The Netherlands
Research School for
Transport, Infrastructure
and Logistics
TRAIL

11th TRAIL Congress
November 2010

USER ACCEPTABILITY IN TRAFFIC NETWORK MANAGEMENT

Toward effective strategies

Jaap Vreeswijk MSc
Faculty of Engineering Technology, Centre for Transport Studies,
University of Twente, the Netherlands
Peek Traffic bv

ABSTRACT

Today's urban traffic network management strategies often overlook the interests of the individual road user, insufficiently consider travel choice behaviour and underestimate the importance of human psychology. Their effectiveness is at stake. This research contributes to knowledge about trade-offs between conflicting interests and objectives, by combining insights from traffic management, travel choice behaviour and traffic psychology disciplines. The objective is to better understand and be able to anticipate to these trade-offs and the processes that underlie them, based on example strategies from the FP7 eCoMove project. This extended abstract presents findings from literature review and the research approach.

KEYWORDS

Traffic network management, user acceptability, trade-offs, travel choice behaviour

INTRODUCTION

Urban traffic network management aims to optimize the overall performance of a transportation system, yet there is little evidence that the expectations of individual drivers are met. Often, their interests are overlooked and their benefits unclear. The influence on user acceptability and travel choice behaviour is uncertain, and when not sufficiently considered in management and control actions, may ultimately lead to disproportionate outcomes making traffic management strategies ineffective. Network management concerns the execution of a set of functions to control, plan, allocate, deploy, coordinate and monitor the resources of a road network covering a larger area. However, apart from the efficiency of the transportation system, measures of effectives should also include its equity or fairness, its effect on the environment, and the qualitative experience that users enjoy (Levinson, 2002). The challenge is to find and implement solutions that achieve an efficient reallocation of network capacity

over time and space without seriously violating any individual road user's preferences for mode, route, departure and/or arrival time (Adler and Blue, 2002). Current models insufficiently consider individuals and human behaviour. Their disadvantage is that they presume ideal conditions which do not reflect the real world in a realistic way; in particular psychological factors are being underestimated. By explicitly addressing human behaviour and the gains for individuals in a network solution, this research may serve as input for the development of better and more realistic models.

SOCIAL DILEMMA

When interests are at odds, mostly in scarce conditions, making trade-offs is needed. The conflict between individual and collective interests that the demand for travel poses, can be typified as a commons or social dilemma (Steg, 2007). This research studies the trade-off between a collective environmental interest with an objective of fuel use reduction, and an individual interest of accessibility with an objective to minimize travel time. Knowledge from equilibrium theory (i.e. user equilibrium versus system optimum paradoxes), game theory (e.g. prisoner's dilemma) and psychological theories are a basis for further work (e.g. Wardrop, 1952, Braess et al., 2005, Correa et al., 2007, Steg, 2007). They help understand selfish, (non-) cooperative and altruistic phenomena, but also counterintuitive cases which illustrate how the improvement of one goal or interest may have a negative effect on another interest or goal. Little is known about the scale and contradictions of these processes, the relation with travel choice behaviour and the existence and severity of rebound effects.

TRAVEL CHOICE BEHAVIOUR

Travel behavioural models typically integrate insights from psychology and neo-classical transportation theories. It uses social, cognitive and emotional factors in understanding travel choice decisions of individuals. Hence, they may explain why traffic management measures are effective or not, but more empirical research into individuals' responses is needed in order to reach better descriptive models of travel choice behaviour and its effect (Avineri, 2010).
Conservative approaches assume that changes in the performance of a traffic system affect choice behaviour, that people make rational decisions and eventually change to a better alternative. However, a number of studies indicate that travellers are not necessarily utility maximizers or rational decision makers and that within a certain band, they are indifferent to change or potential improvement (Srinivasan and Mahmassani, 1999). Nonetheless, it has also been shown that people tempt to act in their own interest in favour of their benefits, act strategically in specific circumstances, but generally avoid risk (Senk, 2010, Razo and Gao, 2010). These findings offer opportunities for network management but also lead to a number of new questions which will addressed in this research:

1. What is the ability of people to observe and rightly assess changes in the performance of a traffic system?
2. What causes people's interest or indifference to alternatives and which conditions lead to a change in travel choice behaviour?
3. Which information and stimuli are successful in steering people toward desirable behaviour from a system's perspective?

COGNITIVE PSYCHOLOGY

Behaviour and decision making are not just influenced by the content of information, the context of the problem is also important. Travel information theory argues that individuals

provided with travel information can make more informed choices, which will be to their personal advantage and potentially to that of the transport system as a whole. However, people's cognitive abilities are limited which leads to biases in reasoning and introduces a certain randomness in behavioural and choice outcomes that can only be explained by contextual factors and the way they are perceived by individuals (Avineri, 2010, Tawfik et al., 2010). This suggests that the rational man theory is rather naïve, especially as the expectations with respect to the effects of information provisioning on travel choices in general may be mildly optimistic (Chorus et al., 2007). Without discussing the details and being all-inclusive, the following psychological factors are considered relevant to understand acceptability judgement: habitual behaviour, problem awareness, reference point, values and norms, moral obligation, fairness, distributive justice, significance of contribution, feedback, and penalties and rewards (e.g. Tawfik et al., 2010, Steg, 2007, Steg and Schuitema, 2007).

RESEARCH APPROACH

The aim of this research is to understand and anticipate to trade-offs between collective and individual interests on travel time and fuel consumption in existing strategies for urban traffic network management as defined in the FP7 project eCoMove (Vreeswijk et al., 2010). These strategies combine three measures which are based on vehicle-to-infrastructure (V2I) interaction:

1. *Rerouting of traffic* to evenly distribute traffic over a road network. For example as a result of accidents, road works or to avoid areas with a high concentration of emissions.
2. *Speed advice* to smoothen traffic flows. For example speed advices on specific network links to optimize the throughput, or speed advices at traffic lights to create green waves and avoid stops.
3. *Priority schemes* at controlled intersection. For example green priority for heavy trucks to minimize the emission of high pollution vehicles. Or green priority for traffic flows that have been rerouted, or for platoons that have been created by means of speed advices.

Each of the measures hold scenarios in which interest or goals are opposed. For example an increase in travel time, a cruising speed below the desired speed or additional delay at controlled intersections versus a reduction in the overall (not necessarily individual) fuel consumption. V2I interaction literally allows a 'working together' of road users and road operators and has the potential to tailor information to needs and preferences to change motivations and attitudes to help achieve specific goals.

This research focuses on travel choice behaviour rather than network optimization or V2I technologies and is divided into four phases. The first phase, the definition phase, deals with understanding and describing the principles of network management in relation to travel choice behaviour, its measurability and important control variables. In the second and most extensive phase the factors which influence user acceptability and travel choice behaviour as well as their interrelations, dominance and indicators will be studied for the three measures mentioned earlier. Given the limitations, constraints and opportunities found, the final two phases are concerned with reflection on the design of network management strategies and evaluation of exiting strategies derived from the eCoMove project.

The research method includes but is not limited to: focus group sessions to discuss remarkable contradictions, causal models to register cause and effect relations between factors of influence, a driving simulator experiment using verbal protocols to study the travel choice behaviour questions discussed before, and a simulation study to evaluate the performance of strategies in a medium-sized urban road network.

CONCLUSIONS

This research combines knowledge from traffic management, travel choice behaviour and traffic psychology disciplines and contributes to knowledge about trade-offs between conflicting interests and objectives. Through the explicit consideration of human behaviour, the gains for individuals in a network solution and user acceptability, the result of this research may serve as input for the development of better and more realistic transportation models. Furthermore, more attention for the expectations of individual drivers is expected to improve the effectiveness of urban traffic network management strategies and stimulate pro-environmental behaviour.

REFERENCES

Adler, J. and V. Blue (2002) A cooperative multi-agent transportation management and route guidance system. *Transportation Research Part C: Emerging Technologies,* 10**,** 433-454.

Avineri, E. (2010) 'Choice Architecture' and the Design of Advanced Traveler Information Systems (ATIS), in*: Proceedings of the 13th IEEE ITS Conference - Workshop on Traffic Behavior, Modeling and Optimization*, 2010 Madeira, Portugal.

Braess, D., A. Nagurney, T. Wakolbinger (2005) On a paradox of traffic planning, in: *Transportation Science,* 39**,** pp. 446-450.

Chorus, C., E. Molin, B. van Wee (2007) Travel Choice Adaptation Through Information Provision: Insights from Literature Review, In: *86th annual meeting of the Transportation Research Board* (submitted for publication), 2007 Washington D.C.

Correa, J.R., A. Schulz, N.E. Stier-Moses (2007) Fast, fair, and efficient flows in networks, in: *Operations Research,* 55**,** pp. 215-225.

Levinson, D. (2002) Perspectives on efficiency in transportation, in: *International Journal of Transport Management,* 1**,** pp. 145-155.

Razo, M. and S. Gao (2010) Strategic thinking and risk attitudes in route choice, *89th annual meeting of the Transportation Research Board.* Washington D.C.

Senk, P. (2010) Route choice under microscope: Process oriented analysis of decision making, *89th annual meeting of the Transportation Research Board.* Washington D.C.

Srinivasan, K. K. and H.S. Mahmassani 1999. Role of congestion and information in trip-makers' dynamic decision processes experimental investigation, in: *Transportation Research Record***,** 44-52.

Steg, L. (2007) Sustainable transportation - A Phychological Perspective, in: *IATSS Research,* 31**,** pp. 1-9.

Steg, L. and G. Schuitema (2007) Behavioral responses to transport pricing: a theoretical analysis, *Threats from car traffic on the quality of life,* Amsterdam: Elsevier.

Tawfik, A., H. Rakha, S. Miller (2010) Eliciting drivers cognitive trends, examing driver learning, and capturing aggregate evolution in route choice, in: *Proceedings of the 13th IEEE ITS Conference - Workshop on Traffic Behavior, Modeling and Optimization*, 2010 Madeira, Portugal.

Vreeswijk, J.D., M.K.M. Mahmod, B. van Arem (2010) Energy efficient traffic management and control - the eCoMove project and expected benefits,in: *Proceedings of the 13th IEEE ITS Conference*, 2010 Madeira Island, Portugal.

Wardrop, J.G. (1952) Some theoretical aspects of road traffic research, in: *Proceedings of the institute of civil engineers,* 1**,** pp. 325-378.