



EUROPEAN CONFERENCE
OF MINISTERS OF TRANSPORT

TRANSPORT RESEARCH CENTRE



MANAGING URBAN TRAFFIC CONGESTION

Summary Document



JOINT TRANSPORT RESEARCH CENTRE

In January 2004, the Organisation for Economic Co-operation and Development (OECD) and European Conference of Ministers of Transport (ECMT) brought together their transport research capabilities in setting up the **Joint Transport Research Centre**.

The Centre has 50 full members from Asia-Pacific, Europe and North America, including all members of the OECD and ECMT.

The Centre's mandate is to promote economic development and contribute to structural improvements of OECD and ECMT economies through co-operative transport research programmes addressing all modes of inland transport and their intermodal linkages in a wider economic, social, environmental and institutional context.

For more information regarding the Joint OECD/ECMT Transport Research Centre, including its full programme of research activities and other recent publications, please consult www.cemt.org/JTRC/index.htm.

INTRODUCTION

Cities and traffic have developed hand-in-hand since the earliest large human settlements. The same forces that draw inhabitants to congregate in large urban areas also lead to sometimes intolerable levels of traffic congestion on urban streets and thoroughfares. Effective urban governance requires a careful balancing between the benefits of agglomeration and the dis-benefits of excessive congestion.

This document provides a summary of the key messages and findings of the OECD/ECMT Joint Transport Policy Research Centre report on Managing Urban Traffic Congestion. It puts forward policy-oriented, research-based recommendations for effectively managing traffic congestion and eliminating excessive congestion in large urban areas. It also provides a fundamental overview of the nature, scope and measurement of congestion necessary for any effective congestion management policy.

The full report is the result of two years of work by a group of expert researchers in traffic operations, transport economics and urban transport from many Organisation for Economic Co-operation and Development (OECD) and European Conference of Transport Ministers (ECMT) countries. Working Group members from Australia, Canada, the Czech Republic, France, Germany, Greece, Japan, the Netherlands, New Zealand, the Russian Federation, Spain, the United Kingdom and the United States all contributed to the project.

Road traffic congestion poses a challenge for all large and growing urban areas. The full report on which this summary is based aims to provide policymakers and technical staff with the strategic vision, conceptual frameworks and guidance on some of the practical tools necessary to manage congestion in such a way as to reduce its overall impact on individuals, families, communities and societies.

KEY FINDINGS

1. Much can be done to reduce the worst traffic congestion

Dynamic, affordable, liveable and attractive urban regions *will never be free of congestion*. Road transport policies, however, should seek to *manage congestion* on a cost-effective basis with the aim of reducing the burden that excessive congestion imposes upon travellers and urban dwellers throughout the urban road network.

2. Effective land use planning and appropriate levels of public transport service are essential for delivering high quality access in congested urban areas

Integrated land use and transport planning and coordinated transport development involving all transport modes - including appropriate levels of public transport – are fundamentally important to the high quality access needed in large urban areas.

3. Road users want reliable door-to-door trips that are free of stress

Road users generally accept a degree of road congestion but attach a high value to the reliability and predictability of road travel conditions. Reliability needs to be given greater weight in assessing options and prioritising congestion mitigation measures.

4. Targeting travel time variability and the most extreme congestion incidents can deliver rapid, tangible and cost-effective improvements

Unreliable and extremely variable travel times impose the greatest “misery” on road users. An increase in the reliability and predictability of travel times can rapidly reduce the cost associated with excessive congestion levels.

5. The age of unmanaged access to highly-trafficked urban roads is coming to an end

Most traditional congestion relief measures either free up existing capacity or deliver new road capacity, which is likely to be rapidly swamped with previously suppressed and new demand, at least in economically dynamic cities. In future, demand for use of highly trafficked roads will need to be managed. Demand management strategies should take full account of how residents and roadway users wish to see their community develop as well as their longer term mobility preferences.

6. Transport authorities will inevitably need to employ a combination of access, parking and road pricing measures to lock in the benefits from operational and infrastructure measures aimed at mitigating traffic congestion

By comparison with non-road infrastructure managers, road administrations generally have much less of a role – if they are assigned any role at all – in managing overall levels of demand. Often little consideration is given to the question of whether overall demand for use of the roadway system should be managed at all. Management of roadway demand is increasingly likely to be required in large urban areas.

EXECUTIVE SUMMARY

Congestion is one of the major pre-occupation of urban decision-makers. A quick scan of policy statements from across OECD/ECMT cities highlights the importance of congestion to the public, elected officials and road and transport administrations in many urban areas. Yet, there is little consensus across the OECD/ECMT member countries on the types of policies that are best suited to tackling congestion in cities. There is perhaps even less consensus on what precisely congestion is, whether or not it is a “solvable” problem and, in some locations and cases, whether it is problem at all.

Faced with such a divergence of views on approaches and policies for dealing with congestion, what advice can be given to policy-makers seeking to ensure the best possible transport policy outcomes?

Congestion takes on many faces, occurs in many different contexts and is caused by many different processes. Because of this, there is no single best approach to managing congestion – and the report is therefore not prescriptive about specific congestion management measures. However, there are many things that congestion management policies should take into account if they are to achieve the goals they set themselves.

This report seeks to help the reader find their own answers to a series of fundamentally important questions¹:

- What is congestion, how should it be measured and is it getting worse?
- What should policy-makers know about the causes of congestion?
- What are the costs and impacts of congestion and are we measuring them correctly?
- What can we do now to manage congestion better?
- How can we be more effective in tackling congestion than in the past?
- Are institutional arrangements encouraging or discouraging appropriate responses to congestion?

The following pages address each of these questions in turn.

WHAT IS CONGESTION?²

There is no single, broadly accepted definition of traffic congestion. One of the principal reasons for this lack of consensus is that congestion is both:

- A *physical* phenomenon relating to the manner in which vehicles impede each others' progression as demand for limited road space approaches full capacity.
- A *relative* phenomenon relating to user expectations *vis-à-vis* road system performance.

Both operational and user perspectives are important in understanding congestion and its impacts. This report does not seek to select one approach to defining congestion over the other; they clearly both have uses when seeking to develop congestion management strategies. Ideally, urban transport policies should be developed on the basis that congestion is related to both:

- The behaviour of traffic as it nears the physical capacity of the road system.
- The difference between road users' expectations of the system's performance and how the system actually performs.

No Single Definition

Congestion is a situation in which demand for road space exceeds supply.

Congestion is the impedance vehicles impose on each other, due to the speed-flow relationship, in conditions where the use of a transport system approaches capacity.

Congestion is essentially a relative phenomenon that is linked to the difference between the roadway system performance that users expect and how the system actually performs.

Urban traffic congestion must be understood in the wider context of city dynamics and agglomeration benefits

Urban traffic congestion must be understood in the wider context of city dynamics and agglomeration benefits. Traffic congestion in urban areas is often the outcome of successful urban economic development, employment, housing and cultural, policies that make people want to live and work relatively close to each other and attract firms to benefit from the gains in productivity thus derived. There are many indications that, even though they may not be thrilled by the prospect, urban road users are prepared to live with crowded roads so long as they derive other benefits from living and working in their cities.

Congestion prevents us from moving freely and it slows and otherwise disrupts the conduct of business within urban areas. However, it is important to note that unfettered movement is not the primary benefit we derive from living in urban areas. Cities provide access to a wide range of activities, people, services, goods, markets, opportunities, ideas and networks. These benefits can

be delivered either through speed or through greater proximity. Congestion may affect travel speed but in some circumstances, such as dense urban cores, congestion may both be expected and, to some degree, accepted. In these cases, cities have come to accept a degree of congestion and continue to get along relatively well as long as overall accessibility is high.

The question is not how to eradicate congestion but rather, how to avoid excessive congestion – this is what lies at the heart of congestion management policies

In this context, it is difficult to see how congestion can or should be eradicated in economically buoyant urban areas nor is there any indication that urban road users expect to travel in congestion-free conditions at peak hours. This is not to say that cities should not proactively and vigorously address growing congestion – they should, especially in cases where congestion can be linked to specific traffic bottlenecks and cost-effective measures are available. However, in the long run, what matters most for policy is how congestion can be managed such that the beneficial outcomes of agglomeration are not eroded unacceptably by the negative impacts of congestion.

The question is not how should policies *eradicate* congestion but rather, how can authorities best avoid *excessive* congestion – for this is really what lies at the heart of congestion management policies.

When is congestion excessive?

There are two ways of answering this question.

The first is to say that congestion is excessive when people say it is ... but this does not account for what it would cost to bring congestion back down to levels that are tolerable. It may very well be that the cost of reducing congestion to these levels may be much greater than the costs imposed by congestion itself.

A better way of defining excessive congestion is: *when the marginal costs to society of congestion exceed the marginal costs of efforts to reduce congestion (such as adding to road or other transport infrastructure³), congestion is excessive and action to manage it better is warranted.*⁴

How should congestion be measured?

Measuring congestion is a necessary step in order to deliver better congestion outcomes. However, congestion should not be described using a *single* metric for policy purposes. Such an approach is sure to obscure either the quantitative aspects of congestion or its relative and qualitative aspects. These two aspects can not be disassociated and progress in managing congestion should be based on sets of indicators that capture both of these aspects.

Good indicators can be based on a wide network of roadway sensors but simple indicators based on less elaborate monitoring can sometimes adequately guide policy. What is important is to select metrics that are relevant to both road managers (e.g. speed and flow, queue length and duration, etc.) and road users (e.g. predictability of travel times, system reliability, etc).

Free-flow speeds should not be used as a direct benchmark to measure congestion policy outcomes. Such an approach implicitly suggests that successful policies deliver free-flow speeds – an unaffordable goal for peak hour traffic in most OECD/ECMT cities



Source: ECMT, 2007.

Urban roads are not built to deliver free-flow speeds 24 hours a day, 7 days a week, 365 days a year. Congestion management policies should not seek to do so either.

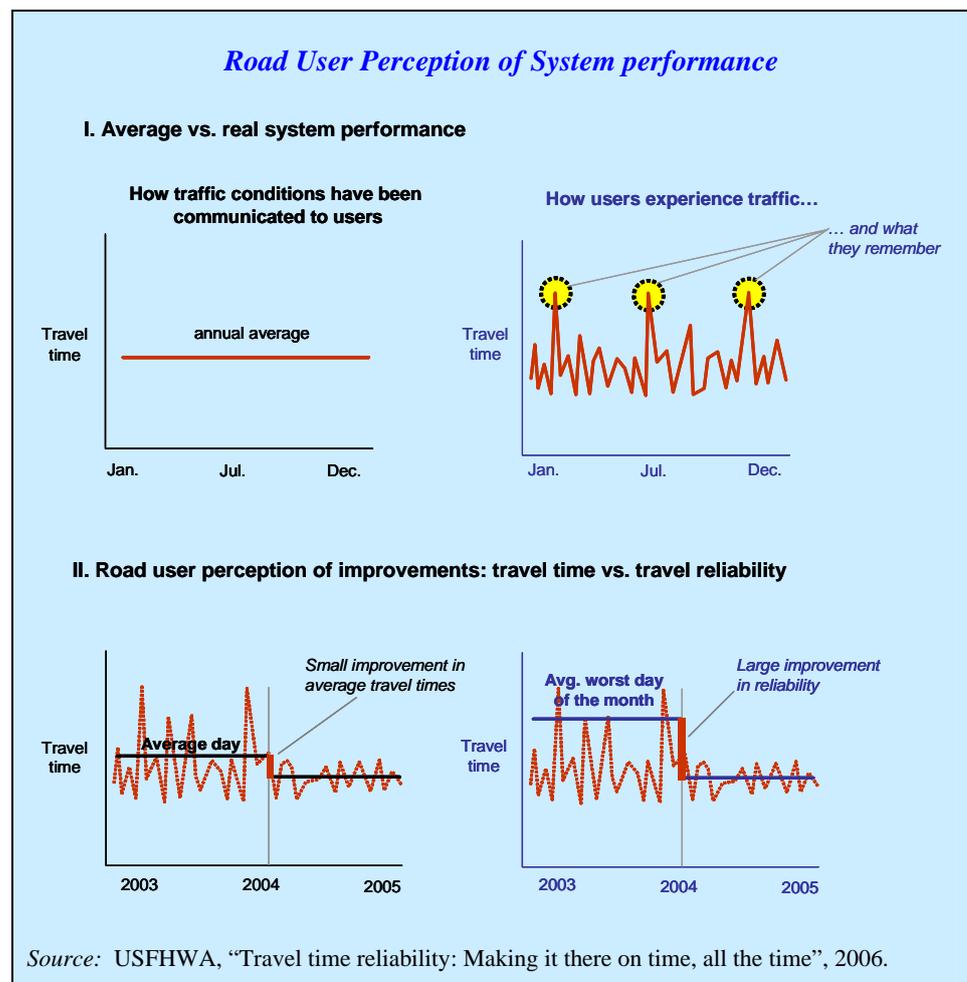
Indicators should be neutral in that they do not contain implied policy goals. In this context, *the use of free-flow speeds should not be used as a direct benchmark to measure congestion policy outcomes as such an approach implicitly suggests that successful policies deliver free-flow speeds – an unaffordable goal for peak hour traffic in most OECD/ECMT cities.* Free-flow speeds might be used as a benchmark of technical system performance but a better alternative might be to use median speeds or to use some other benchmark or set of benchmark values such as percentage of maximum legal speed or different speed bands.

Congestion management policies should keep track of travel reliability indicators

Congestion has an impact on both the speed of travel and on the *reliability* of travel conditions. It is the latter that may be of greatest concern to individuals and businesses. Thus congestion management policies should keep track of travel reliability indicators. These may capture the variance in travel times or, alternatively, communicate the amount of time buffers road users have to include in their travel plans to make their trips “on time”. Insofar as these reliability indicators give an understanding of the quality of travel conditions, they are important to policymakers seeking to address the qualitative aspects of congestion.

Equally important, but more difficult to measure, is the task of identifying who is adversely affected by congestion. In cities where citizens have available (and use) quality public transport, *road* congestion may not concern as high a percentage of the travelling public as in cities with low quality alternatives to car use. Congestion can also have indirect impacts not captured by “on-road”-based assessments (e.g. increased inventory holdings

by manufacturing and retail businesses in response to increased unreliability of travel conditions). Many non-road users are also exposed to the negative impacts of congestion. Developing a common framework for measuring the indirect impacts of congestion, the exposure of urban travellers to congestion *across modes* as well as including the impacts of congestion to non-road users remains a significant challenge.



Congestion has grown in absolute terms in many areas but in some cities it has not grown in relative terms as measured by unit of economic output or per capita

Is congestion getting worse?

Congestion is increasing in many urban areas across the OECD/ECMT regions (and elsewhere) and in locations where populations and city economies are growing it is likely to continue to increase. However, it is not clear that congestion is rising equally fast across all areas in these countries; nor that the rise in traffic has followed the same patterns and has been caused by the same phenomena. In many cases, congestion has grown as cities have grown and as economic activity has expanded. Cities have grown as they attracted more people and activities, they have produced more wealth and, as a by-product, their roads have become more crowded. Congestion has grown in absolute terms in many areas but in some cases, it may not necessarily have grown in relative terms as measured by unit of economic output or per capita.

This may partly explain why some countries view urban congestion and its growth as an issue impacting on city growth and productivity and therefore of critical national importance while others see urban congestion as a “problem” that is to a degree self-regulating – especially in cases where travel alternatives are available and system performance is reliable.

In some cases, national statistics clearly indicate a significant growth in congestion as measured by a degradation of average travel speeds during peak hours (as in many areas of the United States), however, in other areas average speeds have remained constant or even increased (as in France). What is clear is that in many cases, urban congestion has spread in the sense that the period of time that roads are congested during the day has lengthened – “peak-spreading” is a common phenomenon in many cities – and in the geographic extent of congestion within urban areas. Likewise, many, but certainly not all, urban areas seem to have experienced degraded travel conditions in that the predictability and reliability of travel times have decreased.

In one respect, the relative rise in congestion can also be seen as a “natural” consequence of the “lumpy” nature of infrastructure provision. New road capacity can only be provided in large increments leading to a situation where new infrastructure is oftentimes underused in the short-term, well-used in the medium term and over-used in the longer term. New infrastructure provided in the 1950s through the 1980s is now often saturated with traffic and the possibilities for further large-scale expansion are often seriously constrained by the scarcity of available urban land and its costs. In some areas where there remain opportunities to expand or otherwise complete insufficient regional road infrastructure, as in the case of the greater Tokyo region or in Moscow, one can expect that a similar pattern of congestion relief, followed by traffic growth and saturation will occur - absent of any pro-active traffic management policy.

*Congestion is not
only a traffic
engineering problem*

What should policy-makers know about the causes of congestion?

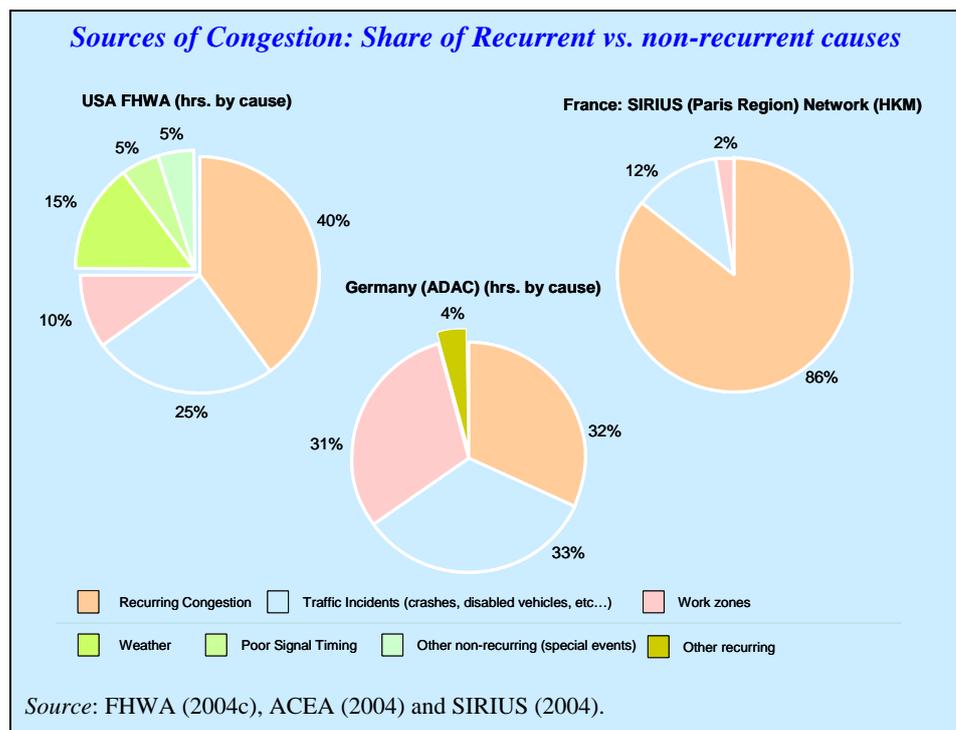
The proximate causes of congestion are numerous, e.g. too many vehicles for a given road’s design or intersection capacity, dynamic changes in roadway capacity caused by lane-switching and car-following behaviour. They are also invariably linked to other indirect factors such as land-use patterns, employment patterns, income levels, car ownership trends, infrastructure investment, regional economic dynamics, etc...

Generally, however, we can identify two principal, broad categories of causal factors; *micro-level* factors (e.g. those that relate to traffic “on the road”) and *macro-level* factors that relate to overall demand for road use. In this context, congestion is “triggered” at the “micro” level (e.g. on the road), and “driven” at the “macro” level by factors that contribute to the incidence of congestion and its severity. This has important implication for policy since – while congestion takes place on the roads, it is not only, nor necessarily primarily, a traffic engineering problem.

Congestion is typically categorized as either recurrent or non-recurrent

Recurrent congestion is generally the consequence of factors that act regularly or periodically on the transportation system, such as daily commuting or weekend trips. However, even recurrent congestion can display a large degree of randomness, especially in its duration and severity.

What is also clear from an examination of the causes of “recurrent” congestion across different types of road networks is the extreme vulnerability of traffic to sudden breakdowns as demand approaches the technical maximum throughput capacity on a link or in the network. When roads are operated at or near their maximum capacity, small changes in available capacity due to such factors as differential vehicle speeds, lane changes, and acceleration and deceleration cycles can trigger a sudden switch from flowing to stop-and-go traffic. Likewise, saturated intersections can quickly give rise to queues whose upstream propagation can swamp local roads and intersections.



Non-recurrent congestion is the effect of unexpected, unplanned or large events (e.g. road works, crashes, special events and so on) that affect parts of the transportation system more or less randomly and, as such, cannot be easily predicted. The share of non-recurrent congestion varies from road network to road network and is linked to the presence and effectiveness of incident response strategies, roadwork scheduling and prevailing atmospheric conditions (snow, rain, fog, etc.).

While most non-recurrent *incidents* have the same negative impact on roadway performance, not all incidents are purely random nor are they equally difficult to plan for. While most crashes are unpredictable by their very nature, accident-prone segments of the roadway can be identified via statistical analysis and specific geometric or other safety treatments applied.

Likewise, *roadworks* can be managed in such a way as to minimise their impacts on traffic (e.g. by undertaking major road works at night). Even weather, while impossible to change, can be better managed on the roads with active speed management and can be prepared-for with contingency planning that can lessen its impact on traffic.

The specific mechanisms relating to the triggering of congestion are different according to different classes of roadways. Congestion on uninterrupted flow facilities such as motorways does not occur in the same manner nor for the same proximate causes as congestion arising on interrupted flow facilities such as those found in dense urban cores.

The impact of induced and/or diverted traffic should not be underestimated – not only for road-building projects but also for policies whose practical result is to free up capacity

One key relationship for policy-makers to keep in mind is the relationship between the release of existing capacity or the provision of new capacity - and the subsequent demand for use of that newly available capacity. This relationship is captured in the *price-elasticity of travel* and has an impact in how quickly newly available capacity is filled. In particular, there is broad evidence that newly available capacity does attract new travel *on the road in question*. This is not necessarily a bad thing since travellers are able to undertake trips that they otherwise could not on those routes or at those times. What matters however, from a policy perspective, is the likely *ex-post* demand for travel and not the existing level of demand. *The impact of induced and/or diverted traffic should not be underestimated – not only for road-building projects but also for policies whose practical result is to free up capacity.*

Finally, effective congestion management policies should seek to understand the nature of travel demand in congested conditions. While commuting trips may be a key factor, it is important not to overlook other types of peak-hour trips including school runs, leisure travel and freight travel that often make a substantial contribution to traffic in peak periods.

WHAT ARE THE IMPACTS OF CONGESTION AND ARE WE MEASURING THEM ACCURATELY?

Congestion impacts

Congestion involves queuing, slower speeds and increased travel times, which impose costs on the economy and generate multiple impacts on urban regions and their inhabitants. Congestion also has a range of indirect impacts including the marginal environmental and resource impacts of congestion, impacts on quality of life, stress, safety as well as impacts on non-vehicular roadspace users such as the users of sidewalks and road frontage properties. Policy-makers should ensure that cost-benefit evaluations or other policy evaluation methodologies include an assessment of these impacts as well as take into account broader considerations such as the type of cities people want.

There exists a real tension between different models of congestion cost and estimates which in turn influences congestion management approaches

Conceptual frameworks used to assess congestion and its impacts

There is rarely a uniform conceptual framework for addressing congestion and appraising congestion management policies across the variety and scope of actors involved. Furthermore, there exists a real tension between different conceptual models underlying congestion cost and impact calculations which in turn can influence congestion management approaches. Economic models can lead to the formulation of quite different congestion management objectives from physical models.

Generally speaking, *traditional approaches* used by road administrations have focused on managing road systems in urban areas in ways that maximise their ability to handle current and expected future traffic demand. Such *flow-based approaches* seek to maximise the physical usage of available road capacity, taking into account other road management goals such as safety. Roads are rated at a set capacity as expressed in flow, density or, synthetically, as “levels of service”. Achieving higher flows, higher densities and higher levels of service in keeping with the rated capacity of the roadway has traditionally been seen as performance “improvement”. Likewise, street networks are operated with an eye to reaching maximum intersection clearing capacities during peak hours.

Approaches that seek to maximise vehicle throughput along major links inevitably take traffic levels into unstable zones and heighten the risks of recurrent and unpredictable congestion

Such operational approaches are well adapted to identifying the locations where bottlenecks exist. They aim to minimise traffic delays and the associated personal, business and resource impacts including personal and productive time lost, fuel wasted and adverse air quality. They allow administrations to highlight locations where action may need to be taken to respond to the delays experienced by users on a regular basis. However, approaches that seek to maximise vehicle throughput along major links inevitably take traffic levels into unstable zones and heighten the risks of recurrent and unpredictable congestion.

Economically optimal levels of congestion take into consideration not only the cost of road provision but also what people are ready to pay in order to use the road

Economic assessments of congestion and its impacts have led to alternative approaches that seek to define an “optimal” level of traffic for a given road, intersection, network, etc. These define the cost of congestion as those costs incurred when traffic levels are beyond the “optimum” level. In particular, they account for the costs imposed by each additional user of the road on other road users and on society as a whole. **Optimal congestion approaches** consider demand for road space as well as supply and seek an “optimal” balance between the two. Economically optimal levels of congestion take into consideration not only the cost of road provision but also what people are ready to pay in order to use the road. Economically “optimal” levels of traffic not only entail a certain degree of congestion – as the term is commonly understood by roadway managers and users – but this “optimal” level of traffic can also vary i.e. it is not related solely to the capacity of the infrastructure under consideration.

One benefit of using an economic framework for describing and analysing congestion is that these approaches allow policies to take into account the heterogeneity of road users and, in particular, the variability in users’ value of time. Well constructed economic approaches can also inform policy-makers when it makes sense to invest in certain forms of congestion relief measures – including the provision of new infrastructure.

There are differences between the outcomes that result from the conceptual frameworks traditionally used and optimal congestion approaches. There are also gaps between the theory and the practice in determining the “optimum” levels of traffic that policy-makers should be aware of when adopting conceptual models to describe congestion and prescribe policy actions. For instance, simplified economic approaches based on speed-flow relationships inadequately capture the manner in which the formation and discharge of queues impact roadway users. Likewise they are not necessarily well adapted to the description of congestion behaviour on dense street networks where intersection clearance times (and not link performance) are the key variables. There are other approaches, such as bottleneck-based models that better capture the spatial and temporal impacts of congestion in these circumstances.

Unreliable travel times impose real costs on individual road users and can have significant downstream impacts on productivity

Another gap exists between the design of many congestion management policies and road users’ concerns relating to the *reliability and predictability* of travel times and not just their average duration. Unreliable travel times impose real costs on individual road users and can have significant downstream impacts on productivity (e.g. as in the case of increased inventory holdings by businesses). These impacts and costs should not be neglected when formulating congestion policy responses.

Congestion cost calculations have often incorporated unrealistic assumptions relating to baseline travel conditions

Overall costs of congestion

Many congestion response strategies have been motivated by misguided, erroneous or misleading overall congestion cost estimates.

Congestion cost calculations have often incorporated unrealistic assumptions relating to baseline travel conditions. Often, such estimates have

sought to determine a total “cost of congestion” by assigning a value to the difference between free-flow travel speeds and speeds actually realised on the transport network – a difference that has alternatively been labelled “lost” time or travel “delay”. However, in order to experience such time losses, there must have been a reference situation in which the same volume of travellers undertaking the same activities in the same city could have travelled without any delay at all, including in peak periods i.e. they must have had the additional time in the first place.

It is clear that most cities cannot afford nor would desire the types of transportation networks that would allow for free and unencumbered travel at all hours of the day. In other words, users have never had the time which these estimates assume they have “lost”. Roads in major metropolitan areas are never built to allow free-flow travel at all times of the day, including in particular peak periods.

Such “cost of congestion” approaches are also misleading when they neglect the fact that congestion is the outcome of crowding in urban areas – itself the successful result of other urban policies. Empty cities are not generally considered successful cities; nor should empty roads.

A key question is whether the costs of mitigating congestion are likely to be less than the current cost of congestion to road users and the city at large

The impacts of congestion are not abstract – they must be linked to roadway users’ experiences and expectations. Instead of attempting to calculate the “overall cost” of congestion, from an analytical viewpoint, it may be more productive to estimate the relative changes in levels and costs of congestion. By comparing current levels with past (and expected future) levels, it is possible to assess the extent to which congestion is reducing the potential benefits - e.g. in overall accessibility to urban facilities and services. Where the costs are increasing a key question is whether the costs of mitigating congestion are likely to be less than the current cost to road users and the city at large of present levels of congestion? Robust benefit-cost assessments are necessary to ensure that the benefits of congestion management strategies exceed their costs.

While benefit-cost assessments are normally employed to assess major expenditures (e.g. new roads or other infrastructure), they are not always employed for lesser interventions that nevertheless can have a cumulative impact on congestion levels. These might include specific bottleneck or congestion hotspot treatments, investments in non-road interventions (accident clearing, parking policies, work-time rules) and generally situations where full cost benefit analysis is viewed as too burdensome for the scale of intervention at hand or where congestion impacts are not considered. In some cases, simplified flow-based assessments for small projects or interventions may be running concurrently with more complex and benefit-cost assessments for major investments and the outcomes of these processes might be working at cross-purposes. In the case of simplified assessment methodologies, care should be taken to explicitly state what has been covered in the assessment and what has been omitted.

WHAT CAN WE DO NOW TO BETTER MANAGE CONGESTION?

Effectively managing congestion requires an integrated strategy that goes beyond the visible incidence of congestion “on the road” and extends to the management of the urban region as a whole

Fully eradicating roadway congestion is neither an affordable, nor feasible goal in economically dynamic urban areas. However, much can be done to reduce its occurrence and to lessen its impacts on roadway users within large cities – congestion is a phenomenon that can be better and more effectively managed. Effectively managing congestion requires both a holistic and integrated strategy that goes beyond the visible incidence of congestion “on the road” and extends to the management of the urban region as a whole.

While there are many possible measures that can be deployed to “treat” or mitigate congestion, *there is no single perfect solution*. Congestion mitigation actions are part of the broad and complex land use, urban planning and general transport master planning process unique to each urban region. Roadway congestion impacts not only road users but all urban inhabitants. Congestion management requires an integrated strategy equal to the scope and scale of the challenge.

This report does not prescribe specific congestion management measures since the appropriateness and applicability of these depends largely on the local context. Instead, the report suggests three strategic congestion management principles that should serve to guide policies in this field.

1. Ensure that land use planning, and the community objectives it embodies, is coordinated with congestion management policies.
2. Deliver predictable travel times.
3. Manage highly trafficked roadways to preserve adequate system performance.

Ensure that land use planning, and the community objectives it embodies, is co-ordinated with congestion management policies

Many urban regions have found that strongly coordinated transport and land use policies allow them to proactively and beneficially manage the scope and nature of urban travel demand and thus reduce the incidence and severity of congestion. These two fields are quite closely linked in reality – land uses give rise to trip generation and the interplay between spatially distant origins and destinations gives rise to regional trip patterns. However, in practice, many regions fail to co-ordinate long term land-use and transport planning.

Experience from a number of countries and regions has shown that well-thought out land-use policies that explicitly link community expectations relating to the long-term development of the city to transport outcomes can have a positive impact on a number of outcomes – including traffic and congestion management.

Deliver predictable travel times

Congestion has an impact on both average travel speed and travel time reliability – and there is much evidence that the latter may be more important than the former in that people can plan around reliably congested travel but are frustrated by unpredictable travel conditions. Unreliable and extremely variable travel times conceivably impose the greatest “misery” on roadway users – “misery” which can rapidly be relieved by an increase in the reliability and predictability of travel times and travel conditions. This finding has been supported by studies that have found that the value to road users of reliability is in many cases higher than their values for travel time.

Typical measures include planning and coordination of roadworks, speedy response to defective traffic signals and to disruptions caused by accidents and debris. From the perspective of urban policy-makers, these approaches can be very attractive in that they can rapidly deliver perceivable benefits to road users for a relatively small investment – especially when compared to the cost of new infrastructure whose impacts on overall travel times may not always be perceived by road users.

There are many potential congestion management strategies but most fall into one of two categories – those that provide new capacity or free up existing capacity and those that cap, limit or otherwise manage traffic levels

Manage congestion on main roads

At present access to roads is generally unconstrained by everything but congestion itself. Indeed, congestion is a powerful rationing mechanism but one that few would agree is efficient. How might signals of relative road space scarcity other than low travel speeds and unreliable traffic conditions be incorporated into road management and travel decisions?

There are many potential congestion management strategies but most fall into one of two categories – those that provide new capacity or free up existing capacity and those that cap, limit or otherwise manage traffic levels on the new or freed-up capacity.

The latter category of measures broadly encompasses three different but related approaches:

- Directly managing the physical access to the roadway through *access policies*.
- Indirectly managing access to the roadway network and directly influencing road travel to particular areas through *parking policies*.
- Managing the level of traffic through *road pricing policies* that target the use of, or access to, roads or urban areas.

Access Management

Access policies seek to restrict vehicle access to certain zones (e.g. historical centres) or to certain road links (ramp metering).

In the case of zone-based access restrictions, traffic may be blocked through the use of physical breaks and barriers in the urban road network

(e.g. through the use of one-way streets and road networks that are structured in such a way as to prevent through traffic) or through traffic bans or permit-based systems. The latter require consistent implementation and clear and robust enforcement to bring good results. Traffic restriction zones should be linked to a set of complementary measures to ensure that one single measure does not bear the full brunt of the traffic reduction effort – the provision of high quality public transport, parking controls and pricing come to mind as complements to access restrictions. Access restrictions can be de-facto as in the case where road space is re-allocated for use by public transport and/or public space (e.g. Paris). The reduced capacity serves to deter access to those links or zones.

A ramp metering approach ensures that road users already on the system are partially protected from the delays that all road users would experience if all vehicles arriving at the ramp were allowed to try to enter the freeway flow. It also ensures that new users presenting themselves for access to the major road network, through delays on the ramp, bear a greater share of the delay costs involved in their access to an already congested roadway system. However, particular attention should be paid to the upstream and downstream impacts that can manifest themselves as queues back up at ramps and as greater traffic volumes are released downstream of the metered links. Also, ramp metering, by increasing travel speeds on the metered roadway links, can encourage longer distance commuting trips.

Parking management

Parking management and control is important because it has the potential to modify demand on an area-wide basis yet, despite being readily available to authorities, often seems under-utilised to tackle traffic congestion.

Like road-pricing and other demand-side approaches, parking management and control can assist the task of tackling traffic congestion by reducing the demand for travel to the area encompassed. Due to the considerable policy and operational flexibility available, parking control can also be quite specifically targeted, in the sense that it can be applied on the basis of location and time.

Controlling parking may be very effective in restricting terminating traffic demand but any capacity on the roads that is freed-up will likely be filled by through traffic attracted from alternative routes by the improved travel conditions. Parking control will be of little assistance in circumstances where the current demand is to drop off or pick up passengers – e.g. parents taking children to and from school. For these reasons, parking management as a tool for tackling traffic congestion needs to be supplemented by other measures (e.g. access control or pricing) to ensure the desired outcomes. It is also important that clear incentives and dis-incentives exist to ensure the effective enforcement of parking policies.

In terms of public acceptability, parking control to tackle traffic congestion is not likely to be universally supported. Parking control is likely

to be seen as a restriction of current “rights” and entitlements by some parties, such as private property owners – and a threat to the commercial viability of businesses currently dependent on convenient customer parking. However, if parking control policies seek to price parking or increase the prices for parking, there will potentially be revenues available to further reduce congestion or to provide for complementary transport improvements such as in public transport.

Pricing policies

Pricing policies include cordon charges such as those implemented in Singapore, London and Stockholm, link-based pricing systems such as have been put in place on certain urban tollways, and mixed-use toll roads (e.g. HOT Lanes in the United States). All have proven to be effective measures to reduce congestion and manage traffic. While their effectiveness is difficult to question, implementation has proven to be challenging.

Equity is a very important consideration. Road users as a group gain but some gain much more than others

Equity is a very important consideration. Even if the proceeds of the congestion charges are redistributed to road users, in the form of lower fuel taxes for instance, a congestion charge is likely to benefit people as a function of their values of time. Road users as a group gain but some gain much more than others.

Another issue is that road/congestion pricing raises similar concerns as access control policies about the loss of “rights” to use the road system without charge. Experience has shown that the level of support for road and congestion pricing generally hinges on the use of the funds raised. If the funding arrangements provide for revenues to go to general budget expenditures, road congestion pricing schemes are generally opposed. If the funding arrangements provide for the funds raised to be used for transport improvements (e.g. public transport or road improvements), experience shows support levels increase considerably.

A further advantage to congestion pricing is that the charges and revenues that result provide market signals as to where and when consideration needs to be given to infrastructure investments. Where the revenues raised are channelled into transport investments, congestion charging can help provide funds for undertaking priority transport investments (e.g. in public transport, ITS infrastructure or road expansion).

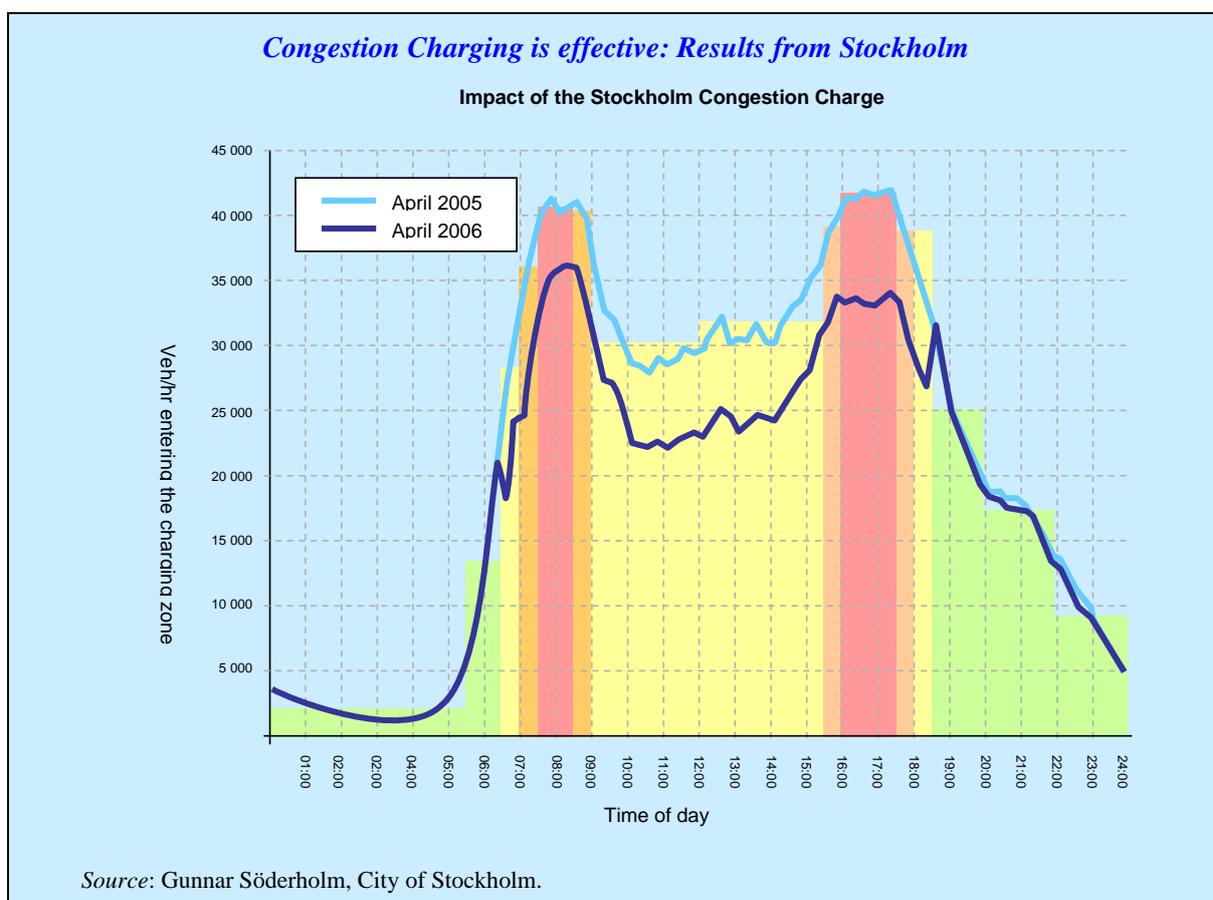
It is essential to account for the costs associated with the collection of a congestion charge – if these are elevated, they can reduce the potential benefits derived from charging

On highly congested facilities, infrastructure has the potential to be self financing with marginal cost pricing. However, it is essential to account for the costs associated with the collection of the charge – if these are elevated, they can reduce the potential benefits derived from charging for access to roads.

In the case of link-based pricing, there is a risk that pricing policies will transfer traffic flows onto free roads and so create new congestion in other areas. It is therefore important to plan complementary measures such as the modification of road infrastructure and traffic operations management. Parallel measures such as investments in public transport can also be

employed to make pricing more acceptable and also fairer for people who cannot afford the charges or tolls and thus contribute to acceptability.

Access management, parking management and road pricing can have a strong impact on total levels of traffic on urban road networks. However, the level of effort necessary to manage demand if any one of these policies is implemented *alone* is likely to be quite high – high enough to lessen the chances of its implementation. In order to reduce the burden of these policies in tackling excessive congestion, urban areas should consider deploying a mix of all three demand measures – in conjunction with the operational and infrastructure measures called for by the local context.



HOW CAN WE BE MORE EFFECTIVE IN TACKLING CONGESTION THAN IN THE PAST?

Many traditional strategies can help to improve travel speeds, however, the practical outcome will be to increase the available capacity of roads which will rapidly be filled unless these strategies are paired with pricing, parking or access management policies

Many strategies can help to improve travel speeds, increase system reliability and mitigate the impacts of congestion. Traditional congestion management strategies can be divided into four broad classes: those that seek to improve traffic operations, those that seek to shift urban traffic to public transport or otherwise reduce the demand for urban road travel, those that seek to modify existing infrastructure so as to increase its capacity and those that seek to provide new infrastructure. Insofar as any of these policies are successful, the practical outcome will be to increase the available capacity of roads (either by freeing up existing capacity or by providing new capacity). This capacity will typically rapidly be filled in most dynamic urban areas unless these strategies are paired with pricing, parking or access management policies. Thus, while all of these policies are important and can deliver sometimes significant improvements in urban traffic conditions, they will likely not be sufficient, alone, to deliver desired long-term reductions in congestion.

Improving traffic operations

Proactive traffic operations management has much potential. Road traffic information systems, pre-trip guidance, coordinated traffic signal systems and the implementation of dynamic speed and incident management policies have often proven to be cost-effective ways to deliver better travel conditions, allowing users to reschedule their trips away from traffic peaks and/or select other travel modes. These strategies all allow road managers to get more out of roads – e.g. to allow for greater flows than could otherwise be realised. They should not be deployed with an eye to bringing traffic up to the limit of the physical capacity of the roadway as this inherently leads to major instabilities in traffic flow and increased probabilities of sudden breakdowns. In fact, many of these strategies can be helpful in managing traffic such that flows are held below these unstable threshold zones.

Improving public transport

Public transport has the potential to transport more people than individual cars for a given amount of road space (in the case of on-street systems such as buses and trams) or without consuming any road space at all (in the case of off-road systems such as metros and surface rail systems). The promotion of public transport remains a fundamentally important congestion management strategy. When public transport provides a quality of service that approximates that which car drivers have previously been used to, it can maintain a high level of access throughout urban areas with a drop in overall car usage.

For the congestion mitigation potential of public transport to be realised, travellers must feel that the extent and quality of service provided are sufficient for them to forego using their cars for certain trips – especially those in peak periods. Thus, actions taken to encourage a mode shift to public

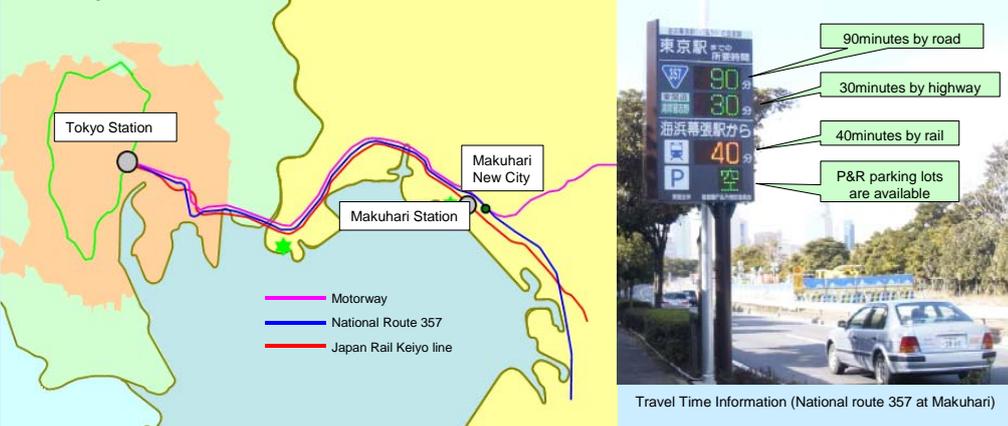
transport should address the perceived costs by the user, ease and comfort of travelling by public transport as well as its reliability, safety and security.

There are many measures that can improve the attractiveness and performance of public transport systems (e.g. extending services, adapting fee structures, operational improvements, public transport information provision, etc...) but these measures come at a cost and, alone, will likely not be a sufficient congestion management response. Urban areas with high levels of public transport use often also have high levels of road traffic as well. In this context, public transport is not so much a congestion mitigation measure as a way of providing in certain locations a better level of service than users can find on the road network. Public transport services, even when augmented by paratransit services, will likely not be able to provide the level of service that car users enjoy in many lower density or peripheral urban areas. Some road congestion measures e.g. road pricing can only be undertaken if there is sufficient public transport capacity at a acceptable level of service to accommodate travellers displaced from the roads.

Implementing mobility management

There are numerous mobility management strategies that can, when successful, reduce car use in urban areas. These include ride-sharing, promoting bicycling and pedestrian travel or supporting mobility management efforts targeting large trip generators such as companies.

Measures should be combined for greater effectiveness



Source: Japanese Ministry of Land, Infrastructure and Transport.

In the Tokyo region, the combination of ITS, traffic control centres, park-and-ride facilities and public transport allow commuters to make informed decisions regarding their commute options. Here, as travelers approach a suburban commuter rail station and its park-and-ride facilities, travel times by road, motorway and rail are communicated in real-time.

Modifying existing infrastructure

There are many approaches that can squeeze additional capacity out of existing infrastructure. These include adding lanes, re-allocating road space, modifying intersections, modifying the geometric design of roads or creating one-way streets. These approaches can benefit either car users or public transport; however as with operational management policies – these interventions should not seek to bring traffic flows so close to the maximum capacity of the roadway that the probability of sudden traffic breakdowns becomes unacceptable. While these types of measures are ideally suited for treating bottlenecks, care should be given to consider the downstream impacts of releasing greater traffic flows through previously contained bottlenecks. Great care should be taken to at least address what the network effects will be over the mid- to long-term of such bottleneck treatments.

Building new infrastructure

Building new road infrastructure is often constrained by a lack of space in dense urban cores and is nearly always an expensive proposition even in the outlying peripheries of urban areas. Many cities now view infrastructure expansion only as a last resort. The effectiveness of providing new road capacity as a congestion management “solution” is oftentimes eroded by new traffic demand. However, there are instances where the provision of new infrastructure is an effective policy – especially when subsequent demand for the infrastructure in question is actively managed as in the case of toll roads and HOT lanes.

The decision to invest in new road capacity (or parking capacity) should be motivated by a thorough cost-benefit exercise that addresses the wide range of congestion impacts detailed earlier. These should also include costs such as environmental costs and impacts on non-road users. When the benefits of providing new infrastructure outweigh the costs of not providing it, then an argument exists for new construction. However, when the cost-benefit exercise is limited in scope (e.g. internal to the roads authority), other less-costly policies that could potentially deliver the same or greater benefits may be overlooked. There are also sometimes real biases, especially in funding, that promote new construction over operational or demand management measures.

Are institutional arrangements encouraging or discouraging appropriate responses to congestion?

Tackling congestion requires an integrated multi-level approach and therefore a multi-level framework of planning and decision making. The more complex the congestion problem, the higher the levels that need to be incorporated and the broader the scope of planning and decision making required.

Tackling congestion requires a plan that encompasses the complexities of the congestion problem and addresses the spatial extent of the region's travel patterns and the relevant institutional and private actors across the urban area.

There is no single approach best-suited to addressing congestion. But when the scope of institutional decision-making is well-matched to the region's travel to work area, vision or plan-led approaches work well. Conversely, when there is a mis-match between the scope of jurisdictions' reach, powers and funding and the geographical scale of the problem, consensus-based approaches make better sense. Consensus-based approaches may also make sense when there is a mis-match between decision-making authority and availability and/or conditioning of external funds.

There are pitfalls to be avoided. A consensus-led approach may lead to delay and inaction unless agreement can be reached quickly and sustained. A plan-led approach can become unduly dependent on professional planners, who may lose sight of the needs of politicians and some stakeholders. And a vision-led approach is critically dependent on the individual with the vision. If he or she leaves office, it may prove very difficult to avoid abandoning the strategy.

Typically, congestion cuts across jurisdictional boundaries and therefore congestion management requires collaboration between different authorities

Typically, congestion cuts across jurisdictional boundaries and therefore the design and implementation of congestion management policies will require collaboration between different authorities. At the national level, it is important that policies make coordination between regional transport and urban planning bodies legally possible, and encouraged. This includes the design of funding mechanisms.

Implementing a congestion management strategy requires the collaboration of many different actors. Achieving consensus, commitment and public support for the formulation of the strategy requires even wider. Wide participation can ensure that the full range of objectives is considered. It can provide a better understanding of transport problems, help generate innovative solutions and be a key factor in gaining public support and acceptability for the final mix of policies. Early participation can save time and money later in the process, particularly at the implementation stage, as potential objections should have been minimised by taking stockholder's concerns into account. Best practice shows that involving actors who have a "stake" in achieving adequate solutions for the congestion problem often helps prevent breakdowns in the process.

The right combination of policies

Excessive congestion and degraded road traffic conditions are not an unavoidable outcome of city life. This report highlights that much can and should be done to better manage congestion in large urban areas.

Tackling congestion can deliver lasting benefits for the entire urban region. However, mitigating congestion in urban areas requires much more than selecting one or two "silver bullets". There are no "miracle" solutions –

long-term congestion outcomes will only be delivered through a well-framed process that addresses congestion in all its aspects at the metropolitan level in ways that include:

- Understanding what congestion is and how it affects the urban region.
- Developing and monitoring relevant congestion indicators.
- Intervening to improve the reliability of urban travel, to release existing capacity or to provide new infrastructure and, perhaps most importantly.
- Managing demand for road and parking space consistent with a shared vision on how the city should develop.

The success or failure cities experience in tackling congestion will ultimately depend on how well they organise themselves to carry out the task they set for themselves. This report seeks to provide decision-makers and transport system managers evidence from experience around the world to help them acquire the tools they will need to implement effective congestion management policies.

NOTES

1. This list of questions is based on a similar list in the Victoria (Australia) Competition and Efficiency Commission's draft report "Making the Right Choices: Options for Managing Traffic Congestion" released in April 2006. (VCEC, 2006).
2. Congestion can describe the performance of traffic on roads, of public transport systems, of rail networks, of airport slots, etc. This report, however, will focus principally on road traffic congestion – while recognizing that congestion management policy must account for the performance of alternate modes such as public transport and rail.
3. It does not follow, however, that action should be taken to reduce congestion based solely on the travel-time savings that might result to *existing* users ... given the impact of newly available capacity on use, policies should account for travel-time savings for users of the newly available capacity *after* the expansion and thus account for induced/generated demand effects.
4. Adapted from VCEC (2006), p. xvi.

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