POTENTIAL OF AUTOMATIC FIELD DATA CAPTURE IN WINTER MAINTENANCE ON ROADS

R. Hess
Durth Roos Consulting GmbH, Karlsruhe, Germany
rainer.hess@durth-roos.de

ABSTRACT

Satellite-based systems for determining current vehicle position are already found in vehicle navigation systems. Logistics companies use this type of systems in combination with real-time data transfer to a control centre to optimise their routes. The scope for transplanting the technology to winter maintenance and the potential arising from the availability of digital field data has been examined in a feasibility study and is presented here.

KEYWORDS

WINTER MAINTENANCE / GLOBAL POSITIONING SYSTEM / AUTOMATIC FIELD DATA RECORDING

1. INTRODUCTION

The satellite-based global positioning system (GPS) for determining current vehicle position is already found in vehicle navigation systems. Logistics companies use this type of systems in combination with real-time data transfer to a control centre to optimise their routes.

Many winter maintenance equipment manufacturers and some independent telematics companies offer solutions for automatic field data capture. In spite of this, maintenance documentation in Germany mainly consists of written operating reports manually completed by vehicle drivers. In particular, recording the information contemporaneously is a great challenge to the vehicle driver, who normally finds it too much of a burden and concentrates on his core duties. Therefore in practice, this recording of winter maintenance activities often takes place after the activities have ended. In consequence records tend to be incomplete or inaccurate.

2. RECORDING AIM

2.1. Operational Documentation

A public body has the task, but not the duty, of making traffic infrastructure available. However, if existing traffic infrastructure has been approved for use, it is the body's obligation to maintain safety. Amongst other aspects, this gives rise to the necessity of carrying out extensive winter road maintenance. While restrictions concerning the capability of a road to carry traffic do not normally have any legal repercussions, traffic accidents caused by the weather certainly do result in claims for damages. In order to be able to provide proof if necessary that corresponding winter road maintenance has been carried out using state-of-the-art technology, handwritten reports of the winter road maintenance operations carried out are usually drawn up and archived.

Automated operational data capture records both the trip that has been undertaken and the operational condition of the accessory equipment at regular intervals. In addition to the work carried out, some systems use supplementary sensors to record the weather conditions by means of the temperature and the condition of the road surface. In combination with further data, such measurement results can be used to assess the appropriateness of the work performed.

Through the output of the operational data, compilation of the operational reports can concentrate on the actual purpose of the documentation used to provide the evidence. Here it is particularly important to assign the performance data to the appropriate time and location. A convenient possibility, although one which is not absolutely necessary in the case of drivers who are familiar with the location, is to convert the network node designations into street names.

2.2. Accounting of Services

Various aspects may be relevant to the financial processing of winter road maintenance operations. On the one hand the services have to be paid for, either by supplements to the employees' salaries or through inclusion in the invoices to the private companies involved. On the other hand services are also provided to stretches of road of other public bodies, with the resulting claims against these bodies.

Salary supplements have to be paid if operations are carried out outside the standard working times or last longer than these standard working times. Both of the above occur frequently in winter road maintenance services. Furthermore, private haulage contracting firms with additional vehicles are frequently used in winter road maintenance. Automatic operational data capture considerably accelerates the verification of the invoices of these companies.

A deployment is characterised by the costs for the number of operational hours and the lengths of the distances covered, as well as for clearing and spreading salt on the roads. The accounting of services provided to other public bodies also has to include the consumption of salt and brine. As the corresponding data may be used not only for invoice processing, but also in cost and performance accounting, many systems offer the possibility of digital transfer.

2.3. Operational Management

Various levels support the management of such a complex task as operational road maintenance. At the operative level specifically it is essential to enable the performance of the work by providing the necessary resources. On the next level it is possible to analyse the work processes and strive to achieve optimisation of the costs. On the strategic level, further aggregated key data can form the decision-making basis for the institutional organisation of tasks fulfilment.

The planning of capacities with respect to personnel, vehicles and equipment is carried out on the operative level. The tasks of the operative level also include the procurement of the materials to be spread on the roads. If an overriding system receives information both on the quantity of spreading material delivered to the store and on the quantities consumed during the individual deployments – recorded by the automated operational data capture system - it is possible to implement automatic stock keeping even without a modern silo control system.

Furthermore, it is also possible to provide the other two levels with aggregated key data. One possible use worthy of mention here is benchmarking by comparing expenditure values.

3. TECHNICAL SOLUTION

3.1. Operational Data

The basis for automatic operational data capture is the recording of the trip performed with the help of repeat satellite-supported position determination. Applications based on the American Global Positioning System (GPS) have already been tried and tested in many fields. Through calibration with a digitised roadmap and plausibility checks it is possible to reduce inaccuracies that may occur with such a system for position determination to such an extent that the route of a vehicle is adequately recorded. Private vehicle navigation or fleet management in the forwarding agency business are two examples in which this aspect of the problem at hand can be considered to be an application that has already been implemented.

For the capture of the operational data the record of the trip performed as described by positions and times is supplemented by information on the operational condition of the accessory equipment. For a snowplough it must at least be known whether this is raised or lowered. In the case of a spreading machine it is not only of interest whether it is switched on or not, but also the quantity applied and the spreading pattern that has been set. The data capture systems available on the market make use of very different solutions in order to arrive at the above-mentioned information by means of specific indicators. The consequence is the frequently discussed question in measurement technology concerning the primary physical measured variable. For example, is it enough to record the rotational movement of the spreading plate in order to understand the spreading process or is it necessary to measure the actual impact of the material being spread on the surface of the carriageway?

If the data relating to the trip performed and the data concerning the operating status of the accessory equipment are coupled in terms of location and time, this provides full documentation of the deployment. In technical terms it is possible here to identify several steps: re-cording of the deployment status of the accessory equipment, assignment to the record of the trip performed and therefore documentation of the winter road maintenance operations and evaluation of the operational data.

3.2. Data Transfer

In practice a form of transmission from the vehicle to a central data processing system is also required. Physically connected transmission paths by means of cables or memory cards have proven to be disadvantageous. On the one hand the data are only available after a delay, which prevents their use by the director of operations for controlling the winter road maintenance deployment. On the other hand the conditions prevailing in the environment of winter road maintenance operations are not conducive to technical solutions. The damp and salty ambient air, as well as the handling operations performed by tired and stressed drivers, lead to premature mechanical damage to the connections.

Contactless data transmission offers the advantage of a small risk of damage. Within the framework of a pilot application, various methods of online transmission have been tested. Technical solutions which allow contactless transmission of the data over short distances reduce the risk of damage, without however overcoming the problem of the time delay.

The data are always transmitted when the vehicles are in the road maintenance depot. Alternatively, the mobile telephone network can be used for prompt transmission of the data, provided that reception is satisfactory.

3.3. Compatibility

Most current accessory equipment used for winter road maintenance services have interfaces via which third-party systems can determine the operational status. In the case of older accessories these interfaces can be largely retrofitted or the data captured by means of separate sensors. This may result in compatibility problems between the data capture and accessory equipment.

Most manufacturers of accessory equipment offer their own data capture software or are part of a cooperative association with a provider of data capture systems. In most cases the on-board computers are integrated by the manufacturers of the accessory equipment into the control consoles of the devices, so that no additional work is required for their installation. In contrast, separate on-board computers have to be installed as a rule for the accessory equipment of other manufacturers. In addition to the accessory equipment manufacturers, other providers of operational data capture systems have become established today whose origins were in the fields of logistics and road databases, for example. Some of these companies offer their own sensors in order to record the conditions of the accessory equipment. The advantages of these are that the systems are not manufacturer-dependent and as a rule are more specific to the primary physical measured variable. With interfaces it is frequently only the setting of the control console that is determined, which in the case of a malfunction does not show the actual status of the equipment. As some sensors are considerably more sophisticated and therefore also more expensive, in the standard case only the data from the accessory equipment control units are used.

Technical Committee CEN/TC337 "Winter maintenance and road service area maintenance equipment (excluding machinery)" is currently formulating a norm dealing with data capture and transmission in traffic operations. This is intended to standardise and simplify the exchange of data from accessory equipment and systems for operational data capture and thereby minimise possible compatibility problems. The German version of this norm [1] DIN EN 15430-1 "Winterdienst- und Straßenbetriebsdienstausstattung - Datenerfassung und -übertragung - Teil 1: Datenerfassung im Fahrzeug" is currently available in a draft version and specifies a protocol for data transmission between the accessory equipment and an on-board computer located within the vehicle. A further section is planned to deal subsequently with the transmission of data from the on-board computer of the vehicle to a control centre. This is an important precondition for enabling evaluation within one system in the future with different data capture systems.

4. EXPERIENCE

A survey of German road authorities revealed that few federal states have actual experience of automatic field data capture. Just a few states use automatic field data capture on a regular basis, while another third carried out test projects.

Frequently-mentioned difficulties, some of which resulted in a decision being taken against such a system, are compatibility problems and transmission difficulties. In some countries, however, resistance on the part of employee representatives, who fear continuous

monitoring of the employees, has led to such trials being aborted. For the introduction of an operational data capture system it is therefore necessary to take into account not only the technical possibilities and limitations, but also in particular their acceptance among the employees as an important precondition for their successful use.

Further aspects which should be taken into account for the successful introduction of an automatic operational data capture system are:
- uniformity of the recording and evaluation modules with respect to the measured variables recorded and the characteristic values in the evaluation. Otherwise it may not be possible to compare the results.
- automation of the data recording to the greatest possible extent so that the drivers can easily familiarise themselves with the system and do not have to deal with additional tasks during the winter road maintenance operations.
- use of compatible systems, as in most cases the stocks of a road building authority include vehicles and equipment from different manufacturers.

The simplicity of a system for automatic operational data capture should also extend to the software used for the purposes of evaluation. Complicated software in combination with inadequate training of the personnel may lead to acceptance problems with respect to the operational data capture system. Web-based applications offer the advantage that no installation or software updates have to be performed by the user. In the case of software problems the provider is able to react quickly, as it has direct access to the system. However, this necessitates Internet access for the operational commanders at the road maintenance depots. In some cases those responsible for data processing consider this to be a security problem.

5. CONCLUSION

Field data capture in winter maintenance can be expanded to create a highly specialised system by recording additional operational parameters about the connected winter maintenance equipment as well as the road surface and local weather conditions. In combination with the contemporaneous transmission of captured data to a control centre, automatic field data capture can provide a better basis for decision-making by service managers. The decision on a solution must balance the requirements of data availability and accuracy and the robustness of the technology.

The possibilities for use of the captured data by the road authorities include data evaluation to improve operational control and accounting and support of service managers through detailed information on traffic and weather conditions. If captured data is stored it can be used for future analysis and the optimisation of winter maintenance services, leading to benefits for traffic safety and state budgets. The expectations of an automatic field data capture system will vary from region to region not only for climatic reasons.

6. REFERENCES

[1] DIN EN 15430-1 “Winterdienst- und Straßenbetriebsdienstausstattung - Datenerfassung und -übertragung - Teil 1: Datenerfassung im Fahrzeug“
(DIN EN 15430-1 “Winter Road Maintenance Services and Road Service Area Maintenance Equipment - Data Capture and Transmission - Part 1: Data Capture in the Vehicle“)