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METRASYS Working Paper: Traffic management in the context of sustainable urban transport

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Traffic management in the context of sustainable urban transport

Traffic management is a vital element of the Metrasys project. This paper will develop a policy package of traffic management and complementary measures that contribute to climate change mitigation and energy efficiency improvements in transport sector in the city of Hefei, China. It will also explore options for international climate finance and will provide some practical steps towards this.

1. Traffic management in Hefei, China

The City of Hefei is on the verge of passing the threshold towards becoming a mega city within the next decade and is at the stage of rapid development, these change leads also to an important reform of the urban traffic framework. Recently, Hefei was beginning to use technology developed by different Intelligent Transportation System (ITS) Projects. Several equipments of electronic enforcement have been implemented as well as a new Traffic Control Centre by the Department of Hefei Traffic Police. These were good conditions too start the METRASYS project in the context of traffic management. One of the first steps is the development and implementation of an up-to-date traffic management system including traffic data collection and broadcast of traffic information for traffic operators, travellers and drivers. The so-called Floating Car Data (FCD) system localizes vehicles via GPS and collects speed, direction and position of the vehicles in real-time. Thus FCD enables the user to qualify and visualize the traffic flows and traffic situation. It also allows the detection of sensitive spots of traffic congestion. The resulting traffic services are distributed to road users through Digital Multimedia Broadcasting (DMB) using TPEG (Transport Protocol Experts Group), a coding standard for detailed traffic and journey information to provide road user with comprehensive, up-to-date information.

The operational traffic management is based on a closed loop driver information system. In the first step the current traffic situation is detected with floating cars. At the beginning of the project the Chinese partner ASEC could convince a private operated taxi company to participate in the project. Beyond that the ASEC also invested the finance for the equipment of 600 taxis with GPS receivers. By the engagement of ASEC the traffic police of Hefei provided additional 200 police cars. The government of Hefei valued this engagement highly by authorizing the equipment of 1200 construction vehicles with analogous GPS receivers. In the end of the project all in Hefei operated taxis (7000 Taxis) should be linked to the METRASYS system. The FCD software system for data collection, map matching, routing, and data fusion is installed on a server in Hefei at the Traffic Control Centre.

This server is also linked to the radio station of Anhui Radio were the DAB sender for the broadcasting of the information is located. At the police station a workstation is located; at this terminal special traffic information (for example accidents, incidents, events, weather- and congestion information) can be compiled by policemen. This information together with the traffic service derived from the FCD travel speed are subsequently encoded in the TPEG standard and broadcast by Radio Anhui through Digital Multimedia Broadcasting (DMB).
To establish real-time dynamic traffic information service system, the METRASYS project developed an on-board traffic information service terminal (OBU), which is based on multimedia broadcasting, it uses TPEG to code the traffic information and transmit them. The OBU includes a positioning device (GPS) and a digital radio (DAB) and is based on an Ultra-Mobile PC (UMPC). The OBU achieves a place locator and path planning service; it receives traffic status information and can conduct the user to avoid traffic congestions effectively.

In this system traffic information from other already existing sources are integrated too. All these data are fused and stored in a central database. This database is the main core of the ITS system and the base for all technical and planning work: Traffic information for the decision makers, traffic information for public via internet, Variable Message Signs (VMS), and Digital Multimedia Broadcast (DMB) for the drivers. The completed system in Hefei can be seen as a typical example for the dissemination and usage of traffic information in China. The infrastructure chosen here can therefore serve as a model for similar information systems in other Chinese cities. The architecture of the system – beside the addition of the mandatory supervisory body in China - is transferable to even various sites that focus comparable information sources into a unified information propagation using this innovative standards.
2. Traffic management and beyond

The core objective of the Metrasys project is to improve the efficiency of the existing transport network through traffic management to improve traffic flow and increase transport energy efficiency. Traffic management has the potential to reduce congestion and contribute to seamless transport in urban environments. It can also make a contribution to the improvement of air quality in the city centre by diverting traffic. Vital, however, to the contribution to a sustainable transport system is the design of the scheme and the wider concept in which it is embedded. Applied in isolation, traffic management is likely to be less effective in delivering on its primary objective to reduce congestion and is likely to generate trade-offs with other objectives such as energy efficiency of the transport system, greenhouse gas emissions and economic efficiency. This section will explore the potential and also the caveats of traffic management to identify areas where complementary measures are required to minimise trade-offs and maximise synergies.

As part of the Metrasys project it is planned to make real-time traffic information publically available to allow individuals, but also taxi drivers and transport companies to plan and route trips more effectively. Technology based traffic information and management systems can contribute to better traffic flows and can reduce congestion (ECMT/ITF 2007). While this improves the utilisation of the existing road network it may not necessarily improve energy efficiency of the transport task in urban areas. Improved reliability of individual motorised transport will improve the attractiveness of this mode of transport and may even induce transport demand (Goodwin 1996; Lam, T.C., Small 2001).

The effectiveness of traffic management measures in terms of energy efficiency depends on how travellers respond to improved traffic flows in the road network. Several studies suggest that behavioural changes may erode a considerable share of the efficiency gains. In a policy environment such as China, where travel demand is surging and fuel prices are subsidised the rebound effect is likely to be substantial. Reduced travel time and fuel costs are often mirrored by increased travel demand, which undermines the efficiency gains and may even outweigh them (Ruzzzenenti & Basosi 2008). While road network capacity is largely predetermined it varies significantly at the irregularity of travel demand, which can be influenced by traffic management. The level of induced travel trough improved efficiencies in the system depends to a certain extent on the level of income (Portney, P.R., Parry, I.W.H., Gruenspecht, H.K., Harrington 2003). The levelling off of rebound effects from efficiency improvements observed in OECD countries (Small, K.A., Van Dender 2007), is unlikely to occur in emerging economies like China at this stage as the link between discretional income and travel demand is still very high, even though it tends to decline with increasing household incomes (Wang u. a. 2012).

The current approach to congestion management in the city of Hefei focuses primarily on the expansion and completion of the road infrastructure network. The increased road network capacity, however, induces additional traffic, which undermines the intended objectives of congestion relieve, hence not only eroding efficiency gains, but also calling into question the investments made into additional road capacity (Hymel, K.M., Small, K.A., Dender 2010). The
direct rebound effect of efficiency measures in urban passenger transport was estimated at 96% for China (Wang u. a. 2012).

One very effective option to improve traffic flow and reduce overall travel demand is congestion charging. Congestion charging systems have been operating in Singapore for several decades and were implemented more recently in London and Stockholm. As early as 1975 the road pricing was implemented in Singapore to manage the choked streets of the rapidly growing city. First an Area License System was established, which required a permit to enter Singapore’s central area. The city entry charge boosted public transport patronage almost immediately after its introduction and led to a 45% reduction in traffic, road site accidents decreased by 25% and average travel speeds increased from about 20 km/h to over 30 km/h (OECD & ECMT 2007).

The system was upgraded in the late 1990s from manual fee collection to On-Board Units that deduct electronically the required charge when entering the city centre, the central business district, major arterials and motorways. As result public transport has a modal share of over 60% in daily traffic, an increase of nearly 20% (B.W. 1990). The success of the system in improving infrastructure capacity, safety and air quality and reducing travel demand, fuel use and greenhouse gas emissions inspired the congestion charge systems in London and Stockholm and provided the basis for several feasibility studies for similar schemes for cities around the world (Prud’homme & Bocarejo 2005).

Liu et al. (2009) undertook such a study for China, focusing on the example of a congestion change for the old central city of Beijing. The study suggests that congestion charging can reduce the number of cars entering the 2nd Ring Road by about 10% during peak time hours (Liu et al. 2009). It was stressed, however, that congestion charging should be implemented according to the regional circumstances and emphasised that complementary measures such as improved public transport are required to provide affordable and reliable alternatives to the private car (Liu et. al 2009).

3. Traffic management as part of a sustainable transport concept

Measures such as traffic management and congestion charging should not be implemented in isolation. (Wang u. a. 2012) conclude that “any policy that reduces congestion without otherwise making driving more expensive, for example diverting some commuters to transit, will tend to attract new traffic that at least partially offsets the policy’s effect on congestion”. A package of complementary measures is required to actively manage travel demand and improve transport energy efficiency. This includes improvements of the public transport system as reliable and affordable alternative to the car and measures targeting the efficiency of the vehicle fleet. This section will explore some of these measures and in doing so will focus primarily on measures that can be implemented at the local level.
Vital to the success of sustainable urban transport concepts is a mix of measures that improve the efficiency of the vehicle fleet, reduce travel distances via integrated land-use planning and provide modal alternatives to the private vehicle (Newman & J. Kenworthy 1999). Whereas the vehicles fleet policies fall only partially in the jurisdiction of city councils, the land-use planning and modal efficiency are key areas of responsibility for local governments.

A reliable and affordable public transport system is a key element of a sustainable urban transport concept. While providing a similar level of mobility, public transport only requires a fraction of energy and space compared to the private car. Public transport not only contributes to lower energy consumption and emissions it also reduces congestion, which improves traffic flows and reduces travel times (OECD & ECMT 2007). As public transport in China is typically more than twice as energy-efficient per passenger kilometres as individual motorised transport, preserving and enhancing the share of public transport in urban passenger transport yield the potential to mitigate rising energy consumption and emissions (Knörr & Dünnebeil 2008). Thus, it contributes to the objective of reducing congestion and at the same time is part of the wider concept of sustainable urban transport.

Vital elements to shift transport demand from individual motorised transport to public transport are investments in capacity and reliability and physical integration with walking and cycling affordability and park & ride facilities. Reliability is an important factor for modal choice (OECD/ITF 2009). The predictability of travel times with metro (MRT), light rail (LRT) and/or bus rapid transit (BRT) compared to a journey in the private car may provide enough incentive to shift from individual to public transport (Lam, T.C., Small 2001).

In addition to public transport, non-motorised modes, i.e. cycling and walking, can take a substantial share of the urban transport task, in particular on short distances and help reducing emissions and energy consumption and reduce congestion. Walking and cycling is especially suitable for urban transport as in cities the majority of trips are short distance trips (below 5 km) (Moudon, A.V., Lee 2003). One fundamental advantage of non-motorised modes is that they are low cost modes compared to other transport options, not only for the individual, but also for public authorities. Wider benefits of cycling and walking are health benefits for the cyclists or pedestrians as well as environmental and economic benefits resulting from zero emissions and energy consumption (Santos u. a. 2010). While taking up a noticeable share of the transport task, walking and cycling infrastructure consumes only little space compared to roads, yet this infrastructure is often neglected in transport planning. The provision and maintenance of infrastructure for pedestrians and cyclists is crucial to make these modes more attractive. Concerns about safety keep many people from cycling (Noland 1995). Separate crossing signals, cycle lanes and buffers between road and lane can improve the safety (Santos u. a. 2010).

Integrated land-use planning focuses on higher densities, mixed use and the integration of public transport and non-motorised transport infrastructure (Hymel, K.M., Small, K.A., Dender 2010). Combined, these factors can reduce travel distances, can enhance the role of non-motorised modes and can improve accessibility and efficiency of public transport (J. R. Kenworthy & Laube 1996). Smart land-use planning only takes effect over longer time scales, but impacts are lasting.
In cities that are rapidly growing like Hefei, local authorities can largely influence future travel patterns. Thereby, land-use planning decisions of today can ease the traffic management task in the future. Hong-Kong successfully limited the increase in car use and dense urban structures with mixed use playing an important role in achieving an efficient transport system. The city further integrated urban development and public transport infrastructure (Zhang 2004).

Public and non-motorised transport modes play a vital role in reducing congestion, meeting the rising transport demand and improving the overall efficiency of urban transport. Traffic management can only be successful in terms of reducing energy consumption and congestion if additional measures, such as boosting public and non-motorised transport and integrated urban planning improve the efficiency of the urban transport system. Another important element in this regard is the efficiency of the vehicle fleet. As stated earlier, fuel economy of vehicles falls mainly in the responsibility of national governments. However, as many cities, including Hefei, are responsible for vehicle registration they may use this as a lever to influence purchasing behaviour towards more fuel-efficient vehicles. Registration fees could be differentiated on the basis of their fuel-efficiency or CO₂-emissions. Differentiated registration fees or taxes have proven to be very effective in influencing purchasing decision in favour of low-emission vehicles (Giblin, S., McNabola 2009).
Bibliography


