Supporting IT system for Road Weather Quality Management

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1 Introduction

Finland's Road Weather Information System (RWIS) has been developed as a winter maintenance tool already since the mid-1980s. Utilization of road weather data has increased considerably in recent years not only in traditional applications, but also in traffic informing and control of variable traffic signs. During the past few years winter maintenance of roads has been transferred from the Finnish Road Administration (Finnra) to external contractors, and road weather data is increasingly being used in services directed toward road users. The significance, availability and validity of road weather data is becoming more and more important. To address these needs, creation of a quality management system (QMS) for road weather data and the RWIS was started in the autumn of 2002. Already in the beginning it was clear that the introduction of a QMS and its integration as a part of daily routines would require the support of a quality information system. Construction of the Road Weather Quality Information System (RWQIS) began in the spring of 2003.

2 RWIS in Finland

The RWIS developed by the Finnish Road Administration comprises road weather stations and cameras that observe weather and road conditions, computers that gather and analyze data, centralized data banks and users' graphical workstations. The Finnish RWIS also includes road weather predictions and rain radar and satellite images purchased from external sources.

The purpose of the RWIS is to provide winter road maintenance with information about weather and road conditions on the road network in winter. The system facilitates more correct timing of maintenance procedures and optimal use of anti-slipping agents. Another task of the system is to also provide weather and road condition information to road users. Nevertheless, the system offers the greatest calculated benefit as a winter maintenance tool. The system also produces automatic speed limit and information recommendations for controlling variable traffic signs. The intent is to make traffic safer and smoother.

3 Changes in contracting

The RWIS was originally developed for the needs of winter road maintenance. At the end of the 1980s, when larger-scale development of the Finnish RWIS began, road maintenance comprised around 150 regional districts. In winter nearly all the districts employed weather observers. By patrolling on the road, the weather observers acquired information about the weather in their own districts, but only in their own districts. It was possible that the weather observer was ignorant of completely different weather conditions only a few kilometers away.

As the network of road weather stations expanded and became denser, the RWIS began to provide a more accurate picture of the weather and road conditions throughout Finland, so it was no longer necessary to have 150 weather observers monitoring changes in the weather during evenings and weekends. In the beginning of the 1990s a road weather center was set up in each of the nine regions to monitor weather and road conditions in the region. With the development of the road weather system the weather observers had an overall picture of changes in the weather, movement of areas of rain and snow, and the development of weather predictions.

In 1997-98, road planning, construction and maintenance were separated into their own Production unit within the Finnish National Road Administration of that time. At the same time the number of road weather centers decreased to six. Currently the Production unit, which became today's Finnish Road Enterprise, has only four road weather centers left. Thus, the size of the area monitored by each center has naturally grown considerably.

Around the turn of the millennium some of the maintenance areas were opened to competitive bidding, whereupon completely new enterprises have begun taking care of maintenance (in the winter of 2003-04 there are seven enterprises in addition to the Finnish Road Enterprise). These new maintenance contractors did not previously have their own road weather centers. At the same time, however, 'Suomen Kelitieto', a private company that provides road weather center services, was established. The new contractors began using the services of the new company.

In 2004 the remaining contract areas will get contractors on the basis of open competition. During the transition period the Finnish Road Enterprise got part of the contracts as negotiated contracts without competitive bidding.

4 Development of informing

With the establishment of the road weather centers, informing road users about weather and road conditions gradually began to become common. At first informing was limited to periods of congestion during holidays or problematic road conditions caused by major weather disturbances. Gradually informing began to increase.

When road maintenance was finally separated from Finnra to the Finnish Road Enterprise, the road weather centers began to focus on maintenance tasks. Finnra was left with the responsibility of informing, for which reason nine traffic centers were established under Finnra. As the traffic centers developed, their range of tasks expanded continuously. In addition to informing about weather and road conditions, their tasks include informing about road work, accidents, other permanent or temporary traffic incidents, weight limits on frost-damaged roads, etc., in their regions.

In the summer of 2003 the Traffic Center was separated into its own profit unit within Finnra and four points of operation was established.

In the early 2000s external players also began to participate in informing. By utilizing road weather data and road condition camera images they have developed various data services for the Internet and mobile communicators capable of displaying graphical information.

5 The need to specify and itemize the quality of road weather data

A contractor is able to lower the price of a maintenance area contract if the contractor always has access to reliable information about developments and changes in the weather and road conditions prior to a moment of observation and reliable predictions regarding the weather in the near future. The contractor must also be able to somehow indicate the reliability and quality of the information before it can have an impact on the price. Likewise, the need to indicate the correctness of road weather data and the functionality of the system has increased considerably with the entry of new contractors and the increased size of the observation areas.

The use of road weather data to control automatically variable traffic and information signs on weather-controlled roads as well as continuously expanding use of road weather data in various types of informing have also contributed to the need to obtain information about the reliability of road weather data.

In the beginning of the 2000s it was decided to create a QMS for the road weather data and the RWIS. The work started with a preliminary study to examine the QMS in general, to determine and document the current state of the Finnish RWIS and road weather data. On this basis implementation of the actual QMS and its quality manual and appendices was started in 2002.

6 QMS for road weather data

The purpose of the road weather QMS is to assure the quality of road weather data by assuring the quality of the production process.

In principle, road weather data can be verified by making reference measurements. However, this is not possible in practice due to the large number of stations and the continuous collection of data. Another way to verify the information is to compare it with information from surrounding stations. This method only catches major errors in a station’s information.

The only reasonable way to assure the quality of road weather data is to control the production of the information and the chain of production, beginning with careful installation of the stations, regular maintenance of the stations and sensors, etc. Nevertheless, user input is always needed in order to detect faulty station data. The user has a sense of the correctness of the station’s data. The user is able to compare the station’s data with information from other sources and is aware of the station’s history.

The core of the road weather QMS consists of collecting information about the quality of road weather data and the functionality of the system’s different components.

The first version of the QMS was completed in May 2003. Naturally, completion of the QMS's documentation is not enough, but the entire QMS will be taken into use in 2003-04. When it is taken into use, the issues included in the QMS will become a part of daily routines.

7 Road Weather Quality Information System (RWQIS)

The RWQIS makes it possible to begin using the QMS in the production process of the road weather data. The RWQIS supports quality control and quality reporting related to the QMS. With the RWQIS, users are better able to assess the reliability of road weather data. The RWQIS promotes more efficient use of resources in the RWIS. The degree of use of road weather stations and other components can be raised and personnel resources can be allocated more sensibly.

The interest groups involved with the RWQIS are:

- Internal and external customers of the road weather data
- The persons appointed to the quality organization related to the road weather QMS
- Responsible persons of the RWIS
- The staff of traffic centers
- Maintenance and repair service providers of the RWIS (incl. observation stations and cameras)
- Transport Services process managers at Finnra

7.1 RWQIS project

The project for creating a quality information system that supports the road weather QMS was started in late spring of 2003. The project RWQIS has gone ahead and it consists of the following phases:

1. Functional specification of the system
2. Technical planning
3. Implementation of processing of faulty data
4. Implementation of processing of metadata and monitoring of functionality
5. Implementation of maintenance reporting and automatic testing of data
6. Commissioning of the system

The RWQIS will be taken into use in phases during the winter of 2003-2004. The entire RWQIS will be in use by the autumn of 2004. The system will be taken into use everywhere at Finnra at the same time. Six days of training will be arranged for users. The most important user groups are the staff of Finnra's traffic centers, the staff of the road weather centers of winter maintenance contractors, and the persons who maintain the road weather stations and road condition cameras. The total cost of the RWQIS project, not including Finnra's own work, is around 75,000 €.

7.2 Description of the RWQIS

Thus, the RWQIS is an information system that supports Finnra's road weather QMS. The RWQIS

- performs quality-related verifications of the road weather data and the RWIS
- supports execution of quality assurance procedures, such as repairing, thereby increasing the quality of information and the degree of use of the RWIS
- makes it possible to constantly monitor and indicate the quality of road weather data and the functioning of the RWIS
- makes it possible to further develop the quality of road weather data over the long term, based on documented quality information.

The RWQIS includes all the information that describes the quality of road weather data, which users of road weather data and other interest groups need in order to assess the reliability and usability of individual pieces of information for a given purpose, as well as the functionality of the RWIS. This data includes:

- Metadata that describes a station's relatively permanent characteristics, such as location, sensor equipment, and sensor placement. Metadata is needed especially to assess the generalizability of data received from a station over a wider area.
- Results of verifications of measurement data as well as fault and repair data that indicate the functionality and maintenance situation of the stations and the RWIS. The reliability of the measurement data can be assessed on the basis of this information. Fault data is also used to control maintenance operation and to assess the functionality of the RWIS.
- Other records that the management, quality manager and quality team of Finnra's Transport Services need to monitor and indicate quality.

Monitoring the quality of road weather data is important not only for the persons responsible for the RWIS, but also and above all for the users of road weather data. Due to its nature, road weather data can never be proved to be entirely correct, nor can verifications done automatically or by responsible persons catch all error situations. For this reason the RWQIS is as transparent as possible from the user's viewpoint, so that the user of the data has access to all the available data on which basis the user can also assess the quality of the measurement data himself. The RWQIS also offers the user of the data tools with which to report detected problems to the RWIS's responsible persons and to observe how necessary repairs are progressing.

The RWQIS functions integrally with the RWIS. Part of the quality information is automatically produced in conjunction with normal operation of the RWIS, and part of the collected information is also visible to the user alongside road weather data. Part of the RWQIS is realized with minor modifications of existing software, while part of the system requires separate information input and viewing application.

7.2.1 Processing of metadata

Metadata refers to data that describes the relatively permanent characteristics of a road weather station or road condition camera, such as location, equipment, etc. Part of the metadata is created already when the station is being designed. At that time the reasons for the necessity and location of the station are recorded. Likewise, the equipment of the station is

recorded. The metadata is supplemented in conjunction with the installation of the station and during the installation inspection when the installation is finished. All special factors that affect measurement are recorded during the inspection. The metadata is updated on the basis of changes noticed in conjunction with repairs and annual inspections. The history of changes in the metadata is archived.

Updating metadata. Metadata is updated using a separate updating application.

Viewing metadata. The user of road weather data can view the data using expansions of existing visualization applications.

Archiving metadata. Metadata is archived along with road weather data in a metadata database. The history of changes is also archived.

7.2.2 Processing fault and repair data

Fault data indicate different types of problem situations or suspected faults in the components of the RWIS. A component can be a hardware or software component. Repair data show the repair history of a component.

Measurement data can be observed to be faulty by comparing it with information acquired from another source. If the measurement data disagrees often with other information, there is reason to suspect that the measurement data is faulty. Information from another source may be measurement data from other sensors of the same station or other stations or individual observations on the road. Some of the comparisons can be described as accurate deduction rules, but others are so heuristic by nature that they are difficult or impossible to automate.

Automatic verifications of the RWIS. Fault data or a suspected fault may be created automatically as a result of automatic verifications added to the RWIS. Deduction rules used in verifications are not a part of the application logic. Decisions are made using a recommendation and alarm calculation application, which will be developed further as needed.

Entry of suspected faults. Fault data entered by the users of the data as well as part of the problems detected by automatic verifications are classified as suspected faults until the responsible persons have determined that they are faults that require repairs. Suspected faults are also made known to the providers of repair services.

The users of or the responsible persons for road weather data enter the fault data using expansions of existing visualization applications.

Verification of faults. Faults are verified by the persons responsible for the road weather stations and RWIS.

Sending a request for repair. When a fault is verified, the persons responsible for the road weather stations or system send a request for repair by means of the system. A record of the request is left in the database.

Receiving a request for repair. The providers of repair services acknowledge the receipt of a request for repair.

Repair reports. Completed repairs are reported into the system.

Acknowledgement of repairs. The persons responsible for the road weather stations or RWIS change the status of the component to normal only after its functioning has been monitored sufficiently after the repair.

Viewing repair and fault data. In existing user interface applications the station-specific fault situation is visible to the users together with the measurement data and camera images. The fault data has five different statuses:

- problem or suspected fault
- confirmed fault
- request for repair sent
- repair completed
- in operating condition.

The users can also view more detailed information about the type of fault.

Updating basic repair data. There are two kinds of basic repair data: basic data related to station-specific repairs (repair metadata) and basic data of repair service providers.

The basic data of repair service providers are their name, address, phone and email address.

Summary reports. The persons responsible for the road weather stations and the RWIS can run summary reports of repair and fault data.

Archiving repair and fault data. Repair and fault data are stored in a database, where they are saved until the beginning of the next winter season. After that the data are archived.

7.2.3 Processing of other records

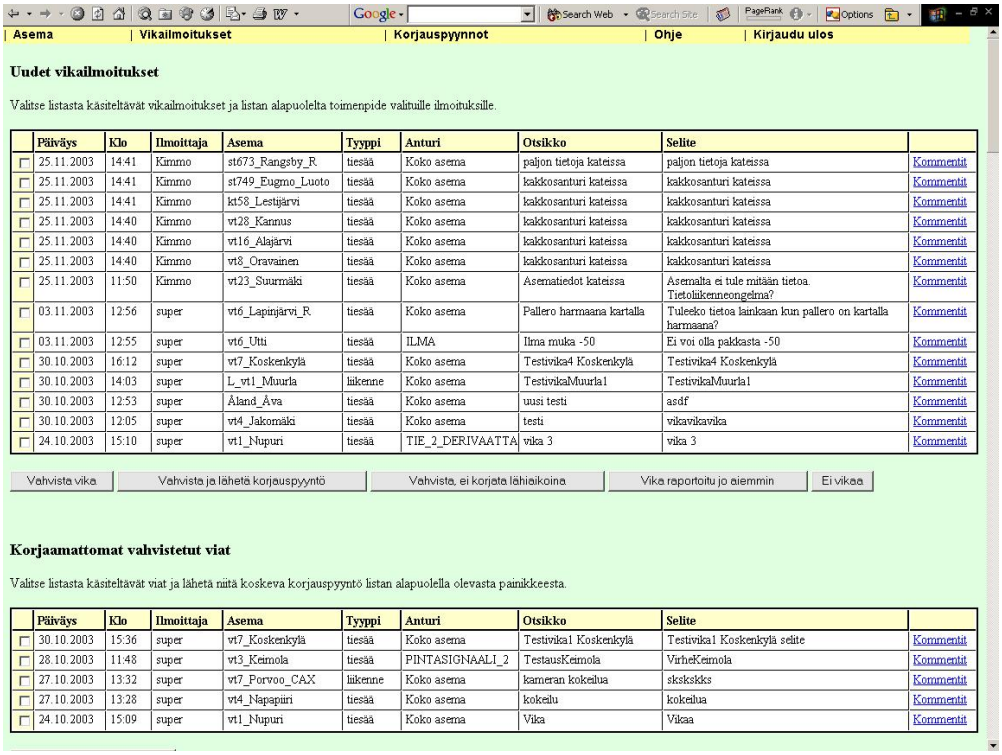
Other records and documents are included in the document file as links. The files are centrally saved in a separately agreed location.

7.2.4 User interface

The user interface of the RWQIS is a form-based Windows application. The users use the road weather application to select the desired road weather station or road condition camera and enters a suspected fault, request for repair, repair report or approval of a repair for that station (Fig. 1). The status of the possible fault data of the road weather stations is visible to the users in the familiar road weather application (Fig. 2).

8 Experiences

Already during the early phase in the autumn of 2003 it is apparent that taking the RWQIS into use at Finnra and the contractors involved with the system is a major, demanding operation. A large group of users needs to be trained. The users must become familiar with the technical operation of the system, but above all, the system must become a part of daily work routines.



Asema	Vikailmoitukset	Korjauspyynnot	Ohje	Kirjaudu ulos

Uudet vikailmoitukset

Valitse listasta käsiteltävät vikailmoitukset ja listan alapuolelta toimenpide valituille ilmoituksille.

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☐	25.11.2003	14:41	Kimmo	st749_Eugmo_Luoto	tiesää	Koko asema	kakkosanturi kateissa	kakkosanturi kateissa	Kommentit
☐	25.11.2003	14:41	Kimmo	kt58_Lestijärvi	tiesää	Koko asema	kakkosanturi kateissa	kakkosanturi kateissa	Kommentit
☐	25.11.2003	14:40	Kimmo	vt28_Kannus	tiesää	Koko asema	kakkosanturi kateissa	kakkosanturi kateissa	Kommentit
☐	25.11.2003	14:40	Kimmo	vt16_Alajärvi	tiesää	Koko asema	kakkosanturi kateissa	kakkosanturi kateissa	Kommentit
☐	25.11.2003	14:40	Kimmo	vt8_Oravainen	tiesää	Koko asema	kakkosanturi kateissa	kakkosanturi kateissa	Kommentit
☐	25.11.2003	11:50	Kimmo	vt23_Suurmäki	tiesää	Koko asema	Asematiedot kateissa	Asemalta ei tule mitään tietoa. Tietoliikenneongelma?	Kommentit
☐	03.11.2003	12:56	super	vt6_Lapinjärvi_R	tiesää	Koko asema	Pallero harmaana kartalla	Tuleeko tietoa lainkaan kun pallero on kartalla harmaana?	Kommentit
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☐	24.10.2003	15:10	super	vt1_Nupuri	tiesää	TIE_2_DERIVAATTA	vika 3	vika 3	Kommentit

Vahvista vika | Vahvista ja lähetä korjauspyyntö | Vahvista, ei korjata lähiaikoina | Vika raportoitu jo aiemmin | Ei vikaa

Korjaamattomat vahvistetut viat

Valitse listasta käsiteltävät viat ja lähetä niitä koskeva korjauspyyntö listan alapuolella olevasta painikkeesta.

	Päiväys	Klo	Ilmoittaja	Asema	Tyyppi	Anturi	Otsikko	Selite	
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Figure 1. Verifying the status of all stations

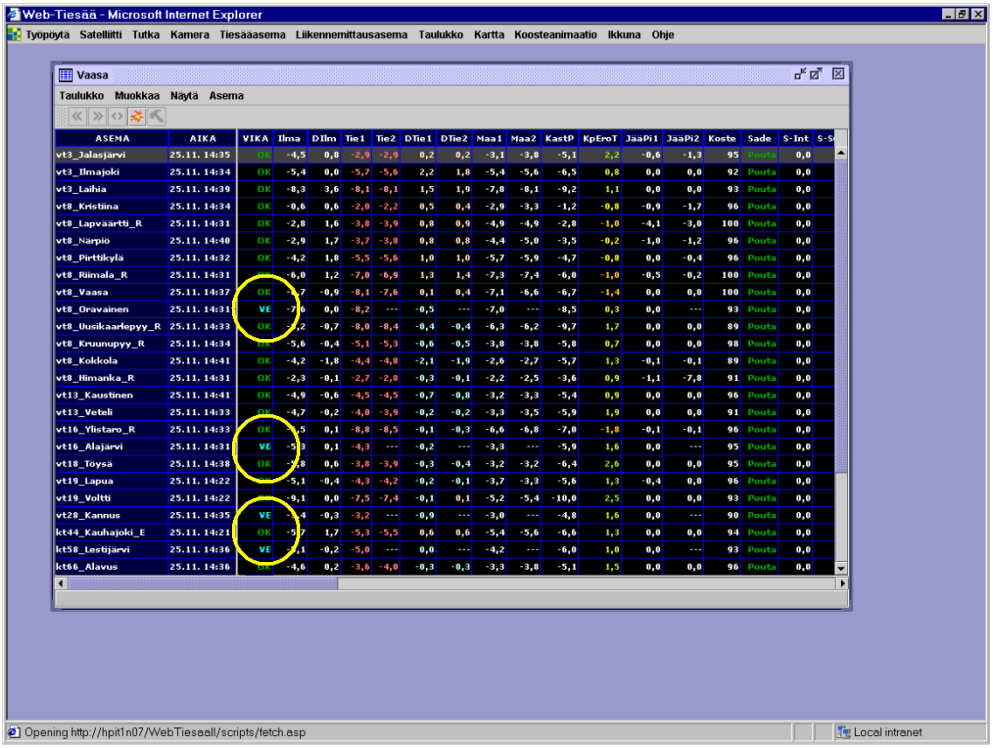

Figure 2. Presenting the status of a station as sensor data