WINTER SERVICE

27 September 2011 (am)

TECHNICAL COMMITTEE B5

INTRODUCTORY REPORT

SUMMARY

The winter road environment is rapidly changing, climate change notwithstanding. Snow, ice, freezing rain, blowing snow, and avalanches continue to severely impact many of the world's roads, regardless of the anticipated changes to the climate. The weather impacts are not going to go away, even if the degree to which they affect roads varies from year to year. So what is the change all about? What is most rapidly changing today is the way in which we operate and maintain our roads. Drivers' expectations, traffic volumes, resource levels, information technology and knowledge of our climate continue to evolve and continue to influence the actions we take to effectively, efficiently and sustainably move people and goods.

A study of winter service management systems (WSMS) and road user information

The development of Road Weather Information Systems (RWIS) and Next Generation RWIS (XRWIS) paved the way for more integrated and complex winter service decision making tools. WSMS and other similar systems use the data utilised by RWIS and the decision making process of XRWIS and combines these with other information sources and technologies such as data logging, national forecast information and Highway Authority protocols to provide treatment recommendations, decisions on when to action, improved information dissemination and post storm reporting facility. These capabilities of WSMS make for an integrated and holistic decision support system, and are currently the most advanced form of support for winter maintenance activities.

The varying rates of technological development amongst the component parts of a WSMS have taken time to establish a common echelon that can facilitate successful implementation. WSMS, MDSS and other decision support systems have emerged as a result of developments in technology, realisation of potential for improvement and integration and experience in deployment of component systems. WSMS is the current worldwide best practice and is at the forefront of decision support for winter maintenance.

Communication with road users

The technical report has been elaborated to bring an overview of current practices in informing road users on road maintenance and specifically winter service at road networks in several countries. The aim of the report is to show the state-of-the-art of solutions used so far and to bring at least some applicable solutions which could be designated as best practices for future inspiration.
The report does not focus only on findings informing road users on general road maintenance proceeds but it deals also with the specific information distributed on winter service. Moreover, the report does not consider only the car drivers, but also other road users, such as cyclists, pedestrians and motorcyclists.
The questionnaire was structured into nine subtopics in order to get a description of specific aspects in the topic, such as use of different platforms for communication with road users on changeable traffic / weather conditions – ITS devices in vehicles, road-side systems, broadcasting of information and other elements contained in the wide topic.

Sustainable development and road winter service

A review of the main social, environmental and economic criteria taken into account within the winter road maintenance strategies and operation. It will also give some perspectives towards the development of a dedicated evaluation method in which sustainable parameters relevant to winter services are integrated.

Identify impacts of climate change on winter service and road infrastructure

It is necessary to work on the general tendencies that one perceives for the great climatic entities and to down scale the climate models to better understand the local operational impacts on winter service. It is also necessary to carry out an analysis of risks which will make it possible to propose tracks to define levels of service.

Snow and Ice Control Data Book – Edition 2010

Available and safe roads during the winter – demographic and climatic constraints – costs and benefits regarding safety, mobility, environment – human, material, equipment means – private partnership – decision support systems: these are the main parameters of today's "winter road maintenance equation". All included in the data book but each country uses its own set of methods to reach the goal.

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1 Outcome of the work of the Committee

The challenges of the today's winter road service are the focus of TC B5's work resulting in the following reports on the State-of-the-Art.

1.1 A study of winter service management systems (WSMS) and road user information

Advancements in information/communication/remote sensing technologies combined with greater understanding of weather at the road surface have allowed winter service operations to become more advanced. The technology revolution has produced Intelligent Transportation System (ITS), global position system (GPS), automatic vehicle location (AVL), data acquisition directly from vehicles and personal communication options which are revolutionizing the way transportation agencies provide winter service and information to users. Road Weather Information Systems (RWIS) and advanced road weather models allow for the forecast of future road conditions and the development of Winter Service Maintenance Systems.

Winter Service Maintenance Systems (WSMS) are a developing technology currently implemented in some countries with marginal and cold winter weather climates. Numerous alternative systems can be utilised for aiding management of winter maintenance. Without an integrated holistic system such as WSMS, the use of disparate systems carries risk of data duplication, repetitive administration and consequential inefficiencies.

WSMS provide a central system, unifying the individual winter maintenance systems and offering the advantages of time and cost savings through simplification of data and decision making, and subsequently improving efficiency and effectiveness of winter maintenance.

Case studies from international Highways Authorities have provided an insight into some examples of best practice from countries including, Denmark, Japan, Lithuania, Sweden, Switzerland, Finland, and the U.S.A. These examples of best practice provide learning experiences to any Highway Authorities wanting to develop and implement a decision support system.

A literature review has identified amongst the case studies, varying types of WSMS utilised throughout the world, these varying between strategic and operational levels of winter maintenance and varying degrees of technicality and implementation. These differences exist due to the requirements of Highway Authorities dependent on the climate of their respective countries. WSMS is certainly not a one-fits-all system and different methods of procurement, either developed independently or bought 'off the shelf', are selected based on these identified needs and performance requirements.

This report informs on many systems available to Highway Authorities to aid in their duty of maintaining a serviceable road network. None, however, match the advanced and technically robust WSMS and systems of the same ilk. For countries requiring or aiming to achieve advancements in performance in routine winter maintenance, the next step forward and at the forefront of modern technology is WSMS.

The report includes the following chapters with case studies:

- introducing winter service management systems (WSMS)
- getting started: developing and implementing a WSMS
- sharing the data: WSMS and other management systems
- on the road: vehicle data collection
- taking it further: forecasting and modelling in WSMS
- getting the benefits: commercial and operational considerations

1.2 Sustainable development and road winter service

This effort consisted of two objectives, to: review the main social, environmental and economic aspects required to achieve 'sustainability' in winter maintenance, and review some relevant Sustainable Development assessment methods for the winter service.

Sustainable development is "universally" defined as follows: *Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs*[1]. Sustainable development is therefore looking for a continuous and dynamic equilibrium between a competitive economy, a social solidarity and an environmental protection, the so called "3 pillars" or "3 dimensions" which interface strongly with each other.

[1] World Commission on Environment and Development (1987). Brundtland report "Our common future".

The technical committee B5 decided to give special attention to such an objective because on one side, this concept is “in vogue,” getting more weight in public and private enterprises and institutions, and on the other side, because of the expectation that the different actors, directly or indirectly concerned by the winter service activities, could highly benefit from a global and multi criteria approach such as the one considered here.

The consequent objective of the committee was therefore to analyse how that concept can be translated concretely to the winter service activities.

The TC.B5 session will review the main social, environmental and economic criteria taken into account within the winter road maintenance strategies and operation. It will also give some perspectives towards the development of a dedicated evaluation method in which sustainable parameters relevant to winter services are integrated.

The report includes the following parts:

- Introduction, presentation of objectives, steps and methodology
- Analyse theoretical and practical elements for the development of a decision support methodology for winter service, integrating the elements of sustainable development
- Propose a basis for the future development of a dedicated methodology by defining sustainable objectives, indicators (or criteria) and parameters relevant to winter service activities
- Perspectives and future work
- Conclusion

1.3 Identify impacts of climate change on winter service and road infrastructure

The following topics will be covered:

- Climate change:
    - Observations in countries around the world
    - Forecasts (days of snow, snow cover, days below and across 0°C
    - Expected impacts on winter maintenance (short term, long term)
- Impacts on winter maintenance:
    - Literature review
    - Impacts on de-icers consumption and use
    - Impacts on manpower (training, renewal)
    - Impacts on costs (investments, repairs, maintenance policies, contracts)
    - Specific case of urban areas, remote areas
- Impacts on infrastructures:
    - Literature review
    - Freeze/thaw cycles. Frost dimensioning
    - Extreme climatic parameters (temperatures, wind, avalanches)
    - Longer construction season. Materials characteristics
    - Environmental compliance of the infrastructure
    - Conventional and routine maintenance- sewage systems
- Conclusion

There are already thoughts and actions pertaining to climatic drift within PIARC and in many other organizations or working groups. Models have been developed on both global and more reduced scales (IPCC), and the first work of analysis of the existing studies is to assess this modelling work.

The general principle of the study is:

- To know the current climatic conditions starting from the identification and of the quantification of the winter phenomena in various climatic zones.
- To know the type of winter service generated in these zones because of these climatic conditions.
- To have one (or more) model of climatic evolution sufficiently fine so that the winter phenomena perceptible are identified and quantified or to make relevant assumptions on the evolution of the winter phenomena deduced from this or these models.
- To deduce from these evolutions of the winter phenomena the evolution of the practices of winter service.

It is necessary to work on the general tendencies that one perceives for the great climatic entities and down scale them to more reduced areas that relate to winter service operations. It is also necessary to carry out an analysis of risks which will make it possible to propose tracks to define levels of service.

Other work conducted under this effort includes the following:

- Conducting a literature review of on the impacts of the climatic changes on the Winter Service.
- Illustrating the relation of the impacts of the climatic changes on the Winter Service.
- Identifying certain important parameters of the climatic changes (temperature, precipitation, etc.).
- Dividing into areas with similar climate.
- Identifying, for each geographical area, the tendencies of the climatic parameters.
- Deducing a level from probability for each impact in each geographical surface, and
- Making an analysis of the consequences of the climate change for each area on resources (cost, organization, road infrastructure, etc).

1.4 Communication with road users

Purpose: Identify innovative approaches to inform and influence road users about road condition, winter operations and safe winter driving.
Working Group B5.4 "Communication with road users" has prepared a questionnaire and sent it to members of TC B5. The idea was to compile an overview of different practices that captures how road administrations provide information of winter road and traffic conditions to regular road users and how the communication with travellers has been arranged. The questionnaire included 9 subtopics. Attention is focused to a highway user and not so much to an urban traveller. 24 filled questionnaires have been returned.

The subtopics follow:

1. Informing road users about the winter road and traffic conditions through mass media
2. Usage of on-road-installed devices for informing road users about changeable road/traffic conditions
3. Informing road users about changeable road/traffic conditions by devices installed into vehicle
4. Individual inquiries of road user in order to get information about winter road/traffic conditions
5. Feedback from road users concerning road/traffic conditions
6. Communication with road users during extraordinary winter road conditions
7. Road/traffic information aimed for winter pedestrians, cyclist, motorcyclists and motorists of ATV
8. Education of drivers and travellers to be active in inquiring of driving condition information
9. Interpretation of road/traffic information for foreigners

Subtopic 1 covers which organization that is responsible for collection of the traffic data and dissemination of the data to road users. Furthermore, the channels by which the information about road and traffic conditions reaches the road users are described where Radio, TV and websites are common examples. All participating countries work with informing the road users and their answers to this questionnaire show that informing road users is one important task for each of the agencies. However, how the road user finds the accurate traffic information and how the road agency can guide their road user to get hold of the right information is a less discussed area with potential for improvement.

Teach your road user how to find the accurate traffic information
Thanks to the rapid development of traffic information systems and road weather information systems, road managers and service providers collect data that could assist road users. A task to be solved is how to make this information available to road users in a convenient way. A traveller should be taught how to acquire the prior information about the road and traffic conditions from a special website or from a Traffic Centre.

Today, the road user can get hold of changeable traffic conditions by devices installed into the vehicle which is something that almost all countries offer. What kind of information that is spread to the road user will be described in this chapter as well as which media that is most common for disseminate the information. The development of new technique and devices is rapidly occurring, which will provide new opportunities for information by devices which make this chapter to an interesting area.

Devices that send electronic messages are seen as more reliable than information from Traffic Centres. Sometimes during extreme road or weather conditions Traffic Centres are too busy for two-way communication and therefore sending electronic messages is more reliable. Therefore, for example, the RDM-TMC will probably become even more popular.

A website that provides the road user with the actual winter road condition is today a matter of course among all countries. However, the possibility of sending warning SMS by mobile phone is less common among the countries. This chapter describe the ordinary way of provide traffic information to road user through Web site and by telephone. Almost all of the countries that answered the question have a Public telephone number to Road/Traffic Information Centre.

Use the same Web site and telephone number for traffic information in all countries
All of the countries do have a Web site and a telephone number where the road user can get information today. One of the issues is that these Web sites and phone numbers often are long and complicated which makes them hard to remember. A recommendation is therefore to use short and memorable names for the sites and numbers such as 0200-2100 in Finland, 1510 in Estonia, 175 in Norway etc. A further recommendation is to strive for the having the same telephone number and Web sites in every country such as USA 511.

The feedback from road users concerning road-traffic conditions should be done by the most simple and effective way so that purpose of identified problems to be corrected quickly. In this sense, different countries use common methods such as road enquires, telephone enquiries, internet, booklets – questionnaires from service provider, and others.

The following findings were documented under this effort:

- Communication with road users during extraordinary winter conditions (snowstorm, ice rain, bad visibility, etc) in order to close or control entry of travellers into zone of winter emergency is done through: Police control and web, radio warnings, VMS, RDS-TMC, TV and SMS.
- Some countries/states warn bus companies and transport associations about adverse road conditions in order to avoid entry of heavy vehicles into winter traffic.
- Web sites are the most common way to inform them, followed by SMS and radio announcements.
- General information on walking and cycling conditions should be distributed, as this heavily influences users´ decisions for mode of transport.
- As the examples of national practices show, providing information on winter road service is not important only for car drivers, but also for vulnerable road users which use the same infrastructure into a large extent.
- Education of drivers and travellers to be active in inquiring of driving condition information had only four countries.
- No country has a mandatory program for new drivers for accessing road information, however in some countries, it is mandatory for people to take a winter driving training program to grant of drivers' licenses. Optional winter driving training programs are also available in various countries.
- More and more foreigners make their journeys in nation states, where they cannot understand the essential text on traffic boards which are exposed only in local language.
- In border crossings there is predominantly insufficient information for foreign travellers - no traffic centre number, no radio channel frequency, no traffic website address, no translation of text signs.

- Public road agencies should provide translation of essential roadside information, especially in border crossings, into widespread language in order to make them better understandable for foreigners.
- Cooperation between the neighbouring countries or states with intent to make the road information available along the through traffic route helps travellers to plan the trip and react in proper time.

1.5 Snow and Ice Control Data book – Edition 2010

Origins, Objectives and Methodology

A new updated Snow and Ice Data Book (3rd edition) was prepared for the XIIIth International Winter Road Congress, 2010 in Québec, Canada with 27 technical contributions. On the website a 28th is added.
Considering the usefulness of the first and second issue to support the exchanges of experiences between international experts in different countries, the PIARC Executive and the Winter Committee decided to pursue this initiative and stated that future efforts should be directed at documenting practices in additional countries.

The update includes:

Assessment of the Snow and Ice Control Measures

The cost and benefit of winter road maintenance activities is given prominence in the data book with summaries provided of measures introduced in recent years to minimise the use of de-icing materials. These include the measurement of efficiency both on an internal and external basis, and the use of performance indicators.

Traffic Safety and Road Users Information

A majority of countries highlighted the importance of sharing of information about road conditions with drivers, traffic information centres and various media organizations. Traffic (information) centres which operate 24 hours a day have been set up in a number of countries. They disseminate real time information to road users by various means including radio, websites and Variable Message Signs (VMS). VMS are used to give a range of information including in many cases road and air temperatures, road closures and recommended diversion routes, wind speed, weather forecasts and general road conditions. Reduced speed limits come into operation in some countries if the road is slippery or snow I present.

On-going Research and Studies

The reports illustrate that the latest technologies to continuously optimize winter maintenance operations are being tested by many countries by either improving the performance of the machinery or by developing the on-board equipment for vehicles involved in snow and ice control (integration of new technologies) but also through research into new spreading methods. Other major research involves the modernization and the improvement of the Road Weather Information Systems and pilot projects related to skid resistance measurement, road surface assessment, residual salt modelling and winter traffic problems.

Some administrations are exploring the idea of refocusing their role in the winter road maintenance process. For example, public-private partnerships are being considered as an alternative. Other countries which already contract with private companies to manage their road maintenance are developing their supervision and assessment methods.

1.6 Sharing Knowledge

1.6.1 Main conclusions from the PIARC XIIIth International Winter Road Congress 2010. Technical Programme Overview

135 accepted papers, most of them for oral presentations and others for poster sessions were accepted. Oral presenters were also given the opportunity to have a poster presentation to allow for deeper discussions. More than half of the oral presenters also wanted to take part in the poster session.

Topic 1 Winter Service Planning, Management and Implementation
6 sessions

- Overview of National Strategies and Policies (2 sessions)
- Winter Maintenance Managements Methods (2 sessions)
- Interaction Between Road Users and Agencies
- Challenges of Contracting

Topic 2 Safety and Mobility in Winter: Social, Environmental and Economic Aspects
4 sessions

- Accident and Traffic Flow Analyses
- Optimized Driver Information for Better Road Safety
- Special Traffic Problems and Solutions in Wintertime
- Sustainable Winter Maintenance in Road Tunnels

Topic 3 Winter Service Information Systems
6 sessions

- Monitoring and Observing Weather & Road Conditions
- Forecasting Weather & Road Conditions
- Decision Support Systems (2 sessions)
- Vehicle-based Technologies (2 sessions)

Topic 4 Snow and Ice Control Techniques and Technologies
7 sessions

- Innovative Techniques for Snow Removal (2 sessions)
- The Environment and Snow Control
- Techniques for the Application of De-icing Chemicals
- Measurement of Pavement Surface Condition
- Analysis of the Spread Rate of Chemical De-icers
- Prevention of Dealing with Snow/Ice

Topic 5 Winter Service and Sustainable Transportation
4 sessions

- Salt and the Road Right-of-Way
- Alternatives to Salt & Salt Quality
- Salt, Snow – Sustainable Options
- History of Maintenance in Various Countries

Topic 6 Winter Service and Climate Change Impacts
1 session

Some new aspects from previous years and reported in the Winter Road Congress 2010 will be highlighted. Some are quite new while others build on earlier results.

News since XII International Winter Road Congress.
The winter road environment is rapidly changing, climate change notwithstanding. Snow, ice, freezing rain, blowing snow, and avalanches continue to severely impact many of the world's roads, regardless of the anticipated changes to the climate. The weather impacts are not going to go away, even if the degree to which they affect roads varies from year to year. So what is the change all about? What is most rapidly changing today is the way in which we operate and maintain our roads. Drivers' expectations, traffic volumes, resource levels, information technology and knowledge of our climate continue to evolve and continue to influence the actions we take to effectively, efficiently and sustainably move people and goods.

At the Winter Road Congress in 2006, we learned about many technical, mechanical and institutional advancements in winter maintenance. In 2010 we had the opportunity to learn about all that has been achieved since then. To begin with, we could see how expanding a focus from winter maintenance to winter service reaps efficiencies through integration and information sharing. Likewise, we discovered the challenges and opportunities that were introduced when we extended the time horizon to consider how today's activities will impact the next generation. This sustainable perspective – considering long-term social, economic and environmental consequences – ensures that our efforts to meet our needs today will not impede others from meeting their needs in the future.

Summaries of select papers presented at the 2010 Congress represent a slice of the many exciting and intriguing topics to be covered. For example, we learned about efforts in Finland to incorporate customer needs into the planning process, as well as French efforts to explore ways to increase competition between contractors and to decrease contract costs. We explored the social, environmental and economic aspects of winter services, including the importance of winter maintenance for cyclists, and the use of advanced communications to address visibility hazards during heavy snowfall. Expanding on technology, specifically with respect to winter service information systems, we learned about efforts in the U.S. to improve road weather information products using vehicle probe data, as well efforts in Japan to use real-time positioning information of snow removal machinery to improve operations.

With respect to more traditional winter maintenance challenges, the Congress included an examination of the distribution of spreading agents on the road surface and an assessment of skid resistance of porous asphalt pavement under winter conditions. While at the same time, there was exciting papers about sustainability, such as more thorough studies of the impact of de-icing salts on the environment. And the link between climate change and winter service is explored in multiple studies that examine regional climate models on the road network and how to incorporate the anticipated changes into winter services.

Road users' demands for consistent, high quality level of service, matched with reductions in resources and a need to reduce our environmental footprint means that we must change. Sharing our successes ensures that we evolve in a coordinated manner. And sharing our experiences, both bad and good, helps each of us make the best decisions possible about what to implement next. The 2010 Winter Road Congress proved to be an invaluable opportunity for all to advance the state-of-the-practice and to raise awareness about these successful solutions.

In spite of the numerous demands on attendees' time; technical tours, visits, equipment displays etc. available to Congress attendees, the technical sessions were very well attended. It can be concluded that there is no single combination of winter road maintenance approaches suitable universally for all countries. There are simply too many climatic, societal, economic, and other environmental considerations. However, sharing knowledge and learning from each other certainly can lead to significant savings in time and precious resources.

Based on the experiences, the International Winter Road Congresses continue to be premier world forums for the international exchange of information. A final sincere wish; that to facilitate technology transfer, road administrations and their service providers employ, wherever possible, open systems design principles. In closing, we hope that the Congress continues to bring us all a little closer to achieving the Congress' main them 'keeping road users on the move in winter'.

1.6.2 International snowplough championships

In the framework of the XIIIth International PIARC Winter Road Congress, the first international snowplough championships took place in Quebec in 2010. The organization of this event was managed by the Ministry for Transport of Quebec, with the assistance of the Technical Committee B5.
The objective of this friendly competition was to evaluate the ability of the truck drivers from around the world to clear snow through a course set up for this occasion.

More generally the idea was:

- To develop a feeling of membership and recognition of the drivers of snowploughs relative with their trade.
- To allow the snowplough operators-plough to exchange and discover the working methods and the procedures in the other countries.
- To sensitize the Congress attendees and the exhibitors with the work of the truck drivers to clear snow.
- To develop skills for precise, fast and sedentary control.

Twenty snowplough drivers come from seven countries, including Americans, Swedes, Andorrans, French, Moroccans, Koreans and Canadians.

Given the success of this competition it was decided to organize a test within the framework of the XIVth Congress in Andorra.

1.6.3 Report from a Seminar in Hrádec Kralové, Czech Republic

Seminar Theme:
International Seminar on Technical Solution for Sustainable Winter Service

The international seminar was held in Hrádec Kralové, Czech Republic on October 7 - 9, 2009. The seminar was planned as a regional event in cooperation with PIARC TC B5 – Winter Service, Ministry of Transport of the Czech Republic, Road and Motorway Directorate of the Czech Republic. The neighbouring countries were especially invited as lecturer and listener.

Seminar Topics:

- Experiences from winter maintenance
- Technology, materials and mechanization in winter maintenance
- Research and new technical solutions in winter maintenance

Seminar objective:
The Seminar was intended as a European event, focused on winter service in European countries, mainly neighbouring countries to the Czech Republic.

Increasing demand and struggling constraints for the winter service: traffic growth/no economical disruption/limited environmental impact/provide safe road conditions/minimum operation costs

Exchange knowledge on technical issues and improve our practices

A global approach is needed: A Sustainable Winter Service

1.6.4 Report from a Seminar in Ulan Bator, Mongolia

Seminar Theme:
Management of Winter Service in an Extreme Continental Climate Country

The international seminar will be held in Ulan Bator, Mongolia on April 6 - 8, 2011. The seminar is planned as a regional event in cooperation with PIARC TC B5 – Winter Service, Ministry of Road, Transportation, Construction and Urban Development of Mongolia and Department of Roads, Mongolian Government Implementing Agency. The neighbouring countries were especially invited as lecturer and listener.

Seminar Topics:

- Level of service for winter maintenance,
- Weather forecast and information to road users
- Solutions for Snow drift
- Winter maintenance on gravel roads (snow removal, sand)
- Grain size (salt, sand) Heated sand;
- Heavy traffic management when snowy;
- Equipment vehicles (chains, studs)...

Seminar objective:
The Seminar was intended as an event, focused on winter service in extreme continental climate, mainly neighbouring countries to Mongolia

2 Recommendations for future R&D areas

Many areas deserve attention in the future. Both in the areas listed above under the title news and in areas where development has continued for many years already but also in quite new areas. Stimulating topics for the TC are listed below:

Defining and harmonization levels of service under budget constraints (include also the aspect of acceptability by the public)

Sustainability and climate change consideration in winter operation (taking into consideration increased variability in weather conditions including uncertainty regarding the occurrence and magnitude of harsh winter conditions)

Advanced technology for data collection and information to users and operators, with particular focus on vehicle-based technology

Preparation of the 2014 Winter Road Congress in Andorra

BIBLIOGRAPICAL REFERENCES

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DRAFT CONCLUSIONS

The principle goal of winter service providers and road network operators, globally, is to provide a safe, useable road network with reliable travel conditions. WSMS and other systems such as the case studies of Salt Lake City and Finland's ITS and the Swedish Winter Model are technologies that aim to help operators and service providers to achieve this goal. These systems rely upon their constituent elements which utilise data from sources including GPS, AVL, RWIS forecasting, intelligent infrastructure, traffic management and administrative systems, collecting this information and integrating it into meaningful data-sets to be used within these management systems.

The current situation facing Highway Authorities related to winter maintenance is an amalgamation of independent factors, combining to cause potential severe problems for the Authorities, for maintenance crews, for business and the public. Pressure on the Authorities and maintenance crews will come from increased traffic density and shifting social demographics, more stringent environmental legislation and, not insignificantly, the changing climate conditions of the present and the future. In response to changing demands and increased pressure, Highway Authorities need a response. A way in which to legislate for these future changes is to utilise the rapid development seen in IT-Systems, and to embrace the opportunities that this can present. WSMS is currently the most advanced ITS based system available to Highway Authorities that can be deployed in the fight to maintain and improve highway serviceability and road safety.

The case studies have highlighted the advances in technology and summarised the benefits that can be achieved. In the development and implementation of any future WSMS system, the Highway Authority in question should look to the examples of best practice that these provide and also the lessons to be learnt from them. With this combination of other Highway Authorities experiences, a very objective and ultimately more effective system development and implementation can hope to be achieved.

The benefits that can be realised through development and implementation of a WSMS system include cost savings and increased efficiency and effectiveness resulting in a higher level of serviceability and increased safety. Each system can provide some of these benefits. Other systems and less holistic solutions such as the XRWIS are available, which have resulted in the development of more holistic and technologically advanced systems. However, for maximum benefits to a Highways Authority and maintenance crews the pre-eminent solution is in a fully implemented, tactical decision enabling WSMS.

WSMS are available in a range of forms and operate on two distinguished levels, of operations and strategy. The strategic level takes into account the socioeconomics of a particular strategy, whilst tactical level WSMS are used for the operational management of maintenance activities. Both provide support that maintenance crews can benefit from, and consist of varying levels of complexity and integration. This ultimately affecting their ability to save money, lives and labour: whilst being assessed on their impact to winter maintenance, road users, road management and socioeconomic costs.

The component parts of WSMS define the system, in terms of its functionality and performance. Of these component parts the RWIS weather data input for observational data and forecasts is currently the most important component that offers the most value to the system. This is due to the effect that accurate forecasts can have on the effectiveness of treatments for winter maintenance.

Although RWIS and other weather input data will continue to have a high importance to WSMS there are other components such as mobile data collection and administrative systems within WSMS that are of increasing importance, and increasing more so than RWIS. The developments in technology and in communication systems now can provide WSMS with ways to increase efficiencies and effectiveness way beyond that which has previously been possible. Again international examples of best practice can be called upon in development of similar systems, such as the Danish GPS Controlled Spreading System.

Cost savings and benefits in efficiency and effectiveness that WSMS provide are of such value that a similar decision enabling winter maintenance support system is an operating level of which any Highway Authority, particularly in marginal and cold winter climates, would be well advised to seek the benefits. Increased efficiency can create cost savings. More effective treatments can save lives. And the combined effectiveness and efficiency can sustain a higher level of serviceability, with minimal effects to the environment.

The topic, communication with road users, is equally important as all the practical measures on road networks, as impact of good information is tremendous in the sense of right decision-making of road users, prevention of traffic accidents and activities of transport operators.

The technical report has been elaborated to bring an overview of current practices in informing road users on road maintenance and specifically winter service at road networks in several countries. The aim of the report is to show the state-of-the-art of solutions used so far and to bring at least some applicable solutions which could be designated as best practices for future inspiration. The report does not focus only on findings informing road users on general road maintenance proceeds but it deals also with the specific information distributed on winter service. Moreover, the report does not consider only the car drivers, but also other road users, such as cyclists, pedestrians and motorcyclists.

In two thirds of the countries the State road agency is responsible for collecting data and only one third of the countries use their maintenance service provider for data collection. Is it possible that the maintenance service provider is responsible for collecting data to a higher extent? That would probably be more effective for all actors since the service provider get information from road users. Furthermore if the service provider communicates the traffic information direct to the road user instead of first reporting to the road agency the chain of information would be shorten.

Teach your road user how to find the accurate traffic information. Thanks to the rapid development of traffic information systems and road weather information systems, road managers and service providers collect data that could assist road users. A task to be solved is how to make this information available to road users in a convenient way. A traveller should be taught how to acquire the prior information about the road and traffic conditions from a special website or from a Traffic Centre.
Devices that send electronic messages are seemed as more reliable than information from Traffic Centres. Sometimes during extreme road or weather conditions Traffic Centres are too busy for two-way communication and therefore sending electronic messages is more reliable. Therefore will for example the RDM-TMC probably become even more popular.

As a future study it would be interesting to get to know which kind of information about winter traffic condition the road user value the most. Furthermore a study from the road user's perspective would be interesting where the questions can be based upon which devices the road user prefer to use and why.

Use the same Web site and telephone number for traffic information in all countries. All of the countries do have a Web site and a telephone number where the road user can get information today. One of the issues is that these Web sites and phone numbers often are long and complicated which make them hard to remember. A recommendation is therefore to use short and memorably names for the sites and numbers such as 0200-2100 in Finland, 1510 in Estonia, 175 in Norway etc. A further recommendation is to strive for the having the same telephone number and Web sites in every country such as USA 511.

Input from road users via phone and email is valuable and has to reach the decision makers. Complaints from road users should reach the decision makers without deformation. Therefore recommended telephone numbers, e-mail and Web site addresses should be promoted, especially in countries where winter road maintenance is carried out by contractors.

Start using SMS for texting out accurate traffic information **-** Recommendations to all countries to start offer the application for sending out SMS by mobile phone describing the winter road condition. All road agencies have the collected data and the technique is already out there. Furthermore these applications are already used by some countries so implement this best practice in all countries.
More and more foreigners make their journeys in nation states, where they cannot understand the essential text on traffic boards which are exposed only in local language.

In border crossings there is predominantly insufficient information for foreign travellers - no traffic centre number, no radio channel frequency, no traffic website address, no translation of text signs.

Public road agencies should provide translation of essential roadside information, especially in border crossings, into widespread language in order to make them better understandable for foreigners.

Border crossings should be equipped with telephone number and website address of traffic information centre, with the frequency of the road radio and about the official regulations of usage winter tires, studded tires or wheel chains.

Cooperation between the neighbouring countries or states with intent to make the road information available along the through traffic route helps travellers to plan the trip and react in proper time.

In assessing the environmental impacts of winter maintenance operations, all of the factors should be considered, not just the chemicals used but also the environmental impacts of the spreading operations. Those can include fuel consumption, emissions, noise, durability, recycling, energy use in manufacture etc. So final judgements can only be made after analysing the whole process. Administrations are striving to improve the winter maintenance to minimize the salt consumption. Yet the efficiency of such changes in strategy is not known unless the impact on groundwater is investigated. But to take all effects into consideration a socio-economic model is needed to assess the consequences for road users, road administration and the society at large of changes in strategies and maintenance.

The need is great to identify and analyse the existing methodologies that integrate the sustainable development approach for road infrastructure projects or road services, in various countries.

An example is given from NISTRA – Sustainability Indicators for Road Infrastructure.
Society

- Ensure basic supply
- Promote social solidarity
- Ensure acceptance, participation and coordination

Economy

- Accomplish a good benefit-cost-ratio
- Optimize indirect economic effects
- Achieve (self-)profitability

Environment

- Reduce environmental impacts to a harmless level (long-term)
- Reduce atmospheric pollution
- Preserve resources

With the climate of the world changing we face new challenges to determine its' impacts and then to pro-actively manage the impacts.

- Global temperature will rise and there will be a reduction of days below 0°C. The coldest days will be less. There will be precipitation variations with less snow and more rain.
- Identified impacts winter maintenance:
- Chaotic consumption of de-icers: supply difficulties
- New drivers habits and education: sudden, intense adverse phenomena
- More meteorological complex situations met (near 0°C)
- Materials investments/renewal (RWIS, trucks, snow-ploughs,...)

Some countries have made risk analyses about effects of climate change on road maintenance to assess and to optimize the winter service and infrastructures**;** Important is also to share knowledge, good practices and implement new ones