2020-2023 Strategic Plan

Draft Section 2

ToR detailed description

Draft July-19

TECHNICAL COMMITTEE 1.1 – PERFORMANCE OF TRANSPORT ADMINISTRATION

1.1.1. Framework for measuring efficiency and effectiveness of Transport Administrations

Strategies / Objectives
• More in-depth analysis of the work carried out in cycle 2016-2019 by *T.C.A.1 – Performance of Transport Administrations*, and more in particular to further the work on value creation. • Identify best practices for the establishment and use of assessment indicators/evaluation indexes (benchmarking) to identify opportunities to improve the overall performance of transport administrations, mainly focus on overall customer experience and communication of performance information. • Encourage coordination with *T.C.3.2 – Road Network Operation* and *T.C.3.4 – Asset Management.*

Implementation of Performance Management is at various degrees of adoption throughout the world. Some countries have been working on this issue for some time and continue to advance the implementation of Performance Management including the codification of infrastructure related performance measures in law. At the same time other countries are still lagging in the implementation of an even basic framework of organizational and performance management.

The *Technical Committee A.1 – Performance of Transport Administrations (SP 2016-2019)* and its predecessors have done quite a bit of work on the identification of good practices for performance frameworks and indicators for the road sector.

This cycle should look into updating and providing a more in-depth analysis of the work that was done in previous cycles, concentrating on identifying best practices for establishing a framework for measuring the efficiency and effectiveness of Transport Administrations, including the establishment of assessment indicators/evaluation indexes (benchmarking) that can be used to recognize opportunities for improving the overall performance of transport administrations, with a particular focus on overall customer experience and communication of performance information.

In this Cycle, a full report based on the collection of case studies and a best practice toolkit is expected to be completed.

Outputs	Deadlines
• Collection of case studies and toolkit	• June 2021
• Full report	• December 2021

1.1.2. The transformation and new role of Transport Administrations in face of sharing economy, emerging technologies and Mobility as a Service (MaaS)

Strategies / Objectives
• Define the role and required transformation of Transport Administrations in the face of sharing economy, emerging technologies, and Mobility as a Service (MaaS) and address issues at the intersection of emerging transportation technology and performance management such as big data, digitization, vehicle technologies, shared mobility, and evolving transportation modes and business models. • Follow up to the work carried out by *T.C.A.1 – Performance of Transport Administrations* on change management and outside drivers for change. • Encourage coordination with *T.C. 2.1 – Mobility in Urban Areas, T.F.B.2 – Automated vehicles – challenges and opportunities for road operators and authorities, T.F. 2.1 – New mobility and its impact on Road Infrastructure and Transport, T.C.3.2 – Road Network Operation* and *T.C.3.4 – Asset Management* • Encourage coordination with NCHRP Project Number: 08-127 / B-12 Emerging Issues: Impact of New Disruptive Technologies on the Performance of DOTs.

The combination of the new sharing economy model and new disruptive and innovative technologies such as connected and autonomous vehicles (CAV), on-demand ride sharing services, Mobility as a Service (MaaS), etc., will continue to drastically alter the landscape of how people view mobility, how they travel, how freight moves, and what their overall travel behavior and expectations are. The power of new technologies to connect us to one another and the emergence of sharing platforms is forcing transport industries to re-evaluate their current business-models.

The new paradigm even has the potential to redefine what constitutes our transportation network. This will require organizations that are currently narrow-focused on the "traditional" road infrastructure to adapt to the new paradigm if they are to provide the required services to their customers.

Taking into consideration that the "Sharing Economy" and "Disruptive Technologies" are subtlety different things, the Strategic Plan could provide the option of looking at "The impact of the Sharing Economy and Other Disruptive Technologies on the Performance of Transport Administrations" either separately (Impact of Sharing Economy & Impact of Disruptive Technologies) or under one umbrella.

It is also important to separate the strategy and policy issues from the technological issues. The work of this cycle should focus on the strategy and policy issues associated with these topics and not the technology and technical aspects of each one (as for example in the case of CAV's where a separate Technical Committee is looking at the technology issues).

T.C. A.1 drafted a report focused on Change Management and outside forces of change for a Transport Administration. Therefore, this Issue would be an ideal follow up to that work as emerging and disruptive technologies are part of the outside forces of change that Transport Administrations are facing. It means to investigate about the role and required transformation of Transport Administrations in the face of sharing economy, emerging technologies, and Transport as a Service (TaaS) - focusing on the here and now and immediate future in this rapidly evolving field.

In addition, earlier in 2018, *T.C. A.1* worked with AASHTO's Committee on Performance Based Management (CPBM) and TRB's ABC30 Committee on Performance Management on the submission of a research proposal to NCHRP on the Impact of Emerging Technologies to the Performance of Transport Administrations. While AASHTO and TRB will be taking the lead on that research proposal, *T.C 1.1* could leverage the information coming out of the research to advance this topic.

In this Cycle, a full report is expected to be completed. Prior thereto, it would be interesting to schedule round table discussions as part of each *T.C. 1.1* meeting with host country.

Outputs	Deadlines
• Round table discussions as part of each *T.C 1.1* meeting with host country	• Up to June 2022
• Full report.	• June 2022

1.1.3. Organization of Staff and Human Resources

Strategies / Objectives
• Identify, investigate and document organizational issues of Staff and effective approaches for defining and promoting diversity and equity in opportunity of Human Resources within Transport Administrations. • Effective approaches for recruiting and retaining new talent in Transport Administrations. • Identify, investigate and document participation within Transport Administrations. • Encourage coordination with *T.C. 1.2 – Planning Road Infrastructure and Transport to Economic and Social Development*

Organizations across the World are increasingly concerned with matters of diversity, whether it be focused on gender, ethnicity, culture, disability, age, religion, political ideas or ideology, income or other factors perceived to represent disadvantage in achieving personal and community opportunities. The roads and transportation sector are no exception to this.

There are arguments for transport administrations to focus on, and reflect, all sections of society within their customer base, as well as mirroring this base within their own management structures and workforces. Approaches include positive discrimination, the setting of targets for recruitment or career progression, professional networks, publicity around role models or selective support for educational or training opportunities.

T.C. 1.1 should analyze effective approaches for defining and promoting diversity in opportunity across the roads and transportation sectors. Other important issue to investigate is how to attract new employees into the transport industry/profession, specially, young professionals.

It would be advisable to look at holding the Roundtable/Conference as part of the TRB Conference in January 2022 and organize a foresight session on this issues in the World Road Congress in 2023.

In this Cycle, a full report is expected to be completed. Prior thereto, it would be interesting to schedule round table discussions as part of each *T.C. 1.1* meeting with host country.

Outputs	Deadlines
• Round table discussions as part of each TC 1.1 meeting with host country	• Up to December 2022
• Full report.	• December 2022

1.1.4. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023
• Contribution to the Proceedings	• December 2023

1.1.5. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program

TC 1.1. PROPOSAL OF WORK PROGRAM

ToR (Outputs)	Year 2020												Year 2021												Year 2022												Year 2023											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Framework for measuring efficiency and effectiveness of Transport Administrations.																																																
Collection of case studies and toolkit																																																
Full report																																																
The transformation and new role of Transport Administrations in face of sharing economy, emerging technologies and Mobility as a Service (MaaS)																																																
Round tables with host country in TC meetings																																																
Full report																																																
Organization of Staff and Human Resources																																																
Round tables with host country in TC meetings																																																
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Preparation of the 2023 World Road Congress																																																
Technical session.																																																
Collaboration in Special Sessions and/or Workshops.																																																
Contribution to the Proceedings																																																
Other outcomes to be defined by the Technical Committee																																																
Organization of 2 Seminars in LMIC and possible Conferences in HIC																																																
Preparation of 2 Articles for Routes/Roads																																																

TECHNICAL COMMITTEE 1.2 – PLANNING ROAD INFRASTRUCTURE AND TRANSPORT TO ECONOMIC AND SOCIAL DEVELOPMENT

1.2.1. Transport modeling and forecasting for preparing econometric analyses

Strategies / Objectives
• Application of technological innovation in road planning. • Analyze the accessibility and quality of the data for econometric analyses and transport modeling, in particular of the freight transport data. • Investigate innovative techniques of approach to the movements of people and goods based on big data. • Encourage coordination with *T.C. 2.3 – Freight*, *T.C.3.2 – Road Network Operation* and *T.C.– Road Statistics.*

To be completed

In this Cycle, a full report based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2021
• Full report.	• December 2021

1.2.2. Implementation of sustainable mobility plans

Strategies / Objectives
• Identify good practices in transport planning and multimodality, in particular within the new concept "Mobility as a Service". • Analysis of taking into account women and other vulnerable users when planning and designing road infrastructure. • Proposal to face increased pressure due to population growth, increased urbanization and global trade. Pay special attention to the impact of the increase of e-commerce on the transport of goods. • Evaluation of the emerging transport technologies (autonomous vehicles, automated and connected driving or hyperloop) in road transport system. • Encourage coordination with *T.C. 2.1 – Mobility in Urban Areas, T.C. Accessibility and Mobility in Rural Areas, T.C. 2.3 - Freight, T.F.B.2 – Automated vehicles – challenges and opportunities for road operators and authorities, T.F. 2.1 – New mobility and its impact on Road Infrastructure and Transport* and *T.C.3.2 – Road Network Operation.*

To be completed

In this Cycle, a full report is expected to be completed.

Outputs	Deadlines
• Full report	• December 2022

1.2.3. Economic and social contribution of road transport system

Strategies / Objectives

• Identify, investigate and document:
  o the impact of investment in road infrastructure to stimulate economic growth, productivity and competitiveness.
  o the social value of transport.
• Identify employment opportunities through road construction and road transport, taking into account the promoting of equity.
• Take in account the work and findings of the Special Project on Capturing the contributions of road transportation.
• Encourage coordination with *T.C. 1.1 - Performance of Transport Administration* and *T.C. 1.2 – Finance and Procurement.*

To be completed

In this Cycle, a full report based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• December 2021
• Full report.	• June 2022

1.2.4. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

1.2.5. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program

TC 1.2. PROPOSAL OF WORK PROGRAM

ToR (Outputs)	Year 2020 J	F	M	A	M	J	J	A	S	O	N	D
Transport modeling and forecasting for preparing econometric analyses												
Collection of case studies.	■	■	■	■	■	■	■	■	■	■	■	■
Full report.							■	■	■	■	■	■
Implementation of sustainable mobility plans												
Full report												
Economic and social contribution of road transport system												
Collection of case studies.							■	■	■	■	■	■
Full report.												
Preparation of the 2023 World Road Congress												
Technical session.												
Collaboration in Special Sessions and/or Workshops.												
Contribution to the Proceedings												
Other outcomes to be defined by the Technical Committee												
Organization of 2 Seminars in LMIC and possible Conferences in HIC				■	■	■	■	■	■	■	■	■
Preparation of 2 Articles for Routes/Roads				■	■	■	■	■	■	■	■	■

ToR (Outputs)	Year 2021 J	F	M	A	M	J	J	A	S	O	N	D
Transport modeling and forecasting for preparing econometric analyses												
Collection of case studies.	■	■	■	■	■	■						
Full report.	■	■	■	■	■	■	■	■	■	■	■	■
Implementation of sustainable mobility plans												
Full report							■	■	■	■	■	■
Economic and social contribution of road transport system												
Collection of case studies.	■	■	■	■	■	■	■	■	■	■	■	■
Full report.	■	■	■	■	■	■	■	■	■	■	■	■
Preparation of the 2023 World Road Congress												
Technical session.												
Collaboration in Special Sessions and/or Workshops.												
Contribution to the Proceedings												
Other outcomes to be defined by the Technical Committee												
Organization of 2 Seminars in LMIC and possible Conferences in HIC	■	■	■	■	■	■	■	■	■	■	■	■
Preparation of 2 Articles for Routes/Roads	■	■	■	■	■	■	■	■	■	■	■	■

ToR (Outputs)	Year 2022 J	F	M	A	M	J	J	A	S	O	N	D
Transport modeling and forecasting for preparing econometric analyses												
Collection of case studies.												
Full report.												
Implementation of sustainable mobility plans												
Full report	■	■	■	■	■	■	■	■	■	■	■	■
Economic and social contribution of road transport system												
Collection of case studies.												
Full report.	■	■	■	■	■	■						
Preparation of the 2023 World Road Congress												
Technical session.						■	■	■	■	■	■	■
Collaboration in Special Sessions and/or Workshops.												
Contribution to the Proceedings												
Other outcomes to be defined by the Technical Committee												
Organization of 2 Seminars in LMIC and possible Conferences in HIC	■	■	■	■	■	■	■	■	■	■	■	■
Preparation of 2 Articles for Routes/Roads	■	■	■	■	■	■	■	■	■	■	■	■

ToR (Outputs)	Year 2023 J	F	M	A	M	J	J	A	S	O	N	D
Transport modeling and forecasting for preparing econometric analyses												
Collection of case studies.												
Full report.												
Implementation of sustainable mobility plans												
Full report												
Economic and social contribution of road transport system												
Collection of case studies.												
Full report.												
Preparation of the 2023 World Road Congress												
Technical session.	■	■	■	■	■	■	■	■	■	■		
Collaboration in Special Sessions and/or Workshops.	■	■	■	■	■	■	■	■	■	■		
Contribution to the Proceedings										■	■	■
Other outcomes to be defined by the Technical Committee												
Organization of 2 Seminars in LMIC and possible Conferences in HIC	■	■	■	■	■	■						
Preparation of 2 Articles for Routes/Roads	■	■	■	■	■	■	■	■	■	■	■	■

TECHNICAL COMMITTEE 1.3 – FINANCE AND PROCUREMENT

1.3.1. Best practices in funding and financing of road infrastructure

Strategies / Objectives
• World-wide scanning of road infrastructure funding, financing and cashflows related to the road sector, including public budgets, direct and shadow toll roads, fuel taxes, vehicle taxes… • Identify best practices in special Innovative funding models and Hybrid funding solutions for LMICs. • Investigate methods of financing of road maintenance, small scale rehabilitation, road safety improvement works, ITS, traffic management and other similar investment related to road infrastructure. • Encourage coordination with *T.C. 1.1. – Performance of Transport Administration*, *T.C.1.2 – Planning Road Infrastructure and Transport to Economic and Social Development,* and *T.C. 3.4 – Asset management.*

To be completed

In this Cycle, a full report based on a collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2020
• Full report.	• December 2021

1.3.2. Impact of new propulsion techniques on funding

Strategies / Objectives
• Analyze the impact of new propulsion techniques focused on decarbonization on funding road infrastructure. • Encourage coordination with *T.F. 2.1 – New mobility and its impact on Road Infrastructure and Transport.*

To be completed

In this Cycle, a briefing note is expected to be completed.

Outputs	Deadlines
• Briefing note.	• March 2022

1.3.3. Standardization of procurement

Strategies / Objectives
• Define criteria for standardization, homogenization and good practices on procurement. • Analyze best practices to encourage ethical and social responsibility through procurement procedures. • Encourage coordination with *T.C. 1.1 – Performance of Transport Administration, TF 1.1 Well Prepared Projects* and *T.C. 3.4 – Asset Management.*

To be completed

In this Cycle, a full report based on a collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2022
• Full report.	• December 2022

1.3.4. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

1.3.5. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program

TECHNICAL COMMITTEE 1.4 – CLIMATE CHANGE AND RESILIENCE OF ROAD NETWORK

1.4.1. Uniform and holistic methodological approaches to Climate Change and other hazards resilience

Strategies / Objectives

- Identification of hazards and environmental threats within the context of road infrastructure resilience.
- Approaches to:
  - Risk management within the context of resilience
  - Decision-making and uncertainties/deep uncertainties
  - Emergency management with the context of resilience
  - Resilience management and resilience engineering
- Economic aspects of resilience management
  - Identification of the socio-economic impacts of hazards on roads.
  - Identification of decision areas that need enhanced economic information, and on the key users of such information.
  - Impact and economic evaluation of measures to increase resilience on the availability of road transport infrastructure, and the cost-effectiveness of different adaptation strategies.
- Define criteria to implementation of resilience into asset management practice.
- Take into account works carried out by *T.C.E.1 –Adaptation Strategies/Resiliency w*ithin Cycle 2016-2019, in particular the re-evaluation of 100 already case studies to identify those with this holistic methodology.
- Encourage coordination with *T.C.1.5 – Disaster Management, T.C.3.2 – Road Network Operation, T.C.3.3 – Winter Service, T.C.3.4 – Asset Management, T.F.3.2 – Road Infrastructure and Transport Security, T.C.4.1 – Pavements, T.C.4.2 – Bridges, T.C.4.3 – Earthworks, T.C.4.4 – Tunnels and T.F.4.1 – Road Design Standards.*

Owners and operators are required to manage a very broad spectrum of threats in the future. These alone and in combination (in particular) have a significant impact on the availability of road networks. Therefore, owners and operators must address these key challenges to ensure a reliable operation of their road networks, mobility and supply chains. It is also clear that there are interdependencies with other modes of transport as well as cascading effects which should be considered as part of a comprehensive uniform and holistic (all-hazard) approach. These hazards include:

- Climate change and extreme weather
- Aging infrastructure, state of good maintenance and repair
- Natural disasters
- Man-made disasters
- Cyber and cyber-physical threads.

Without forgetting that Climate Change is one of the main risks faced by the road network, there are others, as listed. For example, cyber-attacks are ranked fifth in term of likelihood, with expected increased risks in 2019, leading to more disruption of operations. The WEF Global Risks Report reflects on new instabilities caused by the deepening integration of digital technologies into every aspect of daily life. In the context of the rapidly advancing digital transformation, digital technologies will also play an increasingly important role in the operation of road infrastructure, whereby the aspects of cyber security, cyber physical security and cyber resilience will play a decisive role in the future.

This results in the question of creating the basis for a PIARC all-hazard framework for resilient road networks. This development requires a very close cooperation and networking effort with other Technical Committees.

Additionally, the road network is a fundamental component to the effective running of the economy. Where disruptions occur due to a range of hazards, the network is as a result compromised, and this leads to serious loss in financial and economic costs to agencies, road operators and transport users. Resilience is therefore of high importance to ensure that road user costs and socio-economic costs are reduced. In principle, when considering financial aspects within the framework of resilience management, the measurement of vulnerable road infrastructure and adaption options should be considered.

The deployment of 21st century mobility services depends on the availability of quality infrastructure. Transportation systems and their services need to be affordable, safe, timely, reliable and secure in order to provide optimal societal outcomes and contribute to the UN Agenda 2030 (NZTA, 2013). Additionally, the Sustainable Development Goal 13 highlights that Climate Action has the specific goal to 'Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries '.

The lack of quality infrastructure systems will delay the systematic implementation of such services. Low quality infrastructure and services induce extensive economic, social and environmental costs for transit authorities and users (e.g. accident costs, travel time and freight delays, vehicle operating costs and externalities). Additionally, the socio-economic impacts of hazards/climate change onto vulnerable communities is an issue identified by Sustainable Development Goal 1 – No Poverty, where "By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters".

It is estimated that the amount of global investment required for roads will be US$ 34 trillion between 2016 and 2040, while the current trend of investments for this period does not exceed US$ 26 trillion (Global Infrastructure Hub, G20). In other words,

each country should spend more than 1.27 percent of GDP while current expenditure on average is approximately 1 percent of its GDP only. Many countries, both emerging and advanced, "have paid insufficient attention to maintaining and expanding their infrastructure assets, creating economic inefficiencies and allowing critical systems to erode" (Woetzel & al., 2016). On the contrary, a state of good repair and maintenance of existing infrastructure contributes significantly to increasing "resilience".

In addition to increasing the robustness and the protection level of elements of the road infrastructure, investments in improving resilience also contribute to enhancing the availability of the road infrastructure, and identification of approaches and tools e.g. Sustainability Rating tools, which includes requirements and guidance for dealing with resilience. These aspects also require an in-depth consideration within the tasks of the work of this *T.C.*

The aim of this Issue is to explore the effectiveness of a PIARC all-hazard framework for resilient road networks. In this respect, one could perhaps say that the climate change is a subsystem of a (future) resilience framework.

It is recognized that in related this Issue, there are starting points for this concept to be explored further. This will include the development of uniform and holistic methodological approaches to climate change and other hazards resilience. This task will also further develop the concept of the effectiveness of economic and financial methodologies addressed by the *T.C.s*, and to bring together and evaluate these by way of best-practice case study approaches.

Firstly, it is necessary to review the work carried out by *T.C. E.1 – Adaptation Strategies / Resiliency (SP 2016-2019),* that collected more than 100 case studies. Although this already provides a very good basis for work in the 2020-2023 cycle, the existing collection of case studies should be continued and extended with regard to the issues identified for the 2020-2023 cycle. The tasks to undertake will be to:

- (Re)Evaluate already collected case studies from the previous cycle, including identification of case studies especially with regard to holistic methodologies on the topic of resilience, resilience measures and to approaches to financial aspects of resilience management.
- Develop a survey/questionnaire on the topics of holistic resilience approaches, resilience measures and financial aspects of resilience management.
- Coordinate and collect positions with the relevant *T.C.s*, in particular with those of Strategic Theme 4 "Resilient Infrastructure".
- Compilation, categorization and pre-evaluation of suitable case studies, framework approaches and etc. with regard to the tasks within this *T.C.*

A roundtable/Workshop involving other *T.C.s* (i.e. *T.C.s* of ST 4 "Resilient Infrastructure", *T.C .1.5 - Disaster Management*, *T.F. 3.2 - Road Infrastructure and Transport Security*) could then be undertaken at a coordinated meeting location. This will provide an opportunity to share case studies and best-practice approaches, and ensure that the developments of each related *T.C.* are complementary. Additionally, a Seminar in a LMIC will also be undertaken throughout the cycle.

It is important to identify commonalities and links with this *T.C.* and other related *T.C.s* in order to avoid any overlap. Collaborative actions across *T.C.s* are proposed in this ToR by way of joint Seminars, technical sharing of objectives of the *T.C.* throughout the cycle, and a potential Special Project with common synergies across these *T.C.s*.

A Briefing note could provide a summary of the preliminary findings from the internal Case Study Task Force, and will benefit the *T.C.* in the development of the Full report.

The findings to date will then be presented at the Conference Session called "Winter resilience", for International Winter Road Congress in Calgary, and other possible conferences such as (TRB Annual meeting, TRA, IABSE, IABMA, ETC.).

Finally, a Full report will be developed using case studies. This will provide the basis for a PIARC all-hazard framework for resilient road networks.

Outputs	Deadlines
• Collection of case studies	• June 2021
• Full report based on case studies.	• December 2022

1.4.2. Update of the PIARC Climate Change Adaptation Framework

Strategies / Objectives
• Update of the PIARC Climate Change Adaptation Framework based in the work carried out on the other ToR of this T.C.: o Setting a strict separation of processes and methodologies. o Split the framework into two separate parts: ▪ Part 1: processes and their descriptions. ▪ Part 2: overview of possible methodologies for risk assessment and risk management, their data requirements and application limits. With integration of best-practice case studies. • Consideration of new and innovative methodological approaches, in particular critically assessment, adaptation pathways and evaluation of the overall economic value of adaptation measures.

The International Climate Change Adaptation Framework for Road Infrastructure was initiated during the Strategic Plan Cycle 2012-2015 of the World Road Association. *T.C.1.3 - Climate Change and Sustainability* developed a proposal for a 'special project' with the aim to create an international framework for climate change adaptation which would be of practical use for road assets owners and managers. It was supported when in May 2014, the World Road Association launched a call for proposals for PIARC special projects. Accordingly, the International Climate Change Adaptation Framework for Roads was published and disseminated during the World Congress in Seoul, November 2015.

In the 2016-2019 cycle, tasks related to adaptation to climate change were assigned to *Technical Committee E.1 - Adaptation Strategies/Resilience*. *T.C. E.1* had the task to formulate proposals for the refinement of the International Climate Change Adaptation Framework for Road Infrastructure, based on the case studies analyzed during the cycle and on findings from direct implementation of the Framework.

The final report developed by *T.C. E.1* summarizes the results of the work on the refinement of the Framework. It provides examples of implementation, discusses the applicability of the Framework for various purposes, reports on feedback from countries comparing the Framework to their own ongoing adaptation work. It also reports the results of a benchmarking exercise, where the Framework was compared to other approaches for adaptation of roads to climate change. The report concludes with a list of proposed options for the refinement of the current PIARC Framework (2015).

The work undertaken by *T.C. E.1* as part of SP 2016-2019 has therefore shown that the PIARC Climate Change Adaptation Framework is in general a good basis to analyze road networks and to select and assess the adaptation measures with regard to the consequences of climate change.

However, it also has become clear that the approach of the framework with a combination of processes and methodological approaches does not always meet the requirements of the users. Furthermore, it becomes clear from the work in the cycle 2016-2019 that, adjustments to the Framework processes are required to ensure more effective world-wide application. In addition, it has been shown based on the case studies analyzed, that new and innovative approaches have been put into practical use since the release of the framework in 2015.

For these reasons, there is a need for a fundamental update of the PIARC Climate Change Adaptation Framework, which is to be considered in this Issue. For it, the following points are to be addressed:

- The work should be based on case studies and in the work conducted previously by *T.C. E.1.*
- Strict separation of processes and methodologies.
- Division of the framework into two separate parts. In particular, this includes progressing the findings from both *T.C. E.1* by way of:
    - Part 1 should contain only processes and their descriptions (e.g. inclusion of the suggested refinements to the Framework from *T.C. E.1* WG2 into the development of an updated Framework)
    - Part 2 should include an overview of possible methodologies for risk assessment and risk management, their data requirements and application limits (e.g. inclusion of worked examples of the methodological approaches identified in the *T.C. E.1* WG1 report. This includes integration of best-practice case studies and data requirements and converting these into worked examples for each phase of the updated Framework). For example, how to perform a risk assessment, which measures to implement, and how to calculate costs and benefits.
- Consideration of new and innovative methodological approaches, which may also result in a modification of the processes of the framework. In particular, questions relating to criticality assessments, the concept of adaptation pathways and the evaluation of the overall economic value of adaptation measures are to be mentioned here.
- Furthermore, it is also considered necessary to identify ways of considering aspects of road resilience in the context of asset management.

The aim of this task is to extend the work developed by *T.C. E.1* into the abovementioned new Framework. The framework is an approach to resilience from climate change.

Firstly, it is necessary to undertake a survey/questionnaire on the topics of holistic resilience approaches, resilience measures and economic aspects of resilience management, jointly with the proposed task for Issue 1.4.1, and to review the work carried out so far by *T.C. E.1*.

A roundtable/Workshop involving other *T.C.s* (i.e. *T.C.s* of S.T. 4 - Resilient Infrastructure, *T.C. 1.5 - Disaster Management*, *T.F. 3.2 - Road Infrastructure and Transport Security*) will then be undertaken at a coordinated meeting location. This will provide an opportunity to share case studies and best-practice approaches, and ensure that the developments of each related TC are complementary. Additionally, a Seminar in a LMIC will also be undertaken throughout the cycle.

The findings to date will then be presented at the Conference Session called "Winter resilience", for International Winter Road Congress in Calgary, and other possible conferences such as (TRB Annual meeting, TRA, IABSE, IABMAS,…).

Finally, a Full report will be developed, which provides a fundamental update of the PIARC Climate Change Adaptation Framework.

Roundtable / Workshops with participation of all relevant *T.C.s* and *T.F.s* will be carried out during this cycle. In addition, Climate Change Adaption Framework for Roads will be updated.

Outputs	Deadlines
• Roundtable / Workshop with participation of all relevant TCs and TFs	• March 2021
• Update Climate Change Adaptation Framework for Roads.	• December 2022

1.4.3. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific climate change and resilience of road network issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare the Technical Session Conference Session called "Winter resilience". In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops on "PIARC Climate Change Adaption Framework", as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session Conference Session called "Winter resilience", for International Winter Road Congress in Calgary.	• IWRC 2022.
• Possible collaboration in Foresight Session and/or Workshops on "PIARC Climate Change Adaptation Framework"	• IWRC 2022
• Contribution to the Proceedings	• May 2022

1.4.4. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023
• Contribution to the Proceedings	• December 2023

1.4.5. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

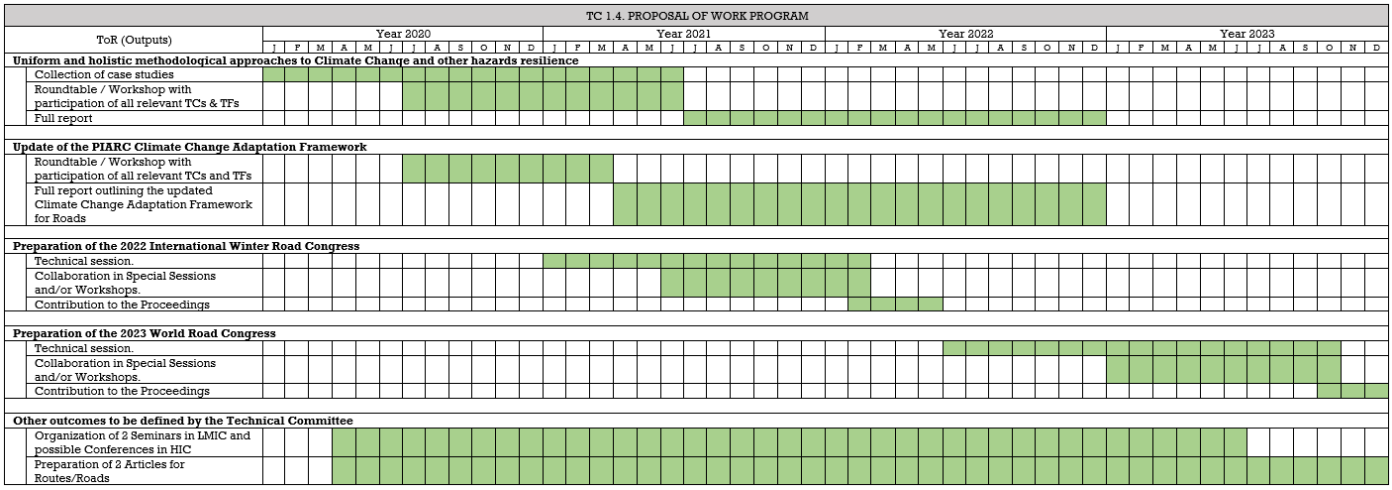
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



1.5.1. Information and communication in disaster management

Strategies / Objectives

- Follow up works carried out by *T.C.E.3 –Disaster Management w*ithin Cycle 2016-2019 in gathering and diffusion information for disaster management, taking into account of new evolutions such as Big Data and Social Networks.
- Study how to process huge amount of information acquired from the Big Data and Social Networks rapidly and efficiently in order to extract necessary and reliable information for disaster management.
- Study how to evaluate the accuracy of information from the Big Data and Social Networks and ensure the quality of the information related to disaster management.
- Study how to disseminate disaster information efficiently among the road users and the relevant parties through social networks.
- Identify the best practice of disaster management techniques using recent evolutions in information, communication area such us Big Data and Social Network
- Encourage coordination with *T.C.1.4 – Climate Change and Resilience of Road Network, T.C.3.1 – Road Safety, T.C.3.2 – Road Network Operation, T.F.3.2 – Road Infrastructure and Transport Security an, T.C.3.4 – Asset Management.*

A proactive approach in disaster management will receive a positive reaction from road users.

In this sense, information management is the primary and fundamental basis of disaster management. Developing a reliable information collection and sharing system is the first step of proactive disaster management toward engaging with internal and external stakeholders and understanding their information needs and expectations.

T.C.E.3 - Disaster Management (SP 2016-2019) made preliminary study on current status of information management especially in collection and provision of disaster information. According to the result of this study, within the management activities using conventional disaster information sources and outlets, effective and successful disaster management could be made with the disaster management center under the specific communicational procedures rather than structure, with the periodical practice training to ensure the procedures work well in emergency situations, and with establishing alliances with media.

It is needless to say that the quality of the information provided to road users and road administrators governs the quality of the subsequent disaster management. With the unexpected development in IoT technologies and devices, and unprecedented increase in mobile telecommunications and social media which can instantaneously convey a huge amount of disaster information data to road administrators as well as road users, management of disaster information is about to change using the benefit of those internet related data.

Internet related data can be divided into two, Big Data and Social Networks. In this paper, Big data is defined as the data generated by IoT devices and Social Networks is defined as the data generated by various activities of "people" such as opinions, evaluations, and behavior.

The most successful application of Big Data in disaster management might be "Passable road map". Japanese car manufactures and ITS japan integrated their car probe data at the occasion of major disasters and provides "Passable road map" on the disaster area on the web.

Social Networks is also a powerful tool for information dissemination but is also a potential tool for information gathering in an emergency. Social Networks is currently used somewhat passively to disseminate disaster information to the road users and receive their feedbacks. The most successful case study can be found in the emergency operation at the Forth Road Bridge Closure. Social Networks has a potential tool for disaster management tool in terms of 1) emergency communications and issue warnings; 2) receiving victim requests for assistance; 3) monitoring user activities and postings to establish situational awareness; and 4) using uploaded images to create damage estimates, among others (Source: OECD report, https://doi.org/10.1787/5k3v01fskp9s-en).

Big Data and Social Networks are pretty huge data, and Social Networks is "People" generated information. Therefore, the road administrator has responsibility for selecting good and concise information, for managing fake news, and disseminating good and accurate news on Big Data and Social Networks. In this meaning, the following studies are essential to road administrators:

- Study how to process huge amount of information acquired from the Big Data and Social Networks rapidly and efficiently in order to extract necessary and reliable information for disaster management.
- Study how to evaluate the accuracy of information from the Big Data and Social Networks and ensure the quality of the information related to disaster management.
- Study how to disseminate disaster information efficiently among the road users and the relevant parties through Social Networks.

Finally, integrating Big Data and Social Networks to disaster information management is in its early stage, this report, based on case studies, will provide the best practice of disaster management techniques using recent evolutions in such information

communication area. This contribution from PIARC will be relevant and useful to not only to disaster management but also all kind of emergency management.

Outputs	Deadlines
• Collection of case studies.	• June 2021
• Full report.	• December 2021

1.5.2. Financial aspects of disaster management

Strategies / Objectives

- Conduct case studies where:
  - To study effective practices for accelerating disaster recovery from the view point of financial, contract and procurement systems.
  - To study financial aspects of disaster management during preparedness, mitigation, response, and recovery phases.
- Explore and document good practices.
- Explore collaboration with TRB and other external organizations for a joint workshop.
- Encourage coordination with *T.C.1.3 – Finance and Procurement, T.C.1.4 – Climate Change and Resilience of Road Network, T.C.3.2 – Road Network Operation, T.F.3.2 – Road Infrastructure and Transport Security, T.C.3.4 – Asset Management, T.C. 4.1 - Pavements, T.C. 4.2 - Bridges, T.C. 4.3 - Earthworks* and *T.C. 4.4 - Tunnels.*

Disaster can be defined as "a crisis situation that far exceeds the capabilities" - Quarantelli, 1985. Therefore, disaster management can be explained as a series of activities to improve the capability of the society.

Disaster management is generally divided into four phases and often discussed (preparation, mitigation, response, and recovery). The disaster prone countries have improved their technology to enhance capacity and management techniques in each phase based on their disaster experiences. Many of these capacity improvement technologies are shared in disaster prone countries. Disaster management in nature is inseparable from financial management in terms of technological improvement and its implementation. However, there are few studies that have organized disaster management from the financial point of view even for such disaster prone countries. The financial discussion in disaster management is often found at the prompt recovery phase in order to minimize the economic losses from the disaster.

In recent years, disaster management activities are evolving from the stage of sophistication of disaster response to the sophistication of disaster mitigation and preparedness. Therefore, the financial aspects in disaster management need to be discussed in not only in recovery phase but also preparedness, mitigation, and response phase.

At the phase of preparedness, disaster insurance and disaster recovery cost pooling, which have been experimentally implemented in some disasters prone counties, will be financially important research issues. In some countries, it is reported that the introduction of disaster insurance enabled effective and efficient disaster response. (Source: World Bank report, Sovereign Disaster Risk Finance in Middle-Income Countries, 2018)

At the phase of mitigation, it will be necessary to consider the improvement of road network redundancy and disaster prevention quality of infrastructure in order to minimize the disaster effect from the financial point of view. In Japan, after the 2011 East Japan earthquake, a new scheme for evaluating road project by considering their effect after disasters. They introduced a disaster mitigation benefit to the cost-benefit analysis for adopting a new road project. (Source: Routes/Roads pp72-pp79, #356, 2012)

At the phase of recovery, the development of procurement methods and contract systems for prompt recovery was an important financial issue. In recent years, it has been reported that, in view of securing a road network, the impact on the regional economy is also considered in the selection of the restoration method. (Source: PIARC report, Disaster Information Management for Road Administrators, 2019)

At the stage of response, securing safety and securing emergency activities are given the highest priority, so there are few cases where financial considerations becomes important, but further investigation is necessary.

In this meaning, the following studies are essential to road administrators:

- To study effective practices for accelerating disaster recovery from the view point of financial, contract and procurement systems
- To study financial aspects of disaster management during preparedness, mitigation, response, and recovery phases

Financial considerations in disaster management activities often include sensitive matter. Careful consideration and discussion will be needed in obtaining information and processing and analyzing the information.

Finally, financial considerations in disaster management are quite new concept to study. Therefore, it is important to collect various case studies from the world and introduce good and informative cases studies to the world. This contribution from PIARC will be relevant and useful to not only to disaster management but also all kind of incident or emergency management.

These case studies will be summarized in a briefing note.

Outputs	Deadlines
• Collection of case studies.	• September 2022
• Briefing note.	• December 2022

1.5.3. Update the Disaster Management Manual

Strategies / Objectives
• Update of the Disaster and Risk Management Manual. • Take into account works carried out by *T.C.E.3 –Disaster Management w*ithin Cycle 2016-2019. • Encourage coordination with *T.C.3.1 – Road Safety, T.C.3.2 – Road Network Operation, T.C.4.3 – Earthworks, T.C. 4.4 – Tunnels, T.C.1.4 – Climate Change and Resilience of Road Network,* and *T.F.3.2 – Road Infrastructure and Transport Security.*

The core role of PIARC is knowledge exchange. PIARC organized technical committees that make a key role of dissemination and exchange of technical information during 4-year cycle period. For this purpose, *T.C.s* produces technical reports and holds at least two international seminars during the cycle period in Low-Middle Income countries, and some international workshop or roundtables in High Income countries. Those seminars, workshops, and roundtables are the good opportunities to exchange their technologies. The technical reports and slide files presented at seminars, workshops, and roundtables are uploaded to the PIARC website for disseminating the information of these activities.

Internet is a powerful, convenient, and economical tool to disseminating technical information to the world, but internet relies on the search engine to find out the information. PIARC is now exploring a good information type for disseminating technical information to be easily searched and to be easily referenced. One of the ideas is to produce "Manuals".

T.C.E.3 – Disaster Management (2016-2019) of disaster management and risk management made technical report that contained a lot of information of management principles, precious case studies, and a bunch of element techniques that support disaster and risk management activities. *T.C. E.3* compiled some of previous materials and launched an English version of on-line disaster and risk management manual at PIARC web site.

With the rapid changes in road administration environment and the development of management techniques, there is a need to constantly update this manual for sustainable use.

Disaster management is not a theoretical based activity but an experience based activities. Useful disaster management manual will be a well-organized bunch of lessons, experiences, and examples of successful practices. In this meaning, there is still significant work to be done to update articles that would not were implemented by the end of 2019.

Risk management is already well documented in the academic field. Our main concern is how the risk management concept can apply to the road engineering. Previous study revealed that the risk management technique is well implemented in the project planning phase, and is gradually implemented in the maintenance field. Enriching the contents of application of risk management is welcomed by the practical engineers.

The work of the cycle 2016-2019 covered some of the principles, technical tools, and case studies documented in the previous report. This cycle continues to effort on updating and enriching the contents of the manual in order to make it more attractive and more in line with what is expected from an online resource, and to make it rich with new case studies and other media.

- Update and enrich the articles using the PIARC latest work (Cycle of 2016-2019) related to disaster and risk management.
- Cooperate with related TCs for finding good case studies
- Update the manual for easy to use by using various forms: images and videos
- Update the manual in PIARC official languages
- Explore the possibility for a webinar for the side menu of the manual

This contribution from PIARC will be relevant and useful to practical engineers who are engaging with disaster management activities.

During the Cycle, Disaster and Risk Management Manual will be updated.

Outputs	Deadlines
• Update of the Disaster and Risk Management Manual	• June 2023

1.5.4. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

1.5.5. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program

TASK FORCE 1.1 – WELL-PREPARED PROJECTS

HOW TO IMPROVE BANKABILITY, ACCEPTANCE, ACCOUNTABILITY AND TRANSPARENCY

TF 1.1.1. Well-prepared projects

Strategies / Objectives

- Review literature and existing project preparation software (e.g. SOURCE) and analyze good practices of project management for improving and optimizing public and private investment.
- Define strategies to accelerate project delivery and reduce project lifecycle cost.
- Identify how well-prepared projects contribute to a culture of transparency and accountability.
- Establish recommendations on:
  - Requirements for road project preparation
  - Management relationship with financiers, with a view to maximizing project economic and possible budgetary return
  - Management communication with stakeholders
  - Continue with the works carried out by *T.C.C.1 – National Road Safety Policies and Programs* and *T.C. C.2 - Design and Operation of Safer Road Infrastructure* within Cycle 2016-2019 to complete the incorporation of pertinent PIARC reports on road safety (from 2003).
- Encourage coordination with *T.C.1.1 – Performance of Transport Administrations, T.C. 1.2 - Planning Road Infrastructure and Transport to Economic and Social Development, T.C. 1.3 - Finance and Procurement* and *T.F. 1.2 – HDM-4.*

It is widely recognized that good preparation of infrastructure projects, first and foremost road projects, is of utmost importance to secure their proper financing, wide acceptance and seamless implementation.

It is nowadays all too common to hear financiers claim that plenty of money is available for project financing, but that what is lacking is good projects.

Whatever the type of country considered (industrialized, emerging, or developing), a good preparation of road projects is of outstanding importance for the following reasons:

- For ordinary projects (e.g. procured on a traditional Design-Bid-Build procedure), there is a need for:
  - Improved acceptability by all stakeholders (e.g. by populations directly affected by social and environmental aspects of the project, or by other donors or public authorities participating in the cofinancing ,…);
  - Improved quality and resilience of the projects, in order to meet Sustainable Development Goals;
  - Reduced risk of delays and cost overruns in construction and its possible impacts on maintenance
  - Improved transparency in the procurement process and ethical behaviour of all parties.
- For complex projects (typically PPP or concession projects), in addition to the above-mentioned reasons, it is necessary to :
  - Explain to stakeholders the need to recourse to these complex procedures;
  - Minimize transaction costs and standardize contract documentation as much as possible;
  - Attract financing at favourable terms and conditions and sustainable funding;
  - Overcome project complexity, while accepting innovative solutions.

To sum up, the better a project is prepared, the smaller the risks of seeing the project rejected by various stakeholders, or unable to reach adequate financing, or fraught during implementation with poor quality, delays, cost overruns, maintenance uncertainties and possible unethical behaviours associated with ensuing change orders.

Topics to discuss in the TF will include:

- Are there big differences between the requirements for road project preparation in high- or low-income countries? Is it possible to define a set of minimum standards or recommendations to be observed in each case?
- How do road authorities manage relationship with financiers, with a view to maximizing project economic and possibly budgetary return?
- How do road authorities manage communication with stakeholders?
- Are available regional platforms [e.g. European Investment Project Portal (EIPP), Global Infrastructure Hub (GIH)] and/or tools (e.g. SOURCE platform, see annex) considered helpful? How could they be improved?
- The work will focus on available material and try to analyze best practices.

The T.F. will aim at representing a wide diversity of circumstances, including cases from several countries and continents.

The final report will be based on a collection of case studies and will outline the various aspects analyzed make practical recommendations for road administrations and authorities and will focus on policy issues both in the short- and medium to long term.

The T.F. will make references to other organizations, especially in the bank, contracting and consulting sectors. It will not duplicate their work.

Outputs	Deadlines
• Collection of case studies.	• December 2020
• Full report.	• September 2021

TF 1.1.2. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Collaborate in Technical Sessions, Foresight Sessions and/or Prepare a workshop • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, collaboration in Technical Session, Foresight Sessions and/or prepare a Workshop, as well as contribute to the Proceedings is expected.

Outputs	Deadlines
• Possible collaboration in Technical Sessions, Foresight Sessions or Workshops.	• WRC 2023
• Contribution to the Proceedings	• December 2023

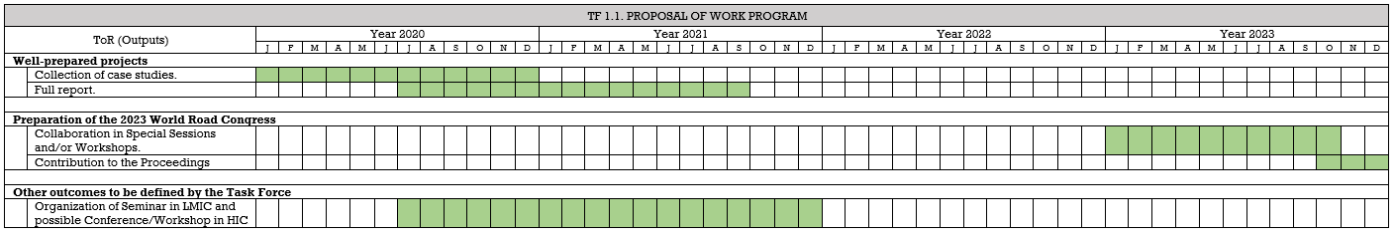
TF 1.1.3. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

In this Cycle, it would be interesting to schedule Seminars in Low and Medium Income Countries or Conferences / Workshops in High Income Countries.

Outputs	Deadlines
• Possible Seminars in LMIC or Conference/Workshop in HIC	• Up to December 2021

Proposal of Work Program



TECHNICAL COMMITTEE 2.1 – MOBILITY IN URBAN AREAS

2.1.1. Accessibility and mobility facing land use in urban and peri-urban development

Strategies / Objectives

- Analysis of inhabitants' mobility daily needs and accessibility and adequate level of urban and peri-urban mobility.
- Emphasis on low development areas with a high growth rate of population and lack of urbanization planning.
- Data collection measuring mobility and accessibility.
- Analyze the use of road infrastructure in urban areas by different vehicles: private cars, public buses, taxis, urban services (cleaning, ambulance, police, fireman…), bicycles, scooters… and role of road infrastructure in enhancing mobility policies.
- Identify good practices of integrating transport planning and land-use planning to optimize modal split.
- Encourage coordination with *T.C. 1.2 - Planning Road Infrastructure and Transport to Economic and Social development, T.C 3.1 – Road Safety and T.C.3.2 – Road Network Operation.*

This Issue will be faced taking in account the work of *T.C. B.3 – Sustainable Multimodality in Urban Regions (SP 2016-2019*). Some of their findings are gathered below:

"Globalization and specialization have enabled cities to flourish and have led to the concentration of activities and populations, resulting in an increase in urban transport needs and a scarcity of public space. In these urban areas characterized by high population and employment densities, congestion of transport systems is the rule and the sharing of public space is a necessity. Moreover, in a context of scarce public finances, new developments were becoming increasingly difficult to implement, especially since in the past they had not succeeded in solving all travel problems. Thus, in these dense areas, it became necessary to organize and optimize existing transport systems.

Then, with the development of means of transport, more and more inhabitants have taken advantage of these new offers to reconcile the attractiveness of the city's jobs with the lower housing costs in the outskirts, or even the quality of life in the countryside. The result has been a rapid expansion of the area of influence of cities in terms of employment, which extends well beyond the urbanized area, well beyond congested networks, and a rapid increase in transport needs for everyday travel. PIARC's Strategic Plan has taken this phenomenon into account by requesting that the reflection on the city be extended to metropolitan regions, focusing on mobility needs and services (and no longer only on transport needs) and multimodality. Thus, in addition to the reflections on the density and scarcity of space, it was necessary to add a reflection on the links that unite rural territories, of very low density, to the dense areas of the city. What transport needs? How can access to jobs in the city center, and more generally access to the city's amenities (education, care, culture), be made possible under good conditions of social equity and cost? How can development be guided in order to limit transport needs without forgetting the essential needs of the inhabitants of the outskirts?

Finally, the 21st century has seen the rapid growth of digital technology and its many applications in the field of mobility (networking applications, car-sharing and carpooling services, electric bicycles, renewal of electric motor vehicles, autonomous driving, etc.) and the emergence of new behaviors (sharing economy, circular economy, etc.). PIARC wanted these trends to be included in the scope of the reflection.", etc.

"Some of the themes developed in the previous report have not been further developed. This is the case, for example, for active mobility, for which the reader may wish to refer to the reports "Strategies to balance the modal share of urban transport in order to improve mobility and reduce road congestion" (PIARC Reference: 2013R02FR) and "Key issues to improve mobility strategies in large urban areas" (PIARC Reference: 2016R27FR). However, new services such as bicycle sharing or electric bicycle are covered in this report.", etc.

"At the end of this four-year cycle, the committee wishes to share some questions but also one certainty.

The questions concern the future of mobility. We have seen in this short introduction that our societies have moved in less than a century from a traditional model with two types of living environment (cities and village communities) practically independent in terms of daily mobility, to a model of peri-urbanization where hundreds or even thousands of village communities located more than a hundred kilometres from a city live in close relationship with it, a relationship that translates into daily exchanges for access to employment, education, care or leisure. The question that arises today is whether this model of spatial occupation, consisting of a mosaic of geographically separated territories closely linked by daily exchanges, will continue to expand, stabilize or multiply?

Since digital technology already allows remote working, will we see a further dispersion of living and working places with less physical presence in the workplace? It will also bring essential services (education, care, etc.) closer to living spaces: it should therefore lead to a reduction in mobility needs. But it also makes it possible, in particular, thanks to the autonomous vehicle, to reduce transport costs, driver time lost and travel discomfort: the result should therefore be a rebound effect consisting in transforming these innovations (as has happened with each innovation in the field of transport) into new desires to travel further (or more often) to access new opportunities. Finally, how can we take into account the challenges of climate change and the scarcity of natural resources?

Certainty relates to the need to continue sharing observations, good and bad practices at the international level, and the multiplicity of views on these practices. It also addresses the need to broaden the transversality of reflection by confronting it with new approaches, particularly through the social sciences.

May these contributions help the road authorities to provide a sustainable response to the needs of the inhabitants of these territories."

As a consequence, for *T.C 2.1* we should ask case studies, good practices, or policies, both in the field of local daily needs (urban mobility needs) but also in the field of daily needs between cities and their hinterland (ie commuting area which includes rural areas) and to share experiences at a workshop. Maybe a joint seminar with *T.C 2.2* could be a good way of facing common or related mobility problems, or a Workshop with adequate organization such as TRB.

Outputs	Deadlines
• Collection of case studies.	• June 2021
• Workshop with adequate organization (TRB, etc.).	• Up to December 2021

2.1.2. Evaluating impacts of new mobility in urban and peri-urban areas

Strategies / Objectives
• Evaluate impacts and challenges of new mobility (automated driving, sharing, MaaS) on urban environment. • Identify good practices of smart cities using ICT Technology. • Pay special attention to vulnerable users. • Analyze the ITS contribution to urban mobility. • Encourage coordination with *T.C. 1.1 – Performance of Transport Administration, T.F.B.2 – Automated vehicles – challenges and opportunities for road operators and authorities, T.F. 2.1. - New mobility and its impact on Road Infrastructure and Transport, T.C. 3.1 – Road Safety and T.C. 3.2 – Road Network Operation.*

For the last few years, the appearance of new mobility formulas is producing a trend change in urban areas, which far from decreasing will increase in the future. There are two reasons for this:

- "Millennials" are used to the current Digital Era, and are betting on this new form of mobility, even having less purchasing power than previous generations.
- Ageing of the population is leading us to prefer forms of mobility than to do not require great physical capacities.

Other factors also have an influence, such as the growing awareness of the need to reduce the emissions produced by vehicles in urban areas. This leads us to an increase use of non-polluting vehicles, public transport, bicycles and other similar elements, and, therefore, to the promotion of intermodality, increasing the need to develop the concept "Smart Cities".

The impact on urban mobility needs to be analysed, as well as which factors can contribute to its greater integration, such as ITS.

An analysis of how to tackle the problem of vulnerable users (pedestrians, cyclists, etc.) whose number is expected to rise considerably in cities, is necessary, considering the measures for their coordinated, and compatible with other modes, integration.

T.C. 2.1 will analyse this impact through case studies, considering cities of different sizes, as well as the impact on peri-urban areas, identifying good practices.

In this Cycle, a briefing note based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2022
• Briefing note.	• December 2022

2.1.3. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

2.1.4. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

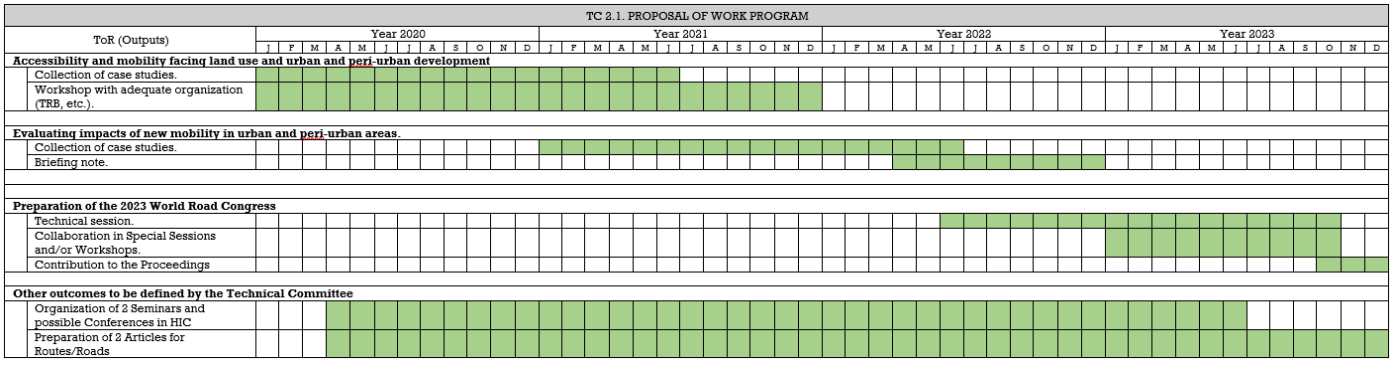
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



TECHNICAL COMMITTEE 2.2 – ACCESIBILITY AND MOBILITY IN RURAL AREAS

2.2.1. Accessibility and mobility in rural areas

Strategies / Objectives
• Analysis of importance of rural roads for accessibility and adequate level of mobility in rural environment ((job access, goods access, hospital, school access…). • Pay attention to vulnerable users. • Involvement of local communities in planning, construction and maintenance of rural road networks, particularly in LMIC. • Identify strategies and measures for enhancing public transport. • Encourage coordination with *T.C. 1.1 – Performance of Transport Administration, T.C. 1.2. – Planning Road Infrastructure and Transport to Economic and Social Development, T.C. 3.1 – Road Safety and T.C. 3.2 – Road Network Operation.*

T.C.2.2 should be asked about taking into account the accessibility to services located in cities (education, care, jobs, …) as well as good practices concerning transport services. It is a question of social inclusion.

In this Cycle, a briefing note based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2021
• Briefing note.	• September 2021

2.2.2. Improving road safety in rural areas

Strategies / Objectives
• Provide findings and recommendations regarding strategies and measures for improving rural road safety. • Pay special attention to vulnerable users. • Analyze ITS contribution to rural road safety. • Encourage coordination with *T.C. 3.1 – Road Safety.*

In this Cycle, a briefing note based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• December 2021
• Full report.	• June 2022

2.2.3. Technical solutions for unpaved roads

Strategies / Objectives
• Define suitable materials and identify good techniques for construction and maintenance. • Encourage coordination with *T.C. 4.3 – Earthworks* and *T.F. 1.4 – Road Design Standards.*

In this Cycle, a full report based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2022
• Full report.	• December 2022

2.2.4. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific freight issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops on, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

2.2.5. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

2.2.6. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

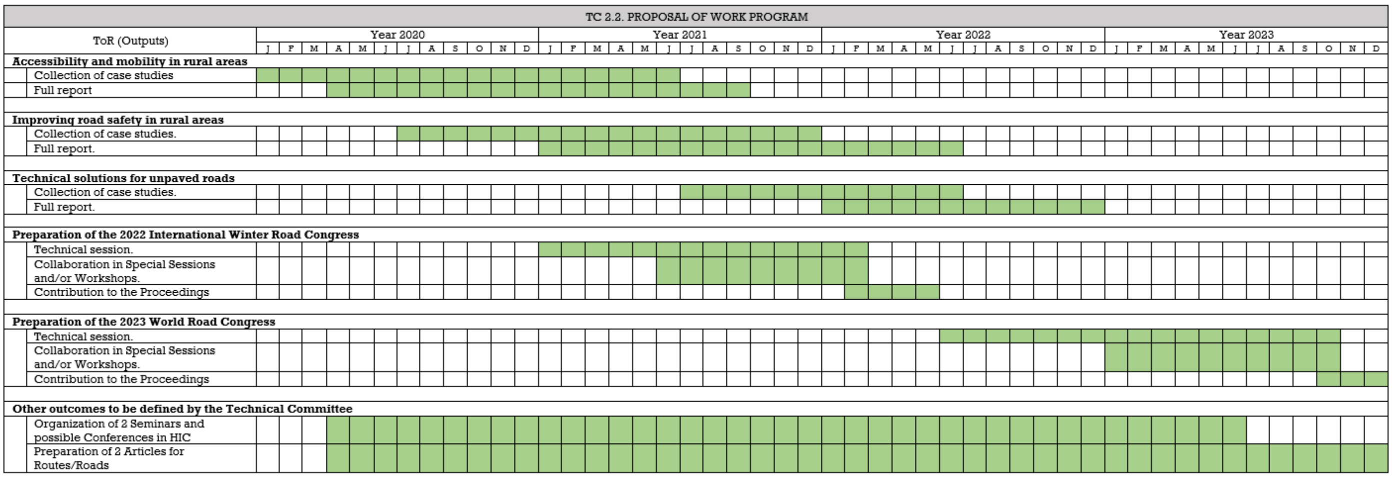
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



2.3.1. Best practices, monitoring and regulation to reduce overloading and associated pavement damage on road networks

Strategies / Objectives
• Investigate and asses the regulation compliance using WIM and direct enforcement (incl. overload control, speeding control, vehicle fitness control, etc.). • Study the potential of Intelligent Access Programme (IAP) and Smart Infrastructure Access Programme (SIAP) • Implementation of Performance Based Standards for heavy vehicles (regarding fleet/vehicle/loading control, safety compliance, driver condition, rollover stability, etc.) • Identify and improve heavy vehicle inspection centers. Including purposes, processes and facilities. • Pay special attention to LMICs and identify their challenges and potential applications. • Take into account works carried out by *T.C.B.4 – Freight* within Cycle 2016-2019. • Encourage coordination with *T.C.3.2 – Road Network Operation and T.C.4.1 – Pavements, and with HVTT Forum and ISWIM*

Overloaded trucks, poor vehicle conditions, driver fatigue and speeding remain a big challenge in road freight transport, especially also in LMIC's. These issues can cause severe safety problems and substantial damage to the road infrastructure. Overloading leads also to unfair competition between transport modes and transport companies.

In Europe about 8 to 15% of the trucks are overloaded. Most overloads are between 5 and 10%, some go up to 20-25%. In LMIC's the share of overloaded trucks is expected to be much higher and also the share of overloads.

Different approaches have been implemented or are under development to improve the regulation compliance using WIM and direct enforcement (e.g. in France, the Netherlands), performance based standards (e.g. in Australia, South Africa), advanced heavy vehicle inspection centers (e.g. in Switzerland and other countries) and Intelligent Access Programme and the Smart Infrastructure Access Programme (e.g. ins Australia). Especially in high income countries more advanced approaches using new technologies have been implemented and or are in a testing phase. From these approaches positive impacts are expected regarding the compliance with regulation, to increase road safety and to prevent damages to the infrastructure. Also a reduction in fuel consumption and emissions can be expected.

It is therefore necessary to make a survey and collect case studies on good practices and current developments using traditional and advanced approaches in different countries. Successful approaches and experiences will be presented and discussed in a seminar in a LMIC. The results of the survey and the case studies will be integrated in a full report available at the end of the cycle.

This contribution from PIARC will be relevant and useful for the public sector and the industry.

The topic could be addressed at the ITS conference or a workshop in HIC.

In this Cycle, a full report based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2021
• Full report.	• December 2021

2.3.2. Greening of freight transport

Strategies / Objectives
• Investigate further strategies and measures (technical incl. alternative fuels, logistics, infrastructural, regulatory, demand related, etc.) in order to reduce the greenhouse gas emissions of road freight transport. • Recommendations regarding suitable framework conditions, support and implementation of strategies. • Electrification of Heavy Goods Vehicles. Take into account works carried out by Special Project – Electric Road Systems. • Last-mile deliveries by electric cargo bikes or electric small vehicles. • Take into account works carried out by *T.C.B.4 – Freight* within Cycle 2016-2019. • Encourage coordination with *T.C. 1.2 – Planning Road Infrastructure and Transport to Economic and Social Development, T.C.1.4 – Climate Change and Resilience of Road Network, T.C.2.4 – Environmental Sustainability in Road Infrastructure and Transport, T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport, and T.F.B.2 Automated vehicles.*

Transport contributes today to about one quarter of energy-related global GHG emissions and about one fifth of energy use. The share of road freight transport is increasing and at the same time road freight transport is heavily depending on fossil fuel. The requirements for fossil independency and other emissions will be tightened. The need to reduce greenhouse gas emissions

is still a dominant issue in the debate over how the transport system should be further developed. There are increased demands from various stakeholders that the climate impact from the transport system should be reduced and fossil fuels phased out. Also, pollution and noise are important issues, especially in urban areas. Tougher policy instruments are seen as a precondition, but it is hard to get political consensus. Especially for freight transport, new solutions need to be tested quickly and come into effect. In many parts of the world, different types of electrical road systems are now being tested, with continuous charging of electricity. There are of course other types of solutions and they are constantly evolving. The hydrogen is also a potential solution for freight vehicles which should be more analysed, both on the vehicle and infrastructure sides. Also multimodality should be further addressed.

To reduce greenhouse gas emission will remain a huge challenge mid and longer term. Strategies and measures reducing the greenhouse gas emissions of road freight transport should be further investigated. This will include technical, logistics, infrastructural, regulatory, etc. measures.

The topic of electric roads should be further investigated also taking into account the results of the ERS related special project.

It is therefore necessary to collect case studies and to provide good practice fact sheets on promising approaches which support the greening of road freight transport. Successful approaches and experiences will be presented and discussed in a seminar in a LMIC.

Based on the case studies and a good practice fact sheets a briefing note is developed containing a synthesis on the actual status of investigation of approaches contributing to greening freight transport. Because still some technologies are in development stage the briefing note can provide guidance at the right stage of the development to assist the public sector in preparing suitable framework conditions.

In this Cycle, a briefing note based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• December 2021
• Briefing note.	• March 2022

2.3.3. Application of new technologies on freight transport and logistics

Strategies / Objectives
• Investigate and document further developments in platooning, partly and fully automated driving in freight transport. • Investigate and document further technology trends and their impact on logistics and freight transport and the potential for the management of transport systems (Internet of things, 3D-Printing, tube logistics, share economy logistics, big data, robotic & automation, etc.). • Identify potential impacts and recommendations regarding efficiency, quality, safety and environment. • Provide findings and recommendations regarding suitable framework conditions implementation support. • Take into account works carried out by *T.C.B.4 – Freight* within Cycle 2016-2019. • Encourage coordination with *T.C. 1.2 – Planning Road Infrastructure and Transport to Economic and Social Development, T.C. 3.2 – Road Network Operation, T.F. 2.1 – New mobility and its impact on Road Infrastructure and Transport* and *T.F.B.2 – Automated vehicles – challenges and opportunities for road operators and authorities.*

Technology trends as internet of things, 3D-Printing, big data, self-driving-vehicles, cloud logistics and robotics create new ways in doing logistics business and in managing the (freight) transport system. Higher degrees of automation in logistics and freight transport will lead to new types of decision support and services. Digitalisation and automation will also have a substantial potential to increase the productivity, reliability and flexibility of logistics and transport services. But it also needs control by society to ensure that the use of the new technology contributes to the objectives of the transport policy. To realize this potential and to ensure the contribution to transport policy objectives several important questions have to be answered, especially regarding

- the impact of digitalisation and automation on logistics and supply chains (incl. the trucking industry)
- the impact of digitalisation and automation on freight traffic and traffic management on roads and combinations with other modes
- the benefits of digitalisation for road and multimodal freight transport and road traffic management of public infrastructure and finally
- the necessary technological, organizational and legal framework conditions for implementation.

The application of new technologies is still at the beginning. Some countries started field trials regarding platooning or other application of big data. The topic needs exploration especially regarding the potential applications and impacts and suitable framework conditions for implementation. In addition, the role of the public sector has to be clairified.

So, firstly it is necessary to make a review of the work carried out so far by different organizations, and to collect and analyze different technologies and applications.

Based on them a briefing note is developed containing a synthesis on the actual status of investigation of new technologies in freight transport including interim results and remaining value for the private sector that wants to cooperate and applicate new technologies in freight transport. Because still many technologies are in development stage the briefing note can provide guidance at the right stage of the development to assist the public sector in preparing suitable framework conditions.

For the technologies which are more mature in application (e.g. platooning, partly automated driving) a full report report will be provided.

This contribution from PIARC will be relevant and useful for the public sector and the industry.

The topic could be addressed at the ITS conference or a workshop in HIC.

In this Cycle, a full report. is expected to be completed. Prior thereto, a literature review could be released.

Outputs	Deadlines
• Literature review.	• June 2022
• Full report.	• December 2022

2.3.4. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific freight issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

2.2.5. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

2.2.6. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

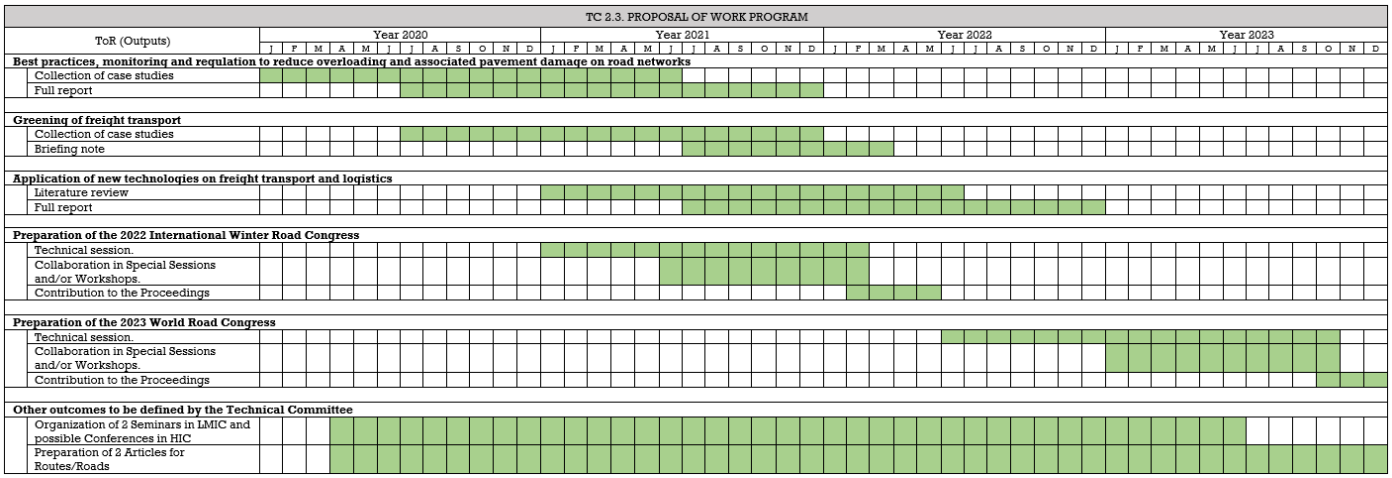
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



TECHNICAL COMMITTEE 2.4 – ENVIRONMENTAL SUSTAINABILITY IN ROAD INFRASTRUCTURE AND TRANSPORT

2.4.1. Real-time evaluation of pollution and low cost air quality sensors assessment

Strategies / Objectives
• Identify traffic operations to minimize the health impact of vehicle emissions. • Investigate and assess how road administrations could help in order to improve air quality through a real time evaluation of pollution and use of low cost air quality sensors. • Take into account works carried out by *T.C.E.2 –Environment Considerations in Road Projects and Operations* within Cycle 2016-2019. • Encourage coordination with *T.C.1.4 – Climate Change and Resilience of Road Network, T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport, T.F.B.2 Automated vehicles* and *T.C. 3.2 – Road Network Operation / ITS.*

Air pollution problems are often observed in the roadside areas of metropolitan regions, where a lot of emission sources such as factories, business offices, residential houses and vehicles accumulate.

Such air pollutions are caused by emissions of SO2, NO2, CO, HC, PM10, PM2.5 etc. which are designated as air pollutants in most countries across the world.

In order to carry out air pollution abatement measures we have long-term evaluation values and short-term evaluation values as regulation standards of air pollutant emissions, and as a step of implementation of the measures we compare real-time evaluation values with the short-term values of regulation standards.

There are several low-cost air quality sensors being used across the world, and they are, of course, different from each other depending on the air pollutants to be evaluated. Such sensors should be assessed in terms of accuracy in measuring and cost.

We also need to prepare a menu of various traffic operation measures to be adopted when real-time values of air pollutant concentrations exceed the short-term regulation standards, and we will select some measures from the menu by examining their applicability to actual sites where air pollution problems occur.

In this Cycle, a full report is expected to be completed. Prior thereto, a Workshop will be carried out.

Outputs	Deadlines
• Workshop.	• September 2021
• Full report.	• June 2022

2.4.2. Noise mitigation

Strategies / Objectives
• Identify improvements of pavement design, construction and maintenance in order to optimize the acoustic performance – as a joint collaborative effort between design, paving, construction and acoustic specialists. • Review novel noise reducing surface treatments for concrete pavement. • Update the database that includes traffic noise policy requirements across PIARC member countries. • Take into account works carried out by *T.C.E.2 –Environment Considerations in Road Projects and Operations* within Cycle 2016-2019. • Encourage coordination with *T.C. 3.2 – Road Network Operation / ITS, T.C.4.1 – Pavement,* and *T.F.4.1 – Road Design Standards*

Road traffic noise problems emerge along trunk roads, which usually have large traffic volume including a number of heavy freight vehicles and have many residential houses in their roadside areas.

Road traffic noise mainly comprises engine noise, intake air noise, exhaust gas emission noise, Aeolian noise and tire-pavement noise (road noise), which are considered noise sources of the road traffic noise.

Such noise sources variously contribute to the road traffic noise depending on vehicle types and vehicle driving modes like low-speed driving or high-speed driving and further stable driving or accelerated driving.

In terms of tire-pavement noise (road noise) road pavement types and maintenance levels of pavement surface affect the noise level very much.

Pavement characteristics in tire-pavement noise differ from one pavement type to another. Asphalt pavements in general have a low noise profile compared to concrete pavements.

Within the asphalt pavements, so-called drainage pavement, which has a lot of pores in its structure, has a lower noise profile than the dense-graded asphalt pavement commonly used. This means the drainage pavement has a reduction effect on the road traffic noise, although the pavement has been developed for water being drained through the pores to avoid water staying on the pavement surface and then to enhance traffic safety during raining.

As to the road surface maintenance levels, unevenness degree of the pavement surface and micro-texture of the surface definitely affect the road noise level, and over-time degradation of the pavement surface make the noise level higher.

The concrete pavements have generally coarse surface micro-texture compared to the asphalt pavements, which is thus a factor that the former makes larger tire-pavement noise. And therefore surface treatments of the concrete pavements should be needed to make surface texture finer and thus to improve their noise emission performance.

In this Cycle, Roundtable / Workshop, as well as a briefing note are expected to be carried out. In addition, during this cycle, the Database will be updated.

Outputs	Deadlines
• Roundtable / Workshop.	• October 2020
• Briefing note.	• December 2020
• Update Database.	• June 2023

2.4.3. Road and road transport impact in wildlife habitats and their interconections

Strategies / Objectives
• Understand how road and road transport impact in wildlife habitats and their interconnections. • Develop a road corridor landscape design and its role in ecological habitat connectivity. • Identify barrier effect mitigation for wildlife. • Encourage coordination with *T.F.4.1 – Road Design Standards.*

When road construction is implemented in the areas with affluent natural environment, the following various impacts take place in a vicinity of the road construction, which we should recognize:

- Natural habitats of wildlife disappear at the road construction site.
- The natural habitats are divided and fragmented into pieces of small habitats.
- Road traffic noise and vehicle emission gases affect fauna and flora in the roadside areas.
- Animals passing the road would collide with the running vehicles and might die, so-called road kills.
- Artificial constructions of roads do not match the natural environment and damage the natural scenery.

Planting areas, median-dividers and road slope surfaces of embankments and cuttings are preferably planted in order to harmonize the road construction with its local natural environment. At the same time, such areas above within the roads need to be designed in structures and devices in order to allow small animals to easily go through the areas, securing connectivity of wild habitats and forming so-called ecological network.

When wildlife habitats fragmented by the road construction, some of animal species will not be able to survive if living on such small fragmented habitats which cannot feed enough food. In such a case fauna passages are required to connect both sides of the road constructed, and we would need to investigate some knowledge and devices for the animals to easily use such fauna passages.

In this Cycle, a full report based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• December 2021
• Full report.	• December 2022

2.4.4. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

2.4.5. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

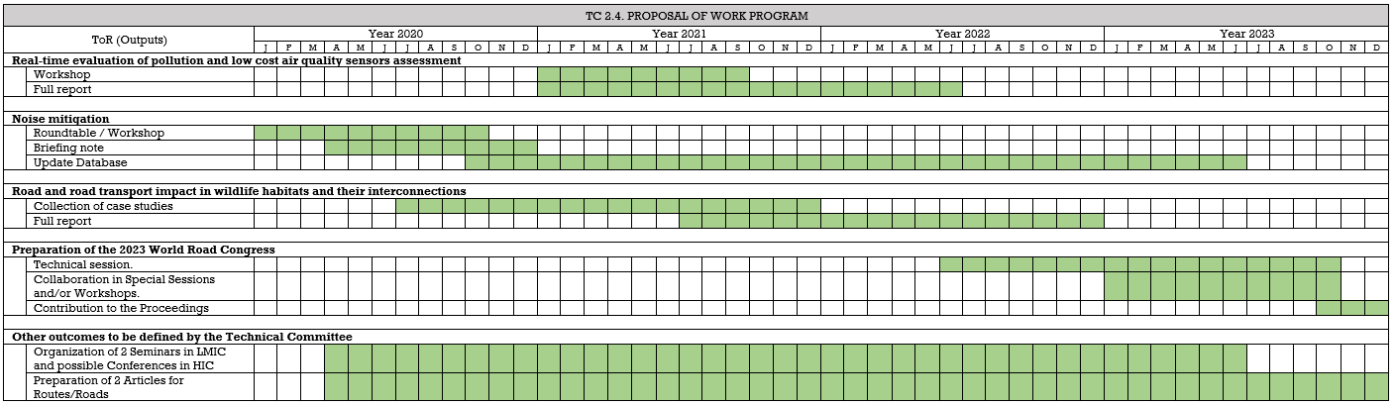
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



3.1.1. Specific road safety issues for LMICs

Strategies / Objectives
• Identify successful stories, paying special attention to those in LMIC countries, with specific examples of safety improvement and management of road safety (in terms of key performance indicators). • Take into account safety of vulnerable users. • Identify the tools, processes, checklist, etc. used to achieve success. • Identify successful stories, paying special attention to those in LMIC countries, in terms of improved approach to the management of road safety. • Identify current PIARC reports considered important for LMIC. • Analyze measures and plans related with *"Decade of Action for Road Safety 2011-2020"* and *"Agenda 2030".* • Encourage coordination with *T.C.2.1 – Mobility in Urban Areas, and T.C.2.2 – Accessibility and Mobility in Rural Areas.*

Road crashes continue to be a major cause of death and serious injury for low- and middle-income countries. At the global level, ninety percent of traffic deaths occur in these countries. In comparison to higher income countries, where the road deaths per 100,000 is 9.2, middle income death rates are twice 18.4 and low income rates are 24.1 (World Health Organization). Almost half of these deaths are among the most vulnerable road users, including people who bike, walk and use motorcycles.

These rates would suggest that much opportunity exist within these countries to building institutional capacity, focus on addressing known safety problems through careful countermeasure selection and adoption of design standards, and use of infrastructure road safety audits could be of significant benefit in reducing death rates.

The intent of this effort is to assess and identify best practice type activities with a focus on low- and middle-income countries, and to gather specific successful examples of safety improvement and safety management activities with a particular interest on the vulnerable road users.

For low- and middle-income countries safety practitioners there is often limited institutional capacity to develop and implement simple tools, process, checklist and other methods to begin to address the road safety challenges. This work will highlight these implementation aids from a review of previous work done by PIARC in past cycles and from other relevant literature, and within the case studies as appropriate. A full report will be produced.

Outputs	Deadlines
• Literature review.	• November 2020
• Collection of case studies.	• June 2021
• Full report.	• December 2021

3.1.2. Implementation of proven countermeasures

Strategies / Objectives
• Increase road safety through the implementation of proven countermeasures to reduce accidents in motorways, rural roads and urban roads, paying special attention to vulnerable road users, speed management and fatigue. • Describe the process for selecting countermeasures given road user consideration and define good practices in strategies related to traffic safety in urban areas, paying special attention to vulnerable road users. • Analyze contribution of proven countermeasures related with *"Decade of Action for Road Safety 2011-2020"* and *"Agenda 2030".* • Take into account works carried out by *T.C.C.1 – National Road Safety Policies and Programs* and *T.C.C.2 – Design and Operation of Safer Road Infrastructure* within Cycle 2016-2019. • Encourage coordination with *T.C.2.1 – Mobility in Urban Areas, and T.C.2.2 – Accessibility and Mobility in Rural Areas.*

It is important for road safety programs to have a process to identify and address high crash risk locations by identifying the contributing factors to those crash sites. Careful analysis allows for the safety professional to select and implement road safety countermeasures that are most likely to reduce the likelihood and severity of crashes at a given location.

Countermeasures are selected based on their benefit to cost of implementation. It is not unusual to see similar crash patterns and crash types occurring at sites sharing common characteristics throughout the road network. In these cases, similar countermeasures can be installed at multiple locations.

Safety professionals recognize that some countermeasures are more effective at reducing the number and severity of crashes. These higher performing countermeasures are often referred to as proven countermeasures because of their large scale use and effectiveness.

The intent of this effort is to increase road safety through the implementation of proven countermeasures. It is important to recognize that not all countermeasures can be applied to all road types and because of this, different roadway types will be highlighted as part of case study development. For example, urban and rural operating environments often experience the same types of crashes but some countermeasure applications are more appropriate in an urban setting and others in the rural locations. To highlight this, case studies will be developed for both contexts.

This work will also describe the process for selecting countermeasures because this is the most important step of the process when identifying, evaluating, and selecting countermeasures. Specific attention will be provided to considerations and effects on vulnerable road users. A number of PIARC and external documents will be considered for inclusion in the final report.

The final outcome of the work will be a full report based on the collection of case studies.

Outputs	Deadlines
• Collection of case studies.	• June 2022
• Full report.	• December 2022

3.1.3. Update Road Safety Audit Guidelines

Strategies / Objectives
• Update the Road Safety Audit Guidelines for Safety Checks on New Road Projects (2011). • Add sections to provide exemplar guidance to LMICs. • Encourage coordination with *T.C.1.1 Performance of Transport Administration.*

Today, road safety audits are a very useful tool to improve safety of roads, by diagnosing of existing problems and detecting possible inconsistencies and / or shortcomings in the design of all the elements.

The main objective of road safety audits is the assessment and definition of potential risks of accidents on the road by establishing a safety diagnosis and proposing actions and measures aimed at the elimination, or at least reduction, in accidents. They must be carried out during the stages of planning, design, construction and operating.

T.C. C.2 – Design and Operation of Safer Road Infrastructure (SP 2016-2019) reported the need of update of PIARC Road Safety Audit Guidelines for Safety Checks on New Road Projects (2011) including additional sections to provide exemplar guidance to LMICs. A clear analysis of improvements to be conducted as well as practical recommendations on how to conduct them were included.

T.C. 3.1 should update Road Safety Audit Guidelines paying special attention to provide guidance to LMICs.

Outputs	Deadlines
• Update Road Safety Audit Guidelines.	• December 2022

3.1.4. Implications of connected and automated vehicles

Strategies / Objectives
• Analysis on classification of traffic accidents which automated vehicle can/cannot prevent. • Evaluate implications of connected and automated vehicles in road safety from the point of view of road design considerations, CAV users and all other users in special vulnerable users. • Identify best practices taking into account CAV to improve road safety. • Identify safety issues as far as transition period to automated driving concerns. • Consider the PIARC report on Road safety infrastructure's role in the transition to automated driving systems. • Encourage coordination with *T.F.B.2 – Automated vehicles – Challenges and opportunities for road operators and authorities, T.C.3.2 – Road Network Operation, T.C.3.3 – Winter Service*, and *T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport.*

The benefits of connected and automated vehicles on road safety will be very significant as an increasing number of vehicles are deployed into the transport fleet. The benefits of CAV to reducing many of the 90% human error related contributing factors to crashes caused by limited vision, reaction time, control, fatigue, distraction and driving under the influence of drugs and alcohol are apparent. Although the benefits will depend on the total percentage of transition into the vehicle fleet for each country.

Question remain, for instance, how might bicycle and pedestrian safety change as these road users will likely have no way of telling which vehicles have high levels of technology and which do not and the potential for errors are relatively high. With all the benefits, how drivers behave and act during this transition may change, and it is uncertain how this change may affect the number and severity of crashes.

How we design and operate our facilities may change overtime with CAV. At this point, we believe that the earliest changes will be about providing the necessary infrastructure to support CAV, through provision of striping, communication and information systems. With more wide scale adoption there may be changes in how we design and operate roadways because of changes from designing for drivers and driver errors versus designing for autonomous operations.

A workshop will be developed to discuss and debate these issues followed with a briefing note related to the Implications of connected and automate vehicles workshop.

Outputs	Deadlines
• Workshop.	• June 2021
• Briefing note.	• December 2021

3.1.5. Update of the Road Safety Manual

Strategies / Objectives
• Updates of Road Safety Manual focus on the work carry out by the TC. • Continue with the works carried out by *T.C.C.1 – National Road Safety Policies and Programs* and *T.C. C.2 - Design and Operation of Safer Road Infrastructure* within Cycle 2016-2019 to complete the incorporation of pertinent PIARC reports on road safety (from 2003). • Launch a survey among HMLICs regarding the use, needs, gaps and issues regarding RSM and perform gaps and needs assessment to recommend changes in how to implement activities, based on priority. • Develop case worksheets or checklist to aid in the implementation and understanding of the RSM, particularly for LMICs. • Encourage implementation of Road Safety Manual.

The Road Safety Manual (RSM) is intended to increase safety performance though capacity building in road safety management. The RSM state-of-the-art international reference to the safety professional in the areas of safe planning, design and operation of the road system. The Manual is online, and available for download and printing.

The RSM was developed to be a comprehensive and accessible technical document. It highlights the Safe Systems approach to road safety management. The manual sets out a path for road safety policy makers and practitioners at work in low, middle and high-income countries.

The third addition of the RSM is an update to the second edition of the road safety manual. It improves clarity and address new information from PIARC in the 2016 – 2019 Cycle. The update incorporates numerous case studies to demonstrate application in best practices from countries around the world.

In the next cycle, the RSM working group will focus on a) working closely with the other safety working groups of the Technical Committee, b) studying the use, needs, gaps and issues of the RSM, and c) support for implementation, and d) finding ways to promote implementation of the RSM.

The RSM working group will work closely with the other safety working groups of the Technical Committee. This will allow future RSM work to incorporate and coordinate work on new documents to ensure relevant and timely updates from new and relevant materials.

A survey will be developed for use by high, medium and low-income countries (LMICs) regarding the use, needs, gaps and issues regarding the RSM and then perform a gaps and needs assessment in how to increase implementation activities.

The RSM working group will also consider the development of case study worksheets and checklists to aid in the implementation and understating of the RSM, particularly for LMICs.

Further focus will on the promotion of the RSM with examples of how best to improve dissemination and use by safety practitioners and policy makers.

Road Safety Manual will be updated during this cycle. Furthermore, a survey among HMLICs regarding the use, needs, gaps and issues regarding the RSM will be carried out, as well as elaborating worksheets or checklists for the implementation and understanding of the RSM, particularly for LMICs.

Outputs	Deadlines
• Survey among HMLICs regarding the use, needs, gaps and issues regarding RSM.	• June 2021
• Worksheets or checklists for the implementation and understanding of the RSM, particularly for LMICs.	• December 2021
• Update of Road Safety Manual.	• Up to June 2023

3.1.6. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific rad safety issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

3.1.7. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

3.1.8. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program

3.2.1. Implication of new mobility to road network operation

Strategies / Objectives

- Investigate new mobility forms (connected and autonomous vehicles, zero-emission vehicles, sharing cars,…) and MaaS concept and its applications around the world in order to explore its critical role and how effective road network management and operations contribute to ensuring mobility.
- Highlight risks challenges and opportunities of new mobility and MaaS.
- Investigate MaaS business model, which the clear aim of address how big the model should to be attractive and viable for road agencies and road users, with a specific focus on:
  - Who should it serve.
  - How to manage the demand?
  - How to integrate the choices and focus clearly on the operational aspects?
- Provide guidance at the right stage of development to assist the industry in implementation and decisions.
- Encourage coordination with *T.C. 1.1 Performance of Transport Administration, T.F. B.2 - Automated vehicles – Challenges and opportunities for road operators and authorities, T.C.2.1 – Mobility in Urban Areas, T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport,* and *T.C.3.1 – Road Safety*

Mobility as a Service (MaaS) is still fairly new concept as a tool of Intelligent Transport Solutions.

MaaS tools have been launched in several countries such as:

- Finland, where this idea was born. Through the website https://whimapp.com/, users are allowed to access various modes of transport through a single app.
- Vienna (Austria) with its SMILE project-pilot. Smart Mobility Info & Ticketing System Leading the Way for Effective E-Mobility Services, which offers a unique mobility solution for users. The pilot allowed 1,000 users access to a smart app to make transport choices with 16 different service providers. The results of the pilot study are shown here http://smile-einfachmobil.at/index.html.
- Hannover (Germany), where the world's first example of Mobility-as-a-Service has been launched. GVH´s (Greater Hanover Transport Association) 'Mobility Shop,' https://www.gvh.de/, the very first fully operational example of MaaS in Germany.

One last example has been developed in order to understand the concept of MaaS. KPMG has created an innovative MaaS requirements Index to help authorities gain a deeper understanding of their platforms and where risks and opportunities lie.

This topic still needs further exploration especially in regard to its effect on road infrastructure management and operations and is quickly evolving.

Where single public transport offerings i.e. rail, bus etc. have failed to entice the private car user, MaaS offers an integrated approach to satisfy all types of users. In a highly connected society, MaaS delivers tailored solutions to fit a user's need.

It represents a convergence of public and private transportation to provide a single integrated solution for individual users needs all while still attempting to address congestion, safety and convenience.

The MaaS concept is still in a developmental stage with various countries implementing pilot projects. As with all developing concepts, there may be many benefits, but risks and challenges need to be considered.

From a demand side, the user expects a myriad of transport choices, however the back end would require multiple private and public service providers to collaborate and provide the best offers of transport. Private partners whilst integrating into such a system will still need to protect their business model whilst partnering with public agencies.

From a supply side, it would require effective operations of road and infrastructure in ensuring that the journey combinations are reliable. This concept however places great emphasis on the reliability and accuracy of traveler information systems. Users will require real time data to make the relevant mode choices. The transportation network needs to understand travel patterns, optimize the network, and calibrate demand and supply.

The front end is where the user will interact with the system and should not only provide modal offerings but transport information that can affect their journey plans i.e. construction activity, traffic alerts etc. with a simple and easy to use interface.

The concept in itself is promising with the potential to transform the way mobility and technology relate to each other however the implementation and operations is complicated where multiple parties with differing needs to cooperate and manage their risks.

In addition, the emergence of autonomous vehicles is the subject of much works and studies within and outside PIARC. In most cases, the approach is vehicle-centered, forgetting the necessary evolution of the infrastructure. Nowadays, the higher the level

of automation (from 1 to 5), needs the higher the performances requirements of the infrastructure. This subject has been briefly addressed (Routes/Roads No. 373) under the acronym HQoSH (High Quality of Service Highway).

The objective is to further develop this concept. This will include identifying all the characteristics of the road that are significant for the autonomous vehicle to be able to travel safely. For each of these characteristics, it may be necessary to define a metric in order to quantify the level of quality offered by the road. This quality level could be related to the level of automation required (for example, for autonomous driving at level n (n between 1 and 5), an infrastructure offering a level of quality at level p (p values to be defined) is required). The issue of the digital infrastructure (definition, condition for updating) needs also to be addressed. Beyond the technical aspect, business aspects, stakeholder's role and underlying value chain could also be addressed. Finally, investigating how private and public sectors should direct their trades and skills to meet these new challenges would be very valuable.

Definitely, the aim of this task is to explore the critical role effective network management and operations contribute to ensuring MaaS is an attractive solution to enable the shift from car ownership to usership for transport, taking in account all the new mobility technologies. It is to address the risks and challenges and the opportunities to mitigate and manage these challenges.

So, firstly it is necessary to make a review of the work carried out so far by different organizations, and to collect and analyze different experiences. Based on them, a briefing note addresses:

- How big the model should be for it to be attractive and viable?
- Who should it serve?
- How do you manage the demand and how would you integrate the choices and focus clearly on the operational aspects?

A briefing note of this nature will therefore not only benefit the public sector but the private sector that wants to cooperate and operate in this space.

Finally, with this concept still in its early stage, this report can provide guidance at the right stage of the development to assist the industry in implementation and decisions. This contribution from PIARC will be relevant and useful if completed early enough for consumption by the industry.

Outputs	Deadlines
• Literature review	• November 2020
• Collection of case studies.	• December 2021 • March 2023
• Briefing note	• June 2021

3.2.2. Optimizing road operations and performances through new technologies and digitalization

Strategies / Objectives
• Identify best practices related to the application of Big Data and data driven decision-making in order to increase the productivity and performance of the road network. • Investigate the role of new technologies and digital tools within the transportation sector, underlining how they can enhance road network operations and enable efficiency. • Investigate traffic management strategies and techniques, including off-line (e.g. traffic signal review) and on-line (E.g. balancing traffic density or gating) approaches related to ITS systems. • Study of the current values of KPI's of the performance of operations and maintenance within RNO and ITS systems in order to enable the comparison thanks to the new tools and processes of optimization. • Take in account the work carried out by the *T.C. B.1. Road Network Operations/Intelligent Transportation Systems,* in particular on "Big data in Road transport" and develop it more to promote knowledge sharing. • Encourage coordination with *T.C.2.1 – Mobility in Urban Areas, T.C. 2.2 – Accessibility and Mobility in Rural Areas, T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport,* and *T.C.3.1 – Road Safety, T.C.3.2 – Freight, T.C. 3.3 – Winter Service, T.C.3.4 – Asset Management* and *T.C.1.5 – Disaster Management.*

As far as "Optimizing the operation and performance of existing facilities" concerns, this topic needs to be studied more deeply because of the fast changes in technology, concepts and processes.

Road network capacity is not fully utilized, as traffic demand is concentrated on only small proportion of the road network (i.e. bottlenecks) and time-of-the day (i.e. peak periods). A balanced operation of the road network has the potential to unlock untapped productivity of the road network resulting in less congestion delay and more reliable travel times.

In the several emerging countries, a lot of road operators and governmental agencies do not have enough knowledge and funds to optimize the performance of operation and maintenance due to different reasons (political, social, legal, technical and economical and/ or lack of knowledge, goals, objectives, will, management, analysis of risks and so on).

This aim of this topic seeks to optimize the performance of operation and maintenance with a systemic and transversal point of view, involving road operators, universities, NGO´s and, urban, interurban and regional Governments.

On the other hand, other topics such as optimizing mobility and education, jobs, welfare, health, industry with their KPI´s and their contribution to the growth of the country, have been taken into account. Another topic considered is the added value or transference of technology of the developed countries to the emerging countries. That process should be developed creating strengths into the local market and in the local engineers. Indeed, emerging countries need to develop their own technologies so that they can get out of the dependence on foreign technologies. In relation to this issue, studying the transition of technology between the existing facilities and the news and the use of the drones, Big Data, electric infrastructure and vehicles, V2V and I2V communications and AI (artificial intelligence) technologies to the process of optimization should be considered too.

In addition, data is the basis for road network operations. While in the past only data generated by own resources (sensor data) has been considered for road network operations, currently, several data sources can be used for a highly improved road network operation in all areas: planning, management and maintenance. Procedures and processes within road network operator need to be improved in order to enable road network operators to use data from different sources efficiently.

Within the new cycle, best practice examples for data driven decision making need to be collected and discussed. This includes how to collect data from vehicles (or vehicle fleets), how to use this data, how to merge data from vehicle sensors with own sensor data and data from 3rd parties, and how to improve existing services with these improved data sets.

Based on the experts' discussions, the future need of a road sensor network should be evaluated. Where road network operators will still need to invest in own sensors in the future, and under which conditions data from other sources might be able to replace own sensor data.

Furthermore, the emergence of more data on road network performance (i.e. Big Data for Road Network Operations) has opened new possibilities in managing and controlling road traffic. For example, ramp signals have taken advantage of data from high density detectors on motorways to prevent flow breakdown on motorways. Similar approaches can be developed for the whole road network, particularly for the arterial road network by employing emerging data on the road network, such as Bluetooth, more detectors, probe vehicle data, etc.

The research objective would be to identify best practice in increasing the productivity of the road network through the application of Big Data and data driven decision-making. The focus would be on the traffic management strategies and techniques, including off-line (e.g. traffic signal review) and on-line (e.g. balancing traffic density or gating) approaches.

By last, we know that data-driven decision making is highly important as soon it comes to connected and automated vehicles using the road infrastructure. Therefore, a clear approach needs to be given.

Besides, almost all technical committees are dealing with data-driven decision-making. The challenge of this cycle should be how to concentrate the knowledge. Ideally, more flexible committee meetings are needed, where committees start working closer or somehow coordinate with each other than to work isolated.

The output of the research work would be a best practice review and a collection of examples case studies. The research would also identify the scale of the impacts, where available. In addition, a Seminar and a Conference/Workshop carried out within the 2020-2023 Cycle have been part of the preparation of the report.

Over the last couple of decades, governments around the world have been seeking policy and investment solutions to meet the ever increasing demand for access and mobility as the world population continues to grow. Rather than focusing on building extra capacity, more efficient solutions can sometimes be found by using existing capacity, where possible and appropriate.

There are at least two aspects to the Smart Use of Roads theme, as defined above:

- How to apply Big Data to extract additional capacities from a congested road network?
- How to balance the various demand for road space from different road users (cars, freight, public transport, cyclist and pedestrians) in a congested network?

Both topics are considerable broad themes by themselves. Both are important but the nature of expertise and application are not the same. The first topic focusses strictly on optimizing vehicular throughout, while the second topic aims to incorporate people throughput, place-making and mode share policies.

Given that within 2016-2019 cycle groundworks on Big Data have been carried out, it appears logical to consider focusing on research on the application of Big Data to optimize vehicular traffic throughput, as it extends from the groundwork already done on Big Data for Road Network Operations. It is also more in-line with the nature of the RNO/ITS technical committee's scope and expertise.

Within the 2016-2019 cycle, a report on Big Data for Road Network Operations examined the potential for the application of Big Data to Road Network Operations. The main core of the report was the framework and benefits of Big Data. It did not examine in detail the traffic operation strategies and techniques that can translate the potential of Big Data to improved road network capacity. Therefore, the topic is a novelty and timely to be studied in this cycle.

To conclude, an expected output consists in a deep report of the current values of KPI´s of the performance of operation and maintenance and the comparison with the achieved values with the new tools and processes of optimization. It is necessary to analyse and describe the different processes in several countries and to compare them with specific KPI´s.

Outputs	Deadlines
• Collection of case studies.	• June 2022
• Full report.	• December 2022

3.2.3. Update of the RNO/ITS Manual

Strategies / Objectives

- Provide a medium-level overview / insight into RNO-ITS for decision-makers, middle managers and young professionals,
- Provide technical advice relevant to countries and regions that have not developed any ITS project yet,
- Exchange knowledge and techniques on RNO-ITS.

- Regular work to:
  - Identify articles that are not relevant (obsolescence,,…).
  - Update the articles (including a research work to illustrate them with images, videos, case studies, references,,…)
- A survey will be carried out regularly in order to ensure that the content of the website is relevant for its users.
- Finish the French version.
- Take into account works carried out by *T.C.B.1 –Road Network Operations/Intelligent Transportation Systems w*ithin Cycle 2016-2019.
- Encourage coordination with *T.C.3.1 Road Safety, T.C.3.4 Asset Management, T.C.4.4 Tunnels, T.C.2.3 Freight, and T.C.2.1 Mobility in Urban Areas.*

The Road Network Operation (RNO) and ITS online manual is one of the few thematic online resource of PIARC. It has been developed thanks to USDoT funds and ITS America expertise and was open to public after a huge work at the end of the cycle 2012-2015 in English, and afterwards In Spanish and French.

The focus of the RNO-ITS website is the role of ITS in Road Network Operations, not the entire scope of ITS. The website is a handbook for people who are not already ITS specialists. The target of the manual is therefore not the experts, but senior staff such as decision-makers or middle managers in road authorities. The website also has value for young professionals who are learning about RNO and ITS and RNO. Many road authorities in developing countries are new to road network operations and look to PIARC for advice and guidance. The RNO-ITS website addresses this need very well, but goes well beyond in trying to keep pace with the latest developments in ITS – such as ITS-based user services and connected and automated driving.

During the 2016-2019 PIARC work cycle, the objective was to maintain and to update the RNO and ITS online manual. In order to achieve this objective, a preliminary task was to create and to edit a monitoring file describing the content of each article: author, date of last change, associated case studies and videos, etc. This file has been consolidated in late 2018 and will be one deliverable of the work of the workgroup in charge of the maintenance and of the update of the website, however it may be an unexpected deliverable.

The main objectives of the development and the update of the Road Network Operations and ITS online manual are:

- Provide a medium-level overview / insight into RNO-ITS for decision-makers, middle managers and young professionals,
- Provide technical advice relevant to countries and regions that have not developed any ITS project yet,
- Exchange knowledge and techniques on RNO-ITS.

This resource is not meant to be an academic resource.

The website is currently composed of 4 themes:

- Basics of RNO and ITS,
- Road network operations,
- Building blocks,
- Emerging economies.

Some figures (2018) about the RNO-ITS online manual give an insight about the content:

- about 350 articles, making the equivalent of 1,050 pages if the whole manual was to be converted as a A4-page report,
- 72 case studies, aiming at increasing with the new case studies written down during the 2016-2019 cycle,
- 53 videos,
- references to PIARC reports from previous cycles.

To achieve the objectives, the website needs to be:

- technically maintained in the three languages: the content, especially the content that is not hosted on the website such as medias and external links, needs to be always accessible,
- reviewed: since PIARC stands for high-quality, out-of-date content is not welcome on this website. The review will ensure that the content is still up-to-date or will suggest articles that needs to be updated. This is particularly true for technologies within RNO and ITS, which evolve quickly,
- updated: to get the latest content, either when content is not up-to-date anymore, or if a new topic has to be tackled with, such as connected vehicles, autonomous driving, etc,

Outputs	Deadlines
• Update of the RNO/ITS Manual.	• Up to June 2023

3.2.4. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific rad safety issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

3.2.5. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

3.2.6. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

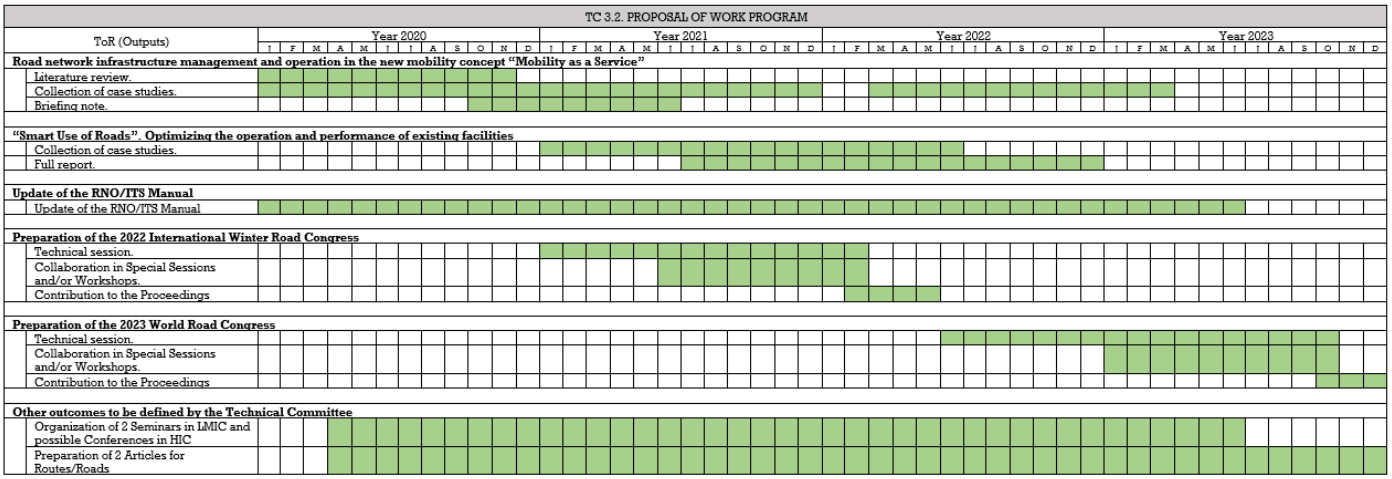
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



TECHNICAL COMMITTEE 3.3 – WINTER SERVICE

3.3.1. Integration of the new technologies in winter services

Strategies / Objectives
• General description of state of the art of the existing technologies and new technologies for winter service. • Expected technology to be used in winter service in the future. • Make a projection on what could be automated or connected equipments for winter service in the future. • Encourage coordination with *T.C.3.4 – Asset Management.*

Fighting snow and ice on roads with de-icing chemicals is a major task in winter maintenance. On the main road network usually sodium chloride is used. Various studies and practical experience have proven the high efficiency of sodium chloride treatments on traffic safety and national economy. The application methods have been enhanced worldwide in the past few years. Pre-wetted salting and application of only brine are more and more established on roads and also bicycle lanes.

However, researches point out that even with pre-wetted salt at 30 percent brine quotient, the potential of salt savings with pre-wetted technology is not fully tapped. Thus, new spreaders have been developed, allowing higher brine share and/or application of only brine via spray nozzles.

In the last PIARC cycle *Technical Committee B.2 - Winter Service* conducted a survey of winter maintenance in the countries represented in PIARC. Scopes were winter maintenance standards, type of de-icing chemical and application method. Besides current development and research projects have been compiled.

Matters of particular interest were the development of spreading techniques in different countries, especially the application method of pre-wetted salt and brine. The current status and different ways of development were analyzed comparative. Best practices and special developments of selected countries will be presented. The report also discusses open questions such as the limit of brine at low temperatures and gives an outlook on future developments.

Around the world, scientific projects and practical approaches concerning de-icing agents and application are conducted. Among the different projects, two main findings have been made independently. Brine, either in form of pre-wetted salting or brine application has been a success. Especially for preventive treatments, brine convinced practical users. The survey of application methods showed that brine is used more and more in the last years all over the world, especially for preventive actions.

The tendency to more brine usage will be going on the next years and should be followed in a PIARC report. Literature in form of research reports and experience of new technologies in operational winter maintenance could build the basis for such a report. The infrastructure needed with the increased use of brine should also be covered in the report.

Apart from spreading techniques there has been development in mobile sensors for winter maintenance application. Such sensors have been developed to measure information's critical for winter maintenance such as temperatures, road state and water/ice film thicknesses.

With accurate measurements from a sensor network it would also be possible to give this information to road users. This can happen either using web interfaces where potential routes to the road user's destination could be checked out before departure. Other ways to communicate this information will be social media or apps for smartphones. If the users are already on the roads, they could be informed using digital road signs or comparable.

Based in a deep research on worldwide use of new technologies on winter service, the report could give some examples of tests or studies to these topics.

Outputs	Deadlines
• Literature review.	• November 2020.
• Full report.	• June 2021.

3.3.2. Winter maintenance in urban areas

Strategies / Objectives
• Make a precise description of the organization of winter service in urban areas. • Response to extreme climate events, information provision, traffic restrictions, etc • Propose a Best Practices Guide with different methods used for several winter maintenance operations. • Encourage coordination with *T.C. 2.1 – Mobility in Urban Areas* and *T.C. 2.3 - Freight*

In 2014, 54% of the world's population lives in cities. If we take the example of European territory the inhabitants live 80% in a city of more than 100 000 inhabitants, 30% of the population living in a city of more than one million inhabitants. In Japan, 92%

of the population lives in urban areas. The vast majority of travels start and end in cities, if they even leave an urban area. This means that road authorities in cities have to provide a good winter maintenance in order to keep the city working. Much of the winter maintenance research tends to lend itself to roads that are of higher volume traffic, and/or non-urban in nature. The intent of this topic is to focus on delivery of urban road winter service, and documentation of successful examples of that.

Compared to rural roads or highways winter maintenance in cities is different in many ways. The different modes of transportation, the lack of space for snow, often very narrow roads and one-way streets make planning winter maintenance very complex.

Many different responsible organizations (Cities, residents, public transport companies…) lead to different service intervals and times on roads next to each other or on different parts of the road (sidewalk, bikeway, bus lane, street).

A specialty of cities are pedestrian areas with a huge amount of walking and shopping persons where winter maintenance is a challenge during times of high pedestrian volume. Thus, it is necessary to finish the winter maintenance during the night to have clean and ice-free pedestrian areas during the day.

Another challenge is the lack of space for snow to be stored temporarily in urban areas. To get the snow out of public traffic areas it has to be dispatched. Some cities have restrictions for storing/dumping contaminated snow that must be removed and transported out of the city centers. Even if there are larger areas where one could store snow, these often are occupied by urban furniture and equipment. It is also of interest what smaller cities do, they have often different problems.

Due to the large percentage of sealed surfaces, compacted soil as well as other environment factors trees and other plants face more troubles compared to the natural soil next to rural roads. Therefore, it is even more important so use as little spreading material as possible in urban winter maintenance.

The plurality of the mode of transport and multimodality is big (Cars, bicycles, buses, scooter, skateboard, tramway, metro, cable transport by air, ferries…) and will be even bigger in the future due to the Political will to reduce the use of cars. A coordination with *T.C. 2.1 – Mobility in Urban Areas should be established*.

Cities and urban areas with significant winter weather events experience unique challenges when it comes to delivering winter services to the traveling public. Even if regular snowfalls can be handled, extreme snowfalls need special preparations and actions.

Documentation of successful urban agencies and how they deal with these challenges would be beneficial to all cities and urban areas confronted with winter weather. Due to the fact that basic conditions vary a lot between cities there might not be a "best practice". A report collecting different approaches however will be a very good guide to find different methods.

The report will be based on a questioner that will cover the questions and problems like the following:

- Strategy to deal with the dense road network with large variations in traffic volume
- Optimization and minimization of the routes for maintenance vehicles.
- Treatment methods and vehicles for winter on bicycle lanes
- How to create a continuous bicycle lane network with different types of infrastructure?
- Sidewalk and pedestrian areas, accessibility (for those with reduced mobility), tactile paving.
- Equipment and layout of urban areas, what to do with the snow, remove or thaw?
- Best practices for tramways, buses and other public transportation, including the tracks and access to stations.
- Solutions to ploughing different surfaces without disadvantaging any transport mode

A particularly attractive session at the XV International Winter Road Congress in Gdansk with twelve papers were presented around 10 % of the communications was on the topic winter maintenance in urban areas. The interest is very high and a report with different strategies would be of good use for people looking for solutions in urban winter maintenance and will strengthen the urban session at the winter road congress.

In this Cycle, a full report and best practices Guide based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies.	• June 2022.
• Full report and best practices Guide	• December 2022.

3.3.3. Implications of connected and automated vehicles on winter services

Strategies / Objectives
• Identify, investigate and document implications of connected and automated vehicles on winter service. • Encourage coordination with *T.F. 2.1 – New mobility and its impact on Road Infrastructure and Transport* and *T.F. B.2 – Automated vehicles – challenges and opportunities for road operators and authorities.*

"What are we talking about when we talk about autonomous vehicles and winter service equipment and where are the problems?". The idea is to know the development of technologies in the field of winter service as well as automated vehicles.

On one hand we need to know how the use of automated vehicles impact on winter service, since they could rely heavily on road markings or other types of sensors.

On the other hand the item could be how to manage traffic in wintery conditions using sensors. Mobile sensors for winter maintenance application have been developed to measure information's critical for winter maintenance such as temperatures, road state and water/ice film thicknesses. How can we use this information for automated spreading and how can you get it to the road users?

By last, another item would be the communication in order to manage data for better winter service. At the XV International Winter Road Congress in Gdansk 2018 there have been some presentations about the developments in Vehicle to Vehicle and Vehicle to Infrastructure communication to help winter maintenance with better forecasts and real-time information. The data may include typical weather observations such as air and road temperature or relative humidity, but may also include vehicle-specific relevant data like wiper blade speed and Anti-lock Braking System (ABS) status.

A briefing note that encompasses knowledge from sharing experiences between experts from the field of winter maintenance and automated vehicles would be a good contribution.

This issue could be also an item for the XVI International Winter Congress in Calgary.

Outputs	Deadlines
• Briefing note.	• May 2022.

3.3.4. Update of the Snow and Ice Data Book

Strategies / Objectives
• To update the Snow and Ice Data Book with the case studies and main findings. • To stablish the Snow and Ice Data Book as a current resource for knowledge transfer globally. • Set up the methodology to update the SIBD. • Study the possibility of developing an online manual or similar.

The Snow and Ice Databook (SID) as a PIARC product contains general information about winter maintenance from many different countries which makes it a very good resource for comparisons or finding of new ideas. Therefore it should be established as a current resource for knowledge transfer globally and been updated.

Due to the long update cycles it takes some time for new information to be found in the SID, thus the possibility of an online manual which could be updated more easily should be checked out. This also means the inclusion of an interactive format to facilitate use by members of PIARC.

The Snow and Ice Data Book will be updated during this cycle. In addition, a Workshop on the possibility of producing an online manual or similar will be carried out.

Outputs	Deadlines
• Update of the Snow and Ice Data Book	• December 2021 • June 2023
• Workshop on the possibility of producing an online manual or similar.	• October 2021

3.3.5. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific rad safety issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

3.3.6. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

3.3.7. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

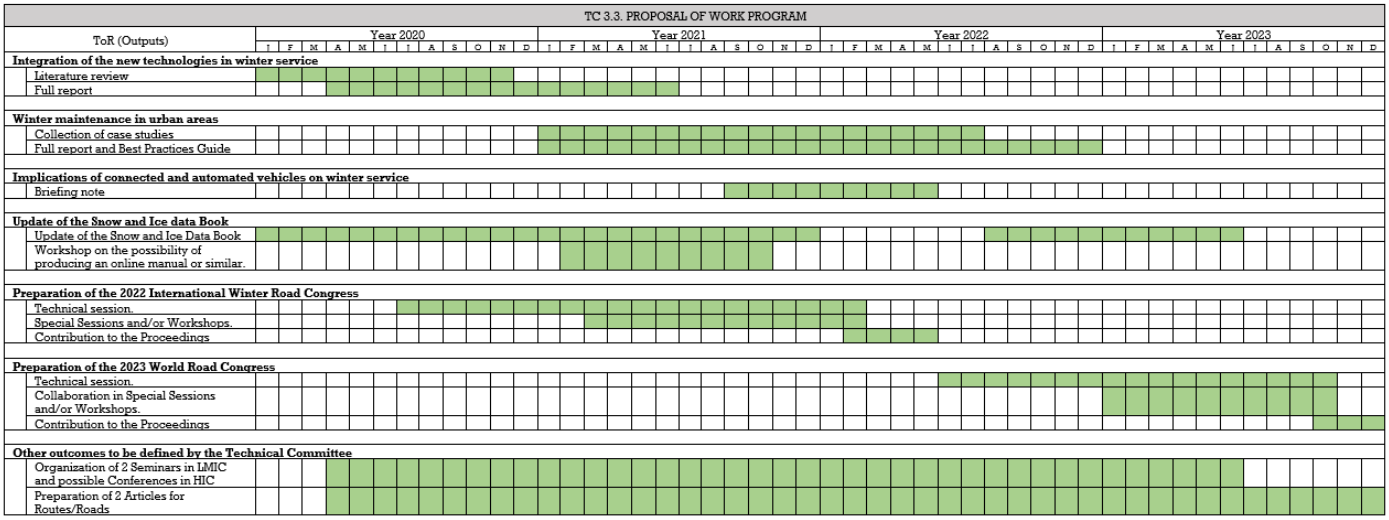
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



TECHNICAL COMMITTEE 3.4 – ASSET MANAGEMENT

3.4.1. Innovative approaches for asset management systems

Strategies / Objectives
• Develop a guideline for implementing Asset Management Systems in the road sector according to ISO 55001, taking in account different road organizations and at different maturity levels. • Incorporation of life-cycle management and risk management approach. • Improve and innovate managing assets approach by taking into consideration of a triple bottom line of sustainability (PPP, i.e. profit, people, planet). • Investigate the use of BIM (Building Information Model, by using a standard format, in conjunction with current AMSs used by road owners and operators. • Investigate the use of Digitalization in Asset Management. • Take into account works carried out by *T.C.D.1 – Asset Management* within Cycle 2016-2019. • Encourage coordination with *T.C. 1.1 – Performance of Transport Administrations, T.C.1.2 – Planning Road Infrastructure and Transport to Economic and Social Development, T.C. 1.3. Finance and Procurement, T.F. 1.2 – HDM-4, T.C.3.2 – Road Network Operation, T.C. 4.1 – Pavements, T.C. 4.2 – Bridges, T.C. 4.3 – Earthworks and T.C. 4.4 – Tunnels.*

To be completed

In this Cycle, a briefing note based on the collection of case studies is expected to be completed.

Outputs	Deadlines
• Collection of case studies	• June 2021
• Briefing note	• December 2021

3.4.2. Measures for improving resilience of road network

Strategies / Objectives
• Identify and quantify the risks and global losses associated to damages of transportation system and to establish efficient risk mitigation strategies within a holistic approach on road infrastructure. • Overview of existing PIARC reports on this matter. • Identify best practices and approaches of Road Asset Management measures to improve the resilience of the road infrastructure. • Encourage coordination with *T.C. 1.1 – Performance of Transport Administrations, T.C.1.2 – Planning Road Infrastructure and Transport to Economic and Social Development, T.C. 1.4 – Climate Change and Resilience of Road Network, T.C. 1.5 - Disaster Management, T.F. 1.2 – HDM-4, T.C.3.2 – Road Network Operation, T.C.4.1 – Pavements, T.C.4.2 – Bridges, T.C.4.3 – Earthworks* and *T.C.4.4 – Tunnels.*

To be completed

In this Cycle, a full report is expected to be completed.

Outputs	Deadlines
• Full report	• June 2022

3.4.3. Renewal and rejuvenation of aging infrastructure

Strategies / Objectives
• Collect and disseminate information on available innovative management, design, and construction methods that can potentially accelerate the renewal and modernization of existing road infrastructure. • Identify best practices and approaches of road asset management that support the renewal and modernization of aging road infrastructure, including the management of road renewal backlogs. • Take in account the emerging vehicle and infrastructure technologies. • Build on the findings of *T.C.D.1 – Asset Management* within Cycle 2016-2019. • Encourage coordination with *T.C. 1.1 – Performance of Transport Administrations, T.C.1.2 – Planning Road Infrastructure and Transport to Economic and Social Development, T.C. 1.3. Finance and Procurement, T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport, T.F.B.2 – Automated vehicles, T.C.3.2 – Road Network Operation, T.C. 4.1 - Pavements, T.C. 4.2 - Bridges, T.C. 4.3 - Earthworks, T.C. 4.4 – Tunnels* and *T.F.4.2 Road Design Standards.*

To be completed

In this Cycle, a full report is expected to be completed.

Outputs	Deadlines
• Full report	• December 2022

3.4.4. Update of the Asset Management

Strategies / Objectives

- Upgrade the content of the Road Asset Management Manual by:
  - Increasing the number of cases studies in order to cover all levels.
  - Introduction of the following topics:
    - Cross asset investment prioritization and optimization.
    - Incorporation of life-cycle cost analysis *"LCCA"* into asset management process.
    - Initiatives to integrate resilience management of risks posed by natural hazards into asset management of road networks.
    - Innovation elements to integrate BIM and database of management system.
- Extend the education and dissemination section of the Road Asset Management Manual by:
  - Enhancement of existing training material.
  - Adding further training material for:
    - Various target audiences.
    - Different maturity levels.
- Take into account works carried out by *T.C.D.1 – Asset Management* within Cycle 2016-2019.

To be completed

The Road Asset Management Manual will be updated during this cycle.

Outputs	Deadlines
• Update of the Road Asset Management Manual.	• June 2023

3.4.5. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives

- Prepare the technical program for the Congress including:
  - Summary of the specific road network operation issues related to winter service.
  - Identification of the following steps for future works.
  - Definition of additional topics to be proposed in order to be presented as individual speeches.
  - Evaluation of abstracts and full individual speeches.
  - Taking into consideration possible contributions from other Technical Committees.
- Possible collaboration in Foresight Sessions.
- Possible collaboration in workshops.
- Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

3.4.5. Preparation of the 2023 World Road Congress

Strategies / Objectives

• Prepare the technical program for the Congress including:
  o Summary of the works carried out during the cycle with the highlighted conclusions.
  o Identification of the following steps for future works.
  o Definition of additional topics to be proposed in order to be presented as individual speeches.
  o Evaluation of abstracts and full individual speeches.
  o Taking into consideration possible contributions from other Technical Committees.
• Possible collaboration in Foresight Sessions.
• Possible collaboration in workshops.
• Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

3.2.6. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

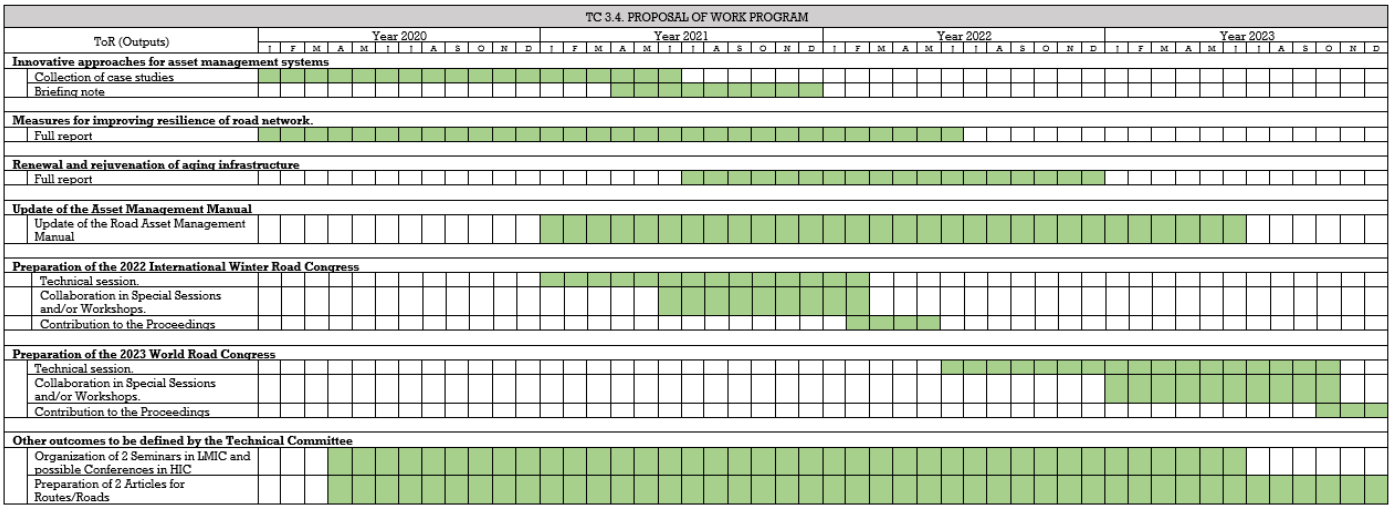
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



4.1.1. Recycled road pavements

Strategies / Objectives
• General description of state of the art of the existing technologies and new technologies for recycling pavements. • Evaluate the use of these techniques in the world, separating by type of road, traffic flow, type of pavement, type of recycling, etc. taking into account the regulations and whether or not there are incentives. • Identify successful pavement recycling projects. • Encourage coordination with *T.C. 3.4 - Asset management and T.F. 4.1 – Road Design Standards.*

The issue of recycling road pavements has been addressed in earlier cycles. In 2003 PIARC published a report from TC C7/8 on "Pavement Recycling". This report contains guidelines for in-place recycling with cement, emulsion or foamed bitumen and hot mix recycling in a plant. During the 2012-2015 cycle there was another objective on "Recycling and Reuse of Materials for Pavements". However, the report was never finalized and hence not published.

The first part of task 4.1.1 can built on these earlier reports to give a state of the art of existing technologies and to update with new technologies that have emerged during the last decade. In this Literature Review both in-place and in-plant techniques should be addressed, as well as the use of hydraulic (cement and other) or bituminous binders. The recycled materials can be bituminous bound materials, cement concrete, bound and unbound base layers, etc. The purpose is to as comprehensive as possible.

The second output is a Collection of Case Studies. This report should contain a collection of successful implementations from around the world from the techniques discussed in the Literature Review. These case studies can also be non-technical, e.g. how recycling is introduced in a certain country, how to deal with environmental aspects such as the recycling of dangerous substances (tar, asbestos, ...), ...

A Briefing Note could summarize the main findings.

Outputs	Deadlines
• Literature Review	• December 2020
• Collection of Case Studies	• June 2021
• Briefing note	• September 2021

4.1.2. Innovative pavement maintenance and repair strategies

Strategies / Objectives
• Identify innovative pavement maintenance and repair strategies of pavements in motorways, urban roads and rural roads. • Pay attention to innovative mechanization or even robotics. • Encourage coordination with *T.C.3.4 –Asset Management and T.C.2.2 – Accessibility and Mobility in Rural Areas.*

The purpose of this task is to publish a Collection of Case Studies regarding innovative maintenance.

The different pavement "families" should be addressed - asphalt, concrete, ... - as well as different road types. T.C. 2.2 has the task to provide "technical solutions for unpaved roads", which also covers maintenance, so unpaved roads are out of scope for *T.C 4.1*, although a collaboration between the two committees will be carried out however.

Innovation can be on the technical level, such as the use of special/new materials or the use of special techniques. But innovation can also be on the organizational level to answers questions on how to do maintenance on motorways with limited interruption of traffic or in urban areas to reduce hindrance to residents.

Several research programmes (e.g. by CEDR in Europe, Infravation projects, ...) deal with innovative materials to do maintenance/repair, which could be input for this task.

Therefore, a Collection of case studies that let know best practices would be a good approach to this issue. The main findings would be included in a Briefing note.

Outputs	Deadlines
• Collection of case studies	• June 2022
• Briefing note	• September 2022

4.1.3. Road monitoring based on Big Data

Strategies / Objectives
• Investigate the use of Big Data for monitoring the condition of roads • Encourage coordination with *TC 3.4 – Asset Management*

In the last two cycles, two reports on Road Monitoring have been published. The first report (published in 2015) dealt mainly with traditional road monitoring techniques, the second report discusses also technologies in the development and experimental stages. Both reports have (short) chapters on the use of smartphone data and CAN-bus data.

The purpose of Issue 4.1.3 is to give a more comprehensive Literature Review on the use of Big Data in the field of road monitoring and should deal with how data is collected and analyzed, the data quality, what distresses can be measured, etc. The main findings would be included in a Briefing note.

The result of this task could be an input to update the PIARC Asset Management Manual, which is maintained by *T.C 3.4*.

Outputs	Deadlines
• Literature Review	• December 2021
• Briefing note	• March 2022

4.1.4. Measures for improving resilience of pavements

Strategies / Objectives
• Identify materials and construction and maintenance techniques for enhancing resilience of pavements. • Encourage coordination with *T.C.1.4 – Climate Change and Resilience of Road Network T.C. 3.3. Winter Service, T.C.4.3 – Earthworks and T.F.4.1 Road Design Standards.*

This is the main task of the TC which covers the whole strategic theme "Resilient Infrastructure".

T.C E.1 – Adaptation Strategies / Resiliency (SP 2016 2019) of the former cycle has done already some preliminary work on the subject of resilience. They defined resilience as "the ability to repel, prepare for, take into account, absorb, recover from and adapt ever more successfully to actual or potential adverse events, i.e. catastrophes or processes of change with catastrophic outcome which can have human, technical or natural causes". *T.C 1.4* continues this work with a holistic approach to resilience, its PIARC Climate Change Adaptation Framework is also input for this task.

The first part of the Full Report should analyse how this definition of resilience translates to pavements and can cover "adverse events" such as

- climate change and extreme weather conditions
- natural and man-made disasters
- increased traffic or higher axle loads
- …

A second part should identify how to deal with these threats to enhance the resilience of a pavement. This can be done via

- the choice of materials
- road design, cfr. *T.C 4.1*
- construction and/or maintenance techniques
- …

This second part could take the form of a literature review and/or a collection of case studies.

Outputs	Deadlines
• Literature review	• June 2022
• Full report	• December 2022

4.1.5. 9th Symposium on Pavements Surface Characteristics (SURF 2022)

Strategies / Objectives
• Organize in conjunction with a PIARC National Committee and the Secretariat General the 9th Symposium on Pavements Surface Characteristics SURF 2022. • Prepare the technical program for the Symposium.

Every four years the Symposium on Pavements Surface Characteristics, SURF for short, is organised. The former SURF symposiums were organised in:

- 1988: Pennsylvania, USA
- 1992: Berlin, Germany
- 1996: Christchurch, New-Zealand
- 2000: Nantes, France
- 2004: Toronto, Canada
- 2008: Portoroz, Slovenia
- 2012: Norfolk, USA
- 2018: Brisbane, Australia

Traditionally, a road research institute takes the lead in organising the symposium. Some members of the TC will be part of the scientific committee. All members will be involved in the review process of abstracts and/or papers.

Outputs	Deadlines
• Symposium	• Up to September 2022.

4.1.6. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific rad safety issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

4.1.7. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

4.1.8. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

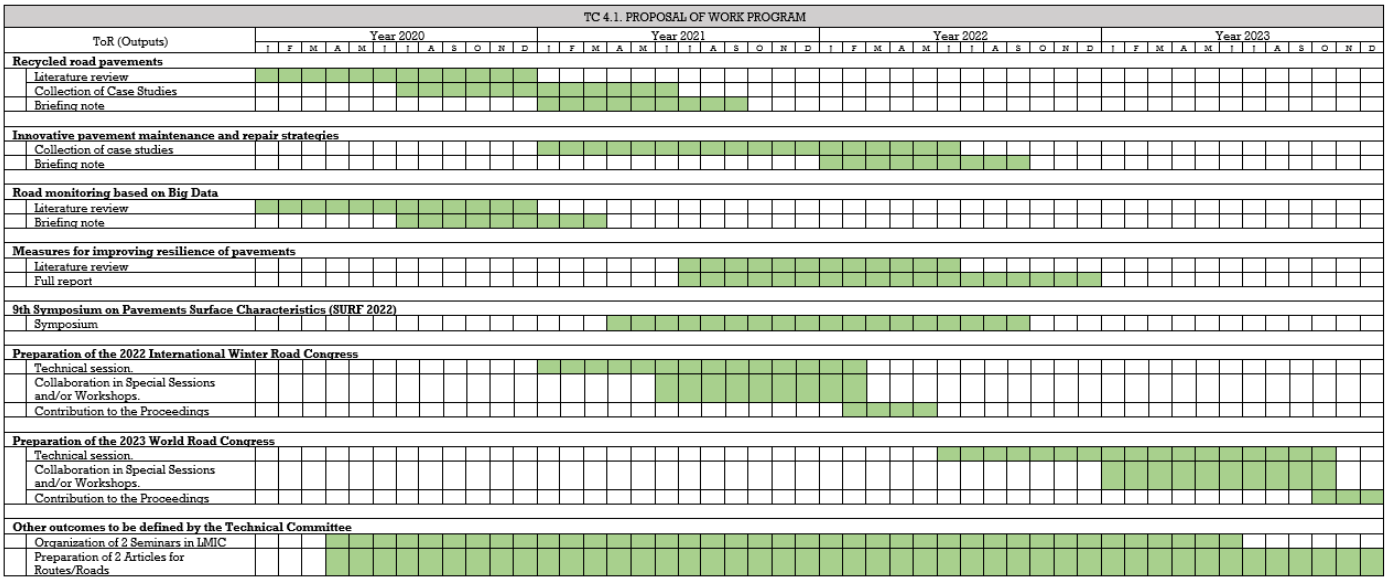
During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program



TECHNICAL COMMITTEE 4.2 – BRIDGES

4.2.1. Measures for increasing resilience to Climate Change

Strategies / Objectives

• Collect case studies of damage resilient measures in different countries to climate change.
• Establish criteria for the design and construction of more resilient bridges.
• Search for innovative solutions to extend the service life of the bridges and rehabilitate them in the most-effective way:
  o Advancement of inspection techniques/technologies and bridge management systems
  o New rehabilitation materials and technologies.
• Encourage coordination with *T.C.1.4 – Climate Change and Resilience of Road Network, T.C. 4.3 – Earthworks* and *T.F.4.1 – Road Design Standards.*

There are already signs of extreme weather in certain parts of the world resulting in events heavy rain, flooding and typhoons. The frequencies of some of these events are also increasing.

In general, there are extreme natural events being experienced in many countries resulting in loss of lives and loss or damage to infrastructure.

Climate change has become a global issue of concern and it is for this reason that PIARC has incorporated it into the strategic themes and technical committee bridges for the terms of 2008-2011 and 2012-2015.

PIARC's International Climate Change Adaptation Framework for Road Infrastructure was produced by PIARC *T.C E.1 - Adaptation Strategies and Resiliency (SP 2016-2019)*. Outputs associated with the issue "Measures for increasing resilience to climate change" will be expected to provide several measures which will be options for road owners within this Framework.

With regard to road bridges, concerns associated with climate change are the extreme day and night air temperatures causing expansion and contraction of bridge superstructures, frequency and intensity of rainfall (causing major flooding), and so on.

Importantly, however, most countries cannot qualify that these events are as a result of climate change. Furthermore, there is very limited information about the effects of climate changes on bridge design and maintenance.

Because of that, it is important first to clear and define the climate change for bridges in order to collect proper information and case studies associated with measures for increasing resilience to climate change.

Based on the above recognition, the scope of this study was first to investigate how the various countries define climate change and policies through literature review and questionnaires, and second to collect case studies with respect to the defined climate change impact, which are applied as measures for increasing resilience to climate change. The main findings would be included in a Briefing note.

Outputs	Deadlines
• Literature review.	• November 2020
• Collection of case studies.	• June 2021
• Briefing note.	• December 2021

4.2.2. Forensic engineering for structural failures

Strategies / Objectives

• Investigate current approaches to forensic engineering in order to Improve safety of the bridges.
  o Identify good practices in managing all data and documentation obtained from failure captures in order to produce actionable information.
  o Review laboratory experimental techniques and computer simulations
• Encourage coordination with *T.C.1.5 – Disaster Management, T.C.3.1 – Road Safety, T.C.3.4 – Asset Management, T.F.3.2 – Road Infrastructure and Transport Security, T.C. 4.3 - Earthworks and T.F. 4.1 – Road Design Standards.*

Despite modern inspection methods and approaches, there are still bridge collapse disasters due to deteriorated materials or systems, construction defects, overloads, and poor design. Recent examples include the collapse of the I-35W Bridge over the Mississippi River in Minnesota as well as the Genova Bridge in Italy.

When a bridge collapse occurs, engineers investigate the cause of collapse to identify how design, materials, workmanship, and/or overloading affected structural performance.

In this meaning, Forensic engineering plays an important role in improving the safety of bridges. Engineers learn from the results of the Forensic engineering investigations and make improvements to the requirements of design, construction and maintenance in order to prevent these tragedies from reoccurring.

Laboratory experimental techniques and computer simulations have become highly developed to analyze material and system failures.

Expert witness testimony is commonplace to determine criminal and civil liabilities. Strategically placed cameras and data recording systems can often capture failures as they occur, greatly reducing the uncertainty of conflicting eyewitness reports.

An understanding of how to best capture all of this data and documentation to produce actionable information would be of value to the bridge engineering community and lead to the improved safety of bridges. Therefore, it is required to investigate the current approaches to forensic engineering in order to improve the safety of bridges and to include the findings in a report.

Outputs	Deadlines
• Full report.	• June 2022

4.2.3. Bridges damage-resilient in seismic areas

Strategies / Objectives
• Evaluate the effectiveness of different retrofit techniques to enhance seismic resilience of highway bridges. • Comparison of different measures to improve the seismic resistance. • Encourage coordination with *T.C.3.4 – Asset Management, T.C.4.3 – Earthworks,* and *T.F.4.1 – Road Design Standards.*

Seismic events caused severe damage on road bridges in seismic areas. It had resulted in closing of road networks.

Bridge damage causes not only bridge repair and restoration, but also produces indirect economic losses due to network disruption as well as traffic delay.

Therefore, it is always desirable to minimize these negative consequences from extreme events and to maximize disaster resilience of highway infrastructures.

Seismic retrofitting of road bridges is one of the most common approaches accepted by bridge owners to enhance system performance during seismic events.

In this relation, this issue evaluates the effectiveness of different retrofit techniques to enhance seismic resilience of highway bridges.

Seismic resilience of bridges can be represented as a combined measure of bridge seismic performance and its recovery after the occurrence of seismic events.

Comparison of different measures to improve the seismic resistance will be a good example for road owners to make decisions. They could be analyzed by a collection of case studies.

Hence, results obtained from this study would be drafted in a report that helps in educated decision-making for selecting efficient and cost-effective seismic design and/or retrofit strategies for highway bridges.

Outputs	Deadlines
• Collection of case studies.	• June 2022
• Full report.	• December 2022

4.2.4. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific rad safety issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

Bridges committee had Bridges sessions in past winter congresses including 2014 Andorra la Vella (Andorra) and 2018 Gdansk, Poland.

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

4.2.5. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

4.2.6. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program

TC 4.2. PROPOSAL OF WORK PROGRAM

ToR (Outputs)	Year 2020												Year 2021												Year 2022												Year 2023											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Measures for increasing resilience to climate change																																																
Literature review.	■	■	■	■	■	■	■	■	■	■	■																																					
Collection of case studies	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																														
Briefing note																■	■	■	■	■	■	■	■	■																								
Forensic engineering for structural failures																																																
Full report.													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																		
Bridges damage-resilient in seismic areas																																																
Collection of case studies.													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																		
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Preparation of the 2022 International Winter Road Congress																																																
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Collaboration in Special Sessions and/or Workshops.																		■	■	■	■	■	■	■	■	■																						
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Collaboration in Special Sessions and/or Workshops.																																					■	■	■	■	■	■	■	■	■	■		
Contribution to the Proceedings																																														■	■	■
Other outcomes to be defined by the Technical Committee																																																
Organization of 2 Seminars in LMIC and possible Conferences in HIC				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
Preparation of 2 Articles for Routes/Roads				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

4.3.1. Measures for increasing resilience of earthworks

Strategies / Objectives
• Identify the main factors and agents of damages earthworks including those due to climate changes. • Identify materials e, design, earthworks techniques for enhancing resilience of earthworks. • Encourage coordination with *T.C.1.4 – Climate Change and Resilience of Road Network, T.C. 2.2 – Accessibility and Mobility in Rural Areas and T.F.4.1 Road Design Standards.*

Resilience is a new term which can explain the adaptation of the road infrastructure to an external event. The infrastructure is considered resilient when, after an extreme and destructive event, its repair makes it possible to return to a sufficient level of use, close to the one preceding the event.

Challenges? Minimize the delays of shut down for axis of transport. Some can be identified as major or critical for mobility. The disorders caused to earthworks are often disorders affecting the entire structure, generally cutting off traffic and mobility on this axis and making dangerous the immediate surroundings.

The damage, caused by a climatic event and / or a natural hazard, are numerous and varied. They range from the complete destruction of the section, to obstruction or degradation of the quality of use by cracking, deformation or rutting.

The natural hazards in question are most often:

- earthquakes,
- landslides,
- rockfalls,
- erosion phenomena,
- storms, tsunamis, hurricanes
- rising water,
- drought, fires,
- collapses of cavities

One frequently cited example of the need for resilient infrastructure is earthquake disasters. An earthquake generates in a few seconds or minutes significant damages and casualties around its epicenter. The material damages evolve shortly after the event, while the number of victims can double or even triple if access to affected areas, are not quickly re-opened to help.

Often linked to the transport infrastructure, the water network, telecommunications and energy networks (electricity, gas) are sorely lacking after an earthquake and networks failures worsen the situation. A health disaster is added to the natural disaster.

(extract RGRA n ° 961, G. Rul) "The floods of June 2016 in the Loiret led to the cutting of the A10 motorway, strategic axis between the center of France and Paris, and to the paralysis of the northern sector of Orléans. That same year, the forest fire near Marseille requiring the closure of the highway had repercussions on all transport networks. Finally, the landslide of Chambon in 2015 caused the closure of the tunnel on the RD1091, the isolation of the population and the paralysis of a whole valley. "

The 5th generation road will have to be thought as resilient from the moment of its conception. For that, it can be proposed the following:

- Road designers will have the list of hazards that can likely affect sections of roads, and these hazards will be listed from the worse to the less important on each sections of identical issues.
- Stakeholders will have to define the minimum level of use they want to maintain in the event of a hazard, and in the same time, the maximum tolerable delay during which the infrastructure cannot be used, and therefore the delay for its repair.
- The design will assess the economic and social risks associated at the occurrence of the hazard.

The subject of resilience for earthworks is a new subject. Therefore, it requires specific thinking that can first be based on key definitions. A consensus will have to be found around these definitions. The Report drafted by Technical Committee *T.C. D.4 - Rural Roads and Earthworks (SP 2016-2019*) "Management of Earthworks" should be completed by the way.

The return to an optimal or sufficient level of use, strongly depends on identified parts of earthworks i.e.: embankments, natural ground, construction tracks, unpaved roads, fills… The proposal is first to identify the damages that are related to these parts and how they affect the mobility on the road. The following question will be to define the level of use for the stakeholder, and what are the expectations for a return to normal infrastructure.

The level of use will have to be defined from sufficient to guarantee the transport of relief or goods, to extreme mobility in any weather or any type of vehicle. In other words, what is the level expected for resilience? And, what is the place of earthworks in reaching the expected level of resilience for the stakeholder?

This subject is a real opportunity to show that earthworks occupy a significant place in the road. The global level of the infrastructure strongly depends on the relative "good" condition of the earthworks. Previous reports have shown that few countries maintain their earthworks, often for cost reasons.

The *T.C .4.3* may be an ideal place to identify the main damages that affect earthen structures.

Working on specific damages that affect earthworks may suggest their importance in a global scope of road management, and it may lead to a methodology that could increase the client's awareness and point out the main challenges.

From the list of disorders affecting earthworks, it could be interesting to establish a list or a classification of soils or rocks that can be used in earthworks, from the most to the least vulnerable to natural hazards or climate events.

Damages, once they exist, must be repaired to ensure the resilience of an infrastructure. This, whatever the conditions of intervention, which can be difficult or even dangerous. Therefore, to investigate from different case studies could be an approach.

A full report would be drafted based on the case studies collected.

Outputs	Deadlines
• Literature review.	• December 2020
• Collection of case studies.	• June 2021
• Full report.	• December 2021

4.3.2. Techniques and innovation for construction and maintenance of earthworks

Strategies / Objectives
• Identify existing techniques for building and repairing earthworks even in extreme situations: harsh weather, inaccessible sites, technological risks, etc. • Identify maintenance techniques. • Identify innovation, new methods and equipment for the construction, monitoring and maintenance of earthworks (robotics, drones, equipment, GPS, monitoring, BIM, etc.) • Encourage coordination with *T.C. 2.2 – Accessibility and Mobility in Rural Areas, T.C.3.4 – Asset Management, and T.F.4.1 Road Design Standards.*

The techniques of construction in earthworks all around the world may be subjects of differences as well as technical and scientific questions, both for earthmoving companies and for contractors when they are faced with companies from other countries.

These questions have already been raised at European level when it came to writing the European standard for earthworks. Highlighting the differences in international practices and bringing out the specific advantages or disadvantages of each practice is a topic that can be very motivating for TC.4.3 members.

This subject can help to understand the design of earthworks and can reveal the specificities of each country. LMIC could find here a way to valorize their specificities, highlighting the difficulties of their sites, the geology and type of materials, or even the constraints imposed by the administrative rules.

Maintenance and resilience: these are two prospective topics for earthworks companies as well as for stakeholders. Consultation can be conducted in a way that brings out existing maintenance practices, if they exist, and what should be the best practices?

As a new topic, it should be very interesting to discuss about the need of maintenance or not of earthworks? What are the difficulties, the needs, the levels of maintenance that can be thought, the link with the desired resilience?

Maintenance is easily accepted when it is for the benefit of the stakeholder or the user. There is reasons to think about the benefits and costs of maintenance. But maintenance does not mean repair: the separation between the two functions will have to be clarified.

Adaptation is the key word of earthworks companies: it is vital to be able to adapt to all situations and constraints when working soils and rocks. The design is not the only way to find good solutions and the company is a real force of proposal when works begin to be difficult. It brings their technicity and their means, sometimes innovative, that should be highlighted.

Adaptation does not necessarily mean innovation. For that, forward looking should be done within TC.4.3 highlighting the innovations in equipment or practices that companies or experts have developed to improve today's earthwork and what can be expected for the next few years.

Innovation can also be the answers of not well-formalized needs: the *TC.4.3* can be a place to discuss the future prospects of earthworks 2.0.

Innovations are sources of motivation and progress for men, companies and stakeholders. For example, earthworks monitoring is a completely prospective subject. Currently reserved for researchers, monitoring can be a way of information that should help to define the level of performance of the works, or the need of specific maintenance. It can also be a source of information on the state of the structures, the location of a localized damage and its importance, and the triggering of appropriate maintenance or repair operations.

A collection of case studies would be carried out to gathered best practices. And a full report based on those findings would be drafted.

Outputs	Deadlines
• Collection of case studies	• June 2022
• Full report	• December 2022.

4.3.3. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

4.3.4. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organize seminars in two low- or middle-income country. Since it takes about one year to organize a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowledge exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to schedule Conferences / Workshops in High Income Countries, as well as producing Articles for Routes / Roads magazine.

Outputs	Deadlines
• 2 Seminars in LMIC	• Up to June 2023
• Possible Conferences/Workshops in HIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023

Proposal of Work Program

TC 4.3. PROPOSAL OF WORK PROGRAM

ToR (Outputs)	Year 2020												Year 2021												Year 2022												Year 2023											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
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Preparation of 2 Articles for Routes/Roads																																																

4.4.1. Measures for increasing resilience of tunnels

Strategies / Objectives
• Use current experience on management of tunnel in order to develop best practices on design and construction for road tunnel operations. • Establish criteria for the design and construction of more resilient tunnels for road tunnel operations. • Identify resilience measures with regard to risk reduction measures and associated risk management methods. • Encourage coordination with *T.C. 1.4 Climate Change and Resilience of Road Networks, T.C.3.1 – Road Safety, T.C.3.2 – Road Network Operation, , T.C.3.4 – Asset Management, T.C. 4.3 - Earthworks and T.F.2.1 – Road Design Standards.*

In the past cycles the topic of best practices in design and construction has been dealt with in different reports like e.g. "Lay bys and protection against lateral obstacles - Current practices in Europe (2016R16EN)". In these reports the focus was mainly on user safety and associated measures to increase safety.

In this topic the new focus should be on increasing the resiliency of the tunnel system, i.e. measures to increase the availability of the tunnel for users and measures to increase the robustness (construction and operation) of the tunnel.

Past PIARC work on risk assessment and risk management includes reports like e.g. "Risk analysis for road tunnels (2008R02EN)" and "Integrated approach to road tunnel safety (2007R07EN)". For existing tunnels, various countries have investigated the possibility of using risk reduction measures as an alternative to structural measures that are very expensive or technically impossible to implement. These types of measures might be temporarily implemented, provided decisions-makers are able to demonstrate an equivalent level of safety through risk analysis. The risk management methods described in the existing reports will be updated regarding best practices for the identification of alternative risk reduction measures and resilience measures.

The approach would be a literature review and a collection of case studies to gathered best practices. A full report would be drafted including the findings.

Outputs	Deadlines
• Literature review.	• September 2020
• Collection of case studies.	• June 2021
• Full report	• December 2021

4.4.2. Best practices in management (maintenance and traffic operation) in urban and heavy traffic tunnels

Strategies / Objectives
• Identify best practices in management (maintenance and traffic operation), particularly of urban tunnels and tunnels with heavy traffic. • Encourage coordination with *T.C.3.1 – Road Safety, T.C.3.4 – Asset Management,* and *T.C.2.1 – Mobility in Urban Areas.*

Since the major fires that occurred in Alpine tunnels, numerous equipment has been installed in road tunnels. The maintenance of this equipment is increasingly complex and has become an important issue. This is notably the case in urban tunnels or tunnels with heavy traffic where accessing equipment and conducting road works while the tunnel is open to traffic can be particularly challenging. Other important issues in this context are special safety aspects and maybe additional resilience measures which should be taken into account during maintenance work under traffic conditions. Additionally, best practices shall be shared on how reductions of redundant safety equipment could take place in order to reduce the "ever increasing workload" of tunnel operators. In Routes/Roads No.378 first approaches were discussed under the label "LeanTech". Sharing best practices in this field could be beneficial to the whole road tunnel community.

This is the reason why the tunnel committee published various reports dealing with these challenging issues during the past cycles, notably:

- Introduction to the RAMS concept for road tunnel operations (2019R05EN),
- Road tunnel operation: first steps towards a sustainable approach (2017R02EN),
- Best practice for life cycle analysis for tunnel equipment (2016R01EN),
- Recommendations on management of maintenance and technical inspection of road tunnels (2012R12EN) and
- Good Practice for the Operation and Maintenance of road Tunnels (2004/05.13.EN).

In order to summarize, highlight and update the best practices in this context, it is suggested preparing a report dealing with "Best practices in management (maintenance and traffic operation) in urban and heavy traffic tunnels", based on the best practices studied from case studies.

Outputs	Deadlines
• Collection of case studies.	• October 2021
• Full report.	• April 2022

4.4.3. Impact of new propulsion technologies on road tunnel operations and safety

Strategies / Objectives
• Identify the impact of new propulsion technologies on road tunnel operations and safety. • Analyze how to prevent and mitigate the potential consequences of incidents involving alternative fuel vehicles. • Encourage coordination with *T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport, T.F.B.2 – Automated vehicles, T.C.3.1 – Road Safety, T.C.3.2 – Road Network Operation, and T.F. 3.1. Road Infrastructure and Transport Security.*

Regarding New propulsion technologies (NPT), considerable headway has been made in this field in recent years. The experience shows that in a road tunnel context these technologies can have a potentially significant impact on user safety. The objective would be to focus on the impacts of NPT on road tunnel operations (e.g. ventilation) and safety. It should notably discuss the many and varied types of alternative fuels now being explored in the industry. Example technologies include: hydrogen, liquefied natural gas (LNG), compressed natural gas (CNG), biodiesel, ethanol and electric vehicles.

Whilst such vehicles remain a small overall proportion of the vehicle fleet, the combination of impacts of Government policy and technological advances in alternative fuels is expected to accelerate their increase in numbers on the road and in tunnels in coming years. There may also be particular initiatives in certain geographical areas, such as on airport land for example, where much higher proportions of alternatively fuelled vehicles are seen much sooner than on the open road. As a result, the nature of tunnel safety risk (including fire) is expected to change with time and detailed consideration of the risk of significant incidents involving such vehicles is required. This should include the evaluation of incident consequences with particular attention paid to fire characteristics and toxic emissions and their impact on tunnel users, ventilation and on intervention strategies. One main focus shall be on batteries, as future vehicles will increasingly be equipped with large batteries. Batteries, mostly Lithium-ion-type, will be for years the leading technology in new-energy-carrier vehicles. This will be the case regardless of the type of propulsion: for example, hydrogen fuel cell vehicles also require large buffer batteries.

In the strategic cycle 2016 to 2019 a Technology Watch document has been produced on the topic of NPT (Technology Watch: Road tunnel safety implications of alternatively fuelled vehicles, Technical Committee D.5 Road Tunnels (SP 2016-2019), 25.04.2019). Additionally an article in R/R was written summarizing the current state of the art regarding NPT and tunnels (RR378-054).

The objective is to prepare a full report on the topic based on a collection of case studies and the before mentioned Technology Watch document.

Collaboration with ITA-COSUF is planned for this topic.

Outputs	Deadlines
• Joint Workshop with ITA-COSUF	• November 2021
• Collection of Case studies.	• June 2022
• Full Report	• December 2022

4.4.4. Intelligent Transport Systems on tunnels

Strategies / Objectives
• Investigate and define the technological advances in ITS related to a road tunnel environment that can have a significant impact on operation and user safety. • Highlight the main expectations from the tunnel community regarding these systems. • Encourage coordination with and *T.F.2.1 – New mobility and its impact on Road Infrastructure and Transport, TF.B.2 – Automated vehicles, T.C.3.1 – Road Safety, and T.C.3.2 – Road Network Operation*

Regarding Intelligent Transports Systems (ITS), the last few years have seen considerable technological advances in this field. In a road tunnel environment, these systems can have a significant impact on operation and user safety. The objective of this task would be to focus on the impacts of such systems on road tunnel operations and safety.

At first sight, it would appear that the main issues to be discussed within this context are as follows:

- Given the very quick development of ITS on open roads, how can service continuity of such systems be guaranteed in the specific context of road tunnels?
- Are there any obstructions for the development of ITS in current tunnels that should be dealt with?
- What changes do we expect in terms of required safety and traffic management systems in a tunnel: what systems could possibly be deleted (under which conditions) and what new systems do we need (under what conditions)?
- What are the tunnel community's expectations with regard to these ITS: safety distance control, lane departure warning systems (LDWS), heavy vehicle guidance systems, vehicle localization and counting systems, identification of hazardous goods vehicles….
- More generally speaking, how can these ground-breaking systems improve user safety in road tunnels?

Past T.C. Road Tunnel Operations reports dealt with ITS topics in connection with user communication and user behavior (e.g. 2016R06EN). The new evolving topics of Vehicle to Infrastructure communication and new vehicle assistance systems were not covered by these reports. In the strategic cycle 2016 to 2019 a Technology Watch document was produced on the topic of ITS.

The objective is to prepare a full report on the topic based on a collection of ITS technological advances and the before mentioned technology watch document. This report will not focus too much on details regarding ITS-technological issues but will definitively highlight the main expectations from the tunnel community.

Outputs	Deadlines
• Collection of ITS technological advances applicable with a significant impact on operation and user safety in tunnels.	• February 2021
• Full report.	• October 2021

4.4.5. Update of the Tunnels Manual

Strategies / Objectives
• Update the FR and ES versions of the Tunnel Manual. • Update Tunnels Manual incorporating the results of the topics mentioned above. • Take into account works carried out by *T.C.D.5 – Road Tunnel Operations w*ithin Cycle 2016-2019.

The expected target audience for the Online Road Tunnel Manual includes:

- Operators: Manual allows them to quickly find any relevant document they are searching for in a few clicks,
- Countries with little tunnel culture: Manual gives them an overview of the main aspects of road tunnel design, safety, equipment, operation and maintenance, that can allow them to discuss issues with foreign consultants and various stakeholders,
- Tunnels owners and administrations: Manual gives them an overview of road tunnel complexity and links to detailed information,
- The tunnel community in general: Manual is a tool that integrates all the PIARC recommendations with links to detailed information (technical reports, R/R articles, and other relevant websites).

At the end of the cycle 2016 to 2019, the T.C. on Road Tunnel Operations will have produced approximately 45 technical reports plus many R/R articles and special issues. The main added value of the Tunnel Manual is to incorporate and disseminate this information through an electronic document currently published in 10 languages, so as to reach the widest possible audience.

In the future development and update of the Manual (starting from this strategic cycle 2020 to 2023) the main focus will be on the EN, FR and ES versions. Other language versions could be updated under the responsibility of the respective countries.

Outputs	Deadlines
• Update of the Tunnels Manual	• Up to June 2023

4.4.6. Preparation of the 2022 International Winter Congress – Calgary Congress (8th to 12th February 2022)

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the specific tunnel issues related to winter service. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2022 International Calgary Congress will gather winter service experts from all over the world. Its objective will be share knowledge and exchange ideas on the latest development and challenges that winter road services are facing. This T.C. is expected to prepare a Technical Session Conference Session called. In addition, it would be appreciated to collaborate in Foresight Session and/or Workshops, as well as contribute to the Proceedings.

Outputs	Deadlines
• Technical Session	• IWRC 2022
• Possible collaboration in Foresight Session and/or Workshops.	• IWRC 2022
• Contribution to the Proceedings	• May 2022

4.4.7. Preparation of the 2nd International Conference of Tunnels

Strategies / Objectives
• Define topics of interest to the road tunnel sector and develop an appropriate technical programme, including: o PIARC works carried out on those topics o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Contribution to the Proceedings

The previous international conference in Lyon (October 2018) was a very successful event.

Outputs	Deadlines
• Technical Programme	• October 2022.
• Contribution to the Proceedings	• January 2023.

4.4.8. Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023.
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023.
• Contribution to the Proceedings	• December 2023.

4.4.9. Other outputs to be defined by the Technical Committee

Strategies / Objectives
• Disseminate and share knowledge. • Encourage networking.

During the four-year cycle, the TC has to organise seminars in two low- or middle-income country. Since it takes about one year to organise a seminar, they are usually scheduled during the two middle years - i.c. 2021 and 2022 - of the cycle. A seminar should be 3 days and can be part of, or be appended to a regional congress.

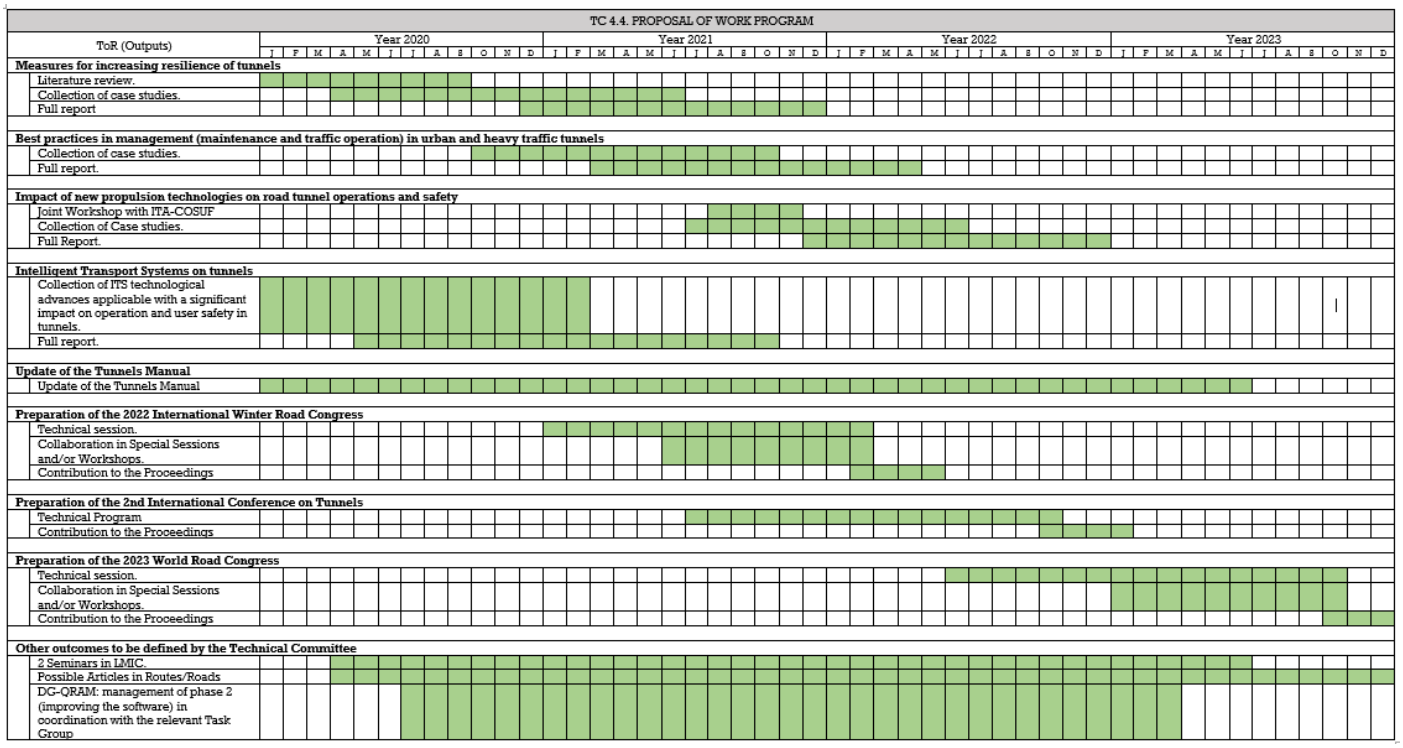
The purpose of a seminar is to exchange knowledge between members of the TC and the host country. This knowlegde exchange can add to the content of the reports of the objectives of the TC.

Furthermore, it would be interesting to produce Articles for Routes / Roads magazine.

Finally, work on DG-QRAM: management of phase 2 (improving the software) in coordination with the relevant Task Group.

Outputs	Deadlines
• 2 Seminar in LMIC	• Up to June 2023
• Possible Articles in Routes/Roads	• Up to December 2023
• DG-QRAM: management of phase 2 (improving the software) in coordination with the relevant Task Group	• Up to March 2023

Proposal of Work Program



TERMINOLOGY COMMITTEE

Updating the World Road Association Dictionary

Strategies / Objectives
• Update and upgrade the existing version of the web-based Road Dictionary in each of the current languages. • Increase the number of languages of translation of the Road Dictionary in liaison with World Road Association member countries. • Improve the management of the web-based Road Dictionary and keep adapted to potential developments of the website of the World Road Association (including the development of an app for the use of the Dictionary on tablets and smartphones if resources are available) • Encourage coordination with Technical Committees of PIARC to analyze new needs an to collect technical words and definitions.

In 1931, the first edition of the "Technical Dictionary of Road Terms" was published in six languages (Danish, English, French, German, Italian, and Spanish). The World Road Association has continued working on terminology ever since. In 2007, the eight edition was released in five languages (English, French, German, Portuguese, and Spanish).

The multilingual terminology database can be accessed on-line for making term searches and searches per theme, and the results can be displayed simultaneously in three languages.

The multilingual Terminology database of the World Road Association comprises the Technical Dictionary of Road Terms, the Lexicon of Road and Traffic Engineering, and a number of specialized dictionaries in the field of roads and road transport.

This database is constantly updated by the PIARC Committee on Terminology, thanks to contributions from all PIARC Technical Committees. This coordination with other Technical Committees of PIARC is a key point for the next Cycle. In order this to be achieved, information should flow between committees. Thus, Committee on Terminology will be able to collect and analyze technical words and definitions, and afterwards, be included in World Road Association Dictionary.

Each line of the Dictionary provides the following information: the term, its definition (or a reference to the main term related to the concept involved), the term's code and its translation into the other languages, always set out in the same order.

This dictionary has been compiled in alphabetical order, as customary in dictionaries or glossaries. At the end of the dictionary a nomenclature with a logical methodical classification is presented, followed by the codes of all terms recorded.

The on-line Road Dictionary is far more comprehensive than the printed version; moreover, it is regularly updated. It offers you to search for one word or part of a word in one language and to obtain the results simultaneously in other languages, including the search language. Grammatical attributes, synonyms and their geographical origins, terminology classification and any illustration shown with the general term are displayed immediately.

The languages available on the Internet since January 2016 are: Arabic, Catalan, Chinese, Croatian, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Hebrew, Hindi, Hungarian, Icelandic, Italian, Japanese, Korean, Latvian, Lithuanian, Maltese, Nepali, Norwegian, Persian, Polish, Portuguese, Romanian, Russian, Serbian, Slovene, Spanish, Swedish, Turkish, Ukrainian, and Vietnamese. However, the input of equivalent terms is improvable because it is still incomplete in most of these languages.

Thanks to the interactivity provided by the Internet, everybody is invited to suggest the addition, amendment or deletion of a term directly on the website. Thus, with the involvement of PIARC's Technical Committees and everyone's contributions, this collective work will become a most valuable tool for both experts and the general public.

A more intensive promotion of the Road Dictionary as a PIARC flagship product would be very important, both within the Association (including for the translation of its technical reports, manuals, other publications and reference documents) and outside it.

Committee on Terminology will focus on promoting the inclusion of specialized glossaries in the reports and manuals developed by the Technical Committees and on the use of these glossaries.

Develop an app for smartphones and tablets, and the possibility of creating and printing personalized lexicons with baskets of words or themes, would be a great improvement for this Committee.

Outputs	Deadlines
• Upgrade and update the web-based Road Dictionary.	• June 2023

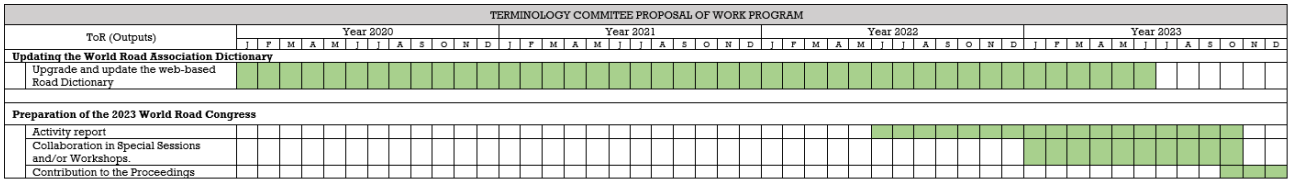
Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, an Activity report will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Activity report	• WRC 2023
• Possible collaboration in Special Session and/or Workshops.	• WRC 2023
• Contribution to the Proceedings	• December 2023

Proposal of Work Program



ROAD STATISTICS COMMITTEE

Road Statistics Data Book

Strategies / Objectives
• Enable an international comparison of road statistics among the countries on the same definition and requirements. • Provide statistical data as well as the outcome of their analysis for road administrations of member countries who conduct quantitative research on and make an objective assessment of actions based on such data analysis when formulating the road policies and measures. • Select international Key Performance Indicators (KPIs) that represent the quality of road and road transport (some important attributes possessed) in each country and can offer enough comparability and consistency with clear definitions. Further, KPIs in wider areas hopefully become the global standard of measurement for road and road transport. • Make a comprehensive, comparative and statistical analysis of data combined with some kinds of primary figures in each member country (population, surface area, GNI,…) • Create a Data Book which will provide members countries with accurate, reliable and extensive dataset accompanied by results from comprehensive, comparative and statistical analyses of data gathered. All data items of this report are clearly defined and internationally comparable. • Allow for possibility of collaboration with the other international roads statistics. • Take into account what is determined and specified in the PIARC Data book of Road and Road Transport (2014-2018). • Encourage coordination with Technical Committees of PIARC to collect and analyze more data of wider technical areas.

The Main objectives of this Committee are to:

- Enable an international comparison of road statistics among the countries on the same definition and requirements, thereby allowing us to accurately gauge maturity of road and road transport of each country, and
- Provide statistical data as well as the outcome of their analysis for road administrations of member countries who conduct quantitative research on and make an objective assessment of actions based on such data analysis when formulating the road policies and measures.

Topics to discuss include:

- Selection and analysis of data items which really suits the needs of the member countries and can offer enough comparability, in addition to those determined and specified in the PIARC Databook of Road and Road Transport (2014-2018),
- Clarification of data definition which is linked with data comparability and consistency, alongside each data source located,
- Comprehensive and comparative analyses of road and road transport data combined with some kinds of primary data in each member country: population, surface area, GNI, etc.,
- Liaison with Technical Committees of PIARC to collect and analyze more data of wider technical areas with valuable information stored in their archives,
- Maintenance and upgrade of outputs in the following working cycles, and
- Possibility of collaboration with the other international road statistics if needed.

In this working cycle (2020-2023), some simple questionnaire surveys will be conducted among member countries to retrieve the data items selected from their road statistics while clarifying each data definition.

Based on the survey results, a report as a databook will be published in the final year of the cycle to provide member countries with accurate, reliable and extensive dataset accompanied by results from comprehensive, comparative and statistical analyses of data garnered. All data of this report is clearly defined and internationally comparable. Nevertheless, some advanced reports could be published during the cycle.

It is expected that the ambitious goal of outputs is to create international Key Performance Indicators (KPIs), which represent the quality of road and road transport (some important attributes possessed) in each country. Such KPIs in wider areas will hopefully become the global standard of measurement for road and road transport.

Outputs	Deadlines
• Upgrade and update the Data Book	• June 2023

Preparation of the 2023 World Road Congress

Strategies / Objectives
• Prepare the technical program for the Congress including: o Summary of the works carried out during the cycle with the highlighted conclusions. o Identification of the following steps for future works. o Definition of additional topics to be proposed in order to be presented as individual speeches. o Evaluation of abstracts and full individual speeches. o Taking into consideration possible contributions from other Technical Committees. • Possible collaboration in Foresight Sessions. • Possible collaboration in workshops. • Contribution to the Proceedings

The 2023 World Road Congress will serve as a forum to share progress achieved over the four-year work cycle. Taking into account the Strategies / Objectives for this topic, a Technical Session will be prepared for the WRC 2023. In addition, it would be appreciated both, possible collaboration in Foresight Session and/or Workshops, and contribution to the Proceedings.

Outputs	Deadlines
• Technical Session	• WRC 2023
• Possible collaboration in Foresight Session and/or Workshops.	• WRC 2023
• Contribution to the Proceedings	• December 2023

Proposal of Work Program