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ROAD USER CHARGING AND IMPLICATIONS FOR TRANSPORT POLICY: FINDINGS FROM THE CURACAO PROJECT

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ABSTRACT

This paper reports on the outcomes of a European project, CURACAO, designed to support the implementation of urban road user charging (URUC) as a demand management tool in urban areas. The project did this through engagement with a User Group of cities interested in pursuing URUC to identify the barriers preventing them from doing so.

The project reviewed the complete process of setting up a URUC scheme from the setting of objectives, through to scheme design, predicting impacts, achieving acceptability and the implementation process and presented its findings in a State of the Art Report and a Case Studies Report. The State of the Art Report provides evidence collated from research and practice to address a series of 14 themes identified by the User Group, including objectives; scheme design; technology; business systems; prediction; traffic, environmental, economic and equity impacts; appraisal; acceptability; transferability; implementation; and evaluation. The Case Study Report reviewed 16 proposed or implemented schemes in Europe, focusing on pricing objectives, scheme design, the implementation process and scheme results. On this basis, the CURACAO Consortium developed a list of policy recommendations aimed at cities and regional authorities, national governments, and the European Commission.

The paper summarises the main findings of the State of the Art Report and the case studies. On this basis, it outlines the policy recommendations which were drawn, and identifies future research needs.

Keywords: urban transport; road user charging; policy implications
Session track: G4 (SIG-10)

1. INTRODUCTION

Urban Road User Charging (URUC) is a transport policy instrument that is uniquely capable of reducing the problems associated with urban travel, but is equally difficult to implement. Those cities which have implemented URUC have achieved sustained reductions in traffic entering the charging zone in the range of 14% to 23%. This represents a change in travel patterns which cannot be approached by any other available transport policy instrument. Yet over the last five years, in which schemes have been implemented successfully in Milan, Stockholm and Valetta, ten UK cities and two US cities have abandoned plans for charging, despite substantial government grants designed to encourage such schemes. In Edinburgh and Manchester in the UK these decisions were made via public referenda which rejected charging proposals by majorities of up to 80% (Saunders, 2005). It is clear that there are serious barriers to the pursuit of URUC, and that cities need guidance if they are to make better use of this potentially powerful transport policy tool.

This gap, between the potential of URUC and the progress in actual implementation, has been the focus of a three year project funded by the European Commission, CURACAO - Coordination of URUC Organisational Issues - which begun in 2006. The project was designed to support the implementation of URUC as a demand management tool in urban areas. It did this by working with a user group of 20 cities interested in pursuing road user charging, to identify the barriers to their doing so, and to provide evidence on ways of overcoming those barriers. Evidence was provided both through a State of the Art Report, which reviewed international evidence on issues of interest to the cities, and through 16 case studies which include successful implementations, current plans and abandoned proposals.

To ensure dissemination of the results the project also developed complementary tools (Guiding Presentation, Fact Sheets, Online Knowledge Base) aimed at decision makers to assist them in understanding the issues surrounding URUC. The results from both the State of the Art Review and the case studies were used to develop a series of policy recommendations for the European Commission, national governments and local governments which were debated with the city partners. These documents are available at http://www.curacaoproject.eu.

This paper has a further four sections. In the next Section we summarise the findings of the State of the Art Report. Section 3 reports on the outcomes of the case study analysis. Section 4 outlines the policy recommendations arising from this research. Finally Section 5 concludes with a summary and provides directions for further research.

2. FINDINGS OF THE STATE OF THE ART REPORT

Organisation of the State of the Art Report

The State of the Art Report (SOAR) (CURACAO (2009a)) was designed to summarise the evidence, collated from research and practice, on a series of themes of concern to cities.

Three editions were produced between 2007 and 2009. Each edition was based on the identified needs of the user group cities. Whilst an early User Needs Assessment Questionnaire focused attention on a set of key themes, each edition was reviewed with the city partners in the project who were asked for suggestions for additional themes of practical interest to them. In this dynamic way, the final edition of the SOAR focused attention on the following central topics of interest:

1. The Urban Road Pricing Context: questions in this category covered the objectives of the URUC schemes, ways in which they can be designed to meet local objectives, the technologies available to support such a scheme and the business systems for operation of the scheme,

2. Prediction: questions in this category focused on techniques for predicting the effects of road user charging schemes, as well as gathering evidence of URUC on traffic effects, impacts on the environment and the economy along with equity implications,

3. Appraisal: this focused on techniques for appraising the effects of road user charging schemes,

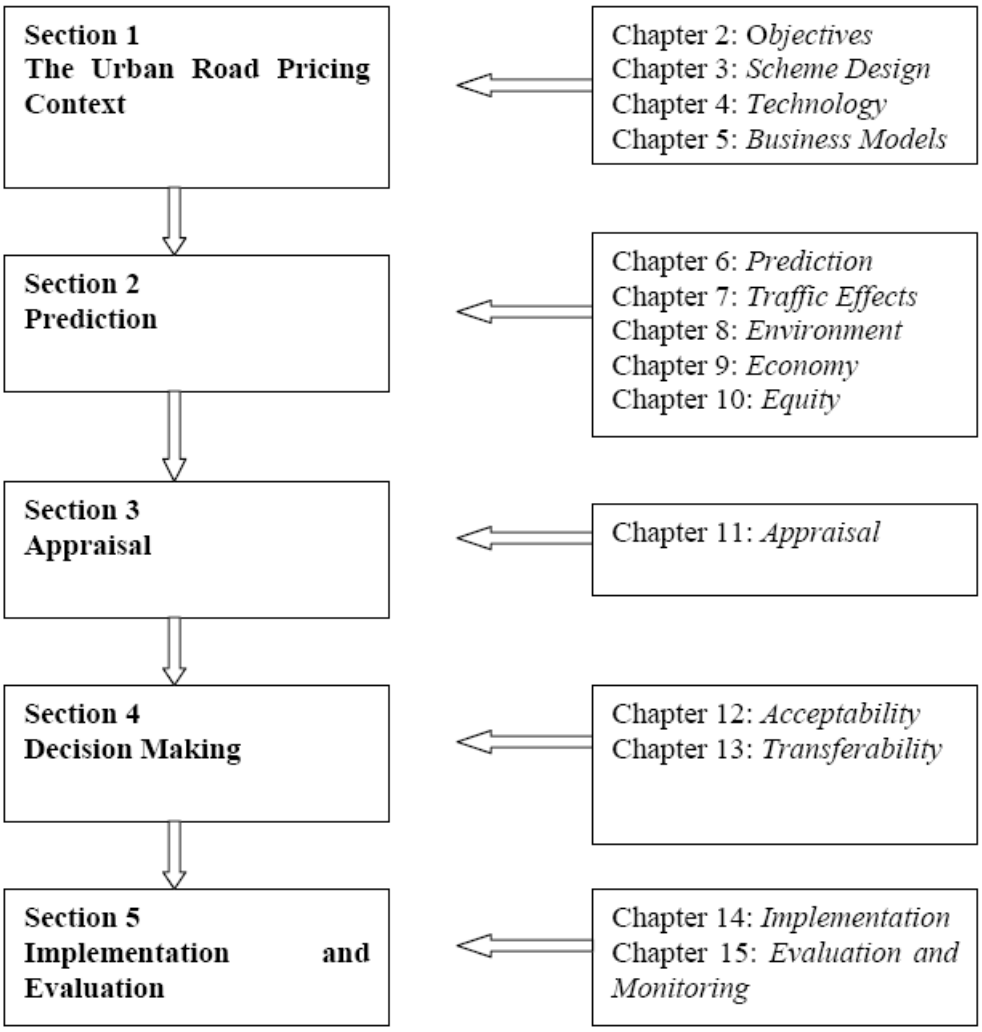
4. Decision Making: this included factors affecting the acceptability of road user charging schemes and the potential transferability of experience from one city to another, and

5. Implementation and Evaluation: this covered good practice in the implementation of urban road user charging schemes and techniques for monitoring and evaluating the effects of road user charging schemes.

Figure 1 illustrates the resulting structure of the Report. Each chapter was based on a series of questions which were agreed with the city user group, and included summaries of the implications for policy, the implications for each of the other themes, and future research needs. The answers to the questions were based on evidence from research and practice, and were critically reviewed both by the scientific team and by the city user group. In addition, the first version was assessed by four international experts from Asia, Australia nd North America. The final version covered all evidence available to the research team up to December 2008.

The SOAR and the case studies were developed in parallel. The information collected in the case studies was structured where possible to match the contents of the SOAR, and actual data from the case studies was included in the relevant chapters of the SOAR.

Figure 1: Organisation of the State of the Art Report (CURACAO, 2009a)



Summary of the Findings

The Urban Pricing Context

Cities should develop transport strategies to reflect their local policy objectives. As experience has shown that road pricing is a controversial instrument, it is particularly important to demonstrate the purposes for which it is being introduced. Road user charging should therefore adopt a logical sequence, whereby the overall strategy is determined before considering the role that road user charging plays within that strategy. CURACAO has identified a set of nine possible objectives which appear to reflect the full range of objectives

for which road user charging is likely to be pursued by cities. These objectives, as identified in the Report, are:

1. Congestion Relief,
2. Environmental Protection,
3. Revenue Growth,
4. Economic Growth,
5. Health,
6. Liveability,
7. Safety,
8. Equity/Social Inclusion and
9. (Provision for) Future Generations.

Among these, congestion relief, environment and revenue generation remain the dominant objectives of road user charging schemes (CURACAO (2009)). Road user charging design should follow a logical sequence, in which the overall strategy is determined first, and the role of road user charging determined as part of that strategy. This will help to demonstrate that road user charging is needed. Road user charging will be more effective if integrated with other policies. Research on integrated strategies has demonstrated that road user charging is a key element of an effective strategy, and is best complemented by actions to promote public transport, to reallocate road space and to manage land use (May et al, 2005; Lautso et al, 2004). These measures are also likely to reduce the adverse impacts of urban road user charging on those travellers who are most disadvantaged by it, and increase its acceptability (May et al, 2006). However, the best combination of these policy instruments will depend critically on the city context in which they are being applied.

Road user charging can be implemented in a variety of ways, using point charges, cordons, area pricing or distance-based pricing. There is increasing evidence that distance-based pricing is the most efficient in terms of social welfare maximisation (May and Milne, 2000), and the technology on which it relies is rapidly becoming available. However, it appears that many cities will wish to rely on cordon and area-based schemes (May et al, 2002).

Whatever the charging system, the design will need to determine the level of charge, variations by vehicle type, location and time of day, and exemptions and discounts (CUPID, 2005). All these elements of charge specification will affect both the effectiveness of the scheme and its acceptability. Trade-offs will almost certainly be needed between these two objectives. The important role of exemptions and discounts in increasing acceptability should

not be overlooked, but care is needed to avoid these substantially reducing benefits (Santos, 2004), or imposing excessive costs (Eliasson, 2008).

Technology and business systems should be specified in terms of the scheme design, rather than imposing constraints on it. Technology will be required for charging, payment and enforcement. Options include automatic number plate recognition, dedicated short range communications and global positioning systems (GPS). GPS is experiencing rapid development and should allow for a wider range of pricing systems, including distance-based charging. However, automatic number plate recognition remains the principal tool for enforcement. Protection of privacy should be feasible with all technology options (Pickford and Blythe, 2006).

Business systems are needed to manage the complex and interacting requirements of monitoring, payment, accounting and enforcement. While such systems are widely available in the private sector (Kalakota and Robinson, 2000) they are still being developed for complex public sector applications such as road pricing. Choice of technology and of business systems will have a significant impact on operating costs and, together with charge levels, will affect the net revenues available for investment. Table 1 indicates the substantial variation in operating cost as a percentage of revenues between schemes (ECMT, 2006).

Table 1: Charges, income and operating costs of schemes in 2005

	Average charge	Annual fee income (millions €)	Operating costs as a percentage of revenues
London	€ 7.4 / day	275	48 %
Stockholm*	€ 2.7 / day	80	25 %
Singapore	€ 0-2 per trip	39	7 %

* Stockholm figures for 2006
** Including costs of deployment, construction, operation and development of the infrastructure network

(Source: ECMT, 2006)

Prediction

The performance of urban road user charging schemes will depend critically on the behavioural responses induced. It is important to identify the full range of both first and second order responses, and to understand their likely levels. In particular, motorists can be expected to change mode, route, destination, timing and number of journeys. Those who use bus and rail or walk or cycle may make similar changes. Similar types of response can be expected from freight operators and drivers. Second order effects will include changes in vehicle ownership and fleet composition, as well as in the location of economic activity, homes and jobs.

There is now increasing experience of methods for predicting the impacts of URUC schemes. However, the complexities of road user charging make conventional prediction

methods less reliable. The prediction of economic, distributional and equity impacts still remains a significant challenge. Despite this, experience in London and Stockholm suggests that it is possible to use strategic and network models to predict the effects of urban road user charging on traffic levels reasonably reliably. In London, traffic reductions of 15% to 20% were achieved, as compared to predictions of 15% (TfL, 2004), while in Stockholm, the actual reduction of 22% in traffic crossing the cordon compared with a prediction of 25% (Eliasson and Brundell-Freij, 2007).

As shown in Table 2 (below), those URUC schemes which have aimed to reduce traffic have typically reduced traffic entering the charged zone by between 14% and 23%. Traffic changes resulting from the Norwegian Toll Rings, which aimed to generate revenue rather than reduce traffic, have been much smaller (Odeck and Bråthen, 2002). Effects on speeds and congestion have been more variable. The London scheme reduced congestion by 30% initially, but this has since been eroded by extraneous factors which have temporarily reduced road network capacity, and by intentional reallocation of road space (TfL, 2008; Kearns 2008). Stockholm experienced a one third reduction in delay in the charged area, which has been sustained subsequently (Stockholmsförsöket, 2006).

Road user charging will have a wide range of impacts on the environment, some of which are easier to quantify than others. Most impacts, arising from reduced traffic, will be beneficial. Effects will be particularly large where reductions in traffic occur in densely populated areas. Tables 3 and 4 (below) indicate the range of impacts on emissions within charging zones. Redistribution of traffic outside the zone may have negative impacts and this may raise concerns over environmental justice (Mitchell et al 2003). However, careful design can minimise these redistributional effects, and road user charging and the policies which complement it can be designed to focus the benefits more directly on environmental enhancement (Jaensirisak et al, 2005).

The business community is likely to be critical of the potential impact of road user charging on the urban economy (Stockholmsförsöket, 2006). Although there is still only limited evidence to counter such fears, the evidence that does exist does not support them. Much still comes from predictive models, which have typically indicated that urban road user charging would only alter population and employment in the affected areas by between +1% and -3% (May et al, 1996; Still et al, 1998; Eliasson and Lundberg, 2002). Some empirical evidence is now becoming available. An early study in Trondheim (Tretvik, 1999) found that a decline in annual turnover prior to the toll ring was reversed after the toll ring had been implemented, and concluded that there was no evidence that the toll ring had adversely influenced trade. A similar finding has arisen recently in Stockholm (Daunfeldt et al, 2009).

The assessment of equity implications relies on the clear identification of the relevant impact groups, and on assessment of the extent to which each is likely to be affected. Good practice on the listing of such groups is now available in the UK (DfT, 2007). However, for many such groups the prediction of impacts remains uncertain. Evidence suggests that inequities are more likely to arise from “horizontal” factors such as location, demography and

transport needs rather than from "vertical" factors related to income. Potential inequities can be reduced by modifying the scheme design, revising charge levels and exemptions, and using the revenues to provide alternatives and complementary policies (Jaensirisak et al, 2005).

Appraisal

Appraisal of URUC proposals should reflect the full range of objectives adopted by the city and should clearly specify whether the scope of the appraisal is limited to the road user charging scheme itself, extends to cover the scheme together with any complementary measures, or also covers any measures financed from surplus revenue. Whilst appraisal requirements are generally similar to those used for any transport policy intervention (Odgaard et al, 2005), the scale of the changes induced by road user charging, and its role in generating revenue, make appraisal more complex.

Decision Making

Acceptability can be defined as the prospective judgement by individuals, interest groups or politicians of a measure to be implemented in the future (Schade and Schlag, 2003). This remains the key concern of cities considering URUC. Acceptability is mainly based on personal outcome expectations, which are typically negative. The roles of complementary policy instruments and of the use of road user charging revenue are critical to increasing acceptability. However, acceptability can also be influenced by pro-social values, and appeals to concerns over the environment or social justice may help to increase acceptability. There is increasing evidence that levels of acceptability are highly dynamic, and in particular are likely to decline as the proposal becomes more concrete and more imminent, and potentially increase again after successful implementation (Schade et al, 2004). Toll rings in Bergen and Trondheim would have been rejected by a significant majority before implementation, but attracted majority support a year after implementation (Odeck and Bråthen, 2002). In London the proportion opposed fell from 40% before implementation to 25% a year later (TfL, 2005), while in Stockholm opposition fell from 55% to 41% over a similar period (Søderholm, 2006). This helps explain why referenda held immediately before implementation are particularly unsuccessful (Gaunt et al, 2007).

Acceptability can be increased by the provision of alternatives and by the use of discounts and exemptions (Jaensirisak et al, 2005). There is potentially a conflict between pursuit of acceptability, through lower charges and increased use of discounts, and pursuit of effectiveness, which may require higher charges and fewer exemptions (Vrtic et al, 2007). The introduction of complementary policy instruments and the use of road user charging revenue to support such policies are critical to increasing acceptability (Jones, 1998; Schade and Schlag, 2000; Jaensirisak et al, 2005; Schuitema and Steg, 2007).

Transferability concerns the ability of a scheme and its resulting impacts to be replicated in another city. The issue of transferability of policy from one city to another has attracted relatively little study, despite early work by Rose (2001) and a fuller analysis by TRANSPLUS (2003). Transferability of results from one city to another remains a little understood aspect of URUC policy, not least because of the lack of empirical results.

Implementation and Evaluation

Implementation processes have also been less fully researched than other aspects of scheme design. Winter's integrated implementation model (Bergström and Sorensen, 2006) and CUPID's implementation actions (CUPID, 2005) offer a useful structure for comparing approaches in different cities. The implementation processes, including legislative frameworks and political structures, differ substantially from one city and country to another. Political commitment is crucial, and the timing of implementation needs to be matched closely to the electoral cycle. Ideally a consensus should be developed at a regional level to avoid conflicts between adjacent authorities (as occurred in Edinburgh, (Saunders, 2005)). It is important not to underestimate the timescale needed for the implementation process.

Effective monitoring of all impacts of a scheme will be important in sustaining and enhancing the scheme, and in increasing the body of empirical evidence on URUC. London and Stockholm both illustrate good practice in monitoring of such schemes. Cities should be encouraged to carry out a comprehensive evaluation of implemented schemes in order to provide evidence for other cities considering such policies. Such evaluations should ideally consider the full range of nine possible policy objectives identified above.

However, the performance of a road user charging scheme, as measured by an evaluation process, will depend critically on the coverage of the evaluation, and the values assigned to individual elements. This is illustrated well by the critical evaluations of the London and Stockholm schemes conducted by Prud'homme (Prud'homme and Bocajero, 2005; Prud'homme and Kopp, 2007). In both cases they presented road user charging in a far less favourable light than did the cities' own evaluations, principally by adopting different assumptions as to what should be included and how each item should be valued. It is thus important that the basis for the evaluation is agreed in advance and, ideally, is specified in a consistent way by all cities involved.

3. FINDINGS FROM THE CASE STUDY EVALUATION REPORT

The Case Study Results Report CURACAO(2009b) is based on the collection of case study data gathered from European cities in United Kingdom, Netherlands, Italy, Norway and Sweden, which have either implemented schemes, abandoned schemes or are in the process of developing a scheme (as at 31st December 2008). As part of the evaluation process, data was gathered regarding traffic flows, delays, pollutant reductions, safety

implications and financial and economic impacts from as many of the eleven case studies in which URUC had been implemented as were able to provide it.

The original intention had been to ask each of these eleven cities to collect comparable data on the major impacts of their schemes in a consistent fashion. It soon became clear that such an approach was infeasible, since some had already devoted considerable resources to collecting data in different formats, while others did not have the resources to collect new data. Instead, it was decided to collate available data on the attributes of interest to other cities and present it in as consistent a fashion as possible. These more limited results are presented in this section.

Traffic Network Impacts

The CURACAO case studies have shown that in response to the implementation of URUC, a proportion of travellers will change their travel behaviour, either changing modes, moving their trips to times outside the hours of operation, combining several trips into one, or foregoing travel completely. Correspondingly, there will be increases in the use of public transport and cycling. Additional provision for public transport might have been made as part of the package of measures accompanying the introduction of URUC, as has been the case in London and Stockholm. The changes in traffic levels entering the zone for a number of cities are shown in Table 2. It should be noted that the result for Durham is atypical, since charges were imposed on the single entry point to a restricted area. Only London and Stockholm measured changes in delay, but both recorded reductions of one-third. (TfL, 2008; Stockholmsförsöket, 2006).

Table 2: Change in number of vehicles entering the zone

City	% change	Notes
Bologna (IT)	- 23%	Access reduction in LTZ during charging hours on a working day, 2004-2006 *(Source: CdB,2006)*
Durham (UK)	- 85%*	From over 2000 to approximately 200 vehicles per day. *(Source:DCC,2004)*
London (UK)	- 16%	Percentage change in vehicles, 2006 figures versus 2002 figures, during charging hours (0700-1830). *(Source: TfL,2008)*
Milan (IT)	- 14%	Decrease in vehicles accessing the Ecopass Zone (2007 versus 2008). *(Source:CdM,2009)*
Rome (IT)	- 18%	From October 2005 to May 2008. *(Source: ATAC Mobility Control Centre)*
Stockholm (SE)	- 22%	Overall reduction in traffic crossing congestion charge cordon during charging period (0630-1829 weekdays) during the trial period. *(Source:* Stockholmsförsöket, 2006*)*

(*:) This scheme is unique in that it involved charging traffic for using a single road to access a historical peninsula.

Environmental Impacts

URUC can significantly reduce carbon dioxide emissions from traffic within the charging zone. This effect is principally caused by the reduction in the number of vehicles in the zone, but other factors include a higher proportion of 'green' vehicles travelling into the zone, due to charging exemptions, and more efficient engine operation as traffic flows are smoothed. The reduction in carbon emissions in the zone recorded by a number of cities is shown in Table 3.

Table 3: Reduction in carbon dioxide emissions in the zone

City	% change	Notes
London (UK)	- 16%	Change between 2002 and 2003. *(Source: TfL 2008)*
Milan (IT)	- 14%	Change after first nine months of operation of scheme. *(Source: CdM,2009)*
Rome (IT)	- 21%	Change in mean values between 2001 and 2004. *(Source: ATAC Mobility Control Centre)*
Stockholm (SE)	- 13%	After trial period, Jan-July 2006, Inner City. *(Source:* Stockholmsförsöket, *2006)*

In a similar vein, URUC can significantly reduce the local emissions (oxides of nitrogen (NO_x) and particulate matter (PM_{10})) measured within the zone. As with carbon dioxide emissions, this effect is principally caused by the reduction in the number of vehicles entering the zone, and smoother traffic flows. The reduction in pollutant emissions in the zone recorded by a number of cities is shown in Table 4.

Table 4: Reduction in pollutant emissions in the zone

City	% change NO_x	% change PM_{10}	Notes
London (UK)	- 13%	- 15%	Change between 2002 and 2003. *(Source: TfL, 2008)*
Milan (IT)	- 17%	- 18%	Before and after the scheme implementation. *(Source: CdM, 2009)*
Rome (IT)	-	- 11%	Change in mean values between 2001 and 2004. *(Source: ATAC Mobility Control Centre)*
Stockholm (SE)	- 8%	- 13%	After trial period, Jan-July 2006, Inner City. *(Source: Stockholmsförsöket, 2006)*

Safety Impacts

Safety impacts are difficult to estimate, given the time required in which to measure statistically significant impacts. In the one result available, Milan recorded a reduction of

14% in the number of accidents in the zone (CdM, 2009). However, it should be noted that this result is based on a single year's observations.

Financial Impacts

All of the cities studied have generated additional finance for investment in other transport policy provisions. The amount of finance will vary, amongst other things, according to the scale of the scheme, the pricing structure, the costs of scheme operations and the exemptions provided. It should be noted that actual scheme revenues can turn out to be less than those estimated prior to implementation, due to the number of exempted vehicles (Stockholm case), and the generally higher than anticipated reduction in traffic levels (London case). For the Italian schemes, while data is available for overall revenues from tickets, passes and fines, it has not been possible to obtain data on net revenues after the scheme running costs have been deducted, except the case of city of Rome. The revenues raised for cities for which figures are available are shown in Table 5.

Table 5: Additional finance for investment

City	Annual Revenues	Notes
London (UK)	€ 140M	Net revenues 2006-7 (*Source: TfL,* 2008).
Rome (IT)	€ 51M	Estimated net annual revenues. *(Source: ATAC Mobility Control Centre)*
Stockholm (SE)	€ 52M	Estimated annual revenues *(Source: Stockholmsförsöket, 2006.)*

4. POLICY RECOMMENDATIONS

Based on the evidence collated in the State of the Art Report and the Case Studies, several policy recommendations have been developed. These were drawn in particular from the policy implications in each chapter of the State of the Art Report, and were debated with the city user group before being disseminated. URUC will typically be the responsibility of city and regional authorities, but national governments and, in the European context, the European Commission play important enabling roles. The recommendations are thus aimed at City and Regional Authorities, National Governments, and the European Commission.

City and Regional Authorities

Before considering URUC as a sustainable urban transport strategy, City and Regional Authorities should specify their objectives clearly, briefly and simply, and should adhere to them consistently. Although we identified nine possible objectives, there is a case for keeping the list short and simple, while not omitting objectives to which road user charging could effectively contribute. A road user charging scheme should not be designed in isolation but in

the context of the full range of complementary policies that will support it. City authorities should be flexible and dynamic in their approach to scheme design and development, while ensuring that scheme performance is as effective as possible. The scheme design should not be technology driven. Technology and business systems should be carefully selected to be effective and to minimise operating costs.

City and Regional Authorities designing a road user charging scheme should allocate resources for establishing baseline conditions, for collection of traffic and other data for analysis, and for continuous monitoring of performance after implementation. Cities which implement road user charging schemes are strongly encouraged to evaluate them against the full set of objectives listed in Section 2 above.

Acceptability should be addressed at the outset in all its different aspects and can be enhanced by demonstrating that there is a serious problem to be overcome, that a measure as dramatic as road user charging is needed, and that it is likely to work. It is essential that the impacts, both positive and negative, are clearly identified and effectively communicated. A continuing dialogue is needed with the public, pressure groups, politicians and the media. In particular, politicians need to understand, but not over-estimate, the concerns of the public.

The use made of road user charging revenues is critical to determining the acceptability and effectiveness of a scheme. Most charged drivers will initially be made worse off by road user charging, and it is only when the revenues have been channelled into transport (or other) improvements that they begin to appreciate the personal benefits. It is thus particularly important that the costs of operating road user charging schemes are kept as low as possible. It is also essential that the surplus revenues are available to the city authorities to use in support of their overall strategy.

Before implementing road user charging, city and regional authorities should pay careful attention to the planned implementation process and endeavour to establish a consensus among all the agencies involved. Wherever possible, the normal planning process should be used to judge the URUC scheme and its complementary instruments. Unless there is a legal obligation to hold a referendum, authorities should be cautious in using this method to determine whether or not road user charging is introduced.

National Governments

National governments have a responsibility to develop a clear national transport strategy, to explain it clearly and consistently, to indicate who is likely to gain and lose from that strategy, and to take steps to compensate those who are likely to lose. As part of that strategy they should recognise the potential benefits of road user charging as a means of demand management at both local and national levels. The application of road user charging should be seen as part of a wider strategy involving the internalisation of external costs and the

adjustment of road and vehicle taxation systems so that user charges vary according to location, time and type of vehicle.

National governments also need to ensure that appropriate legislation exists to allow local authorities to plan and implement schemes, to provide the governance which enables city and regional authorities to implement both road user charging and the policy instruments which will complement it, and to stimulate strong political leadership at local levels. Finally they need to provide support to ensure that implemented schemes are effectively monitored and their results disseminated.

European Commission

The Commission should publish guidance for authorities interested in considering road user charging as a policy option based on the work of CURACAO. They should give financial support to:

1. cities to finance feasibility studies addressing ways to reduce congestion and improve the environment, including RUC options, and research and demonstration projects that specifically address the key issues of acceptability, governance, economic and equity impacts, particularly in provincial cities,

2. educational campaigns, training schemes and toolkits explaining the rationale for URUC as one option in the panoply of measures available to transport planners, and encouraging citizen and stakeholder involvement in discussion of approaches to tackling sustainable mobility issues, and

3. research into standardisation and interoperability of RUC systems and technologies.

In any consideration of institutional structures and governance issues, the European Commission should bear in mind the need for governance structures which enable city authorities both to implement road user charging and the policy instruments which complement it, and to collect and use scheme revenues in accordance with policy objectives.

5. FURTHER RESEARCH

As noted above, the final section of each chapter in the State of the Art Report listed a number of continuing research needs. Once again these were discussed with the city authorities within the User Group, and priorities were assigned to each identified need. On this basis, we summarise in this section the highest priority areas in which further research is still required, and in particular where empirical evidence is lacking.

Further development is needed of methods for the design of road user charging schemes and the related requirements for technology requirements and business systems. A better

understanding is needed of ways of reducing the unit costs of technology and business systems, so that a larger proportion of revenues can be made available for transport policy.

A clear understanding of behaviour and in particular second order responses to URUC is still lacking. There is a lack of firm evidence on the impacts on the urban economy and in particular the differential effects by economic sector and size of firm. Although there is now guidance (DfT, 2007) on assessing the impacts of URUC on different socio-economic groups, robust empirical evidence of such equity effects is still limited.

On the key question of acceptability, research questions remain on the interaction between acceptability and equity and in particular the impact of scheme design on perceived inequity, which in turn affects acceptability. There is a related need for a better understanding of the trade-offs between acceptability and effectiveness in scheme design. It is also important to consider in further research the particular role of referenda in testing and promoting acceptability.

In terms of implementation, it will be important to compare predicted and actual impacts in those schemes which are implemented, and to understand the key requirements for sustaining and adapting road user charging schemes once implemented. Once further empirical results are available, it will be appropriate to analyse further the factors affecting transferability of results from one city to another. Finally, there is a case for research into trends in those cities where URUC was proposed but later abandoned, to assess whether the absence of URUC does in practice lead to the conditions forecast without it.

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