Roadside versus in-car speed support for a green wave: a driving simulator study

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A green wave on a road with a series of coupled signalised intersections enables a driver to pass each traffic light at green light. So he/she does not have to stop. A green wave is an advantage for drivers, through-put and safety on the road network and the environment. At coupled signalised intersections, the driver will get green light at the intersections driving a given speed. Therefore, the driver needs information about the speed he/she has to drive. Variable message signs are already used for giving drivers a speed advice for a green wave. The use of an in-car display for a green wave is new. The given green wave speed advice is adjusted to the current status of the traffic lights. In this study, two systems providing the driver a green wave advice were investigated. These two systems were variable message signs at the roadside and an in-car display.

A driving simulator study was conducted to measure the effects of a green wave advice using these two systems for providing the advice to drivers. Using the fixed-base driving simulator of TNO, this experiment investigated the effects on driving behaviour, workload and user acceptance. Fifty subjects participated in the experiment in the driving simulator. Each subject completed three experiment runs, two containing either one system (variable message signs/in-car display) and one baseline run. A road with signalised intersections in the Netherlands was used to examine the effects of a green wave.

The results for driving behaviour showed that speed support for a green wave resulted in a change in driving behaviour compared to the baseline condition. The subjects responded to the green wave advice by driving a speed closer to the advice. Using the in-car display, subjects drove slower but more the same speed compared to the baseline condition. Subjects were also more able to continue driving using the in-car display than the variable message signs because of the smaller amount of stops.

For workload, the results showed that speed support using the variable message signs resulted in a higher workload for the drivers compared to when no system was used. Compared to the baseline condition, using the in-car display did not result in a higher workload.
After experiencing both systems for the green wave speed support, both systems were found less useful and satisfying as the systems were expected to be. The variable message signs were found more satisfying than the in-car display. The green wave speed advice on in-car display was experienced as more personal than the ones shown on the variable message signs. However, most of subjects preferred the variable message signs. Reasons for this were the easy realisation and the accessibility for all drivers. Subjects said to follow the green wave advice because fuel could be saved and it was pleasant to be benefit from the green wave.

In conclusion, the subjects responded to speed support for a green wave. Using an in-car display and variable message signs, the subjects adhered to the given advisory speed. Comparing the variable message signs and the in-car display applied in this experiment, the following significant differences were found. The results of this study showed that subjects drove more comfortably using the in-car display because they drove more the same speed and they made less stops during the trip. The in-car display caused less distraction to the subjects. But the subjects accepted the variable message signs more. In this study, it was possible to influence driving behaviour by using speed support for a green wave. It can be seen that the objective measurements of driving behaviour and workload differ from the subjective measurement of user acceptance. Based on the findings of this driving simulator experiment, the best system for green wave support in terms of *comfort*, *distraction* and *acceptance* was the in-car display. An in-car display is a promising system for green wave speed support because it has potential advantages for the through-put and safety on the road network. However, determining the best system should be done with care because the in-car display and the variable message signs do not differ very much from each other.