for technical cooperation among not only developing countries but also developed countries.

Risk Management Process Manual

The Risk Management Process Manual is issued by Transit New Zealand (Transit), the organisation that is responsible for the stewardship of New Zealand's state highways. The objective of the risk management process manual is to provide a set of tools that will help to minimize threats to Transit's business and maximize opportunities to enhance it. This manual consists of four sections (Overview, Responsibility, Key Tools and Application) and four appendices.

Risk Management for Roads

The risk management process consists of the following steps: risk identification, risk evaluation, and execution of measures. Risk identification and evaluation includes the aspects of time, cost, function, property (owned by the project or external), human (staff, road user, and third party), intangible assets (image, human resources, etc), and the environment. The risk evaluation is based on a matrix considering the probability and the consequences of the risks. Evaluating risk, all aspects mentioned before need to be considered and balanced.

Risk Management for Projects

Risk management for projects involves the components planning, design and construction of the management process for road networks. The operational aspects have to be considered in the phases planning and design. Some countries have guidelines for risk management in the following sub areas: balanced scorecard, project, network management, internal safety, and crisis management.

Risk Management for Highway Systems Security

This part focuses on the operation of road networks. It deals with risk management principles related to Highway Systems Security. Following the terrorist events of September 2001, matters related to Highway Systems Security have become increasingly important over the last few years as the level of awareness has, itself, become more widespread. Therefore many organizations have become increasingly involved in this area of expertise and several methodologies and approaches were developed to assist responsible authorities in the assessment of vulnerabilities of their infrastructure and the identification of critical assets.

The New Approach Developed by the European Normalization in the Road Sector

Minimum requirements and performance: the Euro codes based Europe has stated this target since 1976 in the so-called "Guidelines for public infrastructures owners and contractors". Several basic requirements oblige public owners to be concerned with risks and the environment and to account for the public command socio-economical and juridical consequences. As far as public infrastructures and their components are concerned, it focuses on requirements dealing with structural resistance, security (construction related risks, service related risks, fire resistance), as well as protection (hygienic working

conditions, health protection, noises, environment), and saving (energy, isolation). The new normalization approach thus moves from a descriptive approach to a performing approach

The Hyogo Framework for Action by ISDR (International Strategy for Disaster Reduction)
In January 2005, 168 Governments adopted a 10-year plan to make the world safer from natural hazards at the World Conference on Disaster Reduction, held in Kobe, Hyogo, Japan. The Hyogo Framework is a global blueprint for disaster risk reduction efforts during the next decade. Its goal is to substantially reduce disaster losses by 2015 - in lives, and in the social, economic, and environmental assets of communities and countries. The Framework offers guiding principles, priorities for action, and practical means for achieving disaster resilience for vulnerable communities. Collaboration and cooperation are crucial to disaster risk reduction: states, regional organizations and institutions, and international organizations all have a role to play. Civil society, including volunteers and community-based organizations, the scientific community, the media and the private sector, are all vital stakeholders.

Recommendations to PIARC

Risk management is surely a growing presence in the road sector and greater attention is devoted to the security of highway systems. But risk management techniques are not widely used systematically in many countries except in some advanced countries like New Zealand. The Technical Committee 3.2 (TC3.2) has focused on three issues on integrated risk management techniques, risk management for mega-project and highways systems security. The primary mission of TC3.2 is how to introduce and implement risk management in the road sector.

The following subjects are recommended for further activities:

- Further study on more guidelines/manuals of risk management for roads from all over the world to contribute to creating risk management process manuals;
- Further study on a greater number of best practices of risk management for natural hazards and technological (man-made) hazards and mega-projects and organizations and the methodologies of risk management to improve expertise of the TC3.2 members;
- Creation of information sharing strategies in collaboration and cooperation with states, regional organizations and institutions, and international organizations;
- Development of risk management technical toolbox for technical cooperation improvement to developing countries; and,
- Organizing international seminars to help promote risk management in not only developing countries but developed countries.

C3.3 ROAD TUNNELS OPERATION

The 23rd World Road Congress has marked the 50th anniversary of the PIARC Technical Committee on “Road Tunnels” (as it was initially named).

Since the Committee’s creation in 1957, more and more tunnels have been built to cross natural barriers or urban areas. Existing tunnels are carrying increasing traffic and a number of them nowadays need refurbishment. In all cases, effective equipment as well as efficient and safe operations are needed. For 50 years, the PIARC Committee on “Road Tunnels Operation” (as it is currently named) has been engaged in the consideration of issues relating to road tunnels operation.

During the 2004-2007 cycle, 5 reports from the preceding cycle have been finalised and published and 11 new reports have been prepared. The presentations and the discussions during the Committee session at the Congress addressed the various areas covered by these reports. They led to the following conclusions, which were complemented the following day at the special session on “Management of Safety in Road Tunnels”.

Recommendations to Decision makers

Whilst tunnel designers and operators can, and are, making every effort to improve the safety of tunnels, the eventual success of their labour will depend greatly upon the ability of the users to respond sensibly in an emergency. The work on human behaviour in tunnels has identified this issue and concluded that this can only be achieved through the dissemination of information, via a whole range of media and appropriate training and exercising. This should be planned and closely managed.
In the wake of tunnel incidents, it is easy to over-react and implement safety “improvements” which are costly and do not significantly improve safety. Efforts are being made to provide the means of making these decisions in a more thoughtful and defensible manner. This involves techniques such as “risk analysis”. This has been reported upon during this cycle but further work needs to be done. Decision makers should support these efforts and help the general public understand and accept the approach.

Technical aspects

Guides have now been produced addressing good management practices and the recruiting and training of appropriate staff. These two guides should now be drawn together with the development of procedures to generally improve tunnel operation based on feedback from operation, training and exercising, but also improved inspection and maintenance organisation.
Whilst much has been achieved over the last cycle, it still remains for some guidance to be provided with regard to responsibilities in tunnel safety management. With responsibilities defined, there should be clarity of the organisational structure and the competency requirements of these roles.
Tunnel systems must be continually reviewed to identify where their performance might be influenced by changing conditions, or better understood as a result of newly available research.

The composition of the vehicle “car park” and the impact of vehicle engine standards continue to change. These changes impact upon the performance of existing ventilation systems and the design of new ones. These need to be continually reviewed.
Similarly, over recent years the results of fire tests have become available which could impact significantly upon what is considered a sensible fire size to be adopted for design purposes. These need to be investigated and their possible impact assessed.
Considerable work has been carried out with regard to fixed fire fighting systems (FFFS) over the last cycle. Whilst new recommendations have been made, there continues to be further developments and operating experience. Close monitoring of this system should be maintained.

Recommendations to PIARC

The potential benefits of video image processing technology are now being investigated as a powerful tool for tunnel operators to detect incidents and take appropriate actions. At that point, real-time communication to inform users of appropriate behaviour is still the weak element of the tunnel safety system. PIARC needs to work with the technical committees and possibly outside organisations to ensure the finalisation and harmonisation of in-tunnel communication means (including radio broadcasting, permanent and variable visual aids, audio aids, etc.) so that tunnel users know what is happening in the tunnel and what they should do.
The “Road Tunnels” committee has produced many reports over the years. These inevitably overlap in some areas and require updating from time to time. This situation can lead, on occasion, to difficulties in interpreting the exact position of PIARC on some issues. There was considerable discussion at the session regarding the possibility of producing information in the future in a structured manner to overcome these difficulties. Various options were mentioned. In was concluded that this was a knowledge management issue. These issues should be discussed within PIARC to see if a modified approach might be more appropriate.

C3.4 WINTER MAINTENANCE

Recommendations to Decision makers

Road transportation has continued to increase markedly over the last few decades making it extremely important, from an economic perspective, to keep roads available and people and goods moving safely. Winter road maintenance services are important to road users in all areas affected by adverse winter weather conditions. Most jurisdictions around the world now rely to some extent on the private sector for their delivery. However, there is considerable variability in the approach and extent of contracting, in the types of contracts, and in the nature of the firms providing the services.

The reasons for these often marked differences, are complex but include legacy issues, the severity and duration of winter weather conditions, recent major political transformations and the degree of willingness to privatize services traditionally provided directly by the administration. The planning and delivery of winter road maintenance services remains a major challenge because winter weather phenomena display considerable variability in types, intensity, extent and duration and remain difficult to predict with a very high degree of accuracy. In such a context, it is a challenging exercise to contract for services in a fair and equitable manner while ensuring optimal financial resource utilisation balanced against the establishment and maintenance of appropriate service standards.

A key to success is gaining a complete understanding of the weather and its impacts on the roadway. This is achieved by collecting and quality-controlling as much road weather data as possible and disseminating it widely but doing so requires good collaboration across agencies and departments. These observing systems bridge the transportation and meteorological communities which further complicates data access and the establishment of data standards. The value of building a relationship between these two communities gives rise to many new opportunities. Finally, there is a need to think winter maintenance at every stage of planning a road.

Technical aspects

The levels of winter road services must be very clearly defined and well understood by all parties. The check procedures for the desired end-state road condition must be developed by establishing suitable indicators and methods of measurement. The question remains, should methods be prescribed or simply the objective? What metrics would one use to compare costs between countries? Which is the method of payment best suited to this type of service: a fixed price for work performed to a specific standard or by some fixed hourly rate? The answers to these questions differ from country to country.

In most nations, data from road weather information systems is now collected and used to better manage winter roadway maintenance operations. Considerable work remains to completely integrate road weather data into decision support or resource management systems and this work is both important and pressing. This is why international standardization initiatives are needed to provide common methods for acquiring and processing road weather information. This would greatly facilitate the establishment of links for data sharing between organizations as well as pave the way for the sharing of information on best practices leading to enhanced international harmonization.

In assessing the environmental impacts of winter maintenance operations, all of the parameters should be considered. This extends beyond just the chemicals and additives used to encompass the full environmental impacts of the entire maintenance operation. The analysis should include full life cycle costs. Administrations are striving to minimize salt consumption and to optimize their winter road maintenance operations. Yet the efficiency of such changes in strategy is not known unless the impact on water resources, vegetation and soil is investigated. It is important to continue to test innovative approaches against a socio-economic model to assess the consequences of changes in maintenance strategies for road users, for the road administration, and for society at large.

A lot of excellent work has been done to support winter road maintenance operators but further development and integration of road weather information systems and winter maintenance management systems together with other systems and data sets is required to meet the entire spectrum of future requirements of road maintainers and road authorities from performance tracking to crew call-outs and documentation. Data issues are fundamental to successful deployment and expansion of Winter Maintenance Management Systems (WMMS).

There is also an urgent need to enhance winter maintenance services for pedestrians and cyclists to increase the use of these modes of transportation during the winter months. The potential resultant decrease in short car trips would be beneficial for the environment as well as decreasing the number of winter road condition related traffic accidents and injuries.

Finally, with the climate of the world changing, we face new challenges to determine the impacts of those changes on the entire transportation system; a necessary first step to then pro-actively manage those impacts.

Recommendations to PIARC

Based on all what was learned at the Winter Seminar held in Riga, Latvia in 2005, the International Winter Road Congress held in Torino-Sestrière, Italy in 2006 and the 100th anniversary World Road Congress in Paris, France this year, there are several conclusions and recommendations. To begin with, the winter maintenance communities as well as the broader road transportation community need to establish better ways of sharing the many success stories presented at these international forums. Some easier means is required for following-up with colleagues to work through the many implementation details from a Congress presentation where time constraints allow only a brief overview. We must develop quicker, easier technology transfer mechanisms. One approach, particularly suited to publicly owned solutions that can be recommended now is the use of open system design principles wherever possible.

At the last PIARC International Winter Road Congress we learned that many components of Winter Maintenance Management Systems have been deployed and are being used operationally. Likewise, we learned that only a few end-to-end systems are being used at this time. Over time, we see an increasing level of complexity and integration of these systems along with a variety of implementation approaches. While one would expect to see these different approaches across jurisdictions, there is a need to ensure that we are not duplicating efforts. We also need to ensure we include and learn from the countries in transition. Finally, we should explore multiple on-going ways to share technology and knowledge beyond just the Congresses themselves.

C4.1 ROAD ASSET MANAGEMENT

Recommendation to decision makers

The Technical Committee explored three fields of activities during the period:

- Analysis of methods aimed at coordinating the management of all road assets, taking into account infrastructure performance as well as the perception of users and residents;
- Proposal of a structure for obtaining and elaborating performance indicators to explain the condition and function of road infrastructures. Those indicators will be integrated into an overall management system;
- The best practices capable of taking into account the expectations of users and residents.

Road asset management

Goals of road network management are often expressed by optimal long-term customer satisfaction:

- providing road network conditions to satisfy present road users and residents expectations; and
- road network preservation and development to satisfy road owners and society interests, including envisaged future needs among users and residents.

It is very important to optimize an evaluation of alternative options and selection of the option that gives the best ratio between customer satisfaction and costs.

The framework of Road asset management contents three components:
1) Owners' objectives (recognition by authorizing entities) & customers' needs (the cost of customer surveys is significant);
2) Administrative & business arrangements - Asset management is very useful for outsourcing, competition, public-private partnerships and privatization. But in the trend of outsourcing, there is concern about decreased technical capacity of in-house engineers. And there is a difficulty for optimum investment, when we don't have a sufficient budget; and,
3) Technical tools - Integration of indicators / Evaluation of indirect benefit

Indicators

The primary objective of performance indicators is to support decision makers at all levels in the management of road assets, ensuring efficient actions and to make the best use of public resources.

Technical Committee 4.1 highlights the importance of not only the hierarchies between these indicators (owner/manager/user and operator) but also the fact that they are not all equally important at the same time world wide. Applying the concept presented by the Technical Committee organizations are able to look at problems from a holistic point of view. This holistic approach is necessary for finding efficient solutions through multi disciplinary engineering as well as co-operation with all involved parties.

Technical aspects

Road asset management

Road asset management should be considered as an integrated approach to the management of road asset optimising over many different aspects of the road asset: components, goals, stakeholders, outcomes, etc.

The optimization must be communicated between different units of the road administration, but also to stakeholders, contractors and partners involved. Input for the optimization must be communicated from the data sources to optimizing functions.

Indicators

The term “drawer” is introduced to refer to a methodology that allows road authorities to organize different indicators in a generalized manner under a common objective. The drawer concept is suitable to be customized in a manner that fits the specific needs and possibilities of a country.

With this concept, a special “drawer” is assigned to each area of interest (environment, finance, human resources, travel time, safety, sustainability and social issues…). This allows the user to develop their own system according to their specific needs.

Recommendations to PIARC

Road asset management

Developing countries & countries in transition

The technical committee should consider:

- making a close study of the current status and practices in developing countries and countries in transition; and,
- identifying what assistance and transformation is required to encourage development in that field

Benefit calculation & methodology for AMS

The technical committee should analyze current practices and give recommendation of the best practice for benefit calculation/methodology for AM for each of the main topics (technical tools, administrative arrangements/business arrangements, owners objectives/customer needs).

Road asset management in the age of outsourcing

The technical committee should:

analyze outsourcing processes in countries with different levels of development;

analyze and recommend optimal role and advantages of private sector in asset management, and also of successive steps in outsourcing; and,

recommend functions which should stay in road administrations and knowledge management in administrations which are required for performing of these tasks.

Indicators

Much more work needs to be done to develop more specific performance indicators based upon agreed levels of service. The main areas that need to be addressed are:

Development of non-technical performance indicators for inclusion in an integrated asset management system;

Reinforcement of information transfer and indicators for developing countries;
Definition of a basis for international benchmarking;
Definition of the “road corridor concept”; and,
Asset management and sustainable development.

C4.2 ROAD / VEHICLE INTERACTION

Recommendations to decision makers

The growth in road traffic is increasing the technical demands made on road surfacing. This in turn has implications for road managers and decision makers in the allocation of limited financial resources to maintain, in a sustainable way, an acceptable level of safety, riding comfort and traffic noise. In addition, the introduction of new contracts for the management of road networks that incorporate functional requirements further emphasizes the need for good quality and up-to-date data on road condition. Hence, the need for the wider adoption of available traffic-speed road condition survey technologies to provide the required data at an economic cost and with minimum disruption to normal traffic operations. Road administrations should encourage and support developments of appropriate technologies for the assessment of different aspects of surface distress. The potential of robust and reduced versions of the equipment for assessing the maintenance needs of lightly trafficked and developing road networks also needs to be promoted.

Technical aspects

The trend in the use of end-product and functional performance type specifications, in the construction and management of roads, has made the provision of accurate and consistent road monitoring systems essential. This provision must also include appropriate quality assurance and operational procedures to secure reliable and robust condition information for use in pavement management. The benefits to be gained from the harmonization of assessment techniques are clear to all parties. Future work should therefore focus on further advancing developments in this area in particular, with the measurement of road-tyre noise and road surface distress. Already, traffic-speed prototype systems for the detection of cracking on paved roads are available in a number of countries. However, the assessment of other distress modes, such as loss of surface material and road edge deterioration also needs to be addressed.

Recommendations to PIARC

The Workshop on the “Vision to the next 20-30 years”, held during the Congress under the auspices of Committee 4.2, has strongly re-emphasised that PIARC should strengthen its links with the automotive industry in order for both sectors to understand their respective plans and constraints so that the necessary co-ordination can be established. In particular, in the next term(s), PIARC should keep track of the development of probe vehicle techniques for monitoring traffic/pavement interactions.

In addition, PIARC will need to keep managing the PIARC test tyre for skid resistance measurements, its availability and the stability of its characteristics.

The International Seminar in Bamako has highlighted the need for more consideration to be given on how to monitor, manage and maintain the most common roads in the world, namely unpaved ones. However, for paved roads there is still the need to pursue the

reflection and exchange of experience regarding the development and use of new advanced monitoring techniques (distress, cracking), pavement management methods and policies (friction, texture and evenness), acceptance methods and criteria and global condition indices.

Regarding the significant, proven influence of road surface characteristics on traffic noise emission, PIARC should help to develop internationally comparable acoustic classifications of road surface materials and technologies, by exchanging experiences and data from the different countries. PIARC should consider the need and timeliness of integrating acoustic parameters in the monitoring, management and maintenance of road pavements.

It is strongly recommended that, in its new Strategic Plan, PIARC retains a technical committee dealing with surface characteristics remembering that issues such as noise, fuel consumption, friction, evenness and rutting have a high impact on traffic safety, economic issues and the environment. The continuing international concern, including developing countries and countries in transition, with road surface characteristics for safe, smooth, and economic transportation is clearly demonstrated by the SURF 2004 Toronto participation and SURF 2008 Ljubljana abstracts.

C4.3 ROAD PAVEMENTS

Long life pavements, recycling and reduction of nuisance impacts from construction activities are of growing interest to the international highway community. PIARC Technical Committee 4.3 has studied these subjects within the 2004-2007 period. Below are the key recommendations that resulted from this work.

Recommendations for Road Decision Makers

- Roads and streets being investments, they should not only be looked at as initial expenses but also be evaluated in terms of benefits to users over the long term. These benefits include minimising hindrance at construction, and delivering good serviceability while maximising the economic performance of the investment.
- Many factors make Long Life Pavements attractive even though their initial costs may be higher. These include: reduced frequency of maintenance works, fulfilling better functional requirements over a longer period, better public image, reduced vulnerability, high potential for economic gains and increased sustainability.
- Many examples throughout the world have shown that this concept of Long Life Pavements is a reality, even though designs are not universal for every set of conditions. These pavements require high levels of quality in design, construction and maintenance. However, further performance monitoring and research are still needed.
- Economic and environmental gains resulting from recycling are so great that using recycled materials remains an option that inevitably should always be considered. Legislation and regulations assist in stimulating supply and demand for recycled pavement materials.
- It is important that information related to recycling is disseminated to the industry and to clients, in particular the benefits in terms of sustainable development, expected performance and whole life costing.
- Many means, either technological or managerial, have proved to be effective in reducing the impact of road works. Innovation still remains necessary to minimize these impacts even more in the future, including those needed to reduce congestion at road works.
- These developments should be directed by road administrations and road agencies, in order to encourage innovation by suppliers and contractors using a legal framework, client policy framework and appropriate contract conditions.

Technical Conclusions

- Many documented examples from several countries of successful long life flexible, semi-rigid and rigid pavements have been recorded. The factors that drive this high level of performance include: appropriate materials, high quality construction, high bearing capacity of the subgrade and subbase, effective drainage, quality of design and preventive maintenance.
- Urban pavements are complex elements of infrastructure that require an integrated planning and design approach combining durability, aesthetics and functional properties of materials.

- Sustainable development requires the minimisation of waste and the efficient use of materials. Barriers to the greater use of pavement recycling can be overcome for instance, by creating a climate beneficial for private investment in recycling technology.
- Access to full information on the benefits of recycling in the long run and clear objectives on sustainable development are key factors that foster development and implementation of pavement recycling techniques.
- Road works have a range of impacts on many stakeholders such as safety of drivers and workers, availability of the road to users, noise, vibrations, pollution (water, air and soils) of the surroundings and other types of nuisances. Most of the road agencies and road administrations have implemented laws, regulations and guidelines to minimize these impacts.
- Road work impact mitigation measures can be put in place at various stages of projects planning, design and preparation as well as during construction. An innovative and improved design as well as modifications to contractual requirements can reduce the duration and impact of works.

Recommendations for PIARC

PIARC should stay as a leading forum for all those involved in the road sector. Moreover, cooperation between experts in the field of urban infrastructures should be encouraged by international bodies such as PIARC.

More extensive exchanges of information and sharing of views between PIARC technical committees would be beneficial. One way of doing this could be by selecting a cross committee transverse topic at the beginning of a period, to be examined jointly under the leadership of the Strategic theme coordinator.

Committee TC4.3 suggests some topics of interest for future work:

- contribution of pavements to sustainability and the effects of climate change on pavements;
- evolution of pavement loadings and impacts on performance and design;
- pavement performance specifications and risk management; and,
- reducing pavement construction time and cost.

C4.4 ROAD BRIDGES AND RELATED STRUCTURES

Recommendations to Decision makers

Durability in design, construction and service life phases

- Durability must be considered explicitly at all stages: specification, conceptual design, detailed design, construction, inspection and maintenance.
- The increasing search for overall optimal financial performance for the whole life of such structures has raised the profile of questions of durability.
- Design standards increasingly respond to durability and decision makers should get involved in this process.

Cost-effective bridge management

- Network level analysis is essential to identify investment candidates that will maximise the return from available funding levels.
- All surveyed countries conduct a manual review of the system derived investment candidates to take account of budgetary limits and aspects of operation and maintenance of the road works not considered in the automated analysis.
- The relatively low weighting of financial aspects in the prioritization factors is probably related to the subsequent moderation process, which is managed by decision makers more than bridge engineers. Some more input is needed on this point.
- Unfunded priorities must be proactively and transparently managed.

Technical aspects

Durability in design, construction and service life phases

- The environmental conditions, which the infrastructure inhabits is of vital importance.
- Major durability problems emanate from poor construction (e.g. low covers to reinforcement), leaking deck joints, chloride attack (often associated with leakage paths from failed joints) and deck waterproofing failure. The significance of these factors depends on the severity of the environment and specific design practices.

Cost-effective bridge management

- Various prioritization methodologies and attendant factors have been adopted by the surveyed jurisdictions however condition/deterioration is the primary factor in the surveyed systems.

Recommendations to PIARC

Durability in design, construction and service life phases

- Recognition of durability problems has led in general to a shift in the design concept for short/medium span bridges towards eliminating (or reducing) deck joints by adopting integral bridges (or favoring continuous decks). Future work on these integral bridges could be developed by the PIARC Bridge Committee.
- The data set from the questionnaire provides a valuable reference point for bridge engineers to take an overview of the situation in their own country, and contrast it with the situation in other countries with similar conditions but with perhaps alternative approaches to mitigating durability problems, which may warrant closer examination.
- The durability topic is a very wide one and should be continued in future committees. For example, the impact of new materials on durability could be further investigated.

Cost-effective bridge management

Recommendations for future work that could be conducted on this subject include:

- Bridge performance measures and relative influence on prioritisation.
- Non-bridge factor influence on prioritisation with particular reference to financial factors.
- Methodology for evaluating bridge needs relative to other infrastructure elements.
- Mappings of condition/defect and treatment options and the relative efficacy of options.
- Deterioration model investigation covering the various deterministic, stochastic and artificial intelligence approaches or combinations thereof.

C4.5 EARTHWORKS, DRAINAGE AND SUBGRADE

Recommendations to Decision makers

Promoting optimal use of local materials

Identifying progress in terms of soil and rocky materials treatment for road applications

- Large development in soil treatment techniques in developed countries over the two last decades. Nevertheless, too many developing countries don't have access to these techniques (cost, lack of binders, lack of adapted equipment etc.)
- Technical guidelines elaboration in the developed countries, for soil treatment, accepted by owners, contract managers, contractors, binders producers etc.
- Need to integrate soil treatment in a sustainable development approach, by taking into account positive aspects (granular materials saving, increasing the use of available materials in the project, limitations on dumping of natural materials…) but also limiting aspects such as energy expenditure and greenhouse gas emissions.
- Elaborate and develop reliable techniques for soil treatment in developing countries. These techniques must be based on a high use of local manpower and simple equipment, instead of heavy, imported equipment for punctual use.

Identifying progress in the use of wastes and industrial by-products as earthwork materials

- High variability of waste and industrial by-products used as road materials. If the use of such materials is common in developed countries, it remains marginal in numerous other countries.
- Two opposing policies are observed: promoting the use of such materials (in France for example) in spite of potential environmental risks and, on the other hand, a rigorous application of the precautionary principle and, thus, systematic dumping (Switzerland for example).
- The nature of industrial by-products used as road materials is governed by local industrial conditions. Except particular cases, there is no or very little importation or exportation of these materials.
- If the impact on environment is a widely recognized concern, it must be addressed more thoroughly.
- Need to set up a quality and following policy for use of these materials.
- For the proper use of these materials both geotechnical and environmental aspects need to be taken into account.

Having indicators representative of the condition of geotechnical structures for road asset management

- A particular focus should be on obtaining good cost, safety and reliability data for asset management regimes operating a 'reactive' approach and those operating a 'pro-active' approach. This would inform the decision to adopt a particular asset management strategy.
- The effective and consistent valuation of geotechnical assets should be explored.

Technical aspects

Promoting optimal use of local materials

Identifying progress in terms of soil and rocky materials treatment for road applications

- Important progress in the design and availability of specialized equipment for soil treatment.
- Develop the understanding of physical, chemical reactions during settings of binders in soil treatment, in order to optimize its effect and durability.
- Improve the adaptation of soil treatment to marginal materials or materials not compliant with specifications, in order to increase their use in earthworks.
- Develop specific road binders or specific methods in order to limit or eliminate the negative effect of disturbing elements (chemical or mineralogical) contained by some soils.
- Climatic changes foreseeable at short and medium term makes it essential to establish reliable methods, equipment and products to ensure placing too dry soils for right compaction as embankment complying with the technical and environmental aspects and without excessive need for local fresh water which is lacking at this time.

Identifying progress in the use of wastes and industrial by-products as earthwork materials

- The destination of these materials is quite similar in the different countries; very often in embankments and sometimes in capping layers or as substitution materials.
- Need to improve the use of these materials thanks to specific platforms for a suitable elaboration to control geotechnical and environmental characteristics.
- For the proper use of these materials both geotechnical and environmental aspects need to be taken into account.
- Great interest to adapt and develop specific tests in order to characterize these materials from both geotechnical and environmental points of view. It appears that the conventional tests used for natural soils are not always adapted to the specificity of wastes and by-products.

Having indicators representative of the condition of geotechnical structures for road asset management

- The effective and consistent valuation of geotechnical assets should be explored.
- The work highlighted that a coherent framework is needed for the evaluation of different types of assets. In particular, areas of whole life costing, risk management and value management should be integrated. This would enable assets with a low frequency of failure but a high impact on the network (such as geotechnical or structures assets), to be compared in terms of risk and value with assets such as pavements that have a high frequency of failure but a relatively low consequence.

Recommendations to PIARC

Promoting optimal use of local materials

Identifying progress in terms of soil and rocky materials treatment for road applications

- Promote the development of reliable techniques for soil treatment in developing countries. These techniques must be based on a high use of local manpower and simple equipment, instead of heavy, imported equipment for punctual use.

Identifying progress in the use of wastes and industrial by-products as earthwork materials

- Well-adapted general legislation (national, European) for countries involved in the development of the use of such materials, even if a need for technical guidelines appears clearly in order to define more precisely the conditions of use.
- If the impact on the environment is a widely recognized concern, it must be addressed more thoroughly.
- Need to improve the use of these materials thanks to specific platforms for a suitable elaboration to control geotechnical and environmental characteristics.
- Need to set up a quality and monitoring policy for use of these materials.
- Great interest to adapt and develop specific tests in order to characterize these materials from both geotechnical and environmental points of view. It appears that the conventional tests used for natural soils are not always adapted to the specificity of wastes and by-products.

Having indicators representative of the condition of geotechnical structures for road asset management

- Consideration should be given by PIARC to extending the current study to look more widely at performance indicators adopted world wide by operators of other infrastructure systems such as flood defences, dams and railways.
- The specific evaluation of the particular merits of the different indicators was outside the scope of the current work but is an area for future potential activity.
- A pro-active asset management approach requires good quality, interoperable data. International work in this area is currently being undertaken and should be supported by PIARC to aid the implementation of geotechnical asset management systems.
- The work highlighted that a coherent framework is needed for the evaluation of different types of assets. In particular, areas of whole life costing, risk management and value management should be integrated. This would enable assets with a low frequency of failure but a high impact on the network (such as geotechnical or structures assets), to be compared in terms of risk and value with assets such as pavements that have a high frequency of failure but a relatively low consequence.

Special sessions

SP3 RESPONDING TO HUMAN RESOURCE CHALLENGES IN THE ROAD SECTOR

This session presented examples of initiatives in different organizations, public administrations, academic institutions, and regional and international road associations. The session was divided into two parts: Issues of competencies and actions to respond to these issues, and making the road sector more appealing.

Recommendations to decision makers

The road organizations from private and public sectors must answer the needs for the construction, maintenance and management the transportation infrastructures. However, many of them are facing an ageing workforce and problems of renewing their staff, in an environment where there is a reduction of resources. Meanwhile, the nature of jobs is changing, with the expanding needs of users, the emergence of new techniques, the diversification and specialization of expertises, and the changing of roles between the public and private sectors.

The continuous development of the competencies of personnel is therefore an increasingly important challenge. This applies to all areas of roads and road transportation, and all types of work: studies and planning, construction, and maintenance. All occupational groups are affected, including engineers, professionals, technicians, and workers.

A comprehensive approach is needed to address this challenge, from student outreach activities to recruitment methods and finally, training and retention programmes.

Technical aspects

Student outreach measures seek to increase the number of qualified applicants for jobs in the road sector, by attracting young people to scientific and technical disciplines. They are aimed at students of various ages: college or university students, as well as high school and even elementary school students.

The promotion of transportation activities raises kids' awareness of the sector, making the associated professions and research activities more attractive to them and encourages them to undertake and continue these types of studies. The measures that can be implemented vary greatly including scholarship programs, grants for university research programs that contribute to training young researchers, job shadow days, workshops in schools, participation in career days, competitions organization support, mentoring program between experienced and new employees or between an engineer and a school teacher, etc.

Recruitment is often more difficult since skilled persons are in demand not only in the transportation sector but also in other industries which are facing workforce shortages. The private sector firms are able to adapt more rapidly to these rather competitive conditions,

but generally all organizations have to rely on various measures.

Different methods have proved effective for example summer internships are an opportunity for students to become familiar with a place and to gain practical experience. Partnerships with universities and colleges help to promote co-operative education, a pedagogical approach whereby students spend alternate trimesters studying in the classroom and earning wages in a workplace.

Once the employees are recruited, the organizations must retain them. Retention programs are generally form part of an employee management framework which could include the management of coaching staff, the quality of working life, management of contribution and of recognition, skill management, the needs of planning the labour force and work/life balance.

Since the expertises in the transportation sector are increasingly diversified and specialized, the road organizations must also maintain and develop the skills of the employees. Professional training is therefore a very important issue. Most organizations do not have the resources required to meet all of their training needs, leading them to collaborate with other organizations, like road associations and academic institutions.

Recommendations to PIARC

PIARC products are of high quality and have a significant potential to become learning material. Since the professional training must take into account the specific problems of every world region, or even every country, PIARC should continue its collaboration with regional organizations, in order to respond as effectively as possible to local needs.

However, the professional training courses offered in PIARC member countries are also increasingly aimed at an international audience: while travelling abroad has become easier and more commonplace, distance training is experiencing rapid growth. Courses that are technical in content and less specific to the local context (regulatory, political, or other) can then find a market beyond the boundaries of the country where a training organization is located.

In light of this, PIARC makes available a directory of professional training organizations in the field of roads and road transportation in its member countries.

SP5 FINANCING INVESTMENTS IN THE ROAD SECTOR THROUGH COMPREHENSIVE LONG-TERM CONTRACTS

To summarise what has been discussed in SP 5, it has been demonstrated that although long-term contracts can be complex and quite risky, they do provide for an alternative means for the implementation of infrastructure.

As we are all aware, infrastructure will be delivered through Public Private Partnership (PPP) projects in only a minority of cases. In Great Britain for example, just 15% of the investments in infrastructure, not only roads, are PPP projects. In addition to this, the German government has implemented guidelines for PPP projects with the goal of reaching 15% of all investment in infrastructure by PPPs.

It is particularly important before implementing a long-term contract, that all stakeholders which are involved have an appreciation of the potential risks and understand how changes will be managed throughout the period of the contract.

It is essential that risk analysis is completed prior to the commencement of the procurement process. The public entity has to manage the risk analysis and considerations when drafting the contracts. If this can be achieved, the negation procedure can be completed in a shorter period of time and the risk value of the private partner will be lessened if both sides are clear about what is specified in the contract. The regulations relating to the management of risk during the implementation period of the contract are also important.

The PPP market is a growing business. Therefore, this Congress provided an appropriate time and place to discuss issues relating to PPPs. I am sure it will be also on the agenda of the next World Road Congress as in four years time, more long-term contracts will have been implemented and there will be more experience of the advantages and disadvantages of this particular method of infrastructure investment.

SP7 ROAD SAFETY ISSUES AND POLICIES IN DEVELOPING COUNTRIES

Road accidents are a major health issue with 1.2 million casualties worldwide a year, and are the leading cause of death in people aged 10 to 25. Road safety related economic loss is very high in developing countries: 2.5% of GDP in Morocco, 3% in India. In low and middle income countries, road accident injuries are expected to grow 83% from 2000 to 2020.

This is tragic. This is avoidable. This is a major political challenge for developing countries.

The Special Session 7 of the World Road Congress on “Road safety issues and policies in developing countries”, through presentations and interventions from various Countries (China, Costa Rica, Ghana, India and Morocco) and from various organizations (*Conférence Interafricaine des Métiers de l’Assurance*, FIA Foundation, the Global Road Safety Partnership, World Bank and PIARC), offered the possibility to determine a list of recommendations and to pave the way for possible and necessary actions in the field:

Recommendations to Decision makers

- Political awareness for road safety has to be raised and maintained high on the agenda in all countries. Continued effort and involvement from all decision makers is required, following up on UN and WHO resolutions as well as renewed commitment from the World Bank and from numerous national, regional and local authorities;
- Actions and policies in the field have to be structured around the human being. But they have also to involve actively the society as a whole in a cooperative, self-improving and perennial manner;
- At the national level, all stakeholders such as emergency services, the police, road engineers, schools, insurance companies etc. must get involved in road safety, and their actions must be prioritised and coordinated (case of the National Road Safety Commission of Ghana for instance). This requires commitment at the highest political level and the establishment of a comprehensive national plan, such as in China or India;
- Appropriate driver and passenger behaviour must be enforced and improved through lifelong education efforts, as well as through legal and police measures (such as the seat belt law in Costa Rica). Traffic laws have to be enforced. On this point, controlling vehicle characteristics and loads are also important safety measures;
- Special attention must be paid to vulnerable road users. Mixed traffic is a source of danger, thus separated lanes for pedestrians and cyclists are a useful option;
- The infrastructure itself has to be improved in order to continuously improve road safety and should be adapted so that road users increasingly avoid accidents and that the accidents' consequences are mitigated. Effective measures do exist in that scheme. They must be implemented according to their cost, effectiveness, feasibility and acceptability;
- On a global level, a number of large road networks are being planned for and built. They must incorporate road safety standards and features. A percentage of each project funds should be set aside for road safety related tasks and projects;

- The existing road network can also be improved, since (low cost) measures do exist. As a minimum prerequisite, regular road maintenance must be enforced;
- Road safety action has to be particularly targeted to the highest concentrations of deaths and injuries on the road network: 20% of the network usually accounts for more than 70% of all accidents;
- Donor organizations should set the example for the road projects that they finance. They should make preliminary safety audits a compulsory condition for the funding for any road projects, and they should also continue making funding available for all road safety measures.

Technical aspects related to infrastructure and accident data

- National road design standards must be updated so that they continuously incorporate best practices on road safety;
- Road safety audits of new projects should be put into practice immediately. They are quite inexpensive to implement and the return on investment is very significant;
- As concerns the existing network, road safety inspections on the whole network as well as the treatment of accident accumulation locations ("hazardous spots") are required;
- Also, a set of comprehensive accident data is a prerequisite in order to target the measures to where they are most needed. Therefore, each country needs to develop a national accident data collection strategy and to enforce it in cooperation with the various parties concerned (police forces etc.). This can be helped by the fact that local population or hospitals already possess valuable information;
- Guidelines already exist regarding improvement of road safety. They have to be adapted to the local contexts and needs, and to be put into practice.

Recommendations to International Road Organisations and PIARC

- The appropriate technical and organizational knowledge already exists and decision makers should promote knowledge exchange, on the national and international levels.
- Workshops at the regional and local levels and teaching efforts in particular seem very effective and should be pursued.

Among the ongoing initiatives, the following actions were pointed out:

- the role of PIARC and in particular its Technical Committee 3.1 on Road Safety, both by elaborating reference documents and by organizing regional seminars in Africa and South America on “Road Safety and Infrastructures”. These efforts should be pursued and expanded during the 2008-2011 strategic plan.
- the “Make Roads Safe’’ initiative launched by the Commission for Global Road Safety to the attention of the General Secretary of the United Nations, aiming at collecting 1,5 million signatures by April 2008. This initiative is supported by the FIA Foundation ;
- the actions of GRSP in the field of knowledge sharing and communication ;

- Also, participants noted with satisfaction the World Bank's creation of a facility dedicated to road safety in developing countries, and hoped that this would give an impetus to the setting up of actions in the field./.

SP9 MOBILITY FOR VULNERABLE USERS

Recommendations for decision-makers

Vulnerable users such as pedestrians and cyclists are associated with sustainable modes of mobility, or in other words, alternative, non-motorized modes of mobility that cannot achieve the high speeds that are attainable by motorized modes of transportation. The alternative mobility of pedestrians and cyclists represents a clean mode of transportation that has no adverse effect on the environment. In order to foster sustainable development, these modes of transportation should be promoted. Therefore, road administrations and road network managers should adapt road infrastructures in order to make them safe and comfortable for pedestrians and cyclists. This requires taking into account the conditions under which the safety of users can be improved, by adopting and implementing policies that can guide decision-makers in terms of infrastructure and legal and service requirements, and that can help to define actions aimed at informing and educating people in order to promote sustainable modes of mobility.

Mode sharing must be analyzed from the point of view of safety and mobility. This is a crucial issue, especially in the case of developing countries, where safety and mobility needs are increasing.

It is also important for persons with impaired mobility to be able to travel under similar conditions to the general public. Accessibility should be guaranteed from the point of departure to the destination. Furthermore, developments and road signs must take into account the needs of demographic ageing.

In order to ensure sustainability, elected officials and network managers must try to preserve the quality of accessibility at all times. In relation to the costs, decision-makers must be aware that it is better and more economic to consider at the beginning of a project the needs associated to the mobility of the whole vulnerable road users.

Special attention should be paid to roadwork, where accessibility for persons with impaired mobility and for pedestrians as a whole should be maintained.

Technical considerations:

Sustainable modes of mobility require quality infrastructures in order to ensure the safety and comfort of users and to improve the quality of life. The inclusion of alternative mobility in road planning requires an adequate level of expertise, and the measures taken must be adapted to the local context.

Adequate facilities for cyclists, pedestrians, older people and persons with impaired mobility are recommended. Certain types of equipment are also recommended, such as pedestrian signals and audible signals with pushbuttons and tactile coatings. New audible signal designs, where the audible signal alternates from one side of the intersection to the other, seem to produce a better alignment of pedestrians before and during the crossing. New detection systems can control the time allocated to crossings, and can detect pedestrians waiting to cross. Devices are being developed that will guide visually impaired or

wheelchair-bound persons on a route that meets their specific requirements. In the not-too-distant future, designers will need to incorporate these devices into their facilities.

Recommendations for PIARC

Although the road accident record is improving in high-income countries, it is deteriorating in most developing countries. In addition, an alarming proportion of these accidents involve the most vulnerable road users, namely pedestrians, cyclists, persons with impaired mobility, and handicapped persons, or in other words, people who have no protection. The need to design road environments that are adapted to the needs of all vulnerable users is widely recognized. Furthermore, certain conditions must be met in order to improve the safety of sustainable modes of mobility. Given their mission to disseminate information concerning best practices, international road organizations and the PIARC can exercise their influence in order to ensure that vulnerable users are taken into account during the design and planning of roads. Decision-makers and designers should be guided by general principles that are based on a sustainable development philosophy, where sustainable mobility is promoted. Through its activities, the PIARC can influence the direction of reflections pertaining to this issue.

SP13 VULNERABILITY OF ROAD SYSTEMS TO CLIMATE CHANGE

Recommendations to Decision makers

Within the lifetime of existing and planned highway infrastructure around the world significant changes are expected in the world's climate. These changes are not uniform, they vary geographically. This variation combined with the variation in the characteristics of highways across the world and the local regions within which they sit, means that the impacts of climate change will also vary. The significance of these impacts such as increased risks of floods and the need to take appropriate responses can only be judged at the local/regional level. There are unlikely to be uniform global responses.

Road administrations and decision makers now need to begin to factor climate change adaptation issues into their processes. Currently there is no comprehensive, quantitative assessment of the various transportation sector costs and opportunities associated with climate change.

As a necessary first step towards doing this, decision makers need to support the necessary collaborations between engineers and climate scientists to ensure that relevant tools are developed to inform the adaptive design, maintenance and operation of highways.

Technical aspects

The development of highway design codes across the world have generally been based around the use of historic weather data for the regions from which the codes originate. Under the conditions of changing climates this reliance on historical records as a guide to future conditions is problematic.

Currently however, the development of climate models has not allowed highway network operators to consider in sufficient detail, the impacts that climate change may have on their networks. There has been neither the spatial resolution nor a sufficient quantification of the uncertainty in the projections of climate change to inform investment decisions. Indeed the present tendency to average climate change impact globally is likely to obscure consequences for local and regional areas. In order to identify and evaluate the potential interaction between transportation and climate change, we need a reliable comprehensive assessment of the anthropogenic microclimate changes at the regional and sub regional level, the scope and magnitude of infrastructure vulnerability to climate variability and how such climatic changes could influence these variations.

However, climate models that can address these two issues are beginning to become available and understanding and applying these tools to the review of existing standards and practices and their revisions as necessary, will soon become practical.

Recommendations to PIARC

Climate change represents a challenge to one of the paradigms that underpin highway design, maintenance and operational codes across the world. The paradigm being that whilst local climate can vary the extent of that variation can be allowed for through the study of historical data. Climate change requires us to consider the adoption of risk based approaches with climate change currently recognised as one of the least well defined uncertainties.

The challenge for PIARC is to ensure that this new factor of a varying climate is considered across all aspects of its work to ensure that highways are designed and can be maintained and operated in line with these emerging new risks. To achieve this goal, PIARC needs to promote the collaboration of highway organisations with climate scientists and others to ensure that appropriate tools are developed.

SP14 RISK MITIGATION: ROAD AUTHORITIES PREPARATION AND RESPONSE TO EMERGENCIES

The world is very vulnerable to natural disasters, regardless of whether a country is rich or poor.

This means that we have still a lot to do as far as preparedness and responsiveness in relation to the road sector. Many countries are in the same situation and they need the information on how to best prepare for unexpected disasters and to form the best possible system to respond to unexpected events for the road sectors.

Lots of questions raised in this session are related to these matters. Responsible authorities need the information. They know they have to do something to improve their situation against natural disasters but don't know exactly what to do in a practical way.

At the same time we learned a lot from the cases where post-event reactions or responses did or didn't work well. For instance, lack of preparedness of society and of redundancy of the road network has shown to make things much worse. In contrast, systems that are prepared well in advance in the engineering sense and in the sense of crisis management based upon past experiences, worked very well.

Again, we can never stress enough the importance of knowledge and imagination in advance on any kind disasters and of course the importance of the ability to learn from the unfortunate experiences of others and naturally, of their own. This is more easily said than done. How can one expect any country to invest a lot of money and to act properly against disasters without any painful experiences of their own? These facts show how important and vitally necessary it is to disseminate the various information and knowledge on hazards and at the same time, the successful examples of responses and reactions taken at the time of disasters in other countries.

It may be concluded from the discussions and comments in this session that there are a lot of matters for PIARC to address in order for many countries to acquire the necessary knowledge in both the engineering and social aspects and prepare for crucial events they are currently facing or haven't yet faced but might face in the future.

Finally, PIARC SP-14 suggests that each road authority conducts an inspection and assessment on the safety of road structures and implements the retrofit (or strengthening) works with the necessary investment and that PIARC should play a vital role to make these things happen through its activities of the dissemination and transfer of relevant knowledge and technologies.

SP15 MANAGEMENT OF SAFETY IN ROAD TUNNELS

Many of the issues discussed during this session complemented and developed the discussion which took place during the C3.3 session.

There has been a positive trend to improved tunnel safety over recent years. Whilst new standards and directives have been published, the exact nature of their implementation has still to be resolved. Many of the issues raised do not have definitive answers and will rely upon dialogue and agreement between the various stakeholders for their resolution.

The use of risk assessment and of methods to determine the relative value of alternative solutions, have been accepted in principal, but the exact methodology has still to be agreed. Those methodologies which are accepted will have to be understood and accepted by all of the stakeholders. To this end, they will have to be based upon reliable data and accessible to all.

Motorists are a key factor in tunnel safety. It was recognised that whilst activities which raise customer awareness to safety issues, such as EuroTAP, helped gain support / pressure for improvement, it was ultimately the responsibility of road tunnel safety experts to resolve which changes were of actual benefit. To this end, care must be taken in ensuring that motorists do not receive misleading information. All stakeholders should target educating motorists to behave correctly in tunnels in all circumstances. In this regard there was still the problem of how we translate our improving knowledge of human behaviour into sensible system changes and solid advice to tunnel users. Similarly, there was still concern as to how operators actually behave under pressure and how this might be assessed.

The Fire Services have a wealth of experience which needs to be harnessed throughout the whole life of a tunnel, from design, through commissioning to day to day operation. Closer co-operation is required to ensure better understanding and a more co-ordinated interface. Those Fire Services with limited knowledge of road tunnels need to be educated regarding their specific problems. It was recognised that there was a need for clarity on who should be involved in incident management development.

New facilities are already gaining the benefit of the increased awareness of the problems related to safety. Whilst the new European regulations are driving current thinking on many issues, it is recognised that the conclusions being drawn are applicable to tunnels the world over. PIARC possibly occupies a unique position from which it can help encourage dialogue, for instance through international forums, to promote a common understanding and co-ordinated response to road tunnel safety issues.

SP16 NEW CONCEPTS, NEW IDEAS TO FACE ISSUES OF SUSTAINABLE DEVELOPMENT

Recommendations to Decision makers

Tensions in the energy market are inevitable because of a shock-wave from the steep rise in demand for oil products which will happen in the next few decades. At the same time, growing evidence of climate change and global warming shows an urgent need for action to reduce greenhouse gases. In response, decision-makers will need to show leadership and set bold strategies to foster energy efficiency and sustainability. An example is the Berlin clean energy partnership involving the city authorities in concert with national government and energy supply companies to demonstrate a complete hydrogen-based energy supply and distribution chain. This example is very futuristic, but nevertheless a necessary practical demonstration of the need for vision in addressing energy supply problems.

A very substantial growth in the volume of freight and passenger traffic on the roads is forecast over the next decade (e.g. 50% growth for freight and 40% for passengers for the European Union in the period to 2020). This, too, will require leadership and high levels of investment and political commitment to secure measures which will promote sustainability and co-modality in the transport sector.

Safety on the roads is a further issue. European counties, for example, have abolished the death penalty for extreme crimes and now plan to make a big impact on road fatalities. The next goal should be to stop people getting killed when they miscalculate or fail to pay attention when driving.

Intelligent Transport Systems (ITS) have a big part to play, especially in the delivery of safer, cleaner road transport and in tackling congestion. The automobile industry is investing heavily in bringing new technology to market. There is a pressing need for a matching response from the roads authorities to deliver the full potential of these new technologies. Once more, leadership is the key. The development in Europe of a strategy for roll-out of ITS is a timely example.

Technical aspects

The technical challenges presented by these future scenarios are multi-dimensional and multi-faceted. Objectives are to reduce congestion, improve safety, protect the environment, improve energy efficiency and reduce dependence on fossil fuels. These objectives are often in serious conflict with one another.

Sustainability goals can be served by the introduction of energy-saving technology for vehicles, road construction and maintenance. There are proven reserves of oil to support 43 years or more of production and with further investment in production capacity this could be extended further. However, the limitation in supply of fossil fuels is a major issue for the automobile industry. Bio-diesel products can be used as a substitute for petroleum products but raise big political issues over the use of agricultural land.

Recycling of materials and the use of renewable sources in road works will play a big part.

Research is needed to define energy-saving and renewable energy alternatives to conventional construction methods and materials. Innovation to identify renewable sources and substitutes for bitumen-based emulsions and binders in road pavement construction shows the way.

In the domain of ITS and road network operations, safety and efficiency benefits will be determined by the introduction of new technology both on the infrastructure and on vehicles. Developments in sensor technology and mobile communications are already bringing new services that can benefit road users (e.g. the Vehicle Information and Communications System (VICS) in Japan). The private sector now has the means to provide a complete information supply chain. Data from an improving range of on-vehicle sensors can provide high-quality monitoring and information on the road network. These services need to be placed within an operational framework established by the road authorities.

There is a growing recognition that these new services can achieve quite dramatic improvements in efficiency and safety. One example from Japan demonstrated an 80% reduction in accidents caused by congestion on the highway when drivers were warned of stopped vehicles on the curve ahead. Until recently, the cost of installing mobile communications was an obstacle to widespread deployment of these systems. Two initiatives - WAVE (Wireless Access Vehicular Environment) and CALM: (Communications Access for Land Mobiles) - will help facilitate these new services.

Deployment of ITS technologies will require new organisational capabilities and a partnership approach with the private sector. A clear legal and business framework is required, for example in road tolling and electronic payment for gasoline purchase and other services using common electronic payment technologies. Liability issues have also to be clarified, as between the vehicle driver, the vehicle manufacturer, the equipment or service provider and the road authority.

The World Road Association (PIARC) needs to be at the centre of the debate, not least to make sure the needs of those involved in planning, building and maintaining roads infrastructure are not overlooked. One way that deployment can be accelerated is through better understanding and co-operation between car manufacturers, communications providers, system suppliers and road administrations. As a World Road Association involving 113 countries from around the globe, PIARC is well-placed to do this. PIARC members must cooperate globally to interface with the automobile industry in addition to engaging in the more traditional activities of knowledge transfer and establishing recommended best practice.

SP20 ROAD SAFETY AUDITS AND INSPECTIONS

Recommendations to Decision makers

There are effective and efficient measures to improve road infrastructure safety and all countries and road operators are encouraged to deploy them over their network. These include **road safety audits** (RSA) during the project phases and regular **road safety inspections** (RSI) on the whole existing network – two proactive approaches that identify the potential for a crash, and make improvements before the crash occurs. **Road safety audits** can be put into practice immediately in every country. They are inexpensive to implement and the return on investment is significant. As an example, RSAs are implemented for federal and interurban roads in Germany, and they are optional on urban roads, but can be very useful. Countries in transition, in particular, should focus on RSAs for their numerous projects.

- Donor organizations should set the example. They should make preliminary safety audits a compulsory condition for the funding for any road projects. They should also continue making funding available for all road safety measures and emphasize the use of cost-effective safety treatments.
- The EU considers road safety “a shared responsibility” and should continue to foster an integrated approach, including implementing RSAs and other tools to ensure safety is integrated in all phases of planning, design and operations in EU countries.
- Dialogue between policymakers and engineers should be facilitated with ongoing information exchanges. Raising political awareness of roadway safety needs is an important activity.
- Road owners and operators need to consider the broad range of inputs and make the greatest impact in improving safety. Limited funds mean that discrimination and careful prioritisation of actions, using real accident data when available, are essential.

Technical aspects

PIARC has developed and disseminated guidelines on implementing RSAs, along with checklists that can assist new users in adequately using this powerful safety technique. Road safety inspections are a newer, but equally powerful tool for taking a proactive approach to improving safety on existing roadways, and there is also a PIARC guideline on this topic. PIARC has also produced a very practical catalogue of frequent defects and possible solutions.

- Special attention must be paid to vulnerable road users. Mixed traffic is a source of danger, so separated lanes for pedestrians and cyclists are a useful option.
- The legal framework for auditors is an important aspect with regard to minimizing the fear of litigation that prevents some countries from fully implementing RSAs. The same applies to inspectors and RSIs.
- The systematic features of the checklists for performing RSAs and RSIs are an important feature and should be emphasized, but both should be customized for local needs.

- We should continue to compile and share efficacy information on road safety countermeasures to insure that the appropriate range of solutions are considered and applied when deficiencies are identified through RSAs, RSIs or other techniques.
- Other tools and techniques, particularly **Network Safety Management (NSM**) should be used as a complement to the full implementation of a Road Safety Inspection approach. NSM identifies priority corridors as the ones where accidents occur at a high frequency. NSM then aims at understanding the specific local reasons behind this and then making cost-effective recommendations for remedies. NSM goes beyond accident accumulation location treatment and takes a wide perspective on the infrastructure and the driving procedure, so that it is able to take into account all factors affecting the drivers on a given corridor.

Recommendations to PIARC

- Continue to assist developing countries and countries in transition in implementing tools such as road safety audits and road safety inspections to improve safety.
- Support training centres for road safety auditors and inspectors.
- Analyze and disseminate best practices with regard to legal and institutional frameworks to implement RSAs and RSIs.
- Continue to develop and provide easy-to-use tools and information on identifying appropriate countermeasures to improve roadway safety – including maintaining and improving the PIARC *Catalogue of design safety problems and countermeasures.*
- PIARC should clarify the use of the term “accident” vs. “crash”