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THE PERFORMANCE OF ROAD USER CHARGING SCHEMES – BENCHMARKING AND COMPARISON

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ABSTRACT

Road user charging (RUC) is a relatively new term that embraces all policies that charge for road space. In popular literature the term 'tolling' is often used as a generalisation to cover demand management as well as funding the development and operation of new infrastructure. This confusion extends to the measures by which the performance of charging schemes is assessed. Applying the same measures to schemes that have different policy objectives for the purposes of comparison or to develop a business case for the scheme risks introducing large errors and consequently suboptimal decisions on scheme design and operation.

There are enough toll roads, HOT lanes, congestion charging and truck tolling schemes in operation to justify a comparison. There is also increasing interest on both sides of the Atlantic to introduce the 'user pays' principle to road financing through tolls and improving network efficiency through charging. This paper aims to explain what to look for and what to compare.

The attached paper will be developed further for final submission but it will briefly introduce the different policy options, their respective strategic objectives, cost drivers and introduces performance measures for each with examples. Common misconceptions are explored and alternative suggestions are made to improve the accuracy by which some performance measures can be compared even if the underlying policy objectives are different.

The techniques are applicable to RUC scheme designers and organisations that wish to assess scheme efficiency, set service level targets, assess value for money and to benchmark themselves against other international schemes.

Keywords: *Road User Charging, Policy, AET, ETC*

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History

Road user charging is now on the political and public agenda of governments and regional authorities worldwide although charging for road use is by no means a new concept. Toll roads can be traced back to at least Roman times, where travellers paid a fee for using a road/track maintained (and in many cases protected) by the authorities of the day. Across the world today toll-roads make up a significant proportion of the arterial road networks, and in many countries the tolling of estuarial crossings and tunnels is commonplace.

Tolling is essentially the recovery of a fee from users of a facility to cover the capital building, operation and maintenance costs of the road. In many cases toll roads have been given to private operators to Design, Build, Finance and Operate (DBFO) or to operate as a concession for a particular period of time. Other schemes may have a more demand management-led set of objectives, of managing travel demand by car and the consequential congestion when demand (for travel by car) out-strips the supply (of road space). So it is clear that the policies of road user charging could differ by location and by road type. Over time the policies of road user charging may change, for example from no charging (free at the point of use) to area-wide charging or perhaps the addition of a single charged-for High Occupancy & Toll (HOT) lane alongside general travel lanes.

The policy objectives of each scheme will be different so it is reasonable to assume that the measures of success for each policy will be different. This paper identifies the various feasible policy options and progressively links them to metrics and performance measures by which a charging scheme can be rated for its efficiency and attainment of scheme objectives.

[Note the aim is to focus on performance in the broadest sense, including a brief reference to capital and operating cost expenditure, road network performance (e.g. flow rates of vehicles, flow ate of people and goods), social benefits (utility value offset by the costs of compliance), accessibility (are we really being priced off the road or across other transport modes such as transit?]

Policy Options

Tolls are becoming increasingly recognised as an acceptable method of funding infrastructure developments. Innovative debt/equity funding mechanisms have put the private sector closer to the heart of many road building programmes in North America, Australasia, SE Asia, India, China, South America and Europe.

[further discussion on tolling and its objectives from a European and US context. Introduce measures of performance used by toll road operators]

Congestion charging, whether this is applied to a single link or a road network, aims to manage traffic demand and maintain an expected quality of service for road users of all modes, whether travelling by public transport, private car or commercial vehicle. The relationship between traffic demand and flow rate is traditionally described by the 'c-curve'. Here, as in many examples, road performance is measured in terms of 'vehicles / hour' and the demand management objective may be described by maximising this, typically used by Value Pricing schemes in the US for interurban highways where road users are offered the use of a road segment that (usually) guarantees a specific service level such as the time to travel on the road segment.

However the objectives of a congestion charging scheme may alternatively be described as reduction of congestion or alternatively, reduction of the mean segment delay time. Transport for London measures congestion within the London Congestion Charging Zone by comparing link time at periods of no congestion (i.e. 04.00 in the morning) and link times under daytime congestion conditions. Daily demand is measured by the quantity of vehicles that cross the boundary of the zone. This measure would be more appropriate to a road network where there are many possible travel paths.

Comparing schemes on the basis of relative operating costs is problematic; large errors can lead to unfair comparisons and in the worst case could lead to the wrong charging policy being chosen. In many cases the social benefit or utility value of paying a charge is not included.

[introduce truck tolling, HOT lanes and the usual performance measures for each – will help highlight that policy differences cannot be ignored when comparing or benchmarking schemes]

[list the usual bases of comparison and give examples from regions where charging schemes have been implemented including Singapore, SR91, etc.

Road Network Performance

The most common measure of road network performance is the flow rate. The performance of an ETC lane can be measured in vehicles / hour, ranging upto 800 vehicles / hour / lane. There are generally two measures of road network performance relevant to charging – the choice depends on the charging policy:

- Number of vehicles / hour passing a defined point, applicable to urban charging schemes (toll ring, cordon or area pricing) for a complex road network
- Link time under congested conditions / link time under non-congested conditions applicable to easily identifiable interurban road segments

One of the objectives of a demand management scheme is to change travel behaviour for the reasons stated above. The objective is <u>not</u> to reduce net accessibility for people or goods. So, a

simple measure of the flow rate at one or more locations is not adequate.

Vehicle occupancy, captured through roadside surveys and automatic counters on transit and metro schemes, will help present a complete picture of accessibility to the charged area by all modes. Counting vehicles will show a reduction in demand but, by definition, this cannot represent a useful measure of accessibility of people (as a measure of economic and social well-being). However, a reduction in commercial vehicles entering the zone (net of those that only transit through the zone) is undesirable since this reflects a reduction in economic generating capacity for the charged area. Note that if charging period is limited to a few hours per day the measuring period needs to be longer than this since demand management using pricing will also induce some demand to be shifted outside of the charging hours (e.g. it is recommended that measurements are made 24/7, including weekends if charging is limited to weekdays only).

The measurement of flow rate past a point does have other uses, however. A GNSS-based charging scheme also requires enforcement, typically a mix of mobile enforcement and fixed enforcement. A fixed enforcement point that is located on a strategic interurban highway is likely to have lower lifetime and operating costs than a mobile enforcement system at the same location. Mobile enforcement is flexible and can be deployed at most locations but, depending on enforcement technology used may have reduced road coverage than a fixed multi-lane solution particularly if roadside cameras are used as part of an evidential enforcement strategy. In this case, an understanding of the cost drivers and appropriate performance metrics is critical to help decide whether fixed or mobile enforcement is needed and its cost of use

Additionally, the concentration of harmful emissions (NOx, PM10, etc.) and noise (frequency band, amplitude and randomness) is also a useful measure, particularly if the reduction in concentration of harmful emissions or perceived noise levels are scheme operating objectives [2].

Operating Measures

A scheme may be described by its size (economies of scale: lots of similar activities), volume (economies of scope: diversity such as payment channel options, account types, complexity of discount structure, etc.),, whether or not the cost of enforcement is included, the proportion of services provided internally, investment decisions to achieve high or moderate levels of compliance, accounting treatment (amortisation) of scheme development, and the cost of enforcement (related to choice of civil or criminal regime).

The drivers of revenue include the charging policy (high charges versus low charges); to collect tolls to pay for infrastructure build/operations or to elicit change in road user behaviour, the relative demand and willingness to pay charges for services received (elasticity of demand) and whether or not enforcement revenues are included (accounting policy)

[make the point that comparing an area pricing scheme such as the London Congestion

Charging scheme with the German LKW truck tolling scheme with simple cost/revenue measures is therefore inappropriate]

There are several categories of measures, each corresponding to an entity within the RUC domain: the organisations:

- internal: process and inter-process interfaces,
- external: user-related
- external: vehicle-related

[each of these will be elaborated further in the final version of the paper.]

Internal: Process and Inter-process

Internal process performance measures include operating cost / account / period, average revenue recovered for each penalty / fine levied, quantity of incorrectly targeted account holders / road users, quantity of routine enquiries through call centre / minute or per call and the quantity of wrongly targeted offenders (impacts scheme credibility).

[to be developed]

External: User-related

External performance measures are the most widely reported, typically vehicle volumes. Other measures are included in annual reports. In any case the external performance measures also reflect the type of charging policy. So it makes sense to make some comparisons within the same category of charging policy and others between schemes that operate different policies.

Performance measures that relate to the user interaction with a scheme include, the cost to the user to pay the charge (excluding opportunity cost), the full cost to the user to pay the charge including opportunity cost), cost / enquiry / enquiry channel, cost / payment event / type of payment channel and the split of demand between payment channels. The PANYNY is about to embark on the development of an All Electronic Tolling policy that will remove cash, as a means of payment from the toll plaza. Migration to electronic means of payment is only possible if the expected usage is known and the incentives needed to drive this usage.

[compare Melbourne City Link, London, Stockholm here showing channel preferences and service differentials]

A web-based payment front end that takes 4 minutes for each journey has a higher opportunity cost to a user than a method that takes 3 minutes and/or allows payments to be made for multiple journeys.

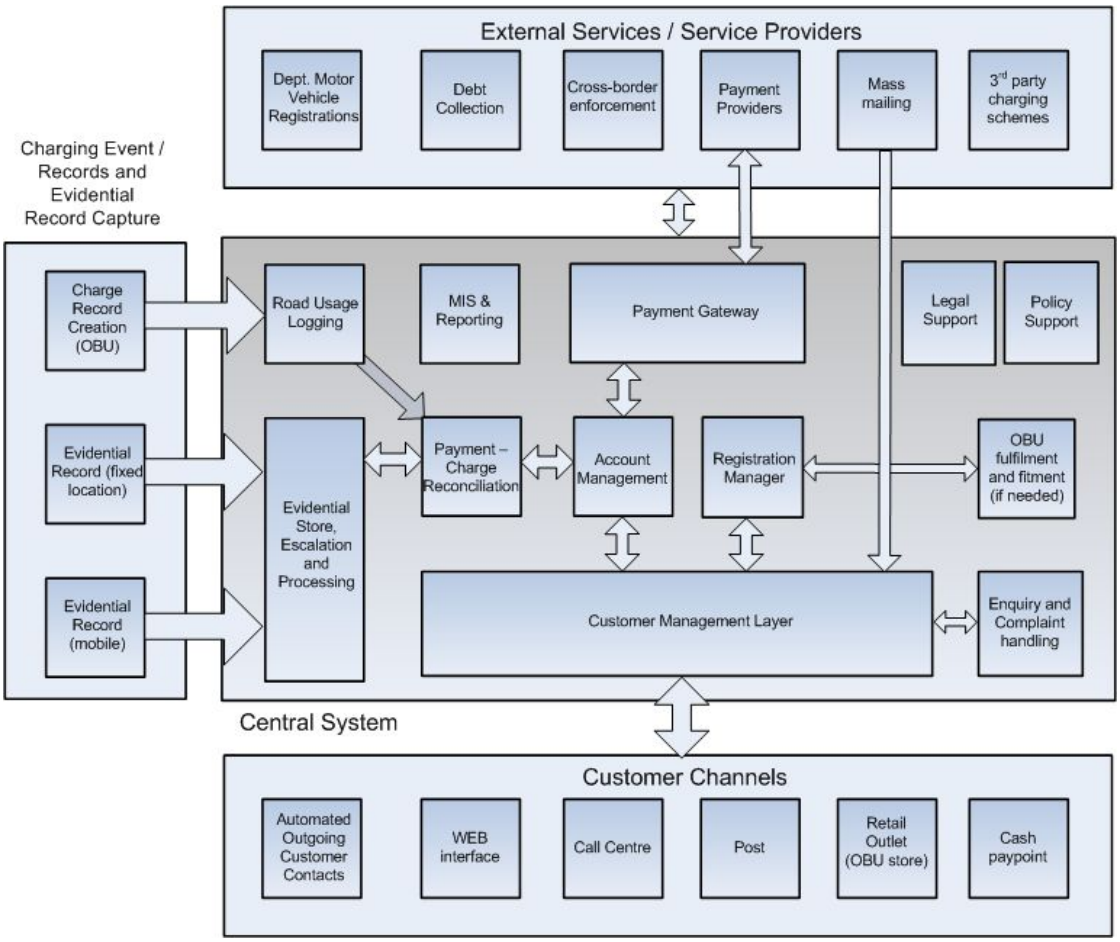

Fig 1. Functional Organisation of a Charging Authority showing interfaces on which performance may be measured.

[outline the official 'value of time' measures used in the UK as an example here.]

Currently the German and Swiss heavy good vehicle charging schemes have alternative manual payment methods based on retail and roadside terminals. These terminals have a higher cost per transaction than an equivalent web-based or vehicle equipment -based method but do have the advantage that no specialised interface or in-vehicle equipment is needed.

In general, encouraging a migration to means of payment that has lower transaction costs increases the economic viability of a scheme whether this is for demand management or toll collection. This is the one of the benefits of All Electronic Tolling (AET) otherwise known as

Multi Lane Free Flow Tolling.

Typically, the transaction cost of a payment made to cover road usage (regardless of the underlying policy) ignores the opportunity cost to the user. This may include waiting time at a toll plaza to pay cash at an Automatic Coin Machine (ACM) or toll booth attendant. A detailed assessment would also consider the relative opportunity costs for different categories of road users, handling cost of cash and increased emissions and generation of particulates due to braking and accelerating into and out of a toll lane. Knowing how to measure the performance of a scheme may help explain the benefits of moving to a new means of revenue collection or revised charging policy.

External: Vehicle-related

There are costs that relate to vehicles that participate frequently or occasionally in the scheme including the opportunity cost of having the vehicle in a workshop having a GNSS OBU installed. This cost of compliance is often forgotten but, benchmarking between GNSS-based schemes should not ignore this. Tag-based schemes usually assume zero cost here.

A concession operator with a planning horizon of 30 years will increase the value of its technology investments if the long run cost is reduced with consequent enhancements in quality of service provided. These investments may be prohibitive if the planning horizon was shorter. Similarly an operator may not need to invest as much in vehicle equipment if there is a critical mass of equipped vehicles / account holders already available. In the future a mandatory national road user charging scheme that replaces fuel tax with a distance-based charge will enable local charging schemes to be provided at lower cost per vehicle or account than a pioneer scheme setting up in isolation. Effectively the economics of an individual scheme can be impacted favourably by a national approach to road user charging.

The Future

It is expected that the intelligence available in the future will enable innovative forms of road pricing that could have a significant demand restraining effect to provide an additional tool to deal with traffic congestion. As the charging policies become more complex and the underlying processes that generate charging transactions become more complex then policy and scale-specific metrics will be needed to assess policy extension such as moving from ORT to AET, introducing video accounts alongside tag-based accounts, defining the scale of a network of retail outlets to enable cash payment rather than web-based payment with a credit card.

Summary and Conclusions

The charging policy and scale of operations are the two most important measures of a charging scheme. As the complexity of charging policies increases and as schemes become more interconnected through interoperability agreement then the traditional measures of performance become increasingly irrelevant and comparisons become increasingly tenuous.

Several performance measures were identified and classified into one of four categories; internal interfaces, external user-related, external road network-related and external vehicle-related.

It is only when these measures are recognised and identified can they be used to make investment appraisals based on cash accounting principles or alternatively political decisions that reflect social benefits and costs. If a city such as New York or San Francisco chose to outsource all or part of its operating then benchmarking is necessary to help development service level agreements with its service providers. Operating decisions and, to the extent to which they are disclosed, can be used to compare scheme along relevant dimensions.

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