Quality Monitoring in Winter Maintenance Management at the Finnish National Road Administration

Helsinki 1994

Finnish National
Road Administration

Quality Monitoring in Winter Maintenance Management at the Finnish National Road Administration

Finnish National
Road Administration

Helsinki 1994

Finnish National
Road Administration
Opastinsilta 12 A
P.O. Box 33
FIN-00521 HELSINKI
FINLAND

PAINATUSKESKUS OY, HELSINKI 1994

1 PRINCIPLES OF WINTER MAINTENANCE QUALITY STANDARDS

The results of routine maintenance activities are the quality and the level of service that is provided for road users. The classification of the quality standards is based on traffic volume and the type of road to ensure the best possible cost-benefit ratio for the activities. (Appendix 1)

The quality standards are defined by traffic needs and available funds, based on an optimum that is derived from cost-benefit principle. The level of service provided for a given road class or traffic volume and the steepness of the steps between maintenance classes form the backbone of the winter maintenance policy.

The quality of winter maintenance in Finland is defined by three variables: friction, snow conditions, and evenness. (Appendix 2.)

The quality standards also define the cycle time, which is the length of time during which the condition of a road must be restored to its required quality. Because it is not worthwhile to maintain the required quality for all road classes throughout the full 24-hour period every day, the applicable period is also defined in the quality standards. This is a question of defining the period (e.g., in the middle of the night) during which the quality level is allowed to temporarily go below the required level.

Part of the winter is quite cold in Finland and the sun does not warm the surface of the road as much as it does farther south. Therefore, it is not always possible to use salt to prevent slipperiness. The friction requirement of busy main roads that are supposed to have a bare surface is temperature-dependent. The friction requirement is less severe when the temperature is continuously below a specific limit. This requirement is also necessary to ensure that the results of quality monitoring are compared to the correct value.

Continuous fluctuation in the weather and readiness and cycle times required by maintenance activities mean that the required quality level cannot be reached 100% of the time. Winter maintenance quality monitoring (explained in detail in section 3) uses random sampling to observe the realization rate (%) of the required technical quality level by road class (maintenance class). The resulting realization rate (%) indicates what part of the time the road meets the set standards. When the observations are distributed so that they correspond to the distribution of traffic, a picture is formed of maintenance quality that represents the average road user's point of view.

2 QUALITY AS A CRITERION AND TARGET OF RESULT-ORIENTED CONTROL

FinnRA's management principle is result-oriented. Road management is divided into products that FinnRA's central administration purchases from regions. FinnRA agrees upon annual result targets and financing with the Ministry of Transport and Communication. Winter maintenance is one product and a FinnRA-level target has been set for it.

FinnRA's directorate defines and approves the winter maintenance policy that defines the level of service to be provided for road users and the necessary quality standards. Though this policy defines the level of service during the winter months for the whole road network, it is not officially handled or approved by the Ministry of Transport and Communication. The basic policy has remained unchanged for quite a long time and has thereby also been generally accepted at the higher level.

The goal of result-oriented management is to encourage activity that follows policy lines so that FinnRA can implement the required result (level of service) as economically as possible. Economically does not only mean achieving as low a cost level as possible, but it also means that FinnRA's financial performance is good. The annual target result of winter maintenance is to achieve a certain percentage (88 %) of the quality standards on the main road network. The financial performance requirement is defined by the financial performance of road management as a whole, without separate mention of winter maintenance.

Result-oriented management within FinnRA is presently implemented with a so called production agreement method in which the central administration purchases road keeping activities as products from the road districts. Winter maintenance is one of these products. The quality standards described in section 1 are presented in a winter maintenance production agreement and the previous invitation to tender. The actual quality is observed with the help of quality monitoring by district that is focused on the roads with highest volumes (maintenance classes Isk...I). 60 % of the traffic moves along these roads. The tender price is also given by maintenance class so that the price can be compared in different districts.

The agreement also defines the basis for a decrease in value in case the road district does not achieve the required quality realization rate (%). The agreement contains a clause for an unusually mild or severe winter that lowers or raises the agreed price by 10 % if the degree of severity of the winter (weather index value) deviates 20 % from its normal value.

The road districts differ from each other in both the structure of their road networks and their climate. Therefore, the winter maintenance quality

realization rate (%) and the related requirements are agreed upon with each district separately. These principles are discussed in more detail in section 3.

3 QUALITY MONITORING OF WINTER MAINTENANCE

Quality monitoring of winter maintenance was developed and implemented in Finland in the early 1980's. At that time, control of activities placed the most emphasis on cost, especially in monitoring. Quality monitoring was implemented to ensure that the maintenance result was realized and that it fulfilled the quality standards. Only then it was seen possible to evaluate activity by using cost-based numbers. From then on quality monitoring has been basically the same. The structure of the quality standards has also remained the same, although they have been modified, especially during the last five years. The randomness and accuracy of quality monitoring have also been improved.

Quality monitoring utilizes measurements based on random sampling in order to decide how well the road network and its various parts fulfill the required technical quality standards (friction, snow conditions, evenness). The road meets the set quality standards only if the requirements of friction, snow conditions, and evenness are all met simultaneously.

The technical quality level of winter maintenance is classified with a 5-step scale presented in table 2. The limit values for slipperiness, snow conditions, and evenness are presented for each quality value. The quality required for a road is agreed upon according to the scale. For example, busy main roads must meet quality level 4 for all the parameters and the most quiet roads must meet level 2. During quality monitoring the quality value of a road is defined based on observations.

Quality monitoring today is organized by road district. In the 1980's, organizing was done by roadmaster district and the monitoring was done by the district roadmaster at certain times each week. According to present monitoring practice, the road district has one or more monitoring patrols that drive a randomly selected (drawn by lot) route at a randomly selected time on five randomly selected days of the week. (Appendix 3.)

The patrol route lasts about 8 hours. The quality of the road is evaluated every 2 km. Snow conditions and evenness are estimated visually and friction is measured with a friction meter installed on the vehicle. Most of the available friction meters measure deceleration during braking, and therefore this measurement cannot always be taken due to busy traffic. The visual evaluations of snow conditions and evenness are practiced beforehand. The observations are made daily between 5:00 and 21:00. The starting times of the routes are selected so that the number of observations per day would correspond as nearly as possible to the daily distribution of traffic.

The routes are carefully planned beforehand to ensure that the observations are randomly distributed. The goal is that the observations made at different times are randomly distributed evenly among the different parts of the road district and different classes of roads. This is necessary because the condition of the roads varies at different times of the day due to the weather.

The quality monitor records the results of the observations every two kilometers. Because of the simplicity of the monitoring process, the information can be recorded with a dictating machine or on paper. At the district office the information is entered into a microcomputer program called "Kuntopiste". The program outputs various reports that show the distribution of the road's condition (condition values 1...5) by road class, road management area, and month. The program also calculates the effectuation percentage.

4 FROM MONITORING INFORMATION TO AN ANNUAL TARGET

The winter maintenance quality standards are defined by road class (maintenance class), as was explained in section 1. These standards, which together form the general policy for winter maintenance, also function as operative maintenance guidelines.

Result-oriented control is based on quality realization rates (%) (Appendix 4) by road class that are obtained through monitoring. To facilitate the use of a single indicator [realization rates (%)] for the whole road network at both the district and FinnRA level, the final effectuation percentage is calculated from the weighted average of the results per maintenance class. Due to the quality standards of the different maintenance classes and especially due to the different traffic volumes, the actual quality is different for roads in different classes. Busy traffic makes it easier to keep the surface of the road bare. Traffic enhances the effect of salt and studded tires wear away any ice that may form on the surface.

The weighted average value is calculated with values obtained from maintenance class road lengths and traffic, with traffic weighted by 2/3 and road length by 1/3. Because the road network in different districts is distributed differently among the various maintenance classes, the realization rates (%) in the different districts are not the same, though they may be the same by maintenance class in all parts of the country.

The results of quality monitoring and annual targets indicate the average service level that FinnRA provides for road users. The monitoring viewpoint is the viewpoint of the road user. Monitoring at this level is always dependent on the existing conditions, especially the weather and the multitude of changes that the weather causes to road conditions. The situation is complicated further by the fact that the quality of roads that are to be kept

bare is dependent on the salting temperature limits; the requirements are not as severe when the temperature drops below the limit. This means that the results of quality monitoring (their numerical values) vary according to area and time. The weather, which the road manager has no control over, is problematic in result-oriented control because it has an effect on the results.

To erase these random changes, monitoring should be focused on situations in which the weather changes and on the success of actual maintenance activities. Quality control will most likely be developed in this direction. As the roles of the producer and purchaser become more divergent and production is increasingly taken care of by private companies or later by FinnRA's own production organization, quality monitoring must be able to serve both result-oriented control and contracting. The accuracy of monitoring will also become more important as quality is monitored more precisely in the future than it is at the present district level (e.g., by contract).

WINTER MAINTENANCE QUALITY STANDARDS

HIGHWAY WINTER MAINTENANCE CLASSIFICATION

ADT	TRUNK ROADS	MAIN ROADS	REGIONAL ROADS	CONNECTING ROADS
> 12000	Isk	Isk	Isk	Is
6000 - 12000	Is	Is	Is	I
3000 - 6000	I	I	I / Ib	Ib
1500 - 3000	I	Ib	Ib	Ib
500 - 1500	Ib	II	II	II
200 - 500	II	II	II	III
< 200		II	III	III
Pedestrian and Bicycle paths	IV	IV	IV	IV

Bare pavement roads

Snow surface roads during cold winter conditions

Snow surface roads

(See also table: Target condition values and cycle time)

HIGHWAY Class	TARGET Condition value	CYCLE TIME De-icing	Snow removal	Slush removal	Leveling
Isk	4	2 h	2,5 h	2,0 h	1 day
Is	4	2 h	2,5 h	2,0 h	1 day
I	4	2 h	3,0 h	2,5 h	1 day
Ib	4/3	3 h	3,0 h	3,0 h	1 day
II	3	4 h	4,0 h	4,0 h	3 days
III	2	6 h	6,0 h	6,0 h	5 days
IV	3	4 h	4,0 h	4,0 h	2 days

HIGHWAY CLASS	TARGET CONDITION VALUES APPLY	SALT USED WHEN WARMER THAN °C
Isk	24 h/day	-8°C
Is	24 h/day	-6°C
I	Always except for the silent night hours	-6°C
Ib	24 h/day for the value 3 Value 4 always except for the silent night hours	-2°C
II	On weekdays: from 6.00 to 22.00 hours During weekends: only daytime	-
III	On weekdays: from 6.00 to 22.00 hours During weekends: only daytime During other times value 2 applies to slipperiness - the allowed maximum snow depth is 10cm	-
IV	Same condition value applies as on adjacent roadway	

WINTER MAINTENANCE QUALITY CLASSIFICATION

	LEVEL OF SERVICE				
Quality class variable	1 Poor	2 Fair	3 Satisfactory	4 Good	5 Excellent
SLIPPERY CONDITION Skid number Road surface texture	0,00-015 Very icy driving or othervise very slippery	0,15-0,25 Dry ice or snow packed	0,25-0,30 Coarse ice or snow packed in cold weather	0,30-0,45 Bare and wet or packed snow between traffic ruts	0,45-1,0 Bare and dry
SNOW CONDITION Dry frozen snow Thawing snow Slush Drifting snow	> 50 mm > 40 mm > 30 mm Easy passage may be difficult in some places, car may become stuck in a snowdrift	< = 50 mm < = 40 mm < = 30 mm Drifting over the road or moderate snow layer at the road edges, driving speed must sometimes be reduced	< = 30 mm < = 25 mm < = 20 mm Drifting here and there over the road, driving speed has to be reduced in some cases	< = 20 mm < = 15 mm < = 10 mm Drifting here and there to the middle of the outermost traffic lane, generally no need to reduce the driving speed	- - - -
EVENNESS Ruts Other roughness	< 30 mm Path very uneven, possible projecting bumps, driving speed must be reduced and uneven spots avoided	< = 30 mm Plenty of worn spots or disturbing holes, driving speed must be reduced in some places	< = 20 mm Path even, possible unevenness does not actually disturb driving	< = 10 mm Thickness of path strips on the road portion under traffic < = 10 mm	- -

WINTER MAINTENANCE QUALITY MONITORING

MONITORING RESULTS

* road network quality distribution during the winter months
* realization of quality standards (realization rate [%])

ORGANIZATION OF MONITORING

* 1-3 patrols/road district
* observations on 5 days per week
* several patrol routes
* daily route drawn by lot
* daily variation in starting time of patrol

REQUIREMENT LEVEL

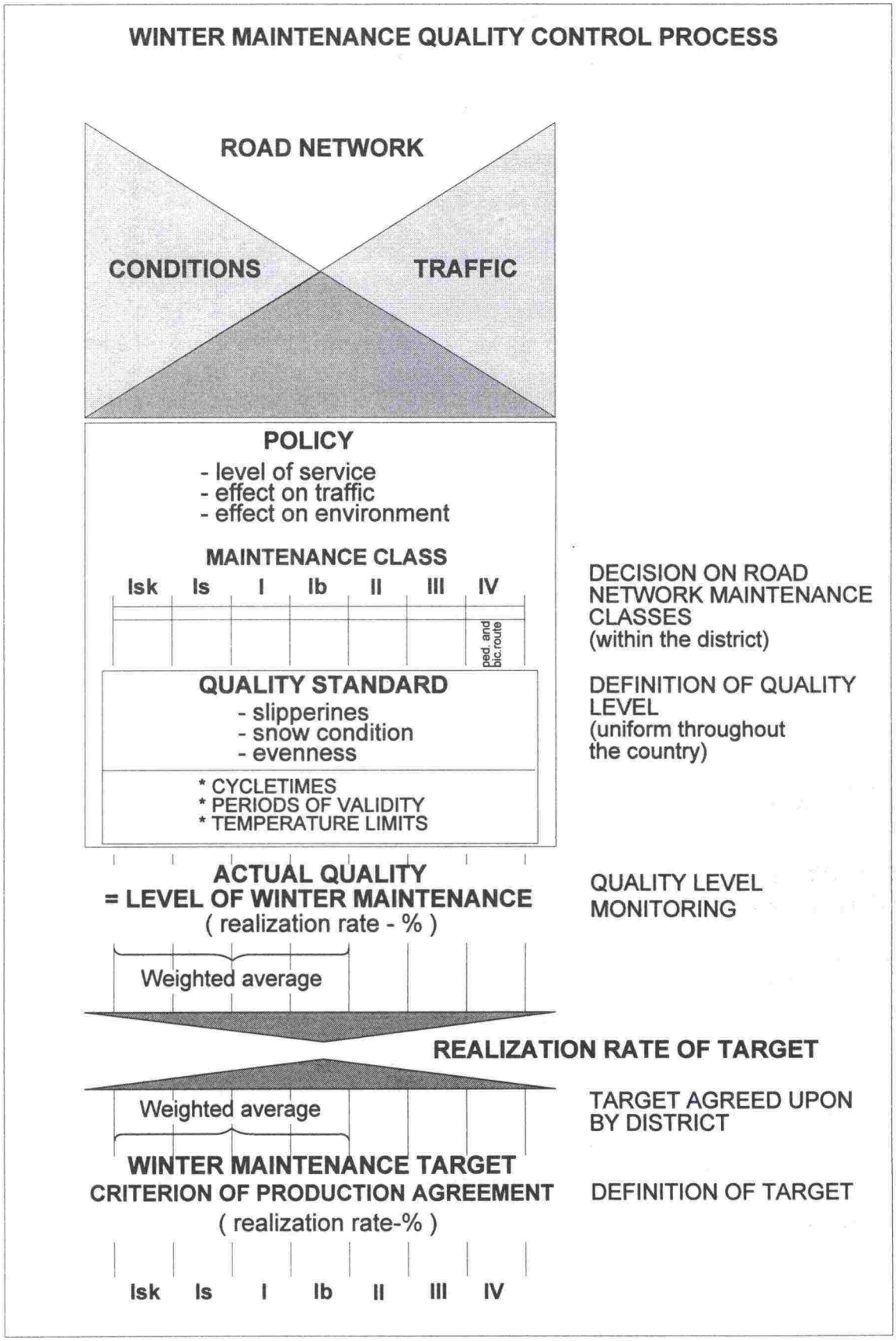
Selection of time and road
* randomness
* sufficient cover

OBSERVATION

* observations every 2km
  - quality standard parameters
    - slipperiness
    - snow condition
    - evenness
  - visual description
    - bare, dry
    - bare, wet
    - snowy
    - slushy
    - icy
* the quality value (1...5) is determined for each parameter
* the parameter with the poorest value determines the quality value of the road
* the result is recorded in a recording device in the vehicle

REPORTING

* reporting at the district level
* the information is entered into a"Kuntopiste" program
* reports
  - distribution of quality (1...5) and effectuation-%
    - by road class
    - by month
    - by region


WINTER MAINTENANCE QUALITY CONTROL PROCESS
ROAD NETWORK
CONDITIONS
TRAFFIC
POLICY
- level of service
- effect on traffic
- effect on environment
MAINTENANCE CLASS
Isk Is I Ib II III IV
ped. and bic.route
QUALITY STANDARD
- slipperines
- snow condition
- evenness
* CYCLETIMES
* PERIODS OF VALIDITY
* TEMPERATURE LIMITS
DECISION ON ROAD NETWORK MAINTENANCE CLASSES (within the district)
DEFINITION OF QUALITY LEVEL (uniform throughout the country)
ACTUAL QUALITY
= LEVEL OF WINTER MAINTENANCE
(realization rate - %)
Weighted average
QUALITY LEVEL MONITORING
REALIZATION RATE OF TARGET
Weighted average
TARGET AGREED UPON BY DISTRICT
WINTER MAINTENANCE TARGET
CRITERION OF PRODUCTION AGREEMENT
(realization rate-%)
DEFINITION OF TARGET
Isk Is I Ib II III IV