Future Research Topics Related to Road Weather

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INTRODUCTION

The paper describes the results of Task Group 4 "Future research" of the COST 344 action "Improvements to Snow and Ice Control on European Roads and Bridges". COST is abbreviation of European Co-operation in the Field of Scientific and Technical Research, which provides a co-operation platform for nationally funded research efforts by covering concertation-related costs (meetings, secretary work, etc.)

According to the COST344 Memorandum of Understanding (COST 1999), the main objective of the COST344 action was to establish and improve the content and performance of snow and ice control methods and operations by defining the requirements and specifying best practice across the EU and other COST member states. In all, 19 countries (Finland, Germany, Spain, Sweden, Switzerland, Poland, United Kingdom, Romania, Hungary, Ireland, Austria, Denmark, Belgium, Iceland, France, Czech Republic, the Netherlands, Slovenia and Norway) have signed the Memorandum of Understanding of the COST 344 action.

Most of the work of the COST 344 action was carried out within task groups or task groups concentrating on the key issues related to the domain of COST 344. The task groups were:
1. Information gathering, literature review and glossary
2. Definition of Requirements
3. Best Practice
4. Future Research
5. Route Management Systems
6. Driver Information Systems
7. Final Report

The objectives of the task group on future research were:
- to identify short-, medium- and long term research issues and topics related to road traffic and infrastructure in the wintertime, and
- to identify those topics with optimum expected benefits

METHOD

Figure 1 presents a schematic description of the method. A detailed description of the method is given later in the chapter.
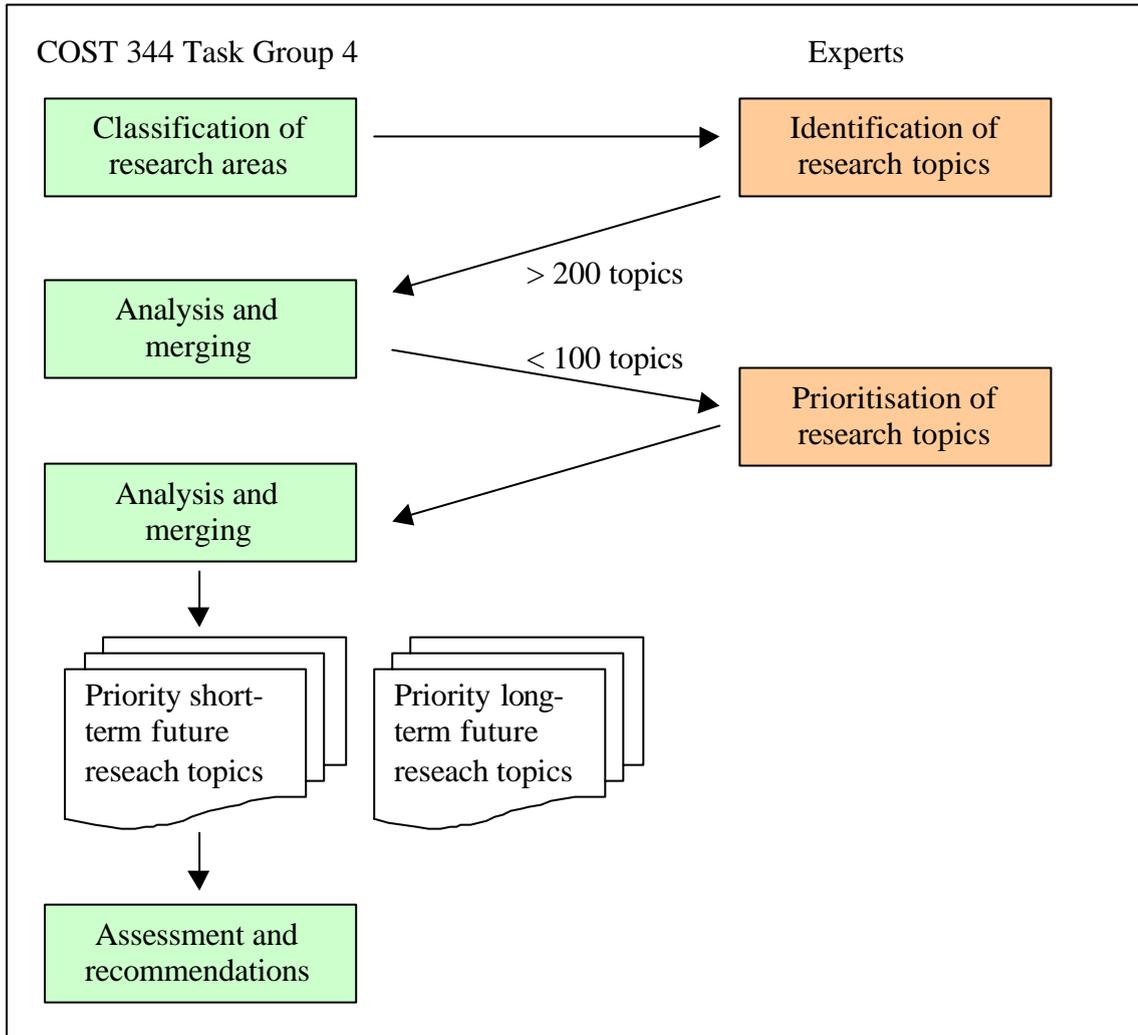
Figure 1. The description of the working procedure used by the study.

Identification of research topics

Firstly, the task group agreed a tentative classification to be used in the identification of issues and topics for future research. The classification was to be sent along with a letter to experts asking them to identify up to five important research topics (in a priority order, if possible) that should be addressed in the national and European R&D programmes in the near future. The letter was sent to all TG4 and Management Committee members, who were asked to send it (possibly after translation) to road authorities, researchers and meteorological offices in their country, and collect the replies. The replies were to contain contact information at least in terms of e-mail addresses. The letter was also sent to industry via the TG4 contacts. More than 90 persons replied to this letter after two reminders had been sent. In all, more than 200 topics were proposed as future research topics. After merging by TG4, the list of topics included less than 100 topics.

Some of the respondents did not specify a detailed topic, but instead prioritised the research areas in the classification enclosed in the letter. After classifying the topics accordingly, the research area prioritisation by the survey respondents was established (Table 1).

Table 1. Priorities of the research areas as indicated in the survey on identifying future research topics.

Topic/Research area	Priority of topic/research area					
	1	2	3	4	5	Total
1. Weather and climate						
1.1 Monitoring and data exchange	11	6	5	4	2	28
1.2 Modelling and forecasting	21	8	16	2	2	49
1.3 Effects on traffic (safety, efficiency, …)	2	5	4	1	2	14
1.4 Implications to infrastructure design	4	3	2	2		11
2. Winter maintenance						
2.1 Maintenance management	8	8	3	7	6	32
2.2 Operational practice	2	7	6	6		21
2.3 Maintenance equipment	5	3	2	6		16
2.4 De-icing products	7	7	10	7	3	34
2.5 Effects on traffic	1	4	1	1		7
2.6 Costs and benefits of maintenance	2	7	1	5	3	18
3. Road users						
3.1 Vehicle control and tyres	1	2	1	3	1	8
3.2 Driver information	4	4	8	6	4	26
3.3 Traffic management and control	1	3	6	1	2	13
3.4 User acceptance and requirements		3	1	1	3	8
3.5 Education	1	3	3	1	5	13
4. Strategic research						
4.1 Policies and strategies	5	2	3	3	1	14
4.2 Harmonisation of quality levels	1	2	2	5	2	12
4.3 Relations to other domains	1					1
4.4 Emerging new technologies	3	1	2	6	6	18
5. Other						
5. Other	3		1		5	9

The most frequently mentioned research areas were modelling and forecasting, de-icing products, maintenance management, monitoring and data exchange, and driver information. These research areas were also most frequently mentioned as the ones with the highest priority. There was a bias in the replies as very many replies have been received from the same organisation in the same country. This was not a problem as this phase was primarily to identify as many relevant research topics as possible.

Internet survey for prioritisation of topics

After the merging had been completed, the topics were prioritised. The task group decided to employ an Internet survey to accomplish this.

The Internet survey was set up on the web site of VTT (Technical Research Centre of Finland), and its address was sent to the persons who had contributed to the first round of topic identification with some exceptions. Firstly, only five respondents were selected from those

countries with more than five authority, research or academic respondents responding to the original survey. Secondly, the Internet address was sent to experts known to the task group members, who had not participated in the first round, in the countries with less than five respondents. All industry respondents were retained in the list.

The Internet survey respondents were asked to classify each topic in the four priority categories:
1. very important - should be studied as soon as possible;
2. important - should be studied within five years;
3. quite important - should be studied in the future; and
4. not important.

In addition, a fifth category was provided:
5. no priority given (in case you do not feel competent or willing to judge it).

All forms had the fifth category ticked as a default value, enabling the respondents to only classify the topics that they wanted to prioritise. This made the filling of the survey form easier. Subsequent comments from the respondents also confirmed that this had been a well-accepted solution.

After two reminders, 57 respondents had completed the survey at the end of March 2001, when the survey was finally closed. Out of these respondents, one third belonged to the COST344 Management Committee. Most of the respondents were road administration representatives (31). Nine (9) were from industry, fourteen (14) from research institutes and three (3) from the academia. The final respondents came from 17 different countries.

FUTURE RESEARCH TOPICS

Topics proposed by international experts

As a result of the first e-mail survey, the task group received about 200 distinctive research topics. Some of the topics were very similar, and after analysis the task group combined some of the topics. In all, after the analysis by the task group, the list included 93 topics. These topics were then used as the list of topics in the Internet survey.

Topics of highest priority

According to the Internet survey to prioritise the research topics, the research areas of :
- monitoring and data exchange,
- modelling and forecasting,
- effects of weather on traffic,
- maintenance management, operational practice,
- de-icing products,
- effects of winter maintenance on traffic,
- driver information as well as traffic management and control

were considered important. This means that these areas contained topics, where the mean priority was at least 2 (1 = very important, 2 = important, 3 = quite important and 4 = not important) in two of the three organisation groups.

The most important topics (means less than 1.7) by the various groups were:

Roads Administrations
- Improved modelling and forecasting of road surface condition (e.g. 4 hours ahead) for preventive de-icing and other maintenance measures.
- Level of services on winter roads.
- Effects of different winter road maintenance quality levels on traffic accidents and traffic flow.

Industry
- Integration of road and meteorological data and real-time information dissemination and exchange networks between various organisations (road operators, rescue authorities, maintenance operators, administrations).
- Development of real-time information systems via different media (VMS, radio, cellular phone,) to affect driver behaviour (especially speed choice) in low friction conditions, based on user requirements.
- Preventive use of anti-icing materials.

Research/Academia
- Improved modelling and forecasting of road surface condition (e.g. 4 hours ahead) for preventive de-icing and other maintenance measures.
- Development of improved methods (contactless, remote, etc.) for road surface condition measurement (e.g. friction, freezing temperature, water film thickness).
- Integration of road and meteorological data and real-time information dissemination and exchange networks between various organisations (road operators, rescue authorities, maintenance operators, administrations).
- Effects of different winter road maintenance quality levels on traffic accidents and traffic flow.
- Development of in-vehicle road surface condition detection system, and its communication to road and maintenance operators.
- Effects of the weather and road conditions on traffic and driver behaviour
- Impacts of ice warning systems on road safety.

There are clear differences between the priorities assessed by the various organisations, but there are also similarities. The low priorities given to topics relating to strategic research (area 4) were, nevertheless, quite unexpected. The task group analysed the responses, and decided to recommend six priority topics for future research in the short term. These six topics were chosen so as to cover the most important topics as revealed by the Internet survey. The most important and urgent future research topics were:

1. Forecasting, measuring and modelling the road surface condition.
2. Winter maintenance and management policies and strategies (service performance, harmonised quality levels etc).
3. Costs and benefits of operational practice in rural and urban areas.

4. Effects of road weather conditions and winter maintenance on traffic flow and safety, capacity and road user behaviour.
5. More cost-effective, efficient and environmentally-friendly friction improvement products.
6. Weather-related traffic management and information systems optimal for traffic safety and efficiency.

A detailed task description of these topics is presented in the task group report (Kulmala 2001). A separate analysis was undertaken to identify the future research topics in the long term. For this purpose, topics with many responses of "3. quite important - should be studied in the future" were selected if not many considered the topic unimportant or if the topic was already among the short-term priorities. There were again large differences between the various organisations. The most important long-term research topics were for the various organisation groups:

Road Administrations
- Identification of the maintenance equipment long-term strategy in terms of each department operational organisation and co-operation between different organisations.
- Effects and benefits of unrestricted and free weather data delivery policy to winter road maintenance in Europe.
- Impacts on congestion avoidance on the Trans-European Road Network by preventive de-icing.
- Environmental impact of winter maintenance: impact on ecosystems (hydrological, fauna, flora - roadside and landscape as a whole - what is the actual extent of impact from salt urea etc).
- Comparison of specialised and multipurpose maintenance vehicles.
- Development of international co-operation in winter maintenance in different levels of integration, based on a continuous level of service and the improvement of operational winter maintenance in border regions.
- Improvement of weather and road surface prediction and observation for local areas.

Industry
- Development of modelling and forecasting for the management of rest time for maintenance personnel.
- Development of road weather oriented advanced driver support and vehicle control systems.
- The study of institutional, legal and social issues related to co-ordinated winter road maintenance and driver information services.

Research/Academia
- Behaviour of tyre friction in changing winter conditions as a function of amount and type of ice as well as the used de-icer compound.
- Feasibility of using aerial thermal imagery.
- Alternative methods for snow and ice control on porous asphalt.
- The effect of possible climate change in planning long-time strategies for road maintenance (methods and equipment).
- Comparison of de-icing methods and products for specific road surfaces.

The long-term priorities include also topics in strategic research such as the identification of maintenance equipment long-term strategies, effects of unrestricted and free weather data delivery policies, effect of possible climate change in winter maintenance, and feasibility of aerial thermal imagery.

ASSESSMENT AND RECOMMENDATIONS

There are three main categories of research:1) innovative and fundamental research, 2) implementation-related research with the operational point of view, and 3) strategic research. The task group on future research approached the problem of identifying the most important research topics by asking experts from road administrations, industry, research organisations and academic institutes for their opinions. The topics obtained in the surveys represent all three categories of research. When prioritising the most urgent research topics, however, the topics of highest priority concentrated on implementation-related research with the operational point of view, and to a smaller extent on innovative and fundamental research.

In all, six priority short-term research areas were identified:

1. Forecasting, measuring and modelling the road surface condition.
2. Winter maintenance and management policies and strategies (service performance, harmonised quality levels etc).
3. Costs and benefits of operational practice in rural and urban areas.
4. Effects of road weather conditions and winter maintenance on traffic flow and safety, capacity and road user behaviour.
5. More cost-effective, efficient and environmentally-friendly friction improvement products.
6. Weather-related traffic management and information systems optimal for traffic safety and efficiency.

These research areas include the most essential elements among the often very detailed research topics regarded as very important or important by the survey respondents.

All of the six priority short-term research areas have an international, global dimension. All of the research areas require field studies and pilot experiments or demonstrations. These should be undertaken at the national level.

In addition to the short-term research areas, a number of long-term research topics were identified. The long-term priorities include also topics in strategic research such as:

- identification of maintenance equipment long-term strategies,
- effects of unrestricted and free weather data delivery policies,
- effect of possible climate change in winter maintenance, and
- feasibility of aerial thermal imagery.

The long-term topics also included:

- innovative fundamental R&D such as development of road weather oriented advanced driver support and vehicle control systems,
- behaviour of tyre friction in changing winter and de-icing conditions, and

- methods for snow and ice control on porous asphalt.

The research topics, and especially the results of research on these short- and long-term topics, can be exploited in winter maintenance management as well as in the actual snow and ice control operations. The industry can utilise the results for provision of improved tools and products. The results can also be utilised in the development and operation of the eventual future road management system, which will integrate all management functions of the road operator e.g. winter management, traffic management and information services.

The research topics identified in this COST Action and additional study ideas are needed to solve issues relating to the interaction between client and contractor, quality assurance, the use of modern technology, and specifications and performance standards to describe and measure the target condition(s).

The COST Action was a useful platform for identifying the most important topics for short- and long-term research. COST344 is one of the few actions involving so many countries in the domain of winter maintenance and road weather. Hence it provided a good network for contacting the relevant experts in Europe, and through them, experts elsewhere.

Due to the good experiences with the COST344 action, the task group proposes a new COST action to continue research on the domain and to build on the achievements of COST344. A COST action is also suited well to these topics as most of them require active efforts and demonstrations/pilot implementations on the national level and co-ordination and integration between the national inputs.

A future COST action should take on board most of the short-term priority topics identified. Some of the research topics will also fit well in to the 6th R&D Framework Programme of the EU, especially the fundamental and strategic research tasks.

REFERENCES

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