Modelling parking guidance systems in S-Paramics

Development of an S-Paramics tool to simulate parking guidance systems

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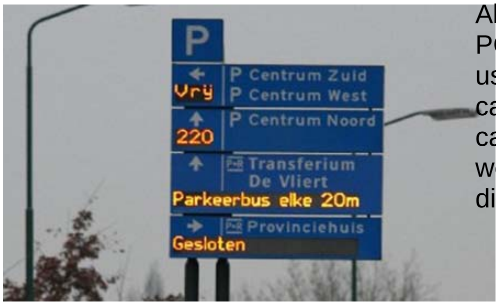
Parking problems in city centres, mainly on Saturdays, are a well-known phenomenon. The parking (capacity) problems are illustrated by full car parks, which result in long queues and unnecessary pollution. To reduce parking problems, parking guidance systems (PGS) have been implemented since the 1970s. At first mainly to inform the car drivers, but nowadays municipalities try to steer car drivers to gain a better distribution over the different car parks and to reduce 'searching' traffic.

The costs of implementing a PGS can however be relatively high. Most of the larger Dutch municipalities have implemented a PGS in the past, but have not carried out evaluation studies of the effects of PGS on the traffic performance. Medium-sized municipalities (60,000 – 100,000 inhabitants) find it hard to justify the high costs of the implementation of PGS, while the expected effects are not known.

Having a tool, which can estimate ex ante what the effects are of implementing PGS, can help municipalities in the decision on whether or not to implement a parking guidance system. The effects on the traffic performance can for instance be part of a cost-benefit analysis and municipalities can decide whether an increase in parking fees is justified to finance the implementation of PGS.

Therefore the main objective of this master thesis is to develop an S-Paramics tool for modelling the effects of the implementation of parking guidance systems on the traffic performance. S-Paramics is microsimulation traffic modelling software, which is used by many municipalities in the Netherlands for modelling their inner cities. Adding a tool to these models for modelling the effects of PGS can give municipalities a clear insight in the effects of implementing PGS.



Although evaluation studies with regards to the implementation of PGS have barely taken place, field studies investigating the usage of the information displayed on PGS signs have been carried out in multiple cities. The field studies consist of surveys carried out among car drivers who parked at car parks, which were part of the information displayed on a PGS sign. The different studies show comparable results:

- On weekdays the amount of drivers changing their car park destination, because the PGS sign displayed that their 'original' car park destination was full, is ranging from 10% to 16%;
- On Sundays this percentage ranges from 15% to 18%;
- The information displayed on a PGS sign was mainly used by non frequent visiting, shopping traffic from nearby municipalities; habitual behaviour of car drivers was barely influenced by PGS signs;
- The higher share of non-frequent visiting traffic on Sundays causes the higher percentage of car drivers which change their parking location based on the information displayed on a PGS sign.

Current microsimulation parking models in S-Paramics do not include PGS, but do include the different aspects and cost factors of parking. In the available S-Paramics models, which include parking, the parking fee and the (egress) walk time are part of the total trip costs. Car drivers in the models try to minimize their total trip costs and chose a car park accordingly. Whether or not the car park has available spaces is an aspect which the car drivers in the model notice once they arrive at the car park. In case of a long queue in front of the car park, the car driver will reroute to another car park. With the addition of PGS to a model, information about the availability of parking spaces is retrieved at an earlier stage by the car drivers.

ITS controllers can be added to an S-Paramics model to represent PGS signs. Car driver behaviour in the model can be influenced at the locations of the ITS controllers. The influence of PGS on the car driver behaviour in the model is programmed and specified in the developed PGS tool. The outcomes of the earlier mentioned field studies are used as a basis for the development of the PGS tool and the response of car drivers to PGS signs in the S-Paramics models.

The PGS tool is triggered by S-Paramics once car parks are full and the tool starts rerouting a share of the car drivers to an alternative car park, once their ‘original’ car park destination is full in the model. The share of car drivers which is rerouted reflects the amount of car drivers which in reality change their car park destination, because the PGS sign displayed that their ‘original’ car park destination is full.

Tests on small networks were carried out to verify the functionality of the PGS tool. The test were mainly performed to check whether the tool functioned as intended. Some small adjustments were made and finally the PGS tool was applied on a larger network: the model of Den Helder. The model of Den Helder was chosen, because the municipality of Den Helder is currently considering the implementation of PGS.

The developed PGS tool was applied to the model of Den Helder to simulate the difference in the future situation with and without an implemented PGS. The setup of the PGS tool (the locations of the ITS controllers and alternative car parks) was determined in consultation with the municipality of Den Helder. The amount of car drivers which would change their parking location, when the PGS signs indicate that their original parking location is full, was set to 18%.

Ten simulation runs were carried with and without the application of the PGS tool, by using the same set of ten random seeds. These ten random seeds release the same amount of vehicles per hour, but have a small randomness in the exact release time of vehicles on the network.

For the analysis of the outcomes several traffic performance indicators were analyzed. Significant differences were found in the traffic performance indicators of which the value is summed up over a time period. The duration of the ‘full time’ of the full car parks dropped with 19.8%, because a share of the car drivers rerouted to alternative car parks. The total travel time within a cordon around the city centre decreased with 4.3% as a result of the reduced waiting times at the full car parks. Significant differences in the traffic intensities were not found, mainly because there was no congestion on the road network in the situation without PGS.

The final product is a PGS tool which simulates the implementation of PGS on a network. The PGS tool is a simplification of reality and the known effects of PGS. The main strength of the current PGS tool is that is relatively easy to add to an existing S-Paramics model which includes parking.

The possibility to manually set the input of the PGS tool makes it a flexible tool with a clear structure, which can be used for multiple purposes. For instance different advised parking routes (by a PGS sign) to car parks can be evaluated. Or the effect of PGS in case a higher percentage of car drivers drives to an alternative car park based on the PGS information.

Another strength of the PGS tool is the fact that is added to a microsimulation model, which gives the opportunity to investigate the effects on multiple traffic performance indicators. Not just the car park occupancies can be analyzed, but also the traffic intensities and travel times for instance.

The main weakness of the tool is that the tool does not model the effect on 'searching' traffic realistically. 'Searching traffic' exists of car drivers who are looking for a parking space, might not be familiar with the road network and are sometimes driving around 'clueless'. The implementation of PGS helps to steer these car drivers towards an available parking space. 'Search traffic' is however very hard to model and to measure within the S-Paramics environment. Car drivers in S-Paramics are 'intelligent', know the road network and always drive towards their destination. Therefore the modelled effect of PGS on the 'search' traffic might be underestimated compared to reality.

The developed PGS tool is a product which can still be further developed. For this master thesis the focus was on the development of a PGS tool, which can be used to predict the effects of implementing PGS. The modelled effect of PGS is based on surveys, which investigated the use of the information on PGS signs. This means that the modelled effects of the PGS tool, can be used to make predictions about the implementation of PGS.

The PGS tool can however be calibrated for an existing PGS situation in case municipalities have available of the parking situation before and after the implementation of PGS. Therefore it is recommended to look at the possibilities for calibrating the PGS tool. The setup of the tool remains the same. The additional variables for calibration are then the amount of vehicles responding to the PGS 're-routing advice' and the alternative car parks which are set as 'advice'. This also opens the possibility to see what the expected effects are, in case the setup of a PGS a the city is changed.

Future developments also offer opportunities for the PGS tool. Dynamic route instructions, based on the traffic situation on the network, are a new development for PGS signs. This is one of the features which can also be incorporated in the PGS tool. The PGS tool can retrieve traffic performance indicators (e.g. traffic intensities, travel times) from S-Paramics and base the route instructions on these indicators.

Another promising development is the addition of PGS to in-car navigation systems. Based on the car park occupancies, the navigation system sets the closest car park with available parking spaces as final destination for the car driver. This means that the in-car systems 'overwrite' the first car park choice of a car driver with an alternative car park, just as now happens with the PGS tool in S-Paramics. In case the majority of cars have in-car systems and use this PGS function, the PGS tool can be used to determine the effects of different advice strategies of in-car systems.