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TECHNICAL
REPORT

Setting the Agenda for an Evidence-based Olympics

A research agenda for transport and infrastructure

RAND EUROPE

Contents

Summary

Big projects bring big challenges, and organising and running the Olympics is just about as big as it gets. Appropriate use of evidence can offer policymakers, organisers and implementers a way to create the right foundations for the decisions that will determine the success or failure of London's Olympic Games.

The full report on the evidence base for the London 2012 Olympics covers three main aspects:

- A **meta-analysis** of policy areas that are pertinent to the planning, delivery and legacy of London 2012 using evidence from previous studies.

- A **research agenda for transport and infrastructure**, identified using modelling techniques that investigate the behaviour of travellers, the transport system and land use. The aim being to create systems that functions effectively and efficiently during the Games and are sustainable system post-Games.

- A method for **understanding the security agenda** for London 2012. Identifying a tool that can aid understanding of the interactions of different aspects of Olympic security - hostile intent; operational capability; and potential influences on security; thereby identify the security capabilities required to address different threats to security during London 2012.

Here we present the previous mega-event evidence base and the research agenda for transport and land use.

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CHAPTER 1 Evidence on mega-events and infrastructure

1.1 Transport

Examining previous mega-events is particularly beneficial for transportation studies because they effectively offer '"real scale" laboratories of alternate mobility patterns and travel behaviour'.[1] Transportation is one of the most important practical challenge to face an organising committee – if spectators and athletes cannot arrive at venues on time, the event will collapse. The scale of operations needed to provide adequate Olympic transportation is vast, Atlanta employed approximately 15,500 transportation staff, Sydney spent more than AUS$370m on transport, and an estimated 21.7m passenger trips were conducted during the Athens Games.[2]

The challenge is even greater if the Olympic organising committee takes on full responsibility for providing spectator transportation during the Games, a task that proved 'extremely challenging' in Atlanta.[3] For example, the Sydney Games ensured that spectators with tickets, the Olympic workforce and volunteers (who amounted to 150,000 people daily) were entitled to free 24-hour transport to Olympic venues. No car parking was provided at any Olympic venue in order to reduce road traffic, which meant that rail traffic grew from 14 million to 29.5 million during the period of the Games.[4] [5]

One of Sydney's particularly useful initiatives was to test the Olympic Park's public transport system prior to the Games – over a period of two and a half years, 3.9 million

[1] Bovy (2001) 'Transport and exceptional public events: Mega sports event transportation and main mobility management issues', Economic Research Centre, Round Table 122, p.5.

[2] IOC (1997), 'The Official Report of the Centennial Olympic Games; Volume One: Planning and Organizing', p.500; IOC (2001), 'Olympic Report of the XXVII Olympiad; Volume One: Preparing for the Games', p.157; Dimitiriou *et al.* (2005) 'Public Transportation during the Athens 2004 Olympics: Facts, Performance and Evaluation', in 'Athens 2004 Summer Olympics: A Compendium of Best Transportation Practices' (CD-ROM), published by the Hellenic Institute of Transportation Engineers, p.2.

[3] IOC (1997), p.522.

[4] Bovy (2006), 'Solving outstanding mega-event transport challenges: the Olympic experience', *Public Transport International* 6/2006, pp.32-34, p.32.

[5] Ibid

people travelled to the Olympic Park for test events.[6] These tests resulted in major operational improvements, mainly in crowd management both within the public transport system and at Olympic cluster entrances. In contrast to this careful testing, the transport infrastructure for Athens 2004 was late in being delivered and therefore '"teething" problems had to be resolved while the project was already carrying paying passengers', which produced negative press coverage.[7] Athens nonetheless had a significant transport legacy, which included new suburban rail and light rail systems, renovations to the metro system, and a new international airport.[8]

It is clear that the legacy of an effective, well-utilised transportation system is now one of the major goals of hosting the Olympic Games. This is reflected in the London 2012 Organising Committee's statement that 'providing a sustainable legacy is at the very heart of the project'.[9] In 2007, the House of Commons Transport Committee commented that the available evidence made this commitment appear 'unconvincing' and voiced 'concern' at the importance being attached to the legacy issue.[10]

Transport is one of the most important aspects of London 2012, as shown by the London 2012 Organising Committee's statement on legacy (above). As such, it is important that the evidence from previous mega-event evaluations informs the questions that need to be asked for London 2012's sustainable transport legacy. On top of questions that can be addressed using evidence from a transport based meta-analysis, there are primary research methodologies that can be applied specifically to transport questions and the following chapter identifies some of the modelling techniques that would be applicable to transport problems faced by London 2012.

1.2 Infrastructure

Some cities, particularly Barcelona, have demonstrated that hosting the Olympics can be a way to rethink the urban profile of a city and the way it uses space. In Barcelona, the transformation of waterfront areas into a multi-use area, including residences, infrastructures, public spaces and new beaches, has been particularly startling.[11] By creating 'central' urban areas in a location previously regarded as inaccessible, the waterfront project indelibly altered the city's infrastructure and became key to its rising reputation as a world tourist destination. The example of Barcelona shows the benefits that can ensue if the

[6] IOC (2001), p.157.

[7] Nellas (2005) 'The Athens LRT – Fast Track Olympic Implementation and High Quality Daily Transport', in *Athens 2004 Summer Olympics: A Compendium of Best Transportation Practices*, p.1.

[8] Bovy (2006) Op Cit, p.33.

[9] http://www.london2012.com/en/ourvision/regeneration

[10] House of Commons Transport Committee (2007) 'Transport for the London 2012 Olympic and Paralympic Games: The Draft Transport Plan', pp.5-6.

[11] Muñoz (2006) 'Olympic urbanism and Olympic Villages: planning strategies in Olympic host cities, London 1908 to London 2012', *The Sociological Review* 54 (s2) 175-187, p182.

Olympics are treated as a catalyst for further urban growth and a generator of urban strategies, rather than just a sporting event.[12]

Nevertheless, the Olympics remain primarily a sporting event, and thus require sporting facilities. Sports stadia have often formed part of urban strategies, on the basis that they are part of the infrastructure needed for a city to expand its economic activity into new sectors and transform its image.[13] However, given the number of new Olympic sports introduced under the Presidency of Juan Antonio Samaranch (1980-1999), the scale of the facilities now needed for the Olympics has made it more difficult for cities to ensure that the resulting expensive, specialist facilities will attract enough users to make them financially sustainable afterwards.[14] The facilities can attract massive spending. The Atlanta Committee for the Olympic Games, for example, spent approximately $1.58 billion, of which $517 million was spent on construction. Of this $517 million, 40.4%, went towards a new Olympic Stadium, and a further 24.6% to the athletes' village. These projects had a major effect on communities, which led to controversy over their development and opposition by residents, often intersecting with race and class issues.[15] In addition, the benefits produced by these new facilities may be counteracted by the closure or movement of existing facilities that are not directly replaced by the new developments. For example, two swimming pools were closed in East Manchester during the build-up to the 2002 Commonwealth Games.[16]

The experience of Sydney offers a warning about the post-Games viability of such stadia. The troubled Stadium Australia, for example, has been severely handicapped by a lack of suitable events for its capacity, by relatively small Sydney attendances for national sporting leagues, and by significant competition from nearby, pre-existing State Government stadia. It has also been argued that planners failed to consider whether Sydney's long-term recreational and entertainment needs required these facilities.[17] Sydney 2000 also shows that the involvement of private sector enterprises does not eliminate risks of this nature, since their expectations may be inaccurate. In Atlanta, the diving and baseball facilities were eventually torn down owing to a lack of utilisation. However it should be noted that in Atlanta the Olympic athletics stadium was converted for professional baseball.[18]

The Chief Executive of London 2012's Olympic Delivery Authority recently emphasised the Games' importance as a catalyst for revitalising the Lower Lea Valley, claiming that London could be remembered as the 'Regeneration Games'.[19]

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[12] Muñoz (2006) p185.

[13] Thornley (2002) 'Urban Regeneration and Sports Stadia', *European Planning Studies* 10:7, 813-818, p.814.

[14] Higham (1999) 'Commentary – Sport as an Avenue of Tourism Development: An Analysis of the Positive and Negative Impacts of Sport Tourism', *Current Issues in Tourism* 2:1, 82-91, p.85.

[15] Andranovich, Burbank, and Heying (2001) Op Cit, p122.

[16] Spring (2003) 'The Social Impact', *Recreation* 62:6, 36-38.

[17] Searle (2002) Op Cit, p.845, p.858.

[18] Chalip (2002) Op Cit, p.6.

[19] http://sport.guardian.co.uk/london2012/story/0,,1954761,00.html. Accessed on 12.02.07.

Although there has been 'little research on the actual regenerative potential of investment in sport',[20] some evidence shows that hosting the Olympics can massively advance the regeneration of previously derelict areas, and even create new metropolitan centres. For example, hosting the Olympics meant that not only was the planned regeneration of Sydney's Homebush Bay brought forward significantly, but also its scope was greatly increased, for example a new rail line was added. The resulting development replaced degraded industrial land with Sydney's largest urban park, the Millenium Parklands, constituting 450 hectares of wetlands and grasslands habitats.

However, as well as advancing the timetable and widening the scope of Homebush Bay's regeneration, the Olympics also changed its nature: the planned industrial areas disappeared, and the whole enterprise was oriented towards spectator venues and major commercial and retail development.[21] It is suggested that city authorities wish to use mega-events to expand into the arena of consumption-based rather than production-based economic development because they believe that convention centres will attract tourists and promoting professional sports will trigger urban regeneration and growth.[22] However, some argue that consumption-based developments create apparently uniform constellations of convention centres, hotels and entertainment complexes, all of which are aimed at improving the experience of *visitors*, rather than residents.[23]

Moreover, when assuming that while 'major sports teams and events are "community assets"' one has to be aware of the fact that 'stadia often exist in close proximity to citizens who cannot afford the price of admission and upon whom the burden of increased taxation is disproportionately placed', as has been the case of the Superdome in New Orleans.[24,25] It has been argued that the Nagano Winter Olympics (dubbed 'the construction firm Olympics') made few improvements to public infrastructure and left little-used facilities that incur heavy operational losses, while stated social goals remain uncompleted.[26] Other studies also point out that various mega-events have led to social polarisation due to the subsequent development of the housing market. For example, low-cost housing had been promised in both Barcelona 1992 and Sydney 2000, but property prices and rents of these new homes increased to such an extent that the area became unaffordable to lower income groups.[27] The distributional aspects of investment and

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[20] Hall (2006) 'Urban entrepreneurship, corporate interests and sports mega-events: the thin policies of competitiveness within the hard outcomes of neoliberalism', *The Sociological Review* 54 (s2), 59-70, 62.

[21] The information about Homebush Bay is found in Searle (2002), 'Uncertain Legacy: Sydney's Olympic Stadiums', *European Planning Studies* 10:7, 845-861, p.850.

[22] Andranovich, Burbank, and Heying (2001) Op Cit

[23] Andranovich, Burbank, and Heying (2001) Op Cit, 116.

[24] Schimmel (2006) 'Deep play: sports mega-events and urban social conditions in the USA', *Sociological Review*, p 160-174.

[25] Whitson and Horne (2006). 'Underestimated costs and overestimated benefits? Comparing the outcomes of sports mega-events in Canada and Japan' *The Sociological Review* 54:2, 71-89, 75.

[26] Ibid

[27] Horn and Manzenreiter (2006) 'An introduction to the sociology of sports mega-events', *The Sociological Review*, 54(s2), 1–24, p 12.

growth around an Olympics are a key issue in assessing the net benefits of the Games and its regeneration projects to the local population.

This leads to a fundamental question raised by recent Olympics: how much does the local area actually benefit from hosting the Games? Clearly, there must be some disadvantages, as evidence of evictions and arrests prior to the Seoul, Barcelona and Atlanta Games suggests.[28] An honest forecast of who will benefit from the public funds that are mobilised is needed. The House of Commons Committee overseeing London 2012 has recently stated that the increased land values that will result from Olympic regeneration 'should not simply be translated into a profit for the owners or developers'.[29] This is important because one of the major factors affecting local acceptance of a mega event is whether the benefits and negative impacts are distributed 'fairly' across society.[30] These are issues that raise specific questions about how regeneration should or could affect London. Some of these questions can be addressed by a more in depth meta-analysis of regeneration activities which would identify potential solutions that could be used by London 2012 in ensuring the regeneration of London is one that achieves the policy aims it has set out to.

[28] Shapcott (1998) 'Commentary on "Urban mega-events, evictions and housing rights: The Canadian case" by Chris Olds', *Current Issues in Tourism* 1 (2), 195–196.

[29] House of Commons Culture, Media and Sport Committee (2007) *London 2012 Olympic Games and Paralympic Games: funding and legacy. Second Report of Session 2006-7. Volume One,* p.4.

[30] Jones (2001) 'Mega-events and Host-region Impacts: Determining the True Worth of the 1999 Rugby World Cup', *International Journal of Tourism Research,* 3:241-251, p.243.

CHAPTER 2

A research agenda for transport and infrastructure

2.1 Effective transport planning is critical for mega-events

An event the size of the Olympics needs well-orchestrated machinery to ensure its smooth running. One of the key components of this machinery is the transport system. It is estimated that the London transport networks will have to move 55,000 athletes, officials and media, 500,000 spectators and 120,000 staff and volunteers each day, in addition to the usual traffic. Much of this additional traffic will be centred in London, but transport links to and from the London area will be substantially impacted as well. The transport network will also have to ensure efficient movement of goods and equipment, which can be expected to grow in volume during the Olympics.

In order to accommodate this unusually high demand, major improvements are planned for London's transport infrastructure, in addition to several ongoing works and adaptations. These include, for example, the provision of new buses, new or refurbished tube trains, upgrades and extensions to the Docklands Light Railway, and the completion of the Channel Tunnel Rail Link to St Pancras, which will provide high-speed rail services directly to the Olympic site near Stratford. Although the Olympics has only served to expedite many of these projects, the Olympics transport plan nevertheless includes a few projects, such as the Olympic Javelin, planned specifically for the Games. With over £17 billion being spent on improving London's transport system over the next 5 years, the 2012 Games is set to deliver a lasting transport legacy for Londoners.[31]

The decisions on how to allocate the money are subject to a number of constraints. Transport planners must ensure that the transport strategy for the Games ensures the smooth flow of people and goods through the transport networks at minimum cost to the environment. The hosting of the Olympics will have to be achieved at minimum cost to the taxpayer. Any investment in transport infrastructure must be justified by future use. It would be grossly inefficient to build roads and networks that are never used in the post-Olympics era, or that need large further investment in order to make them useful after the Olympics.

[31] Quote from Ken Livingstone, mayor of London.

It is therefore essential to understand what infrastructure is required for the travelling public and how travellers can be persuaded to use the most efficient transport options. It is important to be able to predict how traffic on the transport network may vary depending on the changes in basic assumptions about people's travel (for example the proportion of Londoners expected to be on holiday during the Games and thus not making usual commuting journeys), and to understand the impact of failures in crucial parts of the system.

The rest of this chapter will focus on each of these issues. Section 2.2 takes a look at the challenges facing the development of an effective and efficient transport strategy for the Olympics, and discusses several approaches to achieve this. Section 2.3 discusses the importance of ensuring that the Olympics leave a lasting legacy that is positive and examines the challenges to this objective. Section 2.4 deals specifically with the issue of prioritising transport plans to meet cost constraints. Finally, section 2.5 concludes with key guidelines for the development of an effective transport strategy for the Olympics.

2.2 Rigorous travel demand modelling is key to effective transport strategy

In order to devise an effective and efficient transport strategy for the Olympic Games, it is necessary to have a reliable and accurate estimate of the demand for various transport services. What is the peak demand expected on the London Underground's Jubilee line during the Olympic Games, and when is this peak likely to occur? What is the average demand expected for a park-and-ride site located at Ebbsfleet? What is the expected demand for coach parking at the venues? These are just a few of the questions that travel demand models must answer.

The following sections present a comprehensive picture of what can be achieved through travel demand modelling for the Games (section 2.2.1), discuss the main challenges in the accurate estimation of travel demand for the Games (section 2.2.2), and present some solutions to overcoming these challenges (section 2.2.3).

2.2.1 Rigorous travel demand models are comprehensive and behaviourally realistic

Reliable estimation of travel demand requires the development of accurate and behaviourally realistic models that assess the number of people who will be travelling to the Olympics venues from different parts of the UK and the world by each relevant mode of travel. These models must examine the variation in the demand for transport by time of day and during the two weeks of the Olympic Games, and capture accurately the sensitivities of the public to different transport arrangements. The resulting spatial and temporal estimates of travel demand can contribute toward effective transport planning, for instance through the introduction of additional bus services to handle excess demand on certain corridors, or the introduction of demand management schemes to control or reroute the demand on those corridors.

In order to develop accurate travel demand models for the Games, it is necessary to form a comprehensive picture of travel behaviour during the Games. Specifically, we need answers to the questions listed in Box 1. Answers to these questions can lead to better specified, and therefore, more accurate travel demand models. In other words, if we can understand the

motivations that drive people we can make a better estimate of their travel demand. Clearly this demand must also be a function of the schedule of events for the Games, but total demand will comprise more than the number of people who travel to London to attend specific events, it will also include the people who travel to London just to feel a part of the festivities, even if they don't have tickets to any of the events. Further, some people may travel to London only to attend the events for which they have tickets while others may plan on staying in London longer to enjoy some sight-seeing and tourism.

- What kind of people travel to special events – income level, age, gender, car ownership, household structure (marital status etc.), employment status? Do different types of people have different travel needs, e.g. mobility restrictions?
- Is willingness to pay for travel to special events any different from other purposes – how does sensitivity to travel times, cost, interchange time etc. differ?
- What is the composition of the groups people like to travel in – what proportion prefers to travel with their entire household, what proportion prefers to travel with large groups of extended family members and friends, how many prefer to travel with colleagues, how big is the expected size of the groups?
- When are people likely to travel – the day before the event or the day of the event? How many are likely to head into London the day before the event and stay with friends/family overnight?
- How many people plan to travel only if they can attend some events at the Olympics? How many would travel just to be in the city during the Olympics, and be content to sightsee even if they don't have tickets to the events? How many people would be happy to view the events at a local large-screen facility?
- How long do people intend to stay in and around London? Do they plan to attend only a few days of the Olympics, or do they plan to stay the entire length of time? How many combine a tourism trip with the Olympics?
- How many people travelling to London during the Games are likely to stay in the Greater London Area and how many prefer to stay outside this region?
- What modes of travel will be used to get to the events? How will this be influenced by provision of information? How many visitors are likely to hire a car?

Box 1. Questions to be answered in understanding travel behaviour during special events

Reliable travel demand models can be developed to address more strategic questions based on an understanding of the issues presented in Chapter 1. For instance, models can be developed to estimate the demand for a new mode such as Park and Ride or to estimate the change in mode shares over time in response to policies that curtail private vehicle use in Central London.

Transport strategy for an event of the magnitude of the Olympic Games must also include a 'worst scenario' plan, under the premise that one or more of the assumptions going into

the transport strategy (such as assumptions of background traffic, venue capacity etc.) could be wrong. Behaviourally realistic travel demand models can not only predict such a scenario reliably by accurately capturing people's sensitivities to different transport arrangements, but can also help the transport planner identify solutions to such a scenario, for instance by identifying under-utilised corridors in the transport network.

2.2.2 Modelling travel demand during 2012 will be a challenge

The development of comprehensive, accurate and behaviourally realistic travel demand models, difficult enough for regular transport planning, is even more difficult when planning for a mega event of the scale of the Olympics.

One of the key challenges is the fact that events such as the Olympics attract a particular segment of the population, and this is compounded by the fact that there has been very little data collected to help describe this segment of the population. On the other hand, transport planners for special events are assisted by the fact that demand for these events can be controlled to a certain degree by ticket sales, and that travel choices can be influenced to a certain degree by provision of information.

Despite the opportunity to influence mode usage, it is important to develop models that can reliably assess travel demand along different corridors in order to support and justify the costs of transport investment plans such as the building of park and ride lots and supplementary rail lines. Such investment can be supported by a reasonable estimate of the usage of these facilities not only during, but also after the Olympic Games. Moreover, models of travel behaviour can also estimate the effects of information on travel-related choices. How many visitors with tickets for the Games are likely to follow the travel advice provided with their tickets? And, consequently, what is the best strategy for the provision of information? This is clearly a function of how familiar an individual is with the London area transport network, the mode of travel preferred by the individual on a regular basis, the number of people accompanying the individual etc.

Another challenge facing transport planners is the fact that travel demand estimates for the Olympics will depend heavily on the Games schedule, which is not likely to be finalised until some time close to the Games, by which time the transport strategy should already be in place. The transport strategy must therefore be not only robust but also flexible. Data from ticket sales, which is likely to increase as we get closer to the Games, can be used to fine-tune the transport strategy in the months leading up to the Games.

A third challenge is the fact that total demand will vary geographically as well as temporally, with definite surges expected before and after scheduled events. The geographical variation in demand is likely to be driven by several factors, such as distance from the venues, accessibility by different modes of transport, socio-economic characteristics of the visitors, and availability of local large-screen facilities to view the Games etc. These motivations are also likely to be very different for travellers from other countries, who have the added incentive of visiting a new country and are therefore less likely to be deterred by distances. It is important to take all these factors into consideration in order to develop reliable estimates of the temporally and spatially distributed travel demand for the Games.

A comprehensive travel demand model must not neglect other segments of the population that also need to travel during the Games – the officials and volunteers, press, businesses catering to the Games, the athletes and their families – and the background travel of the residents for commuting, education, shopping and all other usual requirements. Suitable and, to the extent possible, accurate assumptions will need to be made for each of these categories of travel. For instance, because the Games will be held in the summer holiday period, organisers are depending on substantial reductions in commuting traffic. Reasonable estimates of these reductions, and sensitivity tests conducted by varying these estimates, are important for developing an effective transport strategy.

Clearly, a transport strategy for the London Olympics must be capable of handling large volumes of traffic that are spatially and temporally concentrated with a wide range of purposes and degrees of urgency. Moreover, in order to be effective, the strategy must incorporate innovative temporary and/or permanent transport and traffic management schemes. The transport strategy would not be complete unless the long-range plan is well supported by a real-time traffic management system that can handle problems such as scheduling, unexpected vehicle failures, and security concerns.

2.2.3 An effective model has a strong basis in data and an understanding of behaviour

The first step in developing a transport strategy that can meet all the above challenges is the development of reliable and behaviourally realistic travel demand models, and at the heart of these models is data (see Box 2 for details of data collection methods). Although aggregate measures – such as population, employment, and venue capacity – are sufficient to develop rough estimates of travel demand, it is possible to develop more accurate estimates that are also sensitive to changes in the social, economic and transport environments. This can be achieved through surveys designed to enhance our understanding of travel behaviour. The following are some ideas for surveys to increase the evidence base in transport planning for mega-events.

A) Gather revealed preference (RP) data from past events – typical aggregate mode shares at previous Olympics (specifically the difference between a regular weekday mode share and Olympics mode shares); revealed preference data identifying socio-economics, willingness-to-pay (compared to other purposes), and other answers to questions from Box 1. Potential sources of such data include recent events such as the Manchester Commonwealth Games or even a survey based on the FA Cup Final. The 2007 Cup Final presents a particular opportunity because Wembley has been out of use for some years and travellers were unaware of what to expect at the new stadium, as they will be when coming to the Olympics.

B) Conduct stated preference (SP) mode choice surveys specifically for London 2012 – consider existing modes as well as proposed modes such as park and ride. SP games can effectively capture sensitivities to varying travel times and costs, wait times, interchanges, reliability etc. Such SP surveys may also indirectly serve as a means of influencing travel choices for the Olympics.

High quality data collection is critical for the development of robust transport models. However, data collection often involves substantial cost and time. It is therefore of the utmost importance that the right data is collected and it is of the highest possible quality.

A wide range of data collection methodologies and survey instruments have been used in the past to collect data for transport modelling applications. The data collection methods that are typically used in the UK include:

- On-street surveys (including roadside interviews)
- Telephone surveys
- Household surveys
- Internet surveys.

On-street surveys, either in the form of roadside interviews or interception of pedestrians on pavements or in places such as shopping centres, can provide a large quantity of data at relatively low cost. However, any roadside interview will almost invariably require police cooperation to assist in stopping traffic and ensuring unacceptable queues do not develop. There are costs associated with this, and furthermore sites must be found for the interviews where there are sufficient lanes and road space consistent with the traffic flows to ensure minimum disruption to traffic. More advanced transport models require not just trip information but detailed tour and activity information in addition to demographic terms. In particular, household income has been found to have a substantial influence on, for example, road pricing schemes. Achieving this level of information through on-street methods is often impractical.

Other forms of interviews such as telephone and household interviews have been widely used, either alone or in combination. These methods, while more time-consuming and expensive, can provide a much richer dataset which allows the development of more robust and behaviourally rich models than would otherwise be possible. Careful design of the survey instrument and briefing of respondents can produce the high quality data essential to the modelling effort.

In the last few years, the internet has increasingly been used to collect survey information as it can be very cost effective (costing perhaps 20% or less of the cost of traditional survey techniques) and can provide data in very short timescales. A number of companies in the UK provide online panels, often extending to many thousands of respondents, that can be readily contacted for all kinds of transportation research studies. There are however issues with regard to sampling bias associated with internet surveys; although 57% of households in Great Britain now have internet access, this is biased towards younger, more highly educated and higher income groups. As such, it is typical to supplement any internet survey with a telephone recruitment stage to ensure a representative sample of the target population is obtained.

Forecasting demand often requires an understanding not only of current demand drivers, but also the response in future scenarios where step changes in supply occur. Classic examples are the provision of all-new infrastructure such as toll roads, light rail or bus links where previously there was no such connection. In such instances stated preference (SP) methods have been widely used in the transport sector. These are hypothetical scenarios where respondents are presented with possible means of making a journey, each of which has different combinations of cost, time and other relevant attributes. Such methods have been shown, when developed with sufficient care, to produce robust forecasts of future demand. However, being based on hypothetical scenarios these methods should always be supported by existing behavioural data wherever possible (often called revealed preferences (RP)). The methods to incorporate both RP and SP data are now well developed, and widely used.

Box 2. Data collection for special events

C) Add on a few questions to one of the UK panel surveys (and perhaps other European or US panel surveys as well). These questions could be targeted at capturing the responses of a larger population to broad questions such as: would they travel to London to watch Olympic events or would they be happy with a local large screen facility? Would they travel to London to be part of the Olympics festivities even if they didn't have tickets to any of the events? Answers to these questions would help corroborate planning assumptions.

D) Conduct surveys of tourists to London and the UK to understand their travel behaviour and patterns. This can give us a better understanding of how current visitors to London make travel decisions, what information they use, and other factors that influence their decision-making. Such tourist surveys will also have long-term transport planning benefits.

E) As we get closer to the Games, ticket sales data can be used to refine the travel demand models and make suitable modifications to the transport strategy. It would therefore be useful to gather some socio-economic and other data during ticket sales.

F) Conduct surveys during the Games to help improve transport services in real-time. Although a challenging task, this will at the very least serve to improve real-time transport strategy.

As indicated by the above suggestions, survey data – be it RP or SP – help us understand the motivations underlying travel behaviour. For example, the results of a survey conducted by Nerotti et al.[32] during the 1996 Atlanta Games indicated that 51.3% of the people attending the Games were sports fans, while tourists formed the second largest category (16.6%). Data such as this help us answer the questions in Box 1 and thus develop a clear conceptualisation of the travel-related choices made during special events. The next logical step then is to translate this conceptualisation into a model structure.

Take, for instance, mode shares, an important component that characterises travel demand. A mode choice model that captures spectators' and tourists' choice of mode as a function of travel time and cost (among other factors) must be developed to estimate mode shares. Figure 1 presents a nested logit mode choice model that captures the correlations between the alternative modes. The model suggests, for example, that the different coach modes are more interchangeable than coach and rail, and therefore belong together in a nest. In other words, individuals who travel by any one of the coach modes are likely to possess a 'stickiness' for the mode and as a result they would be likelier to switch to one of the other coach modes than to rail. Similarly, the model also suggests higher cross elasticities between the public transport modes. It is possible to take this behavioural perspective a step nearer towards reality by considering a cross-nested logit model, which incorporates the fact that the park and ride mode can belong to both the 'Public Transport' and the 'Private Vehicle' nests (as indicated by the dotted lines in Figure 1).

[32] Nerotti, Bosetti and Teed (2001) 'Motivation to Attend the 1996 Summer Olympic Games', *Journal of Travel Research*, Vol. 39, pg. 327.

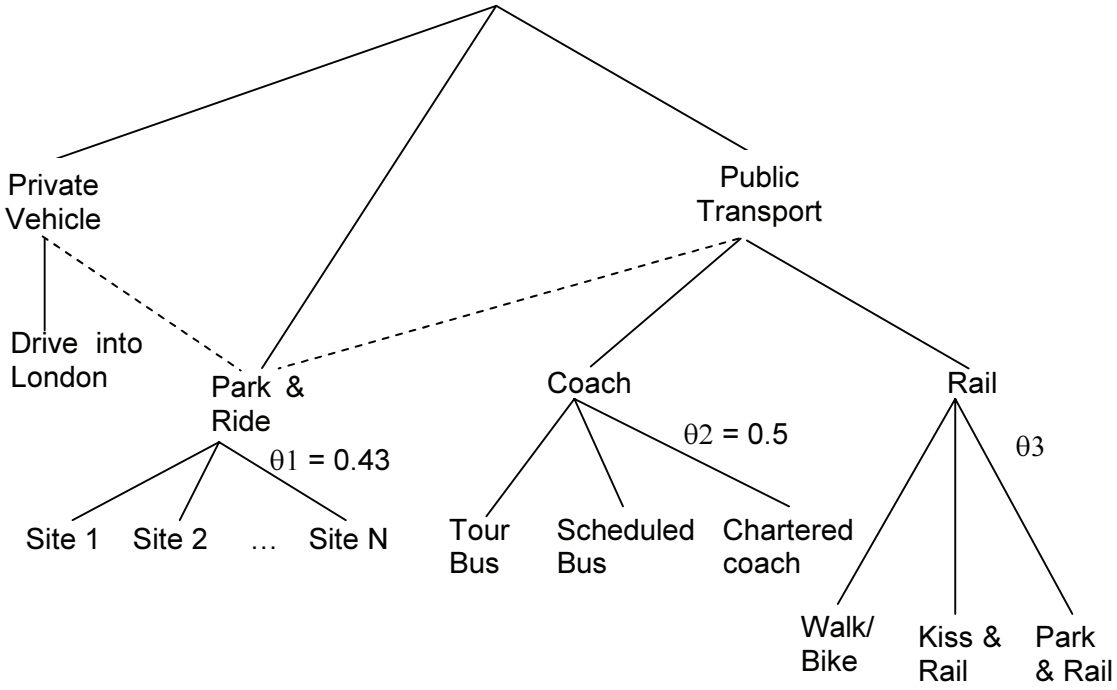

Figure 1. Nested Logit mode choice model

Even apart from exploiting recent advances in modelling as suggested above, behavioural realism can be incorporated into the mode choice models for the Olympics through the intelligent use of data – both existing and collected from surveys as discussed earlier in this section. For instance, car ownership data can be used to refine the mode choice model through accounting for the availability of car-based modes. Similarly, a better understanding of the socio-economics of the Olympics spectators will enable us to develop more accurate mode choice models with travel time and cost sensitivities that are more representative of the traveller population, by accurately accounting for the differences in values of time across socioeconomic groups.

2.3 Transport/land-use legacy impacts of the Olympics can also be modelled

This section will briefly discuss London's legacy planning and how focused research and analysis can help ensure that the hosting of a mega event such as the Olympics can contribute to the economic and community development of the city for the years to come.

2.3.1 Regeneration of East London

Central to the Olympic Delivery Authority's vision is the regeneration of East London. The Lower Lea Valley, covering an area of approximately 1,500 acres, is the largest remaining regeneration opportunity in inner London. It includes parts of the London Boroughs of Hackney, Tower Hamlets, Newham and Waltham Forest. Although the area is situated just three miles from Central London, it is largely underdeveloped and is characterised by derelict industrial land and poor housing conditions. It also houses one of the most deprived communities in the UK, with some of the worst levels of public health.

Unemployment is as high as 35%. Thus, 'regeneration of the area is of crucial importance in tackling poverty, unemployment, lack of basic skills and poor health'.[33]

Lessons on legacy planning can be drawn from other Olympic cities, such as Atlanta and Sydney. Both Atlanta and Sydney staged the Games in relatively underdeveloped areas – a small area of downtown Atlanta and the western suburbs of Sydney. However, the two cities took very different approaches with regards to legacy planning. Atlanta built permanent facilities only if there was an existing demand for them, and planned those facilities from the beginning based on how they would be used after the Games were over. On the other hand, Sydney focused resources on putting on the best Olympics possible and was pressured by sporting organizations to build permanent facilities, so it built many permanent venues that were only needed during the Games. The result was that most sporting venues in Atlanta were fully utilized and enjoyed by citizens afterwards (with some exceptions), whereas in Sydney many sports venues were left empty for long periods and are still being converted to facilities which will hopefully be usable by the local community.[34] Contrast this with the fact that Sydney's transport plan for the Olympics was more successful than Atlanta. Clearly, an effective transport strategy for the Olympics does not automatically fulfil legacy objectives.

Many believe that the London Olympic plans will be a success, since regeneration of the Lower Lea Valley would have taken place anyway, and that the Games simply provide a firm deadline that serves to accelerate the project timelines. Sustained post-Games demand is often seen as a given. However, acceleration of development plans may also force government authorities to make investment decisions on short notice without careful research and analysis, which could result in unwanted legacies. This is a pitfall that government authorities must avoid.

In order to develop an understanding of the impacts of regeneration and transport improvements, the following discussion will examine two key legacy impacts - housing market and the economy.

2.3.2 Housing market

It is expected that the Olympics will have a positive impact on house prices in East London, although the extent of the impact has varied greatly for past Games (see Figure 2).

For London, it has been one and a half years since the bid, but the impact on the housing market in East London has yet to be seen. According to Land Registry Office data, average house prices in four out of the five Olympic boroughs have grown at a lower rate than Greater London as a whole since the bid.[35]

[33] As recognised by the London Development Agency (LDA, 2006)

[34] Dann, B. (2004). "Legacies of the Games: Long-term Impacts of the Olympic Games on the Host Cities of Atlanta and Sydney", Duke University.

[35] Kornblatt, T. (2006). "Setting the Bar: Preparing for London's Olympic Legacy", IPPR Centre for Cities, Discussion paper No. 8, London: Institute of Public Policy Research.

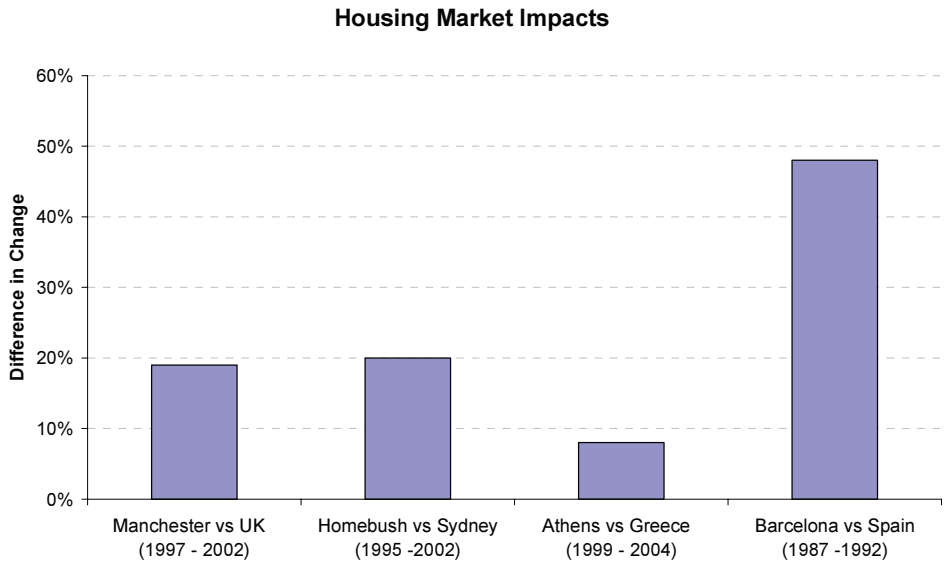

Figure 2. Housing Market Impacts

Source: Halifax (Reproduced from: UBS, 2006)

The Olympic regeneration promises 4,500 'affordable housing' units and 4,500 other houses, with the designation of the Olympic Village as housing stock.[36] More housing in East London could serve to tame the overheated housing market in central London. But is the scale of regeneration any match to the actual scale of the problem? Moreover, if the supply of housing is not enough to meet demand caused by the regeneration of the local economy, it could cause housing prices in the area to soar. The effect could be that local residents, most of whom are relatively poor, will then be forced to move to other deprived areas to find affordable housing. To prevent this negative outcome, ensuring the affordability of housing is key. Thus, it is crucial to have a quantitative understanding of the real estate demand and supply interactions, as well as the residential location choice behaviour of the households, taking into account the willingness to pay of the rich and the ability to pay of the poor.

2.3.3 Economy

A huge amount of funding is often poured into ambitious transportation infrastructure projects such as the Docklands Light Railway extensions or the much higher budget Channel Tunnel Rail Link. It is hoped that this infrastructure will serve as an engine for economic development. This hope is based on the belief that transportation infrastructure creates and induces inward investments.[37]

[36] UBS (2006).

[37] However, it must be remembered that, in the words of the Eddington Study (Eddington, 2006), 'Transport cannot of itself create growth: it is an enabler that can improve productivity when other conditions are right. Economic growth itself causes rising transport demands which, if left unchecked, can put the transport network under strain, damaging productivity and competitiveness.'

In Barcelona, for example, tourism rose from 2% of the city's GDP pre-Games to 12.5% of the GDP post-Games, and continued to grow to 15% by 2005.[38] The Olympics put Barcelona 'on the map' internationally. But London is already on the map. London, as a top-tier world city, is unlikely to reap as much benefit as Barcelona did from the Olympic Games. Several recent impact studies have suggested only modest generative effects on employment.[39]

Instead, regeneration of the East End is likely to bring about redistributive effects. More businesses (and households) will be attracted to the East End. The resulting effect may be an alleviation of the congestion problem in central London. However, if the capacity of the transport system in the East End cannot cope with the upsurge in demand, then the result will be an increase in congestion in the East End. Thus, coordinated planning of transport provision and floor-space provision is crucial.

Another important question is whether economic benefits will also accrue to the rest of Britain. As London is already the primary city in Britain, the gaps between London and the second or third-tier cities are likely to grow wider. The full implications of such effects will be very difficult to measure and will require further analysis.

2.3.4 Further Studies

Various impact assessments on the topic, such as those by the Department of Culture, Media and Sport[40] and Blake,[41] have used macro approaches to analyse the legacy impacts of the Games. These studies should be complemented by modelling approaches which focus on how individuals and businesses respond to improvements in the transport systems, particularly in terms of making travel decisions or locational (such as residential or work location) decisions, in order to fully understand the long-term effectiveness of the Olympics transport strategy. Of equal importance is the need for further analysis to examine how the benefits of the transport plan are distributed spatially so as to develop appropriate spatial strategies for the local community and the UK as a whole. This evidence need calls for an integrated modelling approach to the analysis of transport and land-use.

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[38] UBS (2006).

[39] Blake, A. (2005). "The Economic Impact of the London 2012 Olympics", Christel DeHaan Tourism and Travel Research Institute, Nottingham University Business School.; UBS Investment Research (2006) "Winning by Taking Part: East London's Economy and the Olympics", London: UBS Limited.

[40] DCMS and PricewaterhouseCoopers (2005) "Olympic Games Impact Study", London: PricewaterhouseCoopers.

[41] Blake (2005).

2.4 A behavioural approach to cost-benefit analysis of infrastructure investments

2.4.1 The need for independent quantitative assessment

The Olympics brings with it the opportunity to invest significantly in new or improved infrastructure, be it transport, new facilities or 'softer' changes to the urban environment and social regeneration. Therefore, the ODA will face a series of competing priorities for their investment, and the budgetary constraints are likely to be such that judgements will be required as to which should and which should not be funded.

A key consideration in any cost-benefit analysis of the options will be the necessity of delivering the Olympic events; however, some of the investments will be slightly more peripheral to the core games infrastructure. In other cases, the investments will be necessary, but extra 'value added' options may be possible, where for a small amount of additional investment the legacy of the infrastructure can be improved.

In order to compare competing options, it is necessary to develop a framework that creates a 'level playing field' so that the benefits and costs can be quantified in a consistent manner across bids. While measuring the costs will bring challenges of its own, the issue that we will focus on here is the more complex issue of how best to measure the benefits that a scheme may accrue. We concentrate mainly on the value that those within society place on the investment, which may act over and above any economic value that the investment may return, i.e. what is it 'worth' to the community?

2.4.2 The challenge – how to measure benefits?

The benefits to society are a difficult, but important, component to measure in any investment that claims to have a legacy value over and above its purely economic return. This is an area where subjective valuations and poorly substantiated claims are found more often than robust estimates of the value elicited from the public.

There are two approaches set out in the Treasury Green Book for valuing non-market impacts: contingent valuation and choice modelling. Contingent valuation studies elicit valuations via direct questions such as 'What is the maximum amount you would be prepared to pay every year to receive good x?' or 'Which of the amounts listed below best describes your maximum willingness to pay every year to receive good x?' However, these forms of questions are quite transparent and are easy for the respondent to manipulate if they have strong feelings regarding the item in question, or the concept of paying to receive it. Choice experiments are better suited to eliciting the value that individuals place on situations that are more complex (e.g. have multiple elements to value), or services for which asking for payment may be particularly controversial.

2.4.3 Use of discrete choice experiments

Discrete choice experiments pose the respondent with a choice, for example: choose A, choose B, or choose nothing. By building up the alternatives that the respondent is asked to consider within their choice, it is possible to take the respondent a step away from instantly dismissing a single proposition put to them. Figure 3 illustrates the form of choice that a respondent could be asked to consider.

It is proposed to build a cycling track (velodrome) in East London.

The core funding for the Olympic Games is already provided, but additional investment could allow the facility to serve the community for years to come.

Please consider the following options. We would like to know which of the following, if any, you would be prepared to pay towards through increases in your council tax.

No additional investment	Option A	Option B
Velodrome has expected life of 5 years	Velodrome has expected life of 15 years	Velodrome has expected life of 10 years
No refreshment facilities included in the complex	Café and restaurant included in the complex	No refreshment facilities included in the complex
BMX track relocated following Olympics	BMX track relocated following Olympics	BMX track retained on-site
No guarantee over future events	No guarantee over future events	Hosting of national cycling events guaranteed for 3 years
No increase in Council Tax	£5 per year increase in Council Tax	£10 per year increase in Council Tax

Figure 3. Sample discrete choice experiment

This is provided as an example, and clearly the context of the choice (i.e. the facility under consideration), the attributes within the choice (i.e. the factors used to describe the options), and the levels of these attributes (including the amount of tax to secure the facility) could be varied according to the needs of the valuation.

In discrete choice experiments, we are asking respondents to make trade-offs. Here we ask them to consider combinations of five attributes, of which money is one. The key to these choice exercises is the ability to both capture the value placed by the respondent on each of the attributes considered, and the combined value of these. In this example, given a series of responses to varying questions of this type from each of a number of respondents, we could measure the willingness to pay for the BMX track to be retained on site.

Although the measure we are collecting is willingness to pay, this does not imply that we would necessarily advocate that respondents should be asked to pay this amount. What it does give us is the value that they feel they would gain if such facilities were available. The measurement of this value is at the heart of the legacy debate.

2.4.4 Modelling the preferences of different groups in society

The discussion so far has looked at how much society as a whole values different legacy features, measured by taking an average value across all respondents. With the modelling of this data we can go a number of steps further to providing an insight into how this value differs between different groups in society.

The first refinement we can make is to investigate whether identifiable groups have different values, e.g. does the willingness to pay for improvements increase with disposable income? Do those of particular ages or with particular sporting interests or living in particular areas place higher value on certain types of facilities? These are the types of hypotheses we can test in the modelling, running systematic tests to identify where differences appear to exist and then to quantify the scale of the difference.

The second refinement we can make, once we have accounted for all of the differences we can explain through observed background variables, is to introduce distributions of the

values within the groups. For example, we may find that those on lower incomes are less willing to pay for certain improvements, but this group will not necessarily be homogeneous in their preferences, and we can take account of this by estimating not only the average value for this group but also the standard deviation around the mean.

These refinements will allow a far more insightful analysis of who will benefit from certain investments, an issue of particular interest where legacy features of the investments are being promoted for their benefits in addressing social inequalities.

2.4.5 Calculating the 'value' of investments

The approach outlined above provides a technique which can be used to estimate the willingness to pay for certain attributes of an investment. However, this can be taken a step further and we can obtain the consumer surplus from a given form of investment. Consumer surplus measures the net benefit accruing to consumers for a product which is purchased in a market; it is equal to total benefit minus the price. Of course, for many of the investments being considered there is no market in which a decision to buy the availability of the facility can be made, so in our choice experiments we create a hypothetical market in which households are offered choices between situations with and without the facilities, with changes in tax to represent payments they might make. By analysing their responses to these hypothetical choices, a model can be constructed of 'demand' for the availability of the facilities at 'prices' paid in tax.

Given a model of demand, in economic textbooks a demand curve, measures of benefit can be derived: the consumer surplus or 'area under the curve'. This benefit can be measured in monetary terms. The choice models that we would typically develop would contain variables that differ between households and therefore the demand curves for different households would vary. The consumer surplus for each household can be calculated from the choice models by applying the demand curve relevant to that household.

The consumer surplus that can be calculated is not an absolute measure, but calculations can be made for the situation with and without the facility in question. The difference between the two measures, scaled by the cost coefficient, represents the benefit derived from the facility. Once consumer surplus measures have been calculated for each household, average values for households of various types can be worked out. This provides the policy maker with a powerful quantification of who in society obtains value from a certain proposal, and how much value they obtain.

2.5 Overview

In summary, transport planning for the Olympics will be a challenging task. The development of an effective transport strategy for the Olympics is dependent on the development of rigorous and reliable travel demand models that are behaviourally realistic and therefore accurate in their response to policies. Further it is important to assess the sensitivity of the travel demand estimates to the various assumptions made, such as the assumptions on background traffic during the Olympics. Accurate estimates of travel demand are not only key to effective transport planning but also contribute to the accurate assessment of the environmental effects of the Olympic transport strategy.

Transport planning for the Paralympic Games, although not discussed here, needs to be approached with the same degree of rigour and comprehensiveness. The objectives will be slightly different as the needs of the people attending these events are likely to be different on average. However, in order to produce reliable estimates, the basic approach to estimating this demand and the special needs associated with it must continue to be located in behavioural realism.

It is important not only to develop a transport strategy that is effective during the Olympic and Paralympic Games but to also keep in mind the long-term usage and legacy benefits of the transport investments that form part of the strategy. For instance, improvements to address potential failures (such as vehicle or signal failures) in the London Underground will not only contribute to the Olympic transport strategy but also ease transport conditions for users of the Underground. In order to evaluate the legacy benefits of transport investments, it is necessary to undertake integrated modelling of transport and land-use.

Transport investment decisions must also be achieved with minimal burden to the tax payer. Therefore, a comprehensive cost-benefit analysis of the various alternatives must be undertaken. Discrete choice experiments can contribute to the effective assessment of costs and benefits as perceived by the various stakeholders, including the public.

Finally, it is important to keep in mind that transport systems are not isolated. In fact, they are closely inter-linked with security, technology, media, ticketing, accommodation, environment etc. and should be treated as such. We conclude with the key lessons on transport planning drawn from past Games.

Key lessons to learn

- Plan with an eye to legacy.
- Public communication is important.
- Environment impacts must not be neglected.
- Cluster venues of major events near the regeneration area.
- Pre-test the Olympic sport and transport systems with other big events before the Games.
- Olympic events should be made 100% accessible by free public transport.
- A multimodal centralized transport organisation is needed (which we already have in the form of the ODA's Transport division).
- Plan for client-oriented sub-systems (separate fleets for athletes, media, Olympic Family, sponsors, spectators etc).
    - Such a plan could include, for instance, an Olympic priority lane network.
- Transport strategy must include traffic demand management schemes.
    - For instance, plan venues with live large-screen facilities to spread the load.

- Watch out for worrisome transport failures such as:
    - accident or major breakdown in rail network. Possible solutions include the elimination of freight traffic during the Games, and the maintenance of a reserve fleet of buses for contingency.
    - bus mismanagement, confusion and false routings due to weakly managed bus depots, difficulty pairing drivers and buses, driver walkouts due to discontent, lack of knowledge of road system, Olympic routes etc.
    - traffic congestion around venues and major arterials.