COMPARISON OF PAVEMENT MANAGEMENT IN THE NORDIC COUNTRIES

Paper prepared for 4th EPAM CONFERENCE

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ABSTRACT

In connection of the US world-wide scanning tour on managing pavements and monitoring performance, the road administrations in Finland, Norway, Denmark and Sweden each contributed. These contributions have been summarized in a report together with a comparison of the road network condition in each country.

The report deals with the following main topics:

- Use of Sustainable Performance-Based Programs for Managing Pavements
- Identifying Effective Communication Strategies to Promote Pavement Management Policies
- Developing Agency Cultures to Support Pavement Management Policies
- Availability of Techniques and Tools for Managing Pavements Effectively

The report shows not only differences and similarities in technical matters, but also in organisational, fund raising, budget allocation, and implementation. The report also focuses on factors that affect the comparison of road condition as differences in measurement methods.

1 INTRODUCTION

In connection with the U.S. world-wide scanning tour on "Pavement Management and Monitoring Performance" representatives from road authorities in Finland, Norway, Denmark and Sweden contributed. These contributions were presented at a meeting in Stockholm in June 2011. During the meeting in Stockholm was found that the Nordic contributions included comprehensive information on the situation in the Nordic countries and that much work has been spent into producing this material. The value of the information was considered so important that it is desirable that based on the Nordic contribution compile a report.

When using the term Nordic Countries it should be noted that Iceland, Faroe Islands, Greenland and Åland Islands are also part of the Nordic countries, but they were not part of the US scanning tour.

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This paper is a summary of the full report.

Figure 1: Countries involved in the US Scanning tour

2 THE US SCANNING TOUR

The US scanning tour was organised so that each participating country prepared presentations based on a number of questions from the US delegation. The four main topics were:

- Discovering processes for implementing sustainable performance-based programs for managing pavements, and the use of pavement condition information and projections to support programs such as pavement preservation, public private partnerships, and safety hazard mitigation. This may include the use of financial and other incentives for linking pavement budgeting decisions to cost effective management practices over the life cycle of the pavement.
- Acquiring effective communication methods for upper management and legislative support, including effective strategies to secure public and legislative support.
- Developing agency cultures that support performance based programs, including identifying effective capacity building programs. This includes strategies for addressing organizational or institutional issues to ensure that a decentralized organization works toward specific performance targets established for the entire network.
- Identifying techniques, tools, analyses, and reporting mechanisms that support and encourage performance based management and optimal use of available resources in transportation agencies.

3 ORGANISATION OF ROAD AUTHORITIES

The organization of the authorities in the Nordic countries differs.

Both Finland and Sweden has merged the former responsibilities of different transport authorities (roads, railroads, etc.) and formed the Finnish Transport Agency (FTA) and the Swedish Transport Administration (STA). Norway and Denmark have authorities that deals with roads only; Norwegian Directorate of Public Roads (NPRA) and Danish Road Directorate (DRD)

In Finland, the agency is steered by the Ministry of Traffic and Communications, with main responsibilities for general guidelines for road keeping, budgeting and allocation of funding, steering and follow-up of regional offices (network level decision making). Nine regional offices are steered by the Ministry of Employment and the Economy with main responsibilities for management and operation of the road network, planning and acquisition of maintenance and rehabilitation works

The organization of the Norwegian Directorate of Public Roads is divided in five regions, 19 county divisions and 72 drier and vehicle licensing offices. The directorate is steered by the Ministry of Transport and Communications.

The Danish Road Directorate (DRD) is the public authority, steered by the Ministry of Transport, which administers all state owned roads (primary road network).

The Swedish Transport Administration is divided into the operational areas Society, Transport, Investments, Major Projects and Profit Centres. There are six regions under the Society operational area.

4 ROAD NETWORK

All road authorities in the Nordic countries are responsible for both national road and local roads, except Denmark, where DRD is responsible only for the national network. Table 1 shows the network in each country. In Finland 65% of the network is paved and in Sweden 80%.

Table 1: Road Network in the Nordic countries. (responsibilities are marked in blue)

	Norway	Denmark	Finland	Sweden
National roads	10500	3800	13000	15300
Local roads	44000	69774	64900	83100
	54500	73574	77900	98400

The national roads carries most of the traffic (>50%). A large part of the local roads are rural roads with very low traffic.

5 ROAD FUNDING

Norway consists of five regions with separate budgets for national and county roads. The parliament allocates funds for national roads and the county government allocates funds for County roads. New roads and major development/rehabilitation is funded by tax and road user charges. Maintenance is funded by national and county tax.

In Finland, 100 % funded from the state budget. There are no equity formulas for allocation of funds. However, it has been very difficult to change regional allocation procedures, although demographic and traffic situation has changed in Finland. Sometimes political pressure is strong. Usually the new government outlines the strategy for the coming four years, which makes pavement management more stable

In both Sweden and Denmark, 100 % funded from the state budget

6 PAVEMENT MANAGEMENT HISTORY

History started during 1970-80’s when there was a need to manage pavements with less money, rutting (studded tyres) was causing problems and automated condition measurements were introduced. There was also a need for storing data for present and historical use. The

influence of modern pavement management often came from US (Haas&Hudson) and was brought over to the Nordic countries by dedicated and visionary individuals.

Finland started the work using top-down approach: First network-level analysis and then tools for works programming level. The systems were built to use the network level recommendations at the works programming level. At the start there were plenty of resources for development and strong support from the top managers (at least one). The will to use PMS in decision-making was clearly communicated for stakeholders (management, regions). Challenges to overcome were resistance to change everywhere (especially in regional offices, who were afraid of losing power), language barriers (systems not in Finnish), no tradition of sustainable pavement management, little experience of road condition measurements.

Norway started with a bottom-up approach: focus on project level, but included elements needed for "optimization", e.g. user costs. Norway set a maintenance standard, with trigger values for when action should be taken. Dedicated professionals and leaders as well as more room for dedicating funds to development were a critical factor to succeed. Regions were "on board" and they had a central role in developing the PMS. The focus was not too much on theoretical optimization, but on practical planning tools.

In Denmark, before PMS was introduced, the Regions were responsible for maintenance and rehabilitation of the state road network. They were given money from the DRD but could choose the projects themselves. The Regions were strongly against PMS, they were afraid of losing their right to choose the projects. They were afraid of that everything was going to be centralized. It was partly solved by inviting the critics into the development group of PMS. Support (in-house) was offered in the transition and helping the whole organization through the process. The development of a PMS started in Denmark by buying system, that later was further developed in-house with help from consultants.

Sweden started with a bottom-up approach with focus on tools to identify candidate projects. There was a high focus on quality of road condition data in order to get reliable and repeatable information for analysis and research. Initially there was high focus on implementation but the success of implementation could have been better. Database structure was integrated with other sources of information (accidents, weather, traffic etc.). This also made it possible to use common models for e.g. map drawing but it slowed down the development.

The approaches used in the Nordic countries differ but there are some key factors for success:

- Top management support is necessary
- Different decision levels need of information (regional engineers to top managers)
- Access to right data with right quality (reference system, pavement treatments, condition, etc.)
- Dedicated PMS Manager very important in order to be successful in implementation.
- Pavement Management must evolve with IT-development, better knowledge (condition measurements, technical models, and economical models), re-organizations etc.

7 PAVEMENT CONDITION MONITORING

7.1 Measurement equipment

All Nordic countries use automated equipment for road surface measurements. Finland and Sweden use consultants to measure. Different equipment's are used which requires a careful quality assurance process in order to get reliable data. Denmark uses both in-house

measurements and consultants. Norway uses only in-house measurements. The equipment in Norway differs from the other countries since they use a laser scanning system.

The Falling Weight Deflectometer (FWD) is use for deflection measurements in all countries but most commonly, only on project level.

Denmark uses the High Speed Deflectograph (HSD) for deflection measurements on network level.

7.2 Measurement Parameters

The most common measurement parameters are unevenness (IRI) and rut depth but there is an on-going research in order to get more parameters. Table 2 shows a summary of measured condition parameters in the Nordic countries

Table 2: Summary of measured parameters

	Finland	**Norway**	**Denmark**	**Sweden**
Unevenness (IRI)	Y	Y	Y	Y (3)
Rut Depth	Y	Y (1)	Y	Y (4)
Mega texture	Y	Y	Y	Y
Macro texture	Y	Y	Y	Y
Micro texture	N	N	N	N
Friction	Y(limited)	Y	Y (7)	Y (limited)
Edge deformation		Y		Y
Cross fall	Y	Y	Y	Y
Curvature	Y	Y	Y	Y
Hilliness	Y	Y	Y	Y
Deflection	Y (project)	Y (project)	Y	Y (project)
Cracking	Y (5)	N	N	N
Visual inspection	Y (2)	Y (project)	Y (6)	Y (project)
Photographs	Y	Y	Y	Y

1. Norway calculates rut depth differently than the other countries
2. Visual inspection data (cracks, potholes, edge drops, etc.) was previously used for low volume roads, but no inspection has been done since 2005 (bad quality). In 2011, a new inventory (treatment need, yes/no) was introduced. This will help selection of candidates, and also considers other types of problems.
3. Beside unevenness, Sweden also measure the longitudinal profile each 100 mm
4. Beside rut Depth, Sweden use the transversal profile to calculate other parameters as distance between wheel track bottoms, wheel track width, rut area etc.
5. Finland have started to use automated crack measurements
6. In Denmark: Within the next years the goal is to move away from the visual inspections (subjective) towards objective measurements
7. Denmark measure friction on new surfaces

Based on the maintenance standard directives to operational treatment programming are established. The maintenance standard is used to identify candidate projects but other factors affect the final decisions as well.

8 PAVEMENT MAINTENANCE STANDARD

All Nordic countries have their own maintenance standard or guidelines but there are some differences (Table 3).

- Finland and Sweden use average values for 100-m sections and have a maintenance standard based on posted speed and traffic classes.
- Norway use 95-percentiles, based on 20 m values, for 1000 m sections. The calculation of rut depth is different in Norway than in the other countries.
- Traffic classes are different in the different countries

Table 3: Section length and statistical value used in each countries maintenance standard

	Section length	Value
Sweden	100	Average
Norway	1000	95-percentile
Finland	100	Average
Denmark		

With these differences in mind, figure 2 shows a comparison of the maintenance standards for unevenness and rut depth. For Sweden and Finland the standard for a posted speed of 80 km/h is used and for Norway the standard for main roads are used. For Denmark it is assumed that no roads have low traffic.

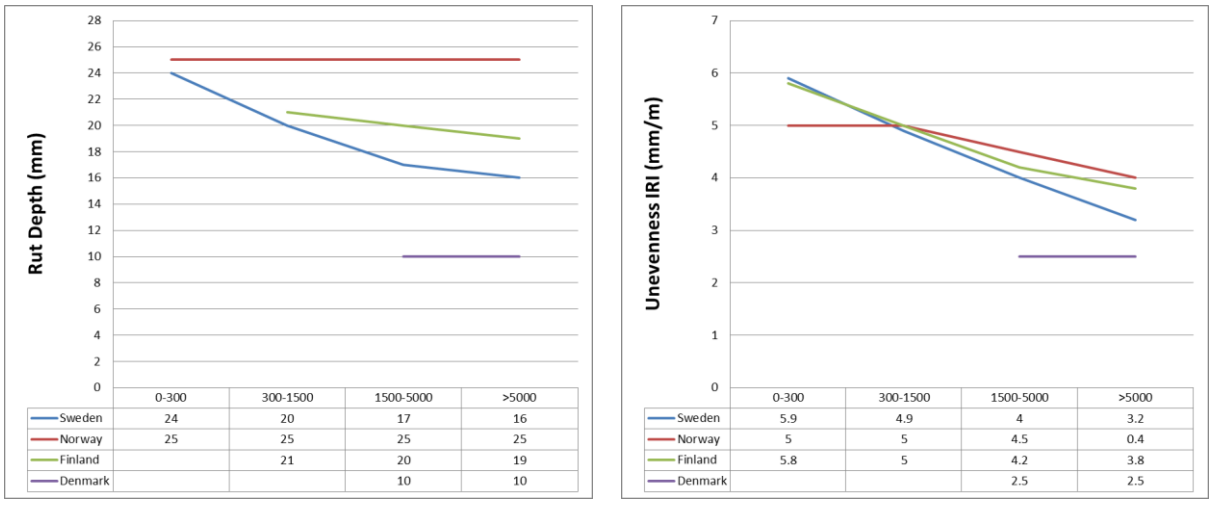

Figure 2: Comparison of maintenance standard for unevenness and rut depth in the Nordic Countries

From the figures it can be noted that:

- Norway has a lower standard in rut depth. However, the measurement of rut depth is different in Norway
- Norway has a higher standard for unevenness on low traffic roads.
- Finland and Sweden have similar standard, but it seems that Sweden has a higher standard on roads with higher traffic.
- Denmark has a higher standard than the other countries. This may be due to the section length (unknown) and that the traffic in general is high.

9 PAVEMENT MANAGEMENT SOFTWARE

9.1 Finland

Mainly two pavement management software applications are used:

- PYRO = Optimisation of Pavement Preservation at Network Level
- PMSPro = Paving Works Programming and Condition Reporting Tool

Money spent on PM activates, including network level analysis, condition measurements, works programming, procurement, quality assurance, systems, R&D, > 3 million euros/year which is about 2-3 % of annual paving budget.

Pavement management system forms the basis for decisions concerning pavement investments (i.e. selection of candidates for treatment). The key issue is condition information and deterioration of roads. PMS is not used as such for selection of treatment – this is done in co-operation by programming and paving engineers. We think that automated selection of treatment type is not accurate enough.

9.2 Norway

The most commonly used relevant PMS Software is:

- NVDB: National Road Data Bank
- PMS 2010: Web based, central Oracle database which works on a project/project-selection level. PMS is used by the pavement managers and contractors (partial access for bidding purposes)
- MOTIV: Budget need and allocation system which also includes pavements need calculated based on unit costs, pavement area, AADT and normative pavement lives.
- Various programs in connection with data collection

9.3 Denmark

The most used PMS software is Vejman:

- Based on the data within the program the PMS makes economic calculations for a pavement program for a specific year (everything is given a price).
- Each section is given several options for routine repairs and rehabilitation, and all the different solutions for network are evaluated and the most economically efficient solution is chosen.

9.4 Sweden

The PMS software used in Sweden is:

- PMS 95: An old software (to be replaced) with capability to handle all relevant information from the National Road Database (NVDB), the Maintenance Treatment Database (VUH) and the road condition database (VYM)
- PMS planning: A size-down module of PMS95 that are free to download for contractors, consultants etc. The software is based on an older version of the Norwegian PMS. Will be replaced by PMS 2012.

- PMS 2012: A new web based system (implemented 2012) with capability to handle the same data as PMS 95 but more user friendly. PMS 2012 will have the capability to combine condition data, maps and photographs
- VUH: Software for handling of all maintenance treatments.
- VYM: Software for handling all road condition measurements.
- VU+: Software for planning maintenance activities

The PMS software are focused on the need of the pavement engineers and are intended to be a tool in identification of candidate projects and a planning tool, but not to select treatments in detail. Since not all significant information concerning pavement performance is measured, it is considered essential to involve the pavement engineers in the final decision.

Network level analysis is carried out on demand, but no specified software is in use. However, a calibrated HDM-4 is under evaluation

10 PAVEMENT MAINTENANCE AND REHABILITATION ACTIVITIES

10.1 Finland

Maintenance, rehabilitation and operations are contracted out entirely. Only traffic management is done in-house. Routine maintenance contracts are 5-7 years, pavement maintenance and rehabilitation mainly annual contracts, some 1-3 year and a few longer ones (up to 18 years). Competition is usually very tight and consists of a maximum of 5 paving contractors. Guarantee period is 3 years (used to be 2) and contractors have to follow national asphalt norms. Condition measurements (IRI and rutting) and laboratory tests are made randomly. Contractors' quality processes are audited. If quality targets are not met sanctions and price deductions are utilised.

10.2 Norway

From 2003 maintenance, rehabilitation and operations are entirely contracted out. Contracts regarding routine maintenance contracts are 5 year contracts for national and county roads. Pavement maintenance and rehabilitation consists mainly of annual contracts but some are two year contracts. Regions organize the contracting process. The contract templates are made by Road Directorate. Competition varies with regional differences (better in southern Norway than in northern parts). The average for 2011 was 3 bidders per paving contract. Guarantee period is 5 years. Contractors have to follow national asphalt norms. Condition measurements (IRI and rutting) and laboratory tests are made randomly. Contractors' quality processes are audited. If quality targets are not met sanctions and price deductions are used. In a few paving contracts the contractor chooses treatment and guarantees max rutting. The guarantee period varies with AADT.

In 2003, prices were reduced with approximately 35%. However the administration costs increased (extra costs from change orders etc.) which gives a net saving of 10-15%. The price level steady until 2007 where after the price increased. There has been large increase in prices for the last 6-7 years (50% increase from 2004 – 2010) mainly due to increase in oil prices.

10.3 Sweden

All maintenance and operations are outsourced. Operations are contracted by area (totally 125 areas). Maintenance and rehabilitation is contracted by projects or group of projects. Contractors have to follow national asphalt norms. Condition measurements (IRI and rutting)

are carried out on larger projects and laboratory tests are made randomly. Contractors' quality processes are audited. If quality targets are not met sanctions and price deductions are utilised.

Some contracts are long-term performance based contracts and there is a trend towards more performance based contracts.

Guarantee period is for operations 3-6 years, maintenance 1 year (will probably be extended), Performance based contracts can cover up to a 15 year period.

11 COMMUNICATION

The demand for information regarding pavement maintenance and management by stakeholders has increased in recent years. Different (as well a similar) means towards better communication have been taken in the Nordic countries, but there is also a need to improve the communication.

In Finland, as well as in other Nordic countries, there is a problem with the communication of the condition of roads. Present condition parameters do not include all aspects what citizens include in their thinking of what the condition is. This leads often to misunderstanding. Looking backward, there is no single piece of information which would have proved to make a breakthrough. Information about road condition, maintenance backlog, increasing maintenance cost, user satisfaction, road user costs, etc., have been tried but with no major success. In order to get success among executive management and elected officials, the most effective information is logical, simple, fact based, non-technical and consistent information of funding needs, road condition and impacts to road users. Focus on "simplifying the message" in order to not be too technical in communicating condition

In Denmark, the most effective information has changed quite a bit over time. In general it has changed from technical parameters to "money". Technical parameters are not "understood" by other than engineers.

Still, technical parameters are of interest for contractors, and are provided by web-solutions as in Norway and Sweden.

Even if there is a trend towards electronic information, annual reports about Pavement condition works well in Denmark and Norway.

Other means of communications are:

- Focus/discussion groups, e.g. residents, schools, local industry have worked extremely well (discussion topic is usually "where are the biggest problems", but there is a good chance to convey information of our strategies)
- Nationwide Road User Satisfaction Surveys
- Newspapers, periodicals, etc. seem to be too slow in todays' society – as well as fairs/exhibitions,
- Web pages and newsletters (targeted ones) work well as in Norway where a detailed paving program, including maps is published on a website
- Direct feedback from road users through telephone, e-mail and internet – also through media (mainly newspapers)
- Occasionally: panel studies, qualitative research
- Communication is based on facts, thus it should be consistent. Consistent information in important in all communication, which means a bit more coordination, regulation and guidelines from the top management

12 CONCLUSION

There are some differences between the Nordic countries but also many similar problems. One thing that is apparent is that the focus has moved from solution of technical problems

towards problems in communication, both within a road authority as well as externally. The focus is less on technical parameters; it is more on how to transfer the technical parameters to something that can be understood by non-engineers, top managers, politicians and road users. However, there is still a need to improve methods to measure and analyze in order to get a better support for decisions in Pavement Management.

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