

## **RWIS in ITS**

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This paper concerns a brief report of a project with the aim to produce recommendations for the use, or further research for the use of the data as these are or may be generated by the RWIS network in the Netherlands, for reinforcing ITS. At the same time the possibilities for applying RWIS technology in other traffic systems are studied.

### **INTRODUCTION**

The Netherlands, a small country in Western Europe, presents itself as 'the gateway to Europe'. With an area of 34,000 km<sup>2</sup> and a population of 16 million, the Netherlands has a road network covering 125,000 km (78,000 miles), around 6.5 million cars and more than 800,000 carrier vehicles. Road transport in the Netherlands is a 24-hour business. The Netherlands has a relatively high number of motorways, totalling some 3,500 km (2,000 miles), managed by 'Rijkswaterstaat' [Directorate General for Public Works and Water Management], a division of the Netherlands Ministry of Transport, Public Works and Water Management) (DOT).

The Netherlands has a sea climate. This results in mild summers and mild winters in terms of temperature. On the other hand the proximity of the sea produces damp air. It is therefore not surprising that the mild winters with frequent periods around freezing often mean icy conditions on the roads caused by condensation. Icy conditions resulting from rain and the freezing of wet roads are fairly common, although falls of heavy snow are rare. In national terms an average 35-40 spreading turnouts are carried out on the main road network in the Netherlands. The costs total around EURO 21 million a year.

For more than 10 years Rijkswaterstaat (RWS) in the Netherlands has been using an Ice Warning System (in Dutch: GMS). A start has recently been made with the modernization of this system, which will provide Rijkswaterstaat with access to a Road Weather Information System (RWIS).

What the Netherlands is called 'Dynamisch Verkeersmanagement' (literally translated as Dynamic Traffic Management (DTM), covered by the international term Intelligent Transport Systems (ITS)) goes back a long way. The first automated traffic systems date from the first half of last century. At the beginning of the eighties DTM gained momentum in the Netherlands, beginning with the large-scale implementation of motorway signing. A multitude of systems and measures were introduced both nationally and internationally, all under the heading of what nowadays is called DTM. In the Netherlands DTM is defined as 'pro-active, anticipatory measures aimed at maximising the safety and traffic flows on the (main) road network'. DTM measures are affected by up-to-date information about the condition on the roads. These measures can be divided into road section

measures and network measures. DTM therefore suits very well to the mission of Rijkswaterstaat (RWS) which also includes 'ensuring safe and fast traffic flows'.

The term DTM measures or systems specifically relates to measures or systems involving all three aspects denoted by its capital letters. The system or measure must relate to Traffic, there must be some degree of influence or steering (Management) and the system must be Dynamic, i.e. there must be a dynamism according to place and/or time (e.g. present/expected situation).

The concept of DTM is constantly changing. This also applies to the systems involved in it. From time to time the players in the DTM field or those involved in using the RWIS are asked to apply data from these systems for DTM. The demand for wider applications is obvious. The RWIS is a roadside system with sensors in and next to the road which measure data from the road surface and the microclimate. With regard to ice warning systems, a global shift has taken place in recent years. The RWIS was originally a decision-supporting system for the road manager. There is a visible tendency to give the data from RWIS a secondary application. This is effectively illustrated by the change of name which the RWIS has undergone in English: from "Ice Warning System" to the internationally used definition "Road Weather Information System"

## **METHOD**

The project included exploratory research in the form of a literature study and interviews with experts. This method has its restrictions: the findings are based on literature and the information available on the Internet and the opinions of experts and have therefore not been subjected to empirical testing. However this method was chosen because it has the great advantage that in a relatively short period of time, a picture can be formed regarding the issues which are important in the use of data from the RWIS in DTM, and which relevant need for data is generated from DTM.

A literature study was undertaken to search for possible applications of RWIS data within DTM at home and abroad. In order to select the relevant literature, use was made of the various databases available at the Dutch Ministry of Transport and Public Works. These were used to find publications about RWIS in relation to DTM. A literature study was also carried out on the Internet to find information about RWIS in relation to DTM and vice versa. Examples of possible (DTM) applications of the RWIS were also sought on the Internet.

During this part of the study, the following delineation was made:

- Only data from the last 5 years;
- Only the languages Dutch, English and German.

In addition the supplementary information/literature provided by the experts interviewed was also processed.

In both the literature and on the Internet searches were carried out into relevant developments, pilots and projects, both national and international. The results of the literature and Internet studies provide both an inventory of completed DTM systems and measures relevant to the project as well as systems and measures currently under development. In addition attention was focussed on the national policy in the Netherlands regarding DTM and an inventory was made of current projects related to the subject of this study.

In this project interviewing experts was an appropriate method of collating information. The main aim here was to collect knowledge and opinions.

The interviews were aimed at using expertise both inside and outside Rijkswaterstaat. Within Rijkswaterstaat, DTM experts were interviewed with varying fields of expertise within the field of DTM. Also outside Rijkswaterstaat DTM experts or traffic experts with varying DTM expertise were interviewed. Outside Rijkswaterstaat interviews were held with people employed in the National Motorway Police Agency (KLPD), the Netherlands Automobile Association (ANWB) and a representative from industry. As a result of the wide range of expertise supplied by the interviewees, the interviews were able to focus on dynamic traffic models, traffic DTM architecture, traffic management, incident management and traffic information, thereby also taking into consideration the development and implementation of DTM systems.

## **RESULTS**

Based on the inventory, around 20 possible applications of RWIS data or RWIS technology were determined for DTM. These possible applications are all in different phases of development: the idea phase, the phase of exploratory research or ready for implementation.

Among these applications are a number of likely applications of the RWIS within DTM. An application is likely if it provides a favourable contribution to achieving the objectives of the Netherlands National Traffic and Transportation Plan (NTTP) and if it concerns a realistic application which can be achieved using technology which is currently operational or will be operational in the short term. In addition any plan to start further research into an application should be economically feasible. The likely research into applications of RWIS data or RWIS technology is described below. The NTTP stimulates the application and integration of technology in traffic and transportation. Integration of various traffic systems may offer great advantages and is therefore stimulated by the NTTP. In order to show the relationships with the objectives from the NTTP, these applications are organised according to the policy themes of the NTTP: accessibility, safety, quality of life, and technology, ICT and innovations.

### *Accessibility*

A wet road has a lower capacity, particularly at high speeds. The link between the measured road surface (dry/wet) and the capacity of the road has never before been accurately determined in the Netherlands. The road surface condition sensor from the RWIS with its related first line processing can be fairly easily integrated in technical terms in various DTM systems. On-line traffic models and capacity estimators under development make further research into this application essential. An initial step might be to study the relationship between the value of the road surface condition sensor from the RWIS with regard to the following distance of vehicles and the capacity of the road respectively. The precipitation sensor from the RWIS should be included in this research.

Once this relationship has been established, parameters such as precipitation, road surface condition and wind can be included in on-line traffic models and capacity estimators.

All this may also be applied for a DTM measure as narrower lanes (dynamic), thus making it easier to let the road surface condition result in a recommended speed or dynamic maximum speed. With these kinds of measures, communication with the road user is of vital importance.

When parameters such as precipitation, road surface condition and wind are included in on-line traffic models, the expectations (forecasts) of these parameters will be important factors. It is possible that the road surface forecasting models developed in the framework of ice detection may be adapted for this purpose.

The road surface temperature measured by the present RWIS is an excellent parameter for determining in the summer when checks on overloading by HGV vehicles would be most effective (countering rutting).

### *Safety*

Another (stand alone) application of the road surface condition sensor from the RWIS in combination with a speed measurement, is a warning system which alerts the road user approaching a bend with a wet road surface, or approaching the bend too fast for the conditions. At critical locations (black-spots) where frequent incidents occur involving vehicles flying out of the bend during precipitation or when the road surface is wet, such a system may reduce the number of such (one-sided) accidents.

A well-known phenomenon is when the road surface becomes slippery after a fairly long period without precipitation. When the pollutants present on the road surface mix with the precipitation, this can temporarily cause a slippery film on the road. Further research into specific locations may indicate where accidents relating to this kind of temporary (summer) slipperiness occur fairly frequently. More research is essential in order to determine how the RWIS can indicate these conditions (algorithms). In principle, the current RWIS sensors would be suitable for this task.

### *Quality of life*

The measuring points of the RWIS may be expanded by the addition of sensors designed to measure the concentrations of exhaust fumes. These could then record the quality of life and environment in DTM rule strategies. In that case the relevant policy should first be developed.

### *Technology, ICT and innovations*

The following future developments in the field of DTM require attention with regard to the further development of the RWIS:

The application of dynamic street lighting (DYNO) requires modification of or extra sensors in the RWIS (precipitation, visibility, wind) and attention to the data transport.

Meanwhile the RWIS data regarding the road surface condition in the winter (icy or not) is not automatically provided to other DTM applications and DTM measures. The present system still requires interpretation by an expert with access to detailed weather information.

European and global developments in the field of travel information, in-car-info and vehicle control systems have generated the need for a more accurate determination of the road surface condition and the microclimate along the road. An intelligent RWIS (expert system) can obviously provide added value within DTM. Maximising the potential of the RWIS is a complex process which will take a number of years and should be approached in phases.

Thermal Mapping may make it possible to 'extrapolate' the point measurements of the road surface temperature in the RWIS over the whole of the road network provided with RWIS.

### *ADA-ESA*

At international level the necessary developments are in progress in the field of Advanced Driver Assistance (ADA). This should result in standardization in the car industry. Once vehicles are able to receive and process information from the roadside, the road manager will be expected to provide the required information.

A number of ADA systems such as Intelligent Speed Adaptation (ISA), Adaptive Cruise Control (ACC) and External Speed Assistant (ESA) require information about the road conditions (dry/wet/precipitation/slippery/visibility/wind/etc.) or a safe maximum speed at the location. As mentioned the RWIS is as yet unable to provide this information automatically; human interpretation continues to be indispensable. Further automation of this task is desirable. During the implementation of the road surface condition within ADA, sufficient attention should be given to the reliability of this data. If such a system is too cautious or too careless, the crucially important credibility or acceptance of the system will be at risk.

Now that almost all new cars are fitted with airbags and ABS as standard accessories it is expected that ACC will be used by the car industry as a sales argument for new cars. The introduction of ACC, which is now gradually making progress, will form a milestone in the implementation of ADA. Some of the hardware for other ADA systems has already been installed in the vehicle. For some applications it will only be necessary to adapt the software here and there, which according to the industry will not result in extra costs to the customer ("just a matter of simple software. It's cheaper to put sensors on the roadside to service every car, rather than equip every car").

An extensive pilot with ESA is planned in the Netherlands in a few years' time. Because the road surface condition will be integrated into ESA at some point, it is clear that the RWIS will have to be prepared to provide the necessary information in the required format.

Just as with the present supply of data from traffic systems, the discussion regarding liability plays an important role in the implementation of systems for ADA whereby data from traffic systems are required.

### *Informing the road user*

In addition to traffic information, road users also urgently require information relating to weather conditions affecting their journey. There is a clear global tendency towards providing the road user with even more information about relevant weather conditions using the relatively new concepts of Variable Message Signs (VMS) and Internet and by means of future concepts for in-car-information. A number of international traffic information Internet sites providing an enormous amount of information (traffic tailbacks, weather, road surface conditions, camera images, work in progress on the roads) are very popular. In the Netherlands such sites are limited to reporting tailbacks or current speed.

Due to the adequate, preventive winter maintenance on the main road system in the Netherlands, serious warnings about icy conditions on the main roads are not very often required. However these warnings are more relevant for the secondary road system which is subject to a different gritting policy.

When developing systems and concepts for providing information to the road user, it is good to ensure alignment with developments at European level so that they can be used during international journeys. One of the first users of these new systems will be international haulage companies. The planned implementation of new developments such as car Internet, GPRS/UMTS and MobiMiles (the Dutch concept for kilometre tolls) will generate an enormous impulse for the production and distribution of in-car-info. However it is still unclear which parties will play which roles in this.

In Japan the first step has been taken for a modified standard for Internet in the car for the distribution and presentation of weather and road surface information (modified XML: RWML).

### *Miscellaneous*

The usefulness of a system is crucial for acceptance. This mainly concerns the perceived use; the system does not actually have to be useful, as long as the user feels that it is. This also applies to a DTM measure or concept or the information provided.

When selecting a DTM application or DTM measure, it is important to study whether the measure concerned is the right one to achieve the desired effect (behaviour).

In addition it is essential for all DTM measures to ensure enough support.

Before using RWIS data for DTM applications, a number of factors should be studied:

- DTM requires a quality guarantee from the data to be supplied. It is important that this data is subjected to continuous quality control. For this purpose a procedure and/or control should be organized. This is also important for the use of this data for research and analysis.
- The legal aspects (liability) with regard to the use of the RWIS data for DTM should be developed in further details.
- This also applies to the financial aspects.
- In the conclusions of the study into the application of RWIS data and RWIS technology, non-existent DTM applications and measures are mentioned and ideas supplied. A number of these require further research. Some are relatively easy to implement in technical terms. However it should be noted that in a number of cases no policy exists for these possible applications or measures. Before these applications or measures can be implemented, they should naturally be legitimated by relevant policy.

## **CONCLUSIONS AND RECOMMENDATIONS**

### *Conclusions*

DTM is constantly changing. This study is certainly not complete; this report merely reflects the situation at a certain moment in time. The study mainly restricts itself to DTM on the main road system. A number of the proposed applications can also be easily applied to the secondary road system.

DTM is also subject to constant change internationally. A large number of the DTM systems and measures studied were in the pilot phase. Based on the inventory it can be concluded that there is very little integration of the RWIS with DTM either nationally or internationally. For successful implementation further research and time is essential.

A large number of applications of the RWIS within DTM are still at the idea stage and require considerable study and development in order to determine whether application can actually be achieved.

Based on the results described, the following applications of the RWIS within the DTM are considered likely:

- The detection of a wet road with RWIS technology; this parameter can be used in on-line traffic models, capacity estimators, for measures for new uses such as on narrower lanes and safety of locations where frequent one-sided accidents occur as a result of a wet road surface;
- The instalment of sensors at the measuring stations of the RWIS for measuring exhaust fume concentrations; this parameter can be used both within and outside DTM;
- The automatic recording of the road surface condition by the RWIS according to a classification system. This requires an expert system within the RWIS. These data can be used within DTM and specifically with systems for ADA. In addition the user can be informed about the road surface condition through the information systems which are currently operational and which will become operational in the future. Such systems must be in alignment with European standards.

### *Recommendations*

On the basis of the analysis and the conclusions, the following recommendations can be made. The recommendations concern aspects which may be implemented in the relatively short term.

- *Further research should be carried out into the possible relationship between the measured value of the road surface condition sensor from the RWIS and the following distance of vehicles, in this case the capacity of the road.*

- *The RWIS should supply more (detailed) information about precipitation.*

For both precipitation and road surface condition, it applies that the affecting factors are with a number of DTM instruments such as traffic control systems, vehicle control systems, target group measures, vehicle information systems and traveller information systems. The integration of these parameters has a favourable effect on both accessibility and traffic safety.

- *A start should be made on the phased development of an expert system within the RWIS in order to improve the quality of the reports.*

The introduction of vehicle control systems within ADA-ESA requires input from the RWIS. In addition research is essential in order to establish in which format and which classification the data should be supplied to ADA-ESA.

- *Further research should be carried out into the possibility of using RWIS to measure exhaust fume concentrations.*

Once relevant policy has been developed, exhaust fume concentrations can not only be monitored, but also under critical conditions or at critical locations serve as a parameter for traffic control systems aimed at dynamic intervention in traffic to promote quality of life.

- *The road and weather situation should be integrated in graphic systems for traffic information. Seek alignment with developments at European level. In order to extrapolate the data from the RWIS to the whole main road system, further research should be carried out into the desirability of thermal mapping of the main road network.*

Travel information and vehicle information systems are and remain important DTM instruments in the traffic process. Road users indicate that besides traffic information, they also place great

importance on other relevant weather information. Development of these systems lies in the field of technology, ICT and innovations.

- *A clear policy should be developed with regard to supplying data from all traffic systems (including RWIS) to third parties.*

As described data from the RWIS may receive applications in various places in DTM and outside. For some traffic systems a policy already exists regarding data supply, although this does not yet apply to the RWIS and WIMS. For the application of RWIS data this policy is essential before data may be given to third parties.

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