MULTIFUNCTIONAL SOFTWARE FOR WINTER SERVICEABILITY MANAGEMENT

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ABSTRACT

The DIR Est carried out a multifunctional software for serviceability management. It satisfies the needs of managers of road networks, users and authorities by planning the level of road monitoring in accordance to weather and to traffic conditions. Patrols key in road conditions in real time and the software performs syntheses that are available for officials as well as for authorities. The decision making for spreading actions is then followed thanks to this software. The whole information is available at any place through an Internet website. So the relevant information can be displayed to road users. Finally, data backup allows post-analysis including the winter's characterization and the road manager activities' assessment.

KEYWORDS

WINTER MAINTENANCE / TOOL / MANAGEMENT / SOFTWARE / EXTRANET

1. CONTEXT

Since reorganization of road services in 2007, the national road network is managed for the non-granted stretches by eleven Direction Interdépartementale des Routes (interdepartement road directorates / DIRs). DIR Est, located in the north-east of France, is one of them. The nature and extent of the road network to manage has significantly changed : the 1660 km of network is now linear and no more meshed, included in a square of 400 km of side. The corresponding treatment surface during winter maintenance is quite 23 200 000 sq m.

Beyond the simple elongation of the territory, significant disparities occur in terms of both geography and climatic conditions, with areas of plains, mountains and plateaus.

2. WINTER MAINTENANCE MAIN CONCERNS

In a general approach, winter serviceability combines the winter maintenance, user information, traffic management and associates developers, contractors, stakeholders and users. The police and the prefectural authorities are also involved. The main concerns are the safety of people and traffic flow, particularly of heavy goods vehicles but also control of costs and preservation of environment and infrastructure.

To address these issues during the winter, road managers define an organization of their winter maintenance which results in different operational stages :

• Network overseeing that is used to monitor weather conditions and their impact on the road. It is completed by weather forecasts to anticipate road-weather

phenomena. The results of this surveillance, which are observed or measured, are a collection of valuable data to decide which actions have to be taken on the road and what is the best way to inform users

- Spreading actions (ploughing, salting) that result in an improved sustainability expected by users. Here again, the results of these actions are important to report to the contractor as well as to inform users.
- Dissemination of understandable information to users on the network status so that drivers must adapt their driving behaviour, including equipping their vehicles or changing the course of their journey (postponement, change of route,...).

To ensure a level of service quite homogeneous or consistent on its roads with cost control, the DIR has therefore developed a management tool of winter maintenance taking into account the recommendations of a methodological guide from SETRA [1].

3. SOFTWARE DESCRIPTION

3.1. Organization of DIR Est

The winter maintenance is described in the framework Dossier d'Organisation de la Viabilité Hivernale (Organization Document for Winter Maintenance / DOVH). This document specifies the organization of the winter maintenance, of work, and specifies the objectives of service levels and the resources used both material and human. Thus, three hierarchical levels are defined by DIR Est, because of the expand of the territory:

- The 3 Divisions d'exploitation (Operating divisions/DE), each assisted by a Centre d'Ingénierie, de Sécurité et de Gestion du Trafic (Traffic Management, Safety and Engineering Centres / CISGT)
- The 7 Districts
- The 28 Centres d'Entretien et d'Intervention (Maintenance and Intervention Centres / CEI).

This document, developed from the methodological guide mentioned above, defines three types of actions to make before intervention :

- taking into account the weather
- collecting information on road network
- choosing the type of intervention.

These activities correspond to three levels of decision staggered with increasingly short deadlines. These decisions and activities are represented below:



Figure 1 : Decision process

The management tool of winter maintenance is called "VH website". It can support various actions and decisions identified above. It helps in optimizing the whole process, particularly at the "feedback" but do not manage working time. Moreover the weather watch is not integrated nowadays.

This tool could end up thanks to new information and communication technologies. Each actor in the winter maintenance can access from any computer connected to the Internet to this tool and may fill in or consult. Thus, whatever his rank, whoever official or responsible can access to the same information simultaneously.



Figure 2 : actors and means of keyboard and display

Different means of mobile keyboard have been tested in order to further reduce the time within feedback information is given. Thus officials have mobile phones at their disposal so they can key in near real time road and circulation conditions. A type-in window was developed in order to facilitate the data entry (a specific data entry form to minimize loading time). However, the display's surface is reported to be too small and the data capture may be difficult, even with a stylus. So other options have been considered, such as netbooks or tabletPCs. The first tests with netbooks have been made, and the screen's size is appreciated. However, the potential fragility of this solution could not be assessed.

The use of laptops is going to increase and a more complete study is started on the subject. The aim is to streamline costs by standardizing the fleet of equipments and optimizing their use because the winter maintenance laptops are only used for six months.

Besides the modules for the various activities, the tool allows archiving all the data acquired and decisions taken. It is also a useful complement to the log book towards the legal risk.

3.2. Software architecture



Figure 3 – winter maintenance software architecture

This management's tool of winter has been fully carried out internally. The integration of external equipments or services required the development of application programming interface. The design, implementation and integration of this tool allow both maintenance and upgrade at lower costs.

3.3. Modules' description

These modules are described below. The information required for these modules (input data) and associated reviews (output data) are explained simultaneously.

3.3.1. Meteorological Conference

The term "meteorological conference" covers the coordination carried out between the district and the CEIs of its area. The objectives are to :

- Identify alert levels and weather forecasts to take into account
- Formalize patrol's instructions and / or snow-clearing
- Inform the other entities (other CEIs, districts and CISGT)
- Ensure the traceability of decisions and their possible changes.

The actors of this action are in each district with the CEI which are attached. The CISGT is also consulted, particularly if main events or global disturbances are expected.

This coordination is made with the usual means (e-mailing, conference call) and is positioned on forecast as far as it is concerned. The input data used are:

- Weather forecasts
- Data from road weather information systems (RWIS)
- Road conditions and the interventions of the previous 24 hours.

This module is used to formalize the synthesis and the decision on surveillance of roads, the instructions given for the next night or for the following weekend.

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Figure 4 : meteorological conferences report

Before weekend, the instructions are given on Friday and cover the whole weekend until the following working day. On weekdays, the first instructions from the district to the CEIs are updated daily by 11h00 am, each CEI should have read before 3h00 pm. However, these instructions may be changed if the weather would change significantly.

All the instructions and their changes are timestamped and archived. They are addressed to intervention responsibles of CEIs and are then available to all actors in report form.

3.3.2. Road conditions

The road's assessment is fundamental to each player. It is necessary that there is a common language between road owners, operators and users. So levels of service that are independent of traffic and weather conditions have been defined.

The methodological guide SETRA [1] gives a unique reference of this practicality: the road conditions.



Figure 5 : road condition definition

It used the standard terminology for meteorological road NFP 99-320, which describes very precisely the state of pavement based on winter weather, but snow and ice were distinguished. The nature of weather itself and its impact on skid resistance which is offered to users result in different ways, thus snow and ice control are specific.

So it is from the state of road and the longitudinal section that winter road conditions are produced. In order to develop synthesis and to inform users, four levels are defined, and a colour code is associated.

Road conditions		General definition	Corresponding state of road				
			Black ice	Snow			
C1	Normale	No winter trap	None	None on the circulated road (eventually around)			
C2	Délicate	Local trap => little risk of jamming problem	Local frost, eventually patch of black ice	Thin fresh snow (< 5 cm) or melting snow or non frosted packed snow			
C3	Difficile	Visble danger => risk of important jamming	Generalized black ice	Fresh snow (10 to 20 cm) or packed and frosted snow or snowdrift			
C4	Impossible	Circulation possible only with special equipment	Thick generalized black ice	Thick fresh snow or frost rut or important snowdrift			

Table 1	:	road	conditions	determination

3.3.3. Road monitoring

The pavement condition is noticed by the intervention responsible when making a patrol then recorded with the software.

Starting from the selected state, a road condition is proposed and the intervention responsible keeps the possibility to change it in order to take into account particular local characteristics. After several winters, it turns out that automatically take into account the longitudinal section is neither desirable nor desired.

The entry form for road conditions is common with that of interventions and is illustrated in paragraph 3.3.5 below.

Road conditions can be displayed either as a table or on a map; on the latter, road conditions are represented with the same colour code as defined above, and the sections are lined with red if a removal turnout occur and with orange if it is a prevention one.

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Figure 6 : examples of road conditions synthesis

3.3.4. Specific areas' monitoring

So far, the sensitive areas of the network were at best equipped with RWIS. Without instrumentation, patrols were often increased in order to verify the practicability of these risk areas in accordance to the winter risks.

From this winter, the first security cameras have been deployed on some areas. These cameras differ from conventional monitoring traffic cameras by providing images via Internet to all officials involved in winter maintenance.



Figure 7 : security cameras on sensitive areas

They help to provide information to all players, from intervention responsible to the head office the DIR Est. They provide a display of these specifics areas in order to detect early either bad weather or lorries that could not progress anymore. Then officials can launch appropriate actions.

The images of cameras are also made available to users via Internet and to our partners. The sharing of common information flow is particularly important in times of crisis and it allows comprehending traffic conditions in those areas in addition to road conditions.

3.3.5. Spreading turnouts

The updated weather information but also RWIS data allow intervention responsible triggering road watch. In this way, the patrols are the first type of intervention. They permit to notice in situ pavement condition and to make local measures. By the way they even may check the circulation conditions.

During the patrol or at its end, the intervention responsible fills in road conditions of its dedicated network. These reports then allow him to trigger preventive or removal turnouts. In order to limit unnecessary browsing, these elements are combined in the same form. This joint layout has some advantages like displaying the consistency of information provided.

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Figure 8 : road conditions and turnouts fill in form

Besides this information reported by human actions, other data come automatically from tools based on global positioning systems, which are:

- Information and position of vehicles in intervention
- Emergency alarms
- Data from winter maintenance vehicles.

Patrol officials and drivers of winter maintenance vehicles intervene alone. Each vehicle involved in winter maintenance is located thanks the global positioning system in order to ensure their safety. It was also decided to equip officials with a personal safety device in case they have to leave their vehicle. An alarm is sent to the traffic management center either on a voluntary action of the official - pressing for more than two seconds on the call button for emergency - or automatically in case of pull off the cord or loss of verticality.

Interventions and automatic alarms are available to all staff but especially for the CISGT dedicated for the area. It can coordinate the various districts of its responsibility and manage information to broadcast to users via variable message signs and local radio stations.

Finally, various data are sent up from spreaders or ploughs, which are:

- Turn on or turn off the blade,
- Turn on or turn off the spreader,
- The width of spread,
- The rate of spread.

These data allow all players to follow not only the state of the network thanks to observations made by officials in intervention, but also the consumption of de-icing agent throughout the winter and therefore managers have a good knowledge of the stock status.

3.3.6. On-line help

On-line helps include:

- Online help to clarify the operating of the software
- Context-sensitive help to explain some fields
- Information refresh rate checking
- Consistency checking.

These last two items are additions from the 2009-2010 release. The first allows raising an alarm when the input data are more than 3 hours old while the second allows identifying inconsistencies entries. The inconsistencies checked include those between road conditions and turnouts (C1 and de-icing or C3 and no intervention for example). These checks enhance reliability of information.

3.3.7. Communication

From the information collected, communication with different partners becomes easier. The Centre Régional d'Information et de Circulation Routière (Regional Centre of Road Circulation and Information / CRICR) was the first to receive information on road conditions. However, they need less accurate data. It was therefore necessary to create rules to aggregate the internal data of the software before transmitting. Thus, the "CRICR" sections include several sections "DIR" and do not include traffic directions. The road condition of a CRICR section is the worst road condition observed on the DIR sections. CRICR would then use this information to inform the users either with their "Bison Futé" Internet website or with radio bulletins.

As for turnout, traffic management centres can dispatch an appropriate piece of information to users during their trip by using variable message signs.

Finally, this software can display directly information to users thanks to websites. The relevant information displayed is the road conditions' map and cameras' pictures. The main goal of this dissemination is to make users more cautious. If conditions are very difficult, it gave them the opportunity to postpone their travel. The reliability and timeliness of information are crucial so that the information given to users have to be neither overly optimistic – not induce blockages - or too pessimistic so as not to block the economy of the area.

3.3.8. Archiving and end of year statements

All the information is archived as winter goes by. The accumulation is essential and gives the possibility of producing indicators used for winter assessment. These assessments allow optimizing a bit more the organization to the met phenomena. Towards the type of the stored data, these indicators can be of several kinds :

- time indicators
- space indicators
- qualification of the winter indicators
- "productivity" indicators, which include the obtained levels of service
- indicators linked to the work organization (and the way it fits for winter maintenance)
- economic indicators, including the consumption of de-icing agents.



Figure 9 : qualification of the winter and "productivity" indicators

4. TOOL'S ACCEPTANCE

During the first year, the deployment of this software caused some reluctance : on one hand to the appropriation of the software was not made yet, and on the other hand the tools based on global positioning system caused some apprehension. Yet officials benefit by a real training plan and a consciousness-raising campaign when the software was put in service.

However, reluctance has been gradually erased thanks to:

- Its flexibility of use : indeed, it is possible to consult or inform the software from any computer connected to the Internet
- Information sharing and the possibility to have a larger even complete view of the road network state
- The possibility gave to nearby centres to better coordinate.

In fact, as a common mean of communication, this software allowed officials to know how turnouts on the nearby centres progress, and thus feel less isolated than before. This loneliness was particularly felt during the first part of night.

The personal safety devices have been deployed on a district last year and its acceptance is not yet fully acquired.

Furthermore, this software was carried out within DIR Est and was developed by an incremental method. Officials could inform their requests for improvements which have been widely taken into account. Thus, this software was no longer felt as an imposed tool but as a tool built by them. It has then become "their" tool, and they could no longer do without.

Finally, the automatic aids proposed do not call into question the appropriateness of the actual organization but they reinforce the roles of different actors and their relationships.

5. PROSPECTS

The next developments aim at improving information broadcast to the general public as well as lessons learned made from crisis; replay solutions are even considered. Finally, the financial monitoring in "real time" and the end of year statements are to improve so that the management will get easier and easier.

The next developments relate to a greater involvement of the traffic management centres and to an enhanced assistance for turnouts.

For traffic management centres, the objective is to no longer distinguish traffic and road conditions but to provide circulation conditions. These must include weather and visibility. It is also considered to develop an aid decision-making module based on the thermal mapping.

The spreading actions will take into account the road residual salt in order to fix the width and rate of spread in accordance to the residual salt measured by the equipment itself. However, these studies are still under research and an operational implementation of this feature can not be considered before long-term.

6. CONCLUSION

The new information technologies and communications have helped make this management software which provides these main contributions:

- A faster feedback, more consistent and more reliable thanks to a significantly lower error rate and faster corrections (because they are detected more quickly)
- Post-analysis and assessments available in shorter time and with better quality
- Gains in safety for drivers
- Common and shared information, especially in times of crisis.

So all actors have the same information in real time whatever is their position in the organization.

With this tool, the DIR Est is no more crafts and become a professional winter maintainer : it controls costs, information delivered to the user and performance from the current situation to the crisis. This tool finally allows the evaluation of policy and of the set-up.

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