TRAFFIC CONTROL: CURRENT SYSTEMS AND FUTURE VISION OF CITIES*

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1. Introduction

Municipal governments need to make decisions on large investments to ensure smooth traffic flows. Instead of building new roads it becomes increasingly accepted that often investments in ITS (Intelligent Transport Systems and Services) can be less expensive and more effective. However, also investments in ITS require significant resources. Besides monetary investments often organisational changes are required and possibly new partnerships between previously independent government sections have to be formed. Therefore it becomes no less important to understand the project impacts before decisions are made in order to avoid a waste of resources. London for example has set out a plan for an extensive overhaul of its traffic management which is summarised in "Transport 2025", the transport vision for London (TfL, 2006). In order to make well informed decisions it is beneficial to understand the impact of similar policies and investments in technology in other cities around the world.

This paper summarises the findings of a data collection exercise with the objective to understand the state of the art in traffic management in some key metropolitan cities around the world. Our interest is in currently employed technologies as well as in identifying problems and future visions. The focus is on "ITS in cities" and a second motivation of the study is to identify whether further in-depth comparisons on specific issues could be worthwhile.

2. Comparative Studies

Comparative studies commonly known as 'benchmarking', are not new and have been successfully applied to a number of problems. Within transportation research the Community of Metros (CoMET) is an example for successful long term benchmarking approach with large metro systems around the world (Anderson, 2006).

There have also been attempts made to evaluate the benefits of ITS systems through comparison of projects in various cities. In particular the International Benefits, Evaluation and Costs (IBEC) working group has helped to establish handbooks and evaluation guidelines for ITS projects. In opposite to initiatives such as CoMET it is not a long-term approach with a few selected group members but the idea is to promote best-practice through one-off projects as well as open workshops at major ITS conferences (see IBEC (2008) for details).

There are further a number of organisations and discussion groups with the aim to promote best practice among its members. Examples for these are Ertico, Polis, Eurocities or IMPACTS: "Ertico – ITS Europe" and various similarly large ITS initiatives in other continents aim to promote ITS technologies including all areas of transportation and are not just focused on urban issues. Polis is a networking organisation focused on co-ordinating discussion between European Cities and Regions "to develop innovative technologies and policies for local transport" (Polis, 2008). Eurocities is a network of 130 larger European cities also with the aim to "provide a platform for its member cities to share knowledge and ideas, to exchange experiences, to analyse common problems and develop innovative solutions, through a wide range of forums, working groups, projects, activities and events" (Eurocities, 2008). Finally, "IMPACTS is an international network of European and North American Capital and Major Metropolitan Cities for exchanging information and experience on Urban Mobility and Transport Policies" (IMPACTS, 2008). All these initiatives vary by the commitment of its members and the level of information exchanged. In many cases groups only facilitate informed discussions rather than lead to an exchange of data. In conclusion, though several approaches have been made an initiative similar to CoMET with the aim to evaluate the impact of traffic management decisions on the city as a whole considering its specific background is missing.

3. Data Collection

Between Nov.06 and Jan.07 questionnaires were sent out to traffic managers (medium or high level management) of cities around the world. Contacts were established either through Polis, through papers published that describe innovative ITS solutions in cities, through personal contact to the traffic managers itself or via academic contacts in local universities. There was no selection of cities according to size, our focus was to get a worldwide overview and to cover cities with recent innovative ITS solutions. Table 1 lists the 28 cities that responded to the questionnaire. The questionnaires were answered fairly complete though follow-up discussions (mainly by email and telephone) were needed to clarify some questions and answers.

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Table 1 Cities responding to questionnaire

Europe		North-and South America	Australasia
Amsterdam	Karlsruhe	Las Vegas	Tel Aviv
Berlin	Munich	Minneapolis	
Birmingham	Paris	New York	Taipei
Brussels	Rome	Toronto	Tainan
Dublin	Stockholm		Taichung
Frankfurt	Torino		Kaoshung
Helsinki	Zurich	Belo Horizonte	Beijing
London			Tokyo
			Sydney

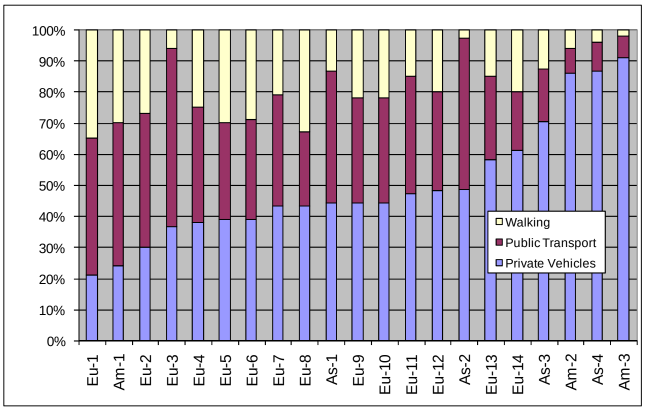

Figure 1 Modal Split in cities (by journeys)[1]

4. City Context

The cities in our sample clearly vary significantly in size. On the lower end is Karlsruhe with a population of around 200,000 whereas Greater Tokyo with a population over 20 million is clearly the largest metropolitan area. For traffic control purposes of similar interest might however be the population density. The Asian cities in our sample have a much higher density (Tokyo: 13600 people/ km^2, Kaohsiung: 9700 people/km^2) than the European cities which mostly have a population density of around 4000 people/km^2). Clearly the answer to our questions is depending on the definition of the city boards which we tried to overcome by asking for the urban as well as the metropolitan area.

Further geographical and cultural background will influence the success of any traffic management policies. The difference between European and American cities in terms of modal split has been well documented and is also apparent in our sample. Am-1 reports that 91% of the journeys are taken by car whereas in many European cities the percentage of journeys taken by private vehicles is below 50%. In our sample London is near the average with 44.8% of the journeys taken by car. In Taiwanese cities nearly 70% of the journeys are taken by motorbike whereas several European cities do not even record motorbike journeys separate from car journeys. Figure 1 illustrates the modal split for cities in the sample which shows that in Eu-1 city only 21% of the journeys are made by private car. Interesting is further the low proportion of walking trips in another European city. Partly these differences in statistics might again be due to definitions. For example there seem to be differences in whether cycling is recorded separately or together with walking. Also the recording of multi-modal journeys is not clear. The results and discussions following from this study suggest that these definitional issues are not just an issue for our data but also for statistics available from other sources.

To better understand why and how particular data are collected and how traffic management strategies were implemented it is further important to understand the organisational structure of the cities. Transport for London for example has undergone significant organisational changes in the past years and is now responsible for public transport as well as traffic control in the city reporting directly to the mayor. A similar situation exists in Taipei which allowed the recent deployment of a more integrated ITS strategy. In Tokyo the situation is very different with Tokyo Metropolitan Police Department being mainly responsible for traffic operations. In London the police are not involved in traffic operational issues which means enforcement of new management strategies becomes more difficult. In Tokyo various road authorities responsible for construction, maintenance of highways as well as local roads are however rather independent as are numerous public transport operators. One might argue that this makes integrated city-wide transport planning more difficult.

To fully understand the city context clearly more information on the current organisational structure as well as historic developments, geographic details, the economic situation and qualities of the transportation network such as reliability, accessibility or comfort are needed. Anderson (2006) argues that the complexity of transportation systems is a main argument for the need of a long-term approach to comparative studies.

5. Signal control

An important aspect of traffic management are signal control strategies which was also a major part of the survey. Figure 2 shows the number of signals plotted against the total road network-km. Clearly in As-1 signal control is the main

1 For confidentiality reasons in this and the following graphs only the continent of the city is revealed (Eu: Europe, Am: North-und Southamerica, As: Australasia)

strategy to enforce priority at junctions whereas in some European cities priority rules and roundabouts are used more. In As-1 in average for less than 2km travelled a driver will encounter a traffic signal controlled intersection but this figure rises to more than 10km for drivers in Eu-13. In how far this has an effect on travel times and traffic safety cannot be concluded from this survey.

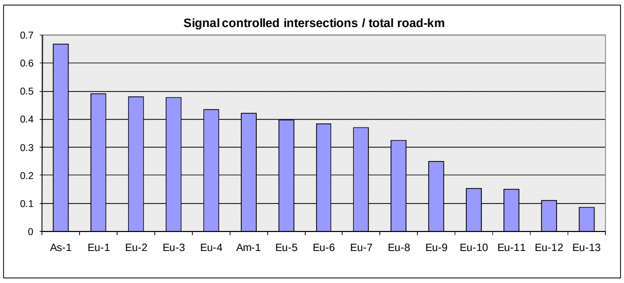

Figure 2 Signal density

Of further interest was to understand in how far cities employ advanced signal control strategies such as dynamic traffic control and urban traffic signal control systems such as SCOOT. We found a huge variance in technologies employed. The questionnaire asked for the number of junctions being controlled with "fixed time", "fixed time with control updates" or vehicle actuated and distinguishing those taking area wide network control into account or not. Figure 3 shows the percentage of junctions that are controlled with fixed time programmes, i.e. are not vehicle actuated. Whereas in Eu-16 all junctions are controlled by vehicle responsive control and most of the junctions have some public transport priority, in other cities fixed time traffic control is still the norm. The largest urban traffic control systems co-ordinating green times between junctions can be found in Tokyo where 50% of its 15,000 junctions are controlled with the STREAM system. London and Sydney operate the largest SCOOT (1800 junction out of total 6000 junctions) and SCATS system (3400 junctions) in the world respectively. Further, Tel Aviv recently introduced a new control system which covers 98 of its 400 junctions and operates as a "coordinated-actuated traffic management scheme". Other cities such as Zurich have developed their own system independent from SCOOT or SCATS with similar functionalities. In Zurich 20% of the junctions are dynamically co-ordinated to provide green waves. In other cities such as Amsterdam and Munich another strategy was chosen where the majority of the junctions are controlled with isolated vehicle responsive control.

Some kind of bus priority integration with the traffic signal control is performed in most European cities. The most advanced system can probably be found in Zurich which enforces priority of buses and trams very strict and in addition operates a decentralised system, i.e. the priority decision is given at the junction and not from a centralised control room. The technologies used to provide priority differ between systems based fully on GPS (Helsinki, Paris, Torino) and other systems using beacons as well as GPS (e.g. London, Munich, Stockholm, Sydney). Only a few cities provide priority not only through prolonged green times or "stage skipping" but by providing separate signals for buses.

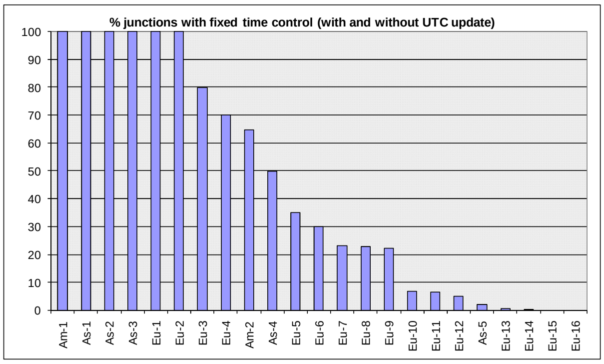

Figure 3 Percentage of traffic signals operating with fixed time control

6. Other traffic management strategies (ITS)

Traffic management goes beyond signal control and recent ITS developments offer the transport planner a wide range of possibilities. The main tools used are various forms of pricing policies, access restrictions as well as advanced information provision to the public to inform them about alternative travel options.

Among the cities in our sample full urban congestion charging is only installed in London (since Feb.02) and Stockholm (since Aug.07). Further in Minneapolis HOT lanes are installed and future investments in HOV and HOT are planned. Besides these a number of cities are interested in implementing pricing projects such as Amsterdam, Torino, New York and Zurich. In follow-up discussions some problems mentioned by cities were often the unclear legislation which prevents or delays the installation.

Rome has probably one of the most advanced automatic access control systems in the world which only allows residents or vehicles with special permission to drive into the historic parts of Rome. Enforcement is ensured with a number plate recognition system. Several other cities mentioned that they have "some kind" of access control system. For example in several cities HGVs are not allowed in certain areas of the city which is however only enforced through traffic signs. Several European cities mentioned however also that they are interested in applying or improving access control in the near future because of new European Commission guidelines on air pollution. How to effectively enforce access control seems to be still a topic for discussion.

All cities provide the public with information about the congestion system on the roads (mostly by web and traffic message channel, except for Tokyo using VICS). In Taipei a system is in place providing travellers with information about the costs and travel times for all modes before they make the journey. Therefore it is offering a website where users type in their OD information and which then provides information on real-time travel times for the journey made by public transport as well as by private vehicle (Taipei City ATIS web, 2008). London and several other cities for example are only providing separate services for public and private transport. Taipei's website is further providing information on the availability of taxis and transport options for those with disabilities. Such an integrated approach could not be found in other cities.

In Taipei as well as a large number of other cities traffic flows are recorded per minute in order to analyse travel times and predict trends. Several cities mentioned that it is their aim to provide drivers not only with information about current conditions but also with traffic predictions for the next 30 to 60 minutes. In our sample currently however only Zurich offers this service and even here only as a test version (see Stadt Zürich, 2008). Based on historic data as well as current conditions trends are predicted using own algorithms.

Our questionnaire further provided data on design and functionalities of the traffic control centres, traffic monitoring, planned investments and performance indicators employed by the cities. For brevity these are not discussed in this paper will however be part of the presentation.

10. Conclusions

This paper summarised the findings from a questionnaire survey and follow-up discussions with traffic control management staff in 28 cities around the world. The sample is clearly biased towards European cities and in particular some key Asian as well as North American cities are missing in order to get a full overview on the state of the art of ITS applications in cities. In further work it is aimed to extend the sample. Nevertheless the survey results provide some interesting information and are aimed to enable a better discussion between the cities:

A wide range of ITS technologies have been installed in today's cities with different foci in the cities depending on prevailing problems, political agenda as well as contacts to local research institutions. Some of these schemes are well published however there is little written about the transport situation as a whole and in how far these (single) technologies have helped to solve the transport problems of its citizens. Our survey results highlighted that this is partly because often evaluation measures not (yet) being developed or authorities are revising these as they realise that they are not appropriate.

It is therefore also currently difficult to understand the effectiveness of ITS technologies and to predict whether a particular solution could be a success in another city a well. However, it is exactly this information that is desired by traffic managers in discussions with government and other stakeholders to justify investments. As the focus of future investments has clearly shifted from road construction to public transport and investment in traffic management strategies such information is becoming particularly urgent. Several cities are currently developing a key performance indicator set so that initiatives to develop common measures might be welcomed by all.

Our results further highlighted a number of other common issues that suggest there is scope for common research possibly in the form of benchmarking. These are strategic/management issues as well as technical issues: For example several cities are currently in the process of developing long-term plans. Other cities have been through this process and could advise on what plans are realistically achievable. Pollution monitoring (due to tougher legislations) and access control is a topic in several cities as well as the restructuring and better integration of the traffic control centre. Common research is needed to develop effective decisions support systems, ITS architectures that allow for the integration of several data sources as well as on issues such as effective presentation of travel information to the public.

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