Winter Road Maintenance System

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VVHS is a data-base tool for improving winter maintenance and making it more effective. VVHS supports all sorts of work, including preseason planning, implementation of follow-up measures, and evaluation of completed work. During the planning phase, VVHS allows users to optimize resource utilization and timing of maintenance. Optimized plans for different situations such as skid control and snowplowing can be used to yield expected results at the lowest possible cost. The consideration of time improves the quality of plans. During work, any deviation from planned ending times for activities can be pinpointed and compensated for by VVHS. VVHS can help gather information on ongoing operations, making information on completion times, resource utilization, and material use easily available for future decision making. In turn, agencies can make information about their winter maintenance operations and traffic conditions available to the public.

The development of the Swedish winter road maintenance system (VVHS) began in 1990, initially as a technical test of Automatic Vehicle Location with the aid of the Global Positioning System (GPS). A further aim of VVHS development was to study various ways of increasing precision and covering the gaps caused by satellite shadow. The project was gradually extended to include other components in a transportation management system—such as digital maps and reliable communication—as software in vehicles and control centers. A requirements specification for the system was produced from spring 1991 to spring 1992, based on improving planning, management, and follow-up capabilities for winter road maintenance. During the winter of 1992–1993, technical tests and certain tests of operations were performed outside Gothenburg in southwest Sweden. The tests showed that the system improves the possibilities for more efficient road maintenance in the following ways:

- Improved road user information;
- Quality assurance for the contractor's commission;
- Improved planning and more efficient resource utilization;
- Simplified management of operations and overview in real time;
- Better follow-up of actions, results, and costs;
- Improved quality and reduced quality variations;
- Improved safety for vehicle drivers; and
- Improved work content for truck drivers.

Components of VVHS

Basic data

Information on the road network is obtained from the Road Database (VDB) of the Swedish National Road Administration. The follow-up information can therefore be related to other information in VDB. The basic data include information on resources, materials, equipment, methods, types of action, and reason for action.

Planning

Since winter road maintenance often has the character of emergency action, it is essential that as much maintenance as possible be planned. Planning allows suitable routes to be created for different given situations such as skid control, snowplowing, and the combination of both.

Management

When an action is to be implemented, the most suitable material, equipment, and routes are chosen on the basis

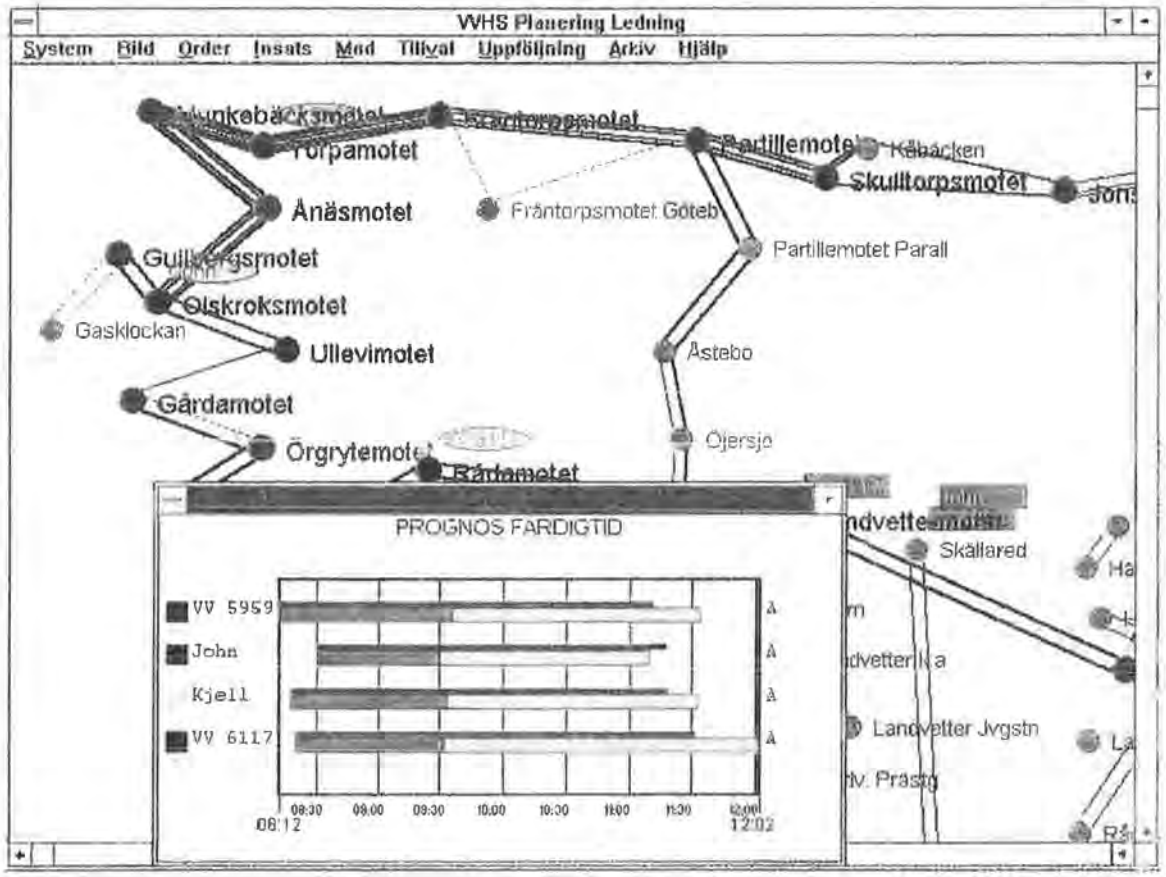

FIGURE 1 Management phase of the VVHS, showing completed actions as unbroken lines and uncompleted actions as broken lines.

of current conditions. The assignments are then communicated automatically to the pertinent vehicle with the aid of mobile data communication. The driver confirms that he is available and is then given information on the required equipment and materials. When the equipment has been fitted, this is confirmed and the vehicle can then set out on its route. Using GPS, the vehicle is tracked along the whole route, and position information is reported as nodes or junctions are passed. This information is immediately displayed to the supervisor on a monitor. The vehicle's own color is shown on a schematic map as well as in a diagram containing start times, forecast completion times, and deviations from plan (Figure 1).

Follow-Up

Using the follow-up section of VVHS, it is possible to display diagram information for a selected period on the number of actions per month, action times for road sections and routes, completion times, material consumption, resource utilization, and costs. This information then provides a basis for reviewing the plan and improving operations.

Test of Operation

During the winter of 1993–1994, an extensive test of operation was carried out in two areas centered on Västeras and Varberg. In Produktion Ost (PO) Västeras district, the system was tested on the E18 highway from Västeras to Stockholm and on parts of trunk road 55. Here, a total of 10 trucks owned or leased by SNRA were fitted with equipment. PO supervises its winter road maintenance from a center in Västeras, where VVHS and a computer system for personnel assignment have been installed. The test involved 30 truck drivers and 10 operators/supervisors at the control center. Road user information was managed from the traffic control centers in Stockholm and Eskilstuna.

Produktion Vast (PV), Production Area Varberg, equipped 12 trucks, both owned and leased by SNRA. The test was carried out by 30 drivers and led by 4 supervisors. The road network consisted of the E6 highway and

trunk road 41, in addition to a number of minor roads. Road user information was managed by the traffic control center in Gothenburg.

Results

The clearest results of the winter's tests in Västeras and Varberg were that the planned time consumption was often greater than the actual, the work being completed sooner than expected. When these results had been fed back to the system and replanning performed, it was found that the maintenance assignments could be carried out with fewer trucks.

In both test areas, it has been possible to reduce the number of vehicles from 13 to 11 with the same quality of work. In some types of preventive antiskid action, two vehicles were used instead of five. The savings resulting from the system's use provide a very significant measure of the economic value of VVHS.

From the results that have been analyzed, it can also be seen that different drivers drove at different speeds. Where the optimal action time was 180 min, action times of 110 min (minimum) and 260 min (maximum) were also recorded. This means that with short action times, the quality of antiskid action and snow clearing deteriorates considerably, more salt being deposited outside the carriageway and more snow left on the carriageway. Excessive action times increase the action cost, and slippery conditions may occur before the action is completed, contributing to accidents. During snowfalls, the snow remains on the carriageway for a longer time, causing trafficability to deteriorate. These results, together with the supervisors' experience, provide a valuable basis for changing and improving operations. Actions can thereby be optimized to the advantage of both the orderer and the contractor.

Technical Concept of VVHS

VVHS is based on a technical concept comprising mobile data communication, a communication platform, positioning, mobile application in a DOS or Windows environment, an application for the control center for several users in a Windows-based network environment, a graphic interface, and schematic maps.

The communications platform comprise a transport protocol with a facility for choosing data network and running several applications simultaneously.

Positioning is achieved with the aid of GPS. When operating to detailed plan, route-matching is used and completion time can be forecast. When operating without a detailed plan, map-matching is used.

The application is implemented in a text-based DOS version, where the route is displayed in the form of a list with nodes, and a Windows version, where the route is presented on a schematic map.

In a control center, the application is implemented with client server technology for a single user or several users in a network.

The graphic interface allows the user interacts with the system by means of diagrams, schematic maps, and authentic maps.

Schematic maps allow road network–related information to be displayed in a clear manner configurable by the user.