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ROADS WINTER MAINTENANCE MANAGEMENT SYSTEM (WMMS)

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Abstract: *The paper presents some winter management systems for roads used in various European countries including Romania and maintenance technologies used in operational traffic and climatic conditions specific to these countries. In this context are considered key components of these systems, namely the state weather information systems, administrative systems, warning systems, equipment, intelligent traffic management systems and road user information. Highlighted new technologies are adopted in various countries to improve road safety in winter ie optimize routes in winter maintenance, traffic control based on weather data and the impact on safety including monitoring systems and climate conditions to development programming specific decision tools. Finally a comparative study as a result of the research effort developed in the frame of COST 353 Action is described with reference to the actual WMMs practiced in our country.*

Key words: *winter maintenance, road weather information systems, administrative system, traffic management*

1. Definition of the Concepts of Winter Maintenance Management System - WMMS

A useful structure of a WMMS developed in the frame of COST 353 [1] research is shown in Figure 1. The components on the left supply the basic information needed before the winter maintenance operation begins. The components in the centre of the chart are relevant during the operation. The components on the right use the data and information acquired during the operation. Apart from the components shown, other systems, such as salt storage management, are a part of a WMMS. In order to assess the main components included in the evaluation table for each country involved in COST 353, groups of experts in the different fields of winter maintenance were asked to participate for discussion on the various aspects, based on expertise, local and practical experience regarding the present status and the evolution in the future along with the improvements necessary to reach an efficient system.

2. Evaluation of Existing Systems

In Figure 2 is presented a complex winter model and the relations between weather, traffic, maintenance actions, and road conditions are illustrated [4].

The components that make up the WMMS system have been divided into following groups: Road Weather Information Systems, Administrative

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System, Call-out System, Intelligent Equipment, Documentation and Follow-up and Traffic Management and Information, as described in Figure 1 .

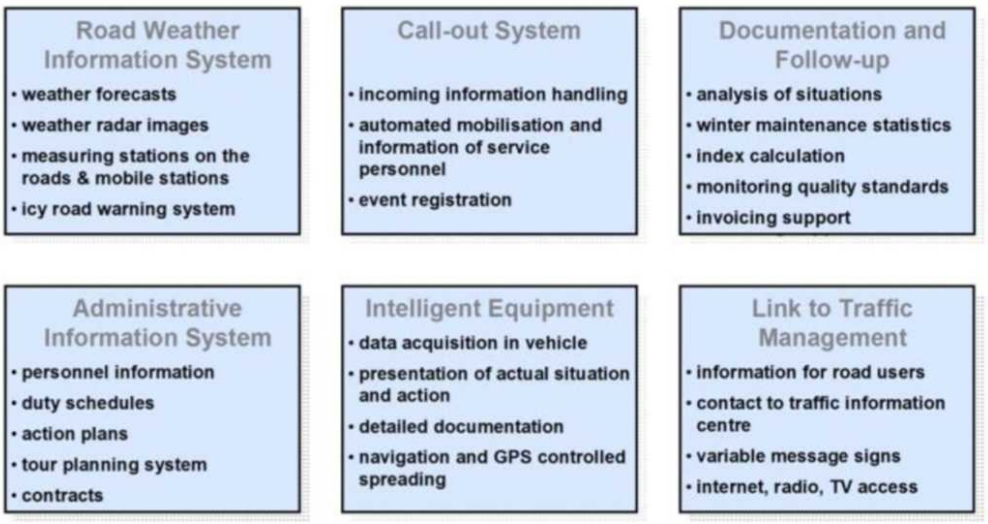

Fig. 1. *Component of a Winter Maintenance Management System – WMMS [1]*

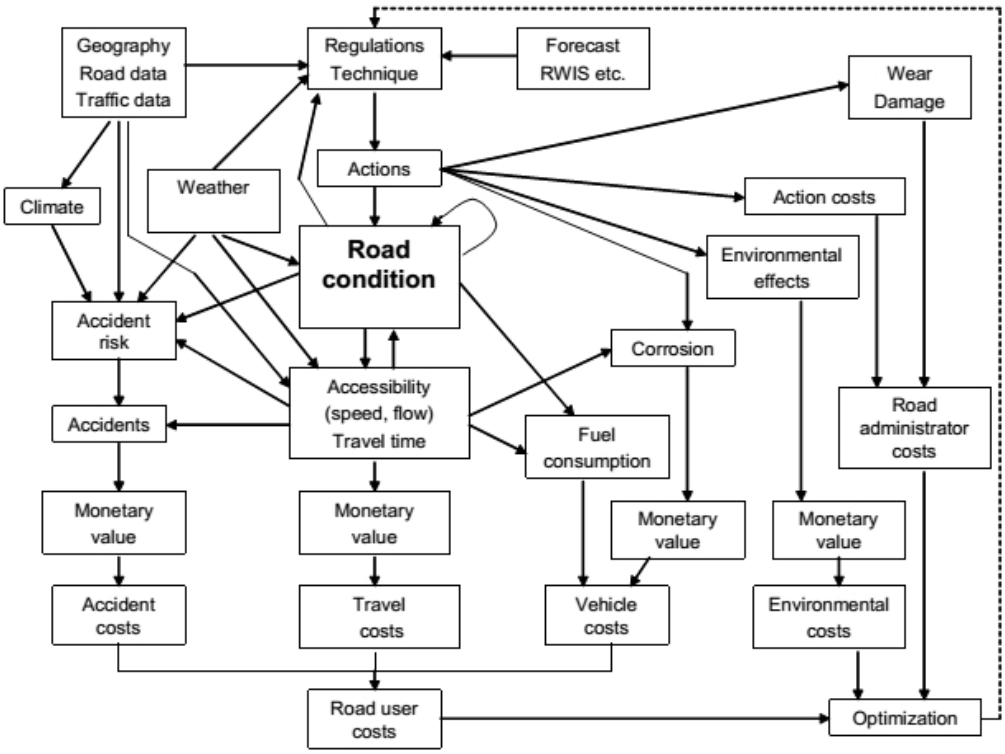

Fig.2. *Winter Model* [3]

The following aspects have been considered in this evaluation:

*Economical aspects***:** These systems, like all installations, generate implementation and maintenance costs that consist in the conservation and running of all the elements. The total cost will be the determining factor, and therefore its compound cost will have to be calculated.

Although this aspect is quantifiable by nature, several coefficients have to be attributed depending on costs in order to assign it the appropriate weight, bearing in mind at the same time the magnitude of the other aspects.

*Functional aspects***:** The efficiency, use or benefits of the system are analysed, based on experience or surveys. The sectors capable of experiencing benefits are as follows:

- Road users
- Administration
- The environment

Conventional evaluation indexes have been assigned according to the degree of benefit, which will be assumed by weighting coefficients, equally conventional, according to the degree of importance, in order to reach the total value of this aspect.

3. Description of Romanian WMMS

The public road network in Romania, with a total length of 85,362 km, is divided into functional categories as follows: 683 km of motorways; 16,589 km of national roads of which 6,194km are classified as European roads; 35,505 km of county roads; 32,585 km of local (communal) roads [3]. Besides these, there are 642 km of private roads.

Due to its geographical location and the continental climate characterized by very hot summers and severe winters, in Romania, the integration of the winter maintenance activities within various serviceability (intervention) levels is established according to the road category, as presented in Table 1. According to Table 1, four levels of serviceability are established corresponding to four different classes of traffic, the ADT ranging from less than 500 to more than 16,000 physical vehicles per day. In case of road sectors classified as service level I, the maintenance centres, provided with radio-telephone stations, are located in such a way that each one covers a road section of approximately 50 km, so the minimum intervention time for the road crew should not exceed 30 minutes.

Permanent information for drivers and pedestrians on road conditions is ensured constantly, 24 hours a day, including holidays.

National Winter Commandments are established at the Ministry of Transport (National Company for Roads and Motorways -CNADNR), for national and European roads.

For county and rural roads the emergency action is established by County Commandments, according to the transport requirements correlated at local and national level, thus ensuring the traffic continuity.

With respect to the service level and also the intervention time during winter, road agencies are organizing the so-called Operation Centres and Informative Points with the necessary provisions. For the Romanian WMMS system the main components of these systems are described as follows.

3.1 Road Weather Information Systems

In the frame of its strategic organization, in Romania this activity is managed by the National Company for Roads and Motorways - CNDNAR, which has 7 road and bridge Directorates, 44 national road operation centres, 275 winter operation

Table 1

Levels of winter road serviceability and maximum time interval allowed for intervention

Service-ability level	Average Daily Traffic (ADT)	Maximum allowed time of intervention on road surface				Maximum allowed time of intervention on road structures and level crossings		
		Snow removal minimum one lane	Snow removal all the platform	De-icing spreading		Snow removal minimum one lane	Snow removal both traffic lanes	Snow removal side walks
				Preventive	Control slipperiness			
I	5000... 16.000	10 hrs since the snowdrift ceased	2 - 4 days	Continuous, depending on weather forecasts	2-3 hrs	10 hrs	2 days	4 days
II	750... 5.000	1 - 2 days	4 - 6 days	Continuous, depending on weather forecasts	3-6 hrs	1 day	4 days	6 days
III	500... 750	4 days	7 - 10 days	Optional	7-12 hrs	4 days	7 days	8 days
IV	<500	Usually roads are closed during winter, except in special situations						

centres and 85 auxiliary operation centres. For county roads, a similar organizational structure includes 41 regional councils and 260 winter operation centres.

They are in charge of the organization of a service during the winter, to check the weather reports and make decisions in case of prognoses that can affect road conditions. They are also responsible for the duty organization of their own personnel and stockpiling of spreading material like grit or salt.

Private companies are also involved in winter maintenance activities. Their employment by the road administration infers their participation during a tender procedure.

Information regarding weather parameters for CNDNAR - Central Dispatcher Station - is provided by the National Institute for Meteorology and Hydrology (NIMH), on a contractual basis. Meteorological and hydrological forecasts for warnings are sent each time the occurrence of a dangerous phenomenon is foreseen. Road Weather Information Systems are located at representative points within the microclimate and can connect to the electricity and GIS networks. These RWIS stations measure the local road conditions and generate the corresponding warning to the road users. Such RWIS stations cover an average road length of 36 km.

During the winter maintenance period (15^{th} of November - 15^{th} of March), the following types of measurements are envisaged every 24 hours:

- air and road surface temperature
- humidity
- amount and type of precipitation
- snow depth
- wind speed and direction
- solar radiation, etc.

At a national level, at the National Dispatcher Station, an information system

processes the specific data provided by the RWIS's, the National Meteorological Institute, daily patrol groups along the roads, local authorities, police teams and " in traffic " road users.

The processed information is then disseminated through a network of computers to the various areas of the country and to the public via radio, TV, telephones, etc.

Generally, the stations are placed at the coldest points on roads and bridges. The determination of the location of new stations takes place through thermal mapping and the experience of the intervention crews and drivers of snow ploughs.

3.2 Administrative System

The documentation of winter maintenance activities is based on achievements or reports made by the drivers. All trucks have a plan document consisting of initiation, process and finalization of the route. Also on this document are service stations, plough width, spreading materials, parking places, one-way streets, as well as roads where salt spreading is not allowed due to environmental reasons.

3.3 Call-Out-System

The drivers can be reached by phone (readiness) or they are at the service station for the next 12 hours. To call out private contractors there are several readiness models. When the truck reaches the service station an onboard transmitter is registered in order to determine the beginning of the service.

3.4 Intelligent Equipment and Documentation

The data on the reading equipment will be read in and transferred to a computer program. The appropriate calculation made by the companies can be controlled and confirmed. The data of the ice warning stations are transferred to the service stations. They give information concerning air and surface temperature, dew point, moisture, wind, precipitation, air pressure and the quantity of residual salt on the surface.

3.5 Traffic Management and Information

The government and also private broadcasting stations inform about the forecasted and current weather and the local conditions during their news bulletins or via RDS.

Weather information is also available on Internet. The weather situation can be observed both in the tourist as well as in the urban areas.

Information concerning winter road conditions should be given as early as possible to drivers. This information is given on the following aspects: road sectors on which traffic flow is difficult due to road works, by observing the appropriate signalling and indicating the by-pass alternatives by means of radio, TV, press and telephone; roads with snow cover, areas with blizzards and meteorological forecasts; in case of an emergency, the road and traffic conditions are transmitted every hour by national and local radio and TV or by special broadcasts.

Some road signs indicate a speed limit when there is a danger of slippery roads. The road agency also uses classical and variable message signs. Information concerning weather, road conditions, traffic jams or surface temperature is given to the drivers.

4. Comparative Status of Romania WMMS in the European Context

The comparative diagrams and comments for analysis of specific aspects of WMMS in various European countries including Romania are extracted and reproduced here from the COST 353 Final Report [1]. Here follows the main conclusions resulted from the comparative analysis of the exiting WMMS systems practiced today in the various countries in Europe including our country.

The importance of RWIS as a part of the whole WMMS will have about a 10% lower weight in the future compared to the weight today. This is mostly explained by the fact that most countries have already invested in RWIS extensively and see now more needs in administration and organization fields.

The administrative part of the WMMS combines all information and procedures needed by operators and decision makers, and must support and assist operators and supervisors to manage all activities for their operations.

All the participating countries except Germany (0 %) foresee an increase in the evaluation of the components of an Administrative system. One other country (Denmark) sees only a minor increase of 0.7 total points. The average of the rest of the countries is a calculated increase of 11.6 total points, with relatively similar increases between them.

The evaluation of the existing systems makes clear that satisfaction with the callout system is not so high at the moment. On average, the systems only rated a 36 % of maximum points.

However, a clear increase in this area is expected in the future, with a 49 % general evaluation for this component.

Low ratings are given especially by the evaluated systems of Romania, Austria and Spain. The highest ratings come from Finland and Denmark. For the future, the highest estimated improvement is seen for the Icelandic and Norwegian systems.

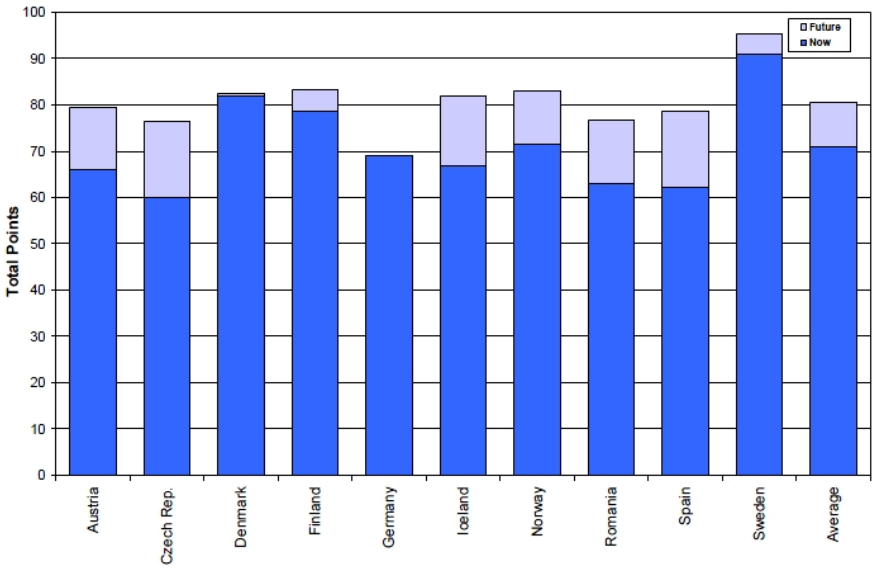

Fig. 3. *Total points for the evaluation of the components of an administrative system in the different countries [1]*

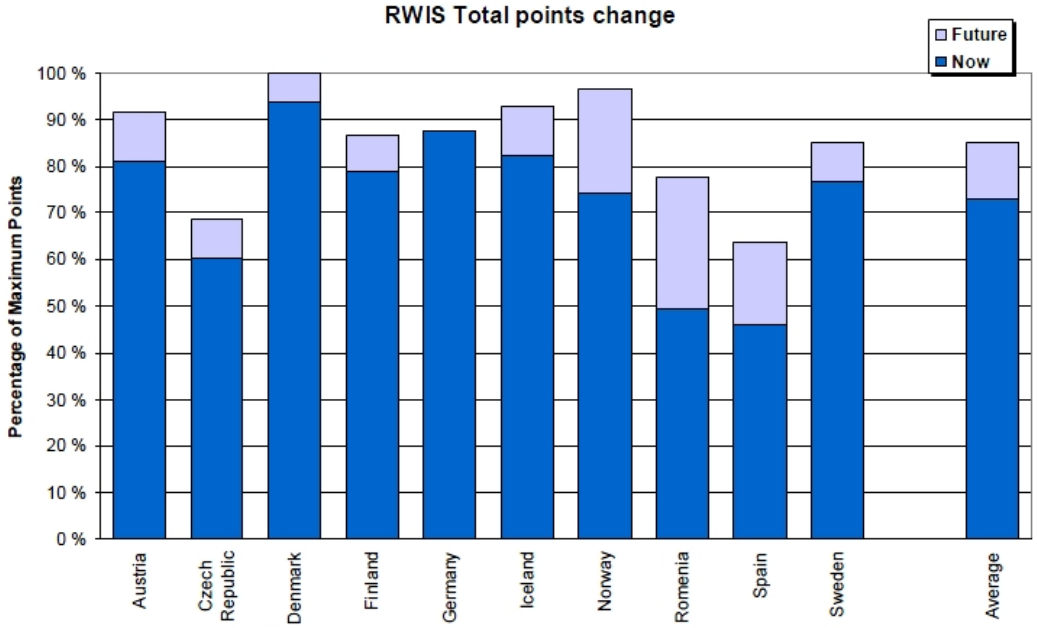

Fig. 4. *Road weather information system changes in future resource allocations by countries [1]*

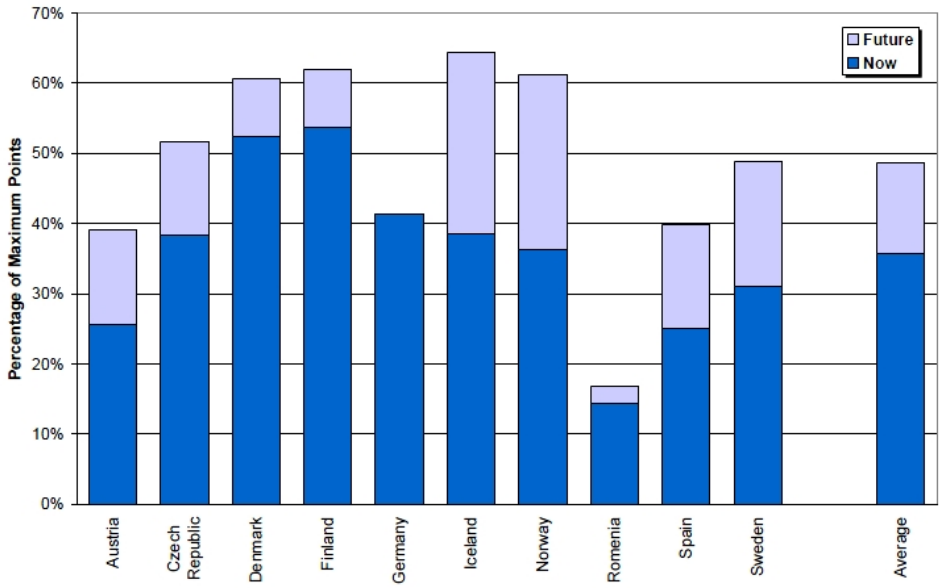

Fig. 5. *Total points for the evaluation of the components of the callout system in the different countries [1]*

The weighting of the callout system as a part of WMMS is on average at the moment nearly 9 °%, and is expected to increase slightly to 10 % in the future. Behind this small average increase of 12 %% are hidden increases of more than 50 %% in Austria, Iceland, Romania and Spain. On the other hand, the weighting of the callout system will decrease in Sweden and Denmark in the future in comparison to the present.

The evaluation of the existing systems clearly indicates that the satisfaction with the components of the intelligent equipment is not very high at the moment (see Figure 3-5). On average, the systems only reached 43 % of maximum points. But in future a clear increase in this area is expected, with an estimated evaluation for these components of 63 %. Low ratings are given especially for the systems evaluated by Austria and Sweden. The highest ratings come from the other Scandinavian countries. For the future, the biggest improvement is expected for the Swedish system. This is due particularly to the implementation of GPS-controlled spreading and the full use of the recorded data. The reason for the low rating by the Austrian system is that the focus at the moment is not on data recording but on navigation support at route level and manual documentation.

At the present moment, the weighting of intelligent equipment as a part of WMMS is on average nearly 12 % and will exceed in future over 15 %. This is an increase of about 30 % on average. The highest increases are expected in Austria and Iceland. However, in some countries no change of the weighting is foreseen.

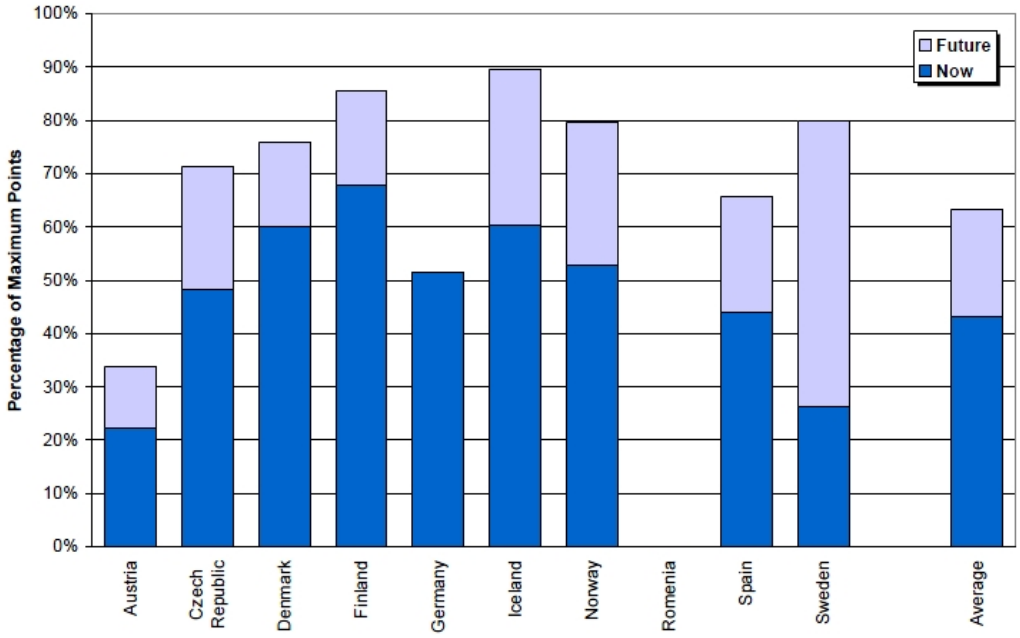

Fig. 6. *Total points for the evaluation of the components of intelligent equipment in the different countries [1]*

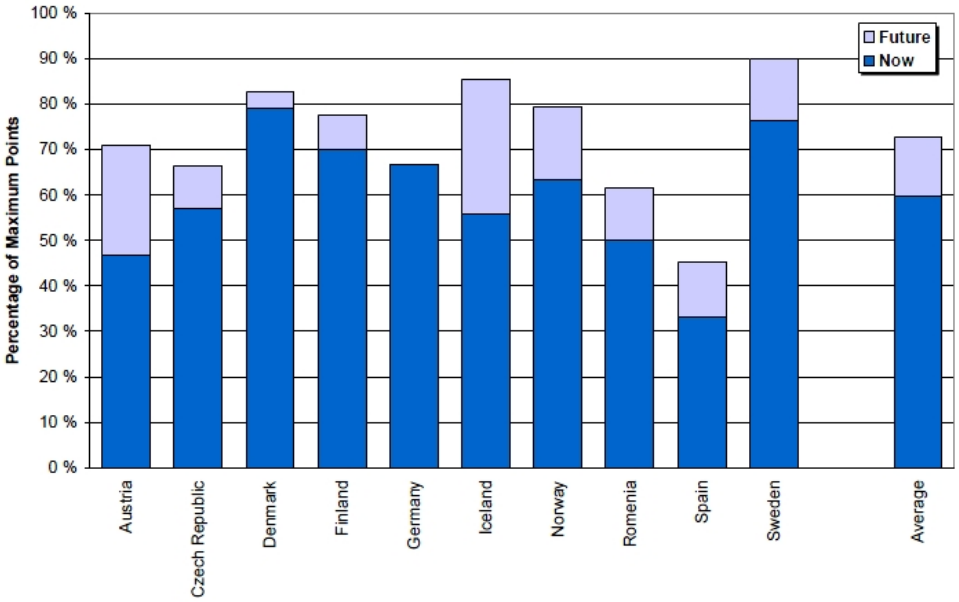

Fig. 7. *Total points for the evaluation of the components of documentation and follow-up in the different countries [1]*

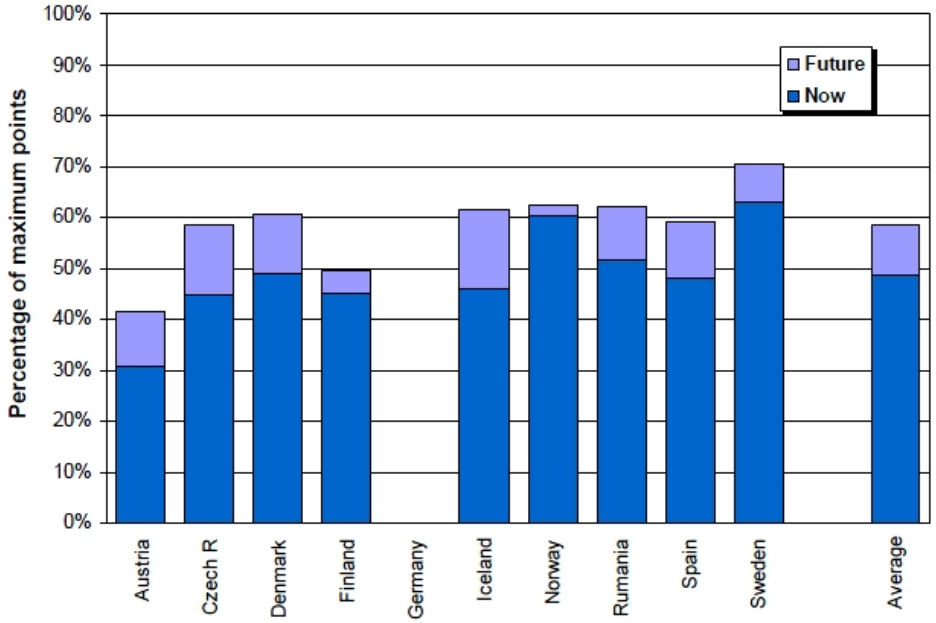

Fig. 8. *Total points for the evaluation of the components of traffic management and information in the different countries [1]*

Since the satisfaction with intelligent equipment components is estimated higher in future than now, and the importance of these components for a WMMS will be greater, the experts foresee a high potential for them. The weighted evaluation will increase on average around 68 %. The highest rises are expected in Austria, Iceland and Spain.

The quality, usefulness and economy of the documentation and follow-up system components have been evaluated by the experts from each country. The evaluation of existing systems shows that the satisfaction with today's system is on average 60 %% of the maximum possible points. In future, the participating countries expect an improvement of between 60 and 73 %, which is about a 20 % increase from over today's figures (see Figure 6-8), the highest increases are expected in Austria and Iceland, but all countries on a lesser or greater level foresee an increase in the future. The Nordic countries have the highest expectations regarding this system in the future.

Their importance as a part of the whole WMMS will have about a 45 % higher weight in the future compared to the weight today. The reconstruction of a situation, statistics and invoicing support seem to be most important in the future. The evaluation of the existing systems clearly indicates that traffic management and information systems are already regarded as having a reasonably high quality in many countries. It is also apparent that the quality of traffic management and information is expected to increase by about 20 % on average in the future (see Figure 6-8). The lowest ratings both now and in the future are given especially in the evaluated systems of Austria and Finland.

The highest ratings are from Sweden and Norway, although other countries, except for Austria and Finland, score these systems with well over 50 points. For the future, the highest improvements are expected in Iceland and the Czech Republic.

The low rating given by Austrian system is a result of the low scores assigned to traffic information centres, Internet sites and RDS-TMC radio/navigation systems. These also affect the low score from Finland.

The quality, usefulness and economy of all the components of information for road users will increase about 20 % from now to the future, and their importance as a part of the whole WMMS will also have about a 40 % higher weight in the future as compared to the weight today.

5. Conclusions

1. One may conclude that the actual WMMS practiced in our country must be improved in order to upgrade it to the European level.

2. The useful information developed in the frame of COST 353 Action Could be assumed base for such feature developments.

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