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Congestion Reduction in Europe: Advancing Transport Efficiency

MG-5.3-2014
Tackling urban road congestion

D5.2
Funding Sustainable Mobility and Liveability: are the current scheme appraisal procedures appropriate?

WP 5 – Combating Congestion and Reducing Car Use in European Cities

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1. Introduction

The CREATE project is concerned with transport policies in cities and how these have evolved over time in response to changing challenges and priorities. In particular it examines how cities have succeeded in limiting the growth and extent of road traffic congestion by reducing reliance on the private car for day-to-day mobility. The project is based around four propositions:

1. The way in which the "congestion" debate is framed in a city reflects the perceived role of the urban transport systems and how performance is measured.

2. The existence of a 3-Stage "Transport Policy Evolution Cycle" spread over 50+ years, which gradually shifts the policy emphasis and investments priorities from catering for road traffic growth to building a liveable and healthy city, through developing streets as 'places'.

3. The examination of future mobility options given a rapidly growing urban population (and a mobility densification), with policy measures which can achieve congestion reduction and promote sustainable mobility, whilst meeting wider policy goals.

4. Promoting the "policy transfer" of understanding gained from investigating the above mentioned ideas, to those cities which are coping with rapid growth in car ownership and promoting "pro-car" policies. This would provide them with insights into how to short-circuit or accelerate the 3-Stage historical "Transport Policy Evolution Cycle".

Deliverable 5.2 seeks to identify how Stage 3 cities assess the benefits of their major transport initiatives in terms of impact on travel behaviour and other relevant city policy objectives, e.g. promotion of healthy lifestyles. This was based largely on an assessment of academic and technical documents published by governments and city partners. UCL led on this sub-task.

It also focuses on how Stage 1 and Stage 3 cities make investment decisions to prioritise the deployment of sustainability measures and then fund and finance their development Master Plans. This has been delivered through structured dialogue with city partners. Examples are presented of local, regional, national and international financing options for investing in urban transport and mobility. This was led by Vectos.

2. Estimating the benefits of introducing Stage 1, 2 and 3 measures in cities: appraisal methods and indicators

Appraisal is the ex-ante assessment of the social worth of public policies in terms of their anticipated performance regarding a pre-defined set of positive and negative impacts. The magnitudes of these impacts are understood as indicators of the success (or failure) of the policies. Appraisal is different from evaluation, the ex-post assessment of how policies achieved their objectives.

As cities move from Stage 1 to Stage 3 of the urban transport policy development process (Figure 1), the shift in policy concerns requires a parallel shift in transport project appraisal methods and a change in the set of indicators seen as appropriate to judge the success of the policies.

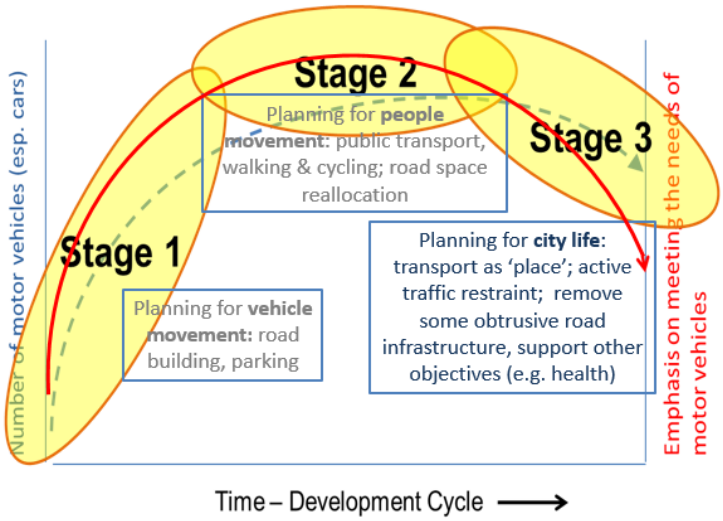

Figure 1: Simplified 'Transport Policy Development Process'

This does not mean that, at each Stage, the indicators of previous Stages cease to be relevant, but rather that the relative priority placed on those indicators is downgraded, as the new set of indicators becomes the focus of policy interventions.

Most indicators are internal to the transport system, i.e. they are aspects experienced by the users of the system. But some indicators are external to the system (known by economists as "externalities"), because transport policies impact on the wider economic, social and environmental spheres.

2.1 Indicators to judge the success of Stage 1 policies

The most relevant indicators to judge the success of Stage 1 policies ("Planning for vehicle movement") (Figure 2) are internal to the transport system and relate mostly to the performance of the road network for motorised vehicles. Those indicators describe:

- The supply of road transport - assessed for example by the road network capacity, provision for freight transport and car parking availability.
- Road travel times - assessed in terms of average speeds on the road network, travel time variability, congestion, delays and parking search times.

- Costs of using road transport - assessed by vehicle operating costs and by the human and economic cost of road traffic accidents.

As the negative external impacts of road traffic on the local environment increase, Stage 1 cities also start to look at the most evident of those impacts, such as air pollution and noise.

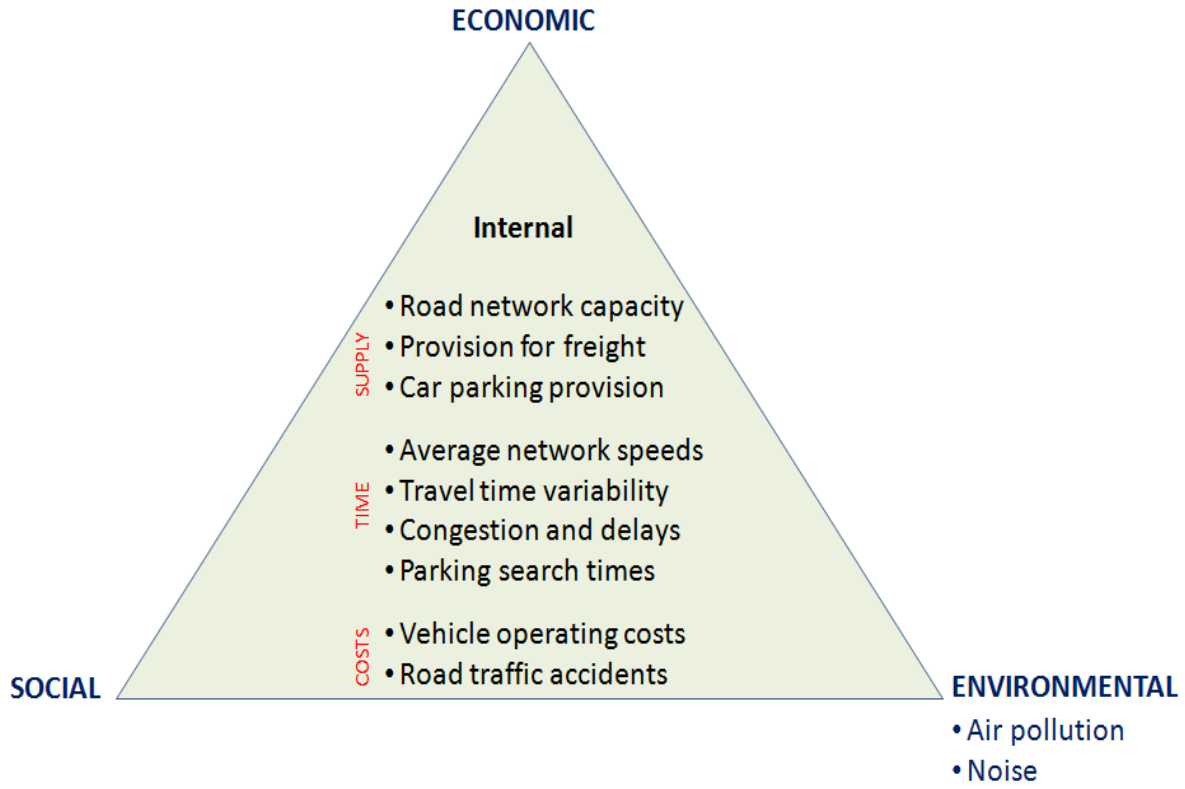

Figure 2: Indicators for Stage 1 (Planning for vehicle movement)

2.2 Indicators to judge the success of Stage 2 policies

As cities reach Stage 2 ("Planning for people movement"), the set of performance indicators (Figure 3) starts to cover transport modes other than private vehicles and to consider trips, rather than network conditions. The internal indicators are usually related to:

- The (multimodal) supply of transport - assessed by public transport service levels (i.e. their frequency and reliability) and provision for walking and cycling.
- Trips - assessed in terms of access to public transport services (i.e. access from homes/destinations to stations and bus stops), door-to-door travel times by each travel mode, seamless travel (i.e. the quality of public transport interchanges), trip expenditure and option values (the range of different transport options available).
- Aggregate indicators - assessed by modal share (looking in particular at the share of public transport, walking and cycling) and the efficiency of road space per person.

In Stage 2 cities, there is also an increased interest in the assessment of the wider external economic impacts of transport, especially how transport policies contribute to economic activity and employment in the medium and long term. The set of environmental concerns of city governments also start to include non-local aspects such as the emission of CO_2.

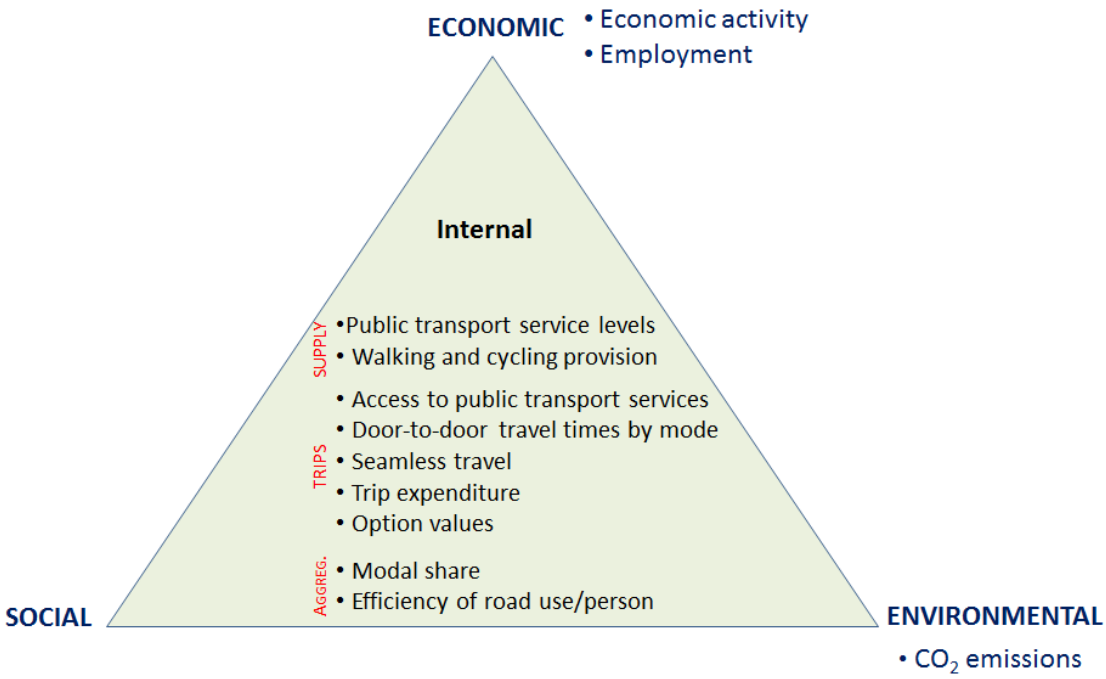

Figure 3: Indicators for Stage 2 (Planning for people movement)

2.3 Indicators to judge the success of Stage 3 policies

In Stage 3 (Figure 4) there is an increased emphasis on qualitative aspects of transport, such as the benefits of the number and length of trips for the individual and the community, trip quality (i.e. the amenity value of the trip), how people use their time while travelling and personal security in streets and public transport.

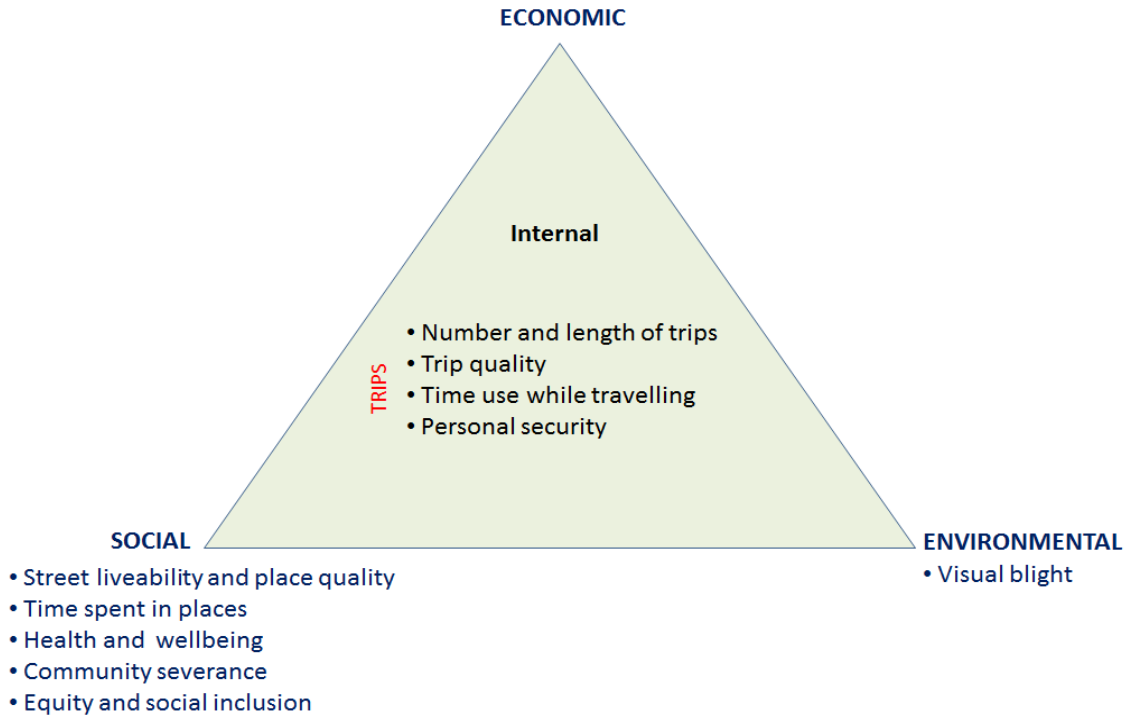

Figure 4: Indicators for Stage 3 (Planning for city life)

However, most of the Stage 3 indicators are related to the external social impacts of transport. As cities recognise the role of streets as places, they become concerned with street 'liveability',

the quality of public places and with the value of the time spent and the activities carried out in those places. Transport is also increasingly regarded as an enabler of wider social objectives such as health and wellbeing. There is also a concern about the potential negative role of transport infrastructure and motorised traffic as barriers separating communities and as factors reinforcing inequalities and social exclusion.

The set of external environmental indicators also expands to include more subjective aspects of transport that influence people's wellbeing and enjoyment of the city, such as the visual blight caused by transport infrastructure.

Stage 3 indicators and methods to measure them, are described in detail in Section 3 of this deliverable.

2.4 Measuring the impacts of transport policies

The indicators that public authorities use at each of the three Stages only partially take into account the policy concerns associated with that Stage. This is because appraisal methods are constrained and distorted by their origins. Also, in some cases, this is due to the lack of robust methods to assess those indicators and issues in applying methods developed by researchers into policy and practice or in transferring methods across cities or countries.

The scales used to measure the indicators are also varied. The indicators can be:

- Qualitative: described with words or expressed in an ordinal scale (e.g. “low”, “medium”, “high”);
- Numerical: expressed in an interval or ratio scale;
- Monetised: expressed in monetary units. The values can be positive (“benefits”) or negative (“costs”).

The appraisal of large transport schemes relies on economic techniques, such as cost-benefit analysis, that place a great emphasis on monetised impacts. This means that impacts that are expressed in qualitative scales or in numerical non-monetary scales (such as most of the social and environmental impacts) tend to be disregarded because within cost-benefit assessments, their implicit value "appears to be zero" (Pearce *et al.* 2006, p.31). For this reason, the tendency in many European countries has been to move towards the monetisation of transport impacts (Mackie and Worsley 2013, p.6).

The monetisation of the benefits of transport policies can also help to 'unlock' sources of funding for those policies, as it gives an estimate of the (social) returns on the investment made by the institutions that provide the funding. This is especially the case of Stage 3 policies, whose benefits are more intangible and widespread (in space and in time) than those of Stage 1 and 2.

Section 3 of this deliverable reviews the state of the art in the monetisation of the ten Stage 3 indicators mentioned above: number and length of trips, trip quality, time use while travelling, personal security, street liveability/place quality, time spent in places, health and wellbeing, community severance, equity/social exclusion and visual blight.

3. Stage 3 Indicators: In-depth study

The measurement and valuation of the Stage 3 indicators presented in Section 2 allows cities to better justify their policies and to unlock sources of financing and funding, by showing the benefits of the policies for the users of the transport system and the wider external benefits on the economy, society and environment.

This section addresses three questions regarding measurement and valuation methods, providing insights that are useful not only for the cities wishing to accelerate their progression towards Stage 3, but also to the EU and to international institutions that may provide the funding for the policies implemented by the cities to reach that Stage of the urban transport policy development process.

The three questions are as follows:

How are the Stage 3 impacts currently measured and valued in transport appraisal?
We look at methods included in 'official' manuals for transport appraisal, published by national transport authorities and at methods that have been used by cities or that are recommended in transport appraisal documentation produced by city governments.

How could they be measured and valued?
We look at methods proposed in the academic literature and in reports commissioned by national transport authorities and cities. In general, in recent years there were major advances in the development of three types of methods:

- Stated preference methods: Surveys asking respondents to choose among alternatives, defined by several attributes. Statistical models then calculate the trade-offs between unit changes in different attributes. If one of the attributes is expressed in monetary units, then it is possible to estimate "willingness to pay" for changes in other attributes. For example, it is possible to estimate the increase in council tax that people are willing to pay for a unit increase in a certain indicator of the quality of local streets;
- Revealed preference methods: These methods assume that the price of some market goods incorporate the value of several attributes. The implicit value of each attribute can be determined by statistical models relating price and the levels of those attributes. For example, we can estimate the impact on house prices of a unit increase in the quality of streets in the surrounding areas;
- Valuation of wider impacts: This involves linking a non-quantifiable impact with its wider consequences and then quantifying the monetary value of these consequences. For example, we can estimate the chain of relationships between improvement of streets, increased active travel and reduction of illness among local populations, then quantify the reduction of health care costs. These costs are understood as an indicator of the value of the health impact of improving the streets.

What are the main gaps or issues in using those methods?
We identify the indicators for which there are still no robust measurement and valuation methods and the major issues in the application of the existing methods in transport practice.

As shown in Table 1 below and described in more detail in the sections that follow, five of the Stage 3 indicators are already monetised in some cities and another three could be monetised, using existing methods available in the literature. It is still difficult to monetise the other two indicators.

Table 1: Monetisation of Stage 3 indicators: state of the art

	Already monetised	Could be monetised, using existing methods	Difficult to monetise with existing methods
Number/length of trips made			X
Trip quality	X		
Time use in transport			X
Personal security	X		
Street liveability/place quality	X		
Time spent in places	X		
Health and wellbeing	X		
Community severance		X	
Equity and social inclusion		X	
Visual blight		X	

3.1 Number and length of trips

Transport and other urban policies may result in changes in the number and length of trips that people make. The increase in number and length of trips may have utility for individuals, for example, if it reflects additional opportunities to visit friends more often or to travel further for recreation. But it may also have 'disutility', for example, if it is the result of the need to escort children to a new school site or travel further to a hospital. Similarly, the decrease in the number of trips and lengths may have utility for individuals, for example, if it is the result of an increased ability to work from home or to shop more locally; but it may also have 'disutility', if it reflects the removal of trip opportunities by cutbacks in public transport services.

How is this impact measured?
The measurement of the changes in the number of trips and in trip lengths is straightforward, using travel surveys before and after the policy intervention. The changes can be disaggregated by trip purpose and travel mode. Forecasting the impacts of policies on travel patterns is more complex. Changes in trip length reflecting generalised cost differences or land use changes can be reasonably well forecast, but changes in trip numbers (generation or suppression) is problematic, unless using simple elasticities (estimates of the % change in the number of trips associated with a 1% change in the generalised cost per trip) imported from previous studies.

How is this impact valued?
This is not currently addressed directly:

- New/generated trips: The increase in the number of trips resulting from a reduction in generalised cost from a transport improvement can be captured by the 'rule-of-a-half' (to approximate the net benefit of new trips as half of the net benefit of existing trips) (see Williams 1977). However, this method does not measure the total value of the new trips that are generated. Furthermore, it implicitly assumes that the extra trips represent a benefit.
- Reduced/suppressed trips are not currently valued. It is not clear if they would have a positive or negative value.
- Changes in trip length are only considered in aggregate, in terms of overall time saved or lost. It is assumed that time savings are a benefit and time losses (from longer trips) would be seen as a cost.

How could the impact be valued?
The impacts could be valued in terms of personal or community benefit:

a) New/generated trips
The personal benefit of new/generated trips could be approximated by the total (generalised) travel costs involved in making new trip, i.e. the total out-of-pocket costs, including travel plus all non-home activity.

The community benefit of new/generated trips could be expressed in terms of the unit impact of trips on economic activity, measured for example in terms of expenditure on local retail businesses (Meletiou *et al.* 2005, Schoner *et al.* 2012). As an example, Table 2 shows the expenditure associated with each cycling trip to a leisure area.

Table 2: Expenditures per bicycling visitor per day (from Meletiou et al. 2005)

Expense Category	Visitor Center Cyclist Expenditure ($/person/day)
Accommodations	72
Restaurants, fast food, bar	33
Groceries, beverages, snacks	21
Retail, shopping	21
Recreation, entertainment	20
Bicycle accessories, equipment	N/A
Car, fuel	8
Total	175

In the case of public transport, an additional measurement of the community benefit could be the impact of the availability of services on the output of workers who would not participate in the labour market otherwise (see for example Mackie *et al.* 2012 and KPMG 2017).

An alternative approach is to estimate associations between the availability of public transport and social capital. For example, the study of Utsunomiya (2016) used a regression model to relate social capital (measured by indices of trust, network and participation) with bus-km per capita. We can then apply estimates of the economic value of social capital - the paper of Westland and Adam (2010) reviews 65 previous studies that produced such estimates.

b) Suppressed/avoided trips
The personal benefit of suppressed trips could be measured by the value of travel time saved, as the new travel time is zero.

The community benefit could be measured as the value of the reduction in negative externalities (noise, air pollution) associated with those trips. There are several robust methods, used in practice, to estimate the values of those externalities (Maibach *et al.* 2007, CE Delft *et al.* 2011).

c) Changes in trip length
The value of changes in trip length could be measured as the value of the additional or reduced travel time.

What are the main issues in measuring and valuing this impact?
The main question that needs to be answered by the methods to measure and value this impact is whether the changes in travel patterns (trip numbers and length) are a benefit or a cost to the individual and the community.

3.2 Trip quality

Trip quality is the collective subjective experience for an individual of all attributes of trips other than cost and travel time. These attributes differ by travel mode (
Table 3).

Table 3: Trip attributes

Travel mode	Trip attributes
Public transport	Facilities at stations, quality of bus stops, information, overcrowding (Figure 55), comfort, in-vehicle amenities, cleanliness
Walking	Amenities (benches, street furniture), cleanliness, sights, pavement width and condition, facilities for the mobility-impaired, route legibility, obstructions
Cycling	Dedicated lanes, route conditions, parking facilities, cycle hire facilities, detours

Figure 5: Trip quality issues faced by public transport users

How is this impact measured?
In most cases, this impact is only assessed subjectively, with qualitative scales.

There are several audit tools to assess the quality of the walking and cycling environments, for example the Pedestrian/Cycling Environment Review System (PERS and CERS) (https://trlsoftware.co.uk/products/street_auditing) and Microscale Audit of Pedestrian Streetscapes (MAPS) (http://sallis.ucsd.edu/measure_maps.html). These tools rely on ratings completed by professionals, based on multiple attributes. The scores of each attribute are combined into an overall score. The assessments are inherently subjective and depend on the perceptions and biases of the assessors.

An alternative method is to use public attitude surveys to assess user perceptions and satisfaction with individual trip attributes and the overall trip experience.

How is this impact valued?
The value of trip quality is in some countries included in project appraisal as part of the "generalised travel cost". Changes in trip quality are converted into cost changes. The impact on travel demand and resulting change in consumer surplus can then be calculated using standard microeconomic techniques.

In the specific case of overcrowding in public transport, an overcrowding index can be used as a 'multiplier' of in-vehicle travel time. Reduction of overcrowding can then be converted into reduction of travel time and then into a reduction of the generalised travel cost, which once again, can be used to estimate change in travel demand and consumer surplus.

As an alternative, Transport for London uses an “Ambience Benefits Calculator” (not publicly available) which integrates the assessments of a large number of trip quality attributes, specific to each travel mode, combined with corresponding unit monetary values, imported from previous stated preference surveys.

How could the impact be valued?

Stated preference methods have been used to estimate the willingness to pay for attributes of pedestrian trips or for policies improving the overall pedestrian experience. For example, a study in the UK has estimated the willingness to pay for different road designs with different levels of priority given to pedestrians (shared space, full pedestrianisation and limited vehicle access) and for different road surfaces (Table 4).

Table 4: Willingness to pay for streetscape improvements (from ITS and Atkins 2011)

Attribute	Willingness-to-pay, £ per annum			
	Norwich (Base)	York	Otley	Horsforth
Priority: Shared Space	24	68	24	-40
Priority: Full Pedestrianisation	64	64	64	-174
Priority: Limited Vehicle Access	74	74	74	-58
Activity (high)	-30	31	-30	-30
Surface (material Hi; contrast Lo)	30	30	30	30
Surface (material Hi; contrast Hi)	21	21	21	21

Stated preference methods can also be applied to estimate the value of improvements to cycle trips. For example, the studies of Hopkinson and Wardman (1996), Tilahun *et al.* (2007) and Poorfakhraei and Rowangould (2015) estimated the willingness to pay for different types of improvements in cycle lanes (using attributes such as the cycle lane design, parking availability, lighting, travel time and cost).

What are the main issues in measuring and valuing this impact?

Users have different perceptions and preferences about trip quality. These depend on age, gender and spatial context (for example, city centre *vs.* suburbs, large *vs.* small city). It is not clear how to aggregate those perceptions and preferences across all users.

There may also be a 'package effect' in trip quality. Summing individual trip attribute values may over- or under-estimate the value of the total package.

There is also a risk of double-counting. For example, safety (from collisions with vehicles) is a major trip quality concern in walking and cycling trips, but this is already accounted for when assessing trip safety (a Stage 1 indicator, as mentioned in Section 2). Personal security is also a concern for walking, cycling and public transport trips, although it can be considered as a separate impact.

3.3 Time use while travelling

Travel time is currently regarded as a 'disutility' in transport appraisal, with the implication that all projects that reduce travel time generate a benefit for the users. However, this approach ignores 'productive' use of time while travelling. Some people may also enjoy the time they spend travelling. There is a growing acceptance of the idea that under some circumstances, travel time can be perceived as "a gift", not as a "burden" (Jain and Lyons 2008)and that even waiting time for public transport "is becoming fun" because some travellers enjoy 'infotainment' (Van Hagen *et al.* 2009). The idea that people can derive utility from travel time applies to most modes of urban transport:

- Pedestrians and cyclists may perceive travel time as an opportunity for exercise, thinking, or enjoying the scenery;
- Public transport users can use personal electronic devices for work, entertainment, or communication while travelling;
- Car users have fewer opportunities to spend travel time productively, especially in the case of car drivers. However, in the future, the use of autonomous vehicles will enable those opportunities.

How is this impact measured?

In principle, measurement of time use while travelling is straightforward. It is possible to use questionnaires to measure the minutes people spend engaging in specific activities. This method is easier to apply in the case of public transport users (Lyons *et al.* 2013, Van Hagen *et al.* 2017) but it has also been applied to study how car drivers user driving time for thinking (Burdett *et al.* 2017). The comparison of time use by users of different travel modes can also be useful for transport authorities planning city transport at the strategic level. For example, Figure 6 below shows the proportion of activities by main travel mode, calculated from a large-scale time use survey in Belgium.

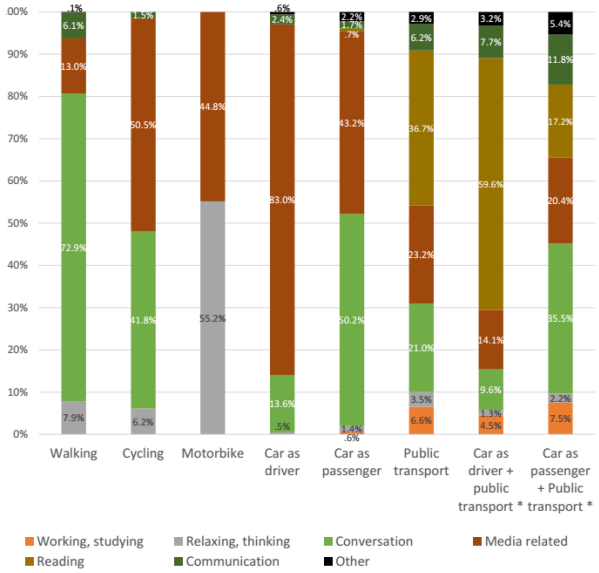

Figure 6: Proportion of activities by main travel mode (from Keseru et al. 2015)

In theory, in the case of public transport users, it may also be possible to record if personal electronic devices are being used and what type of activity is being carried out. In practice, the application of this method raises privacy issues.

How is this impact valued?
No efforts have been made to value time spent while travelling as a utility rather than as a 'disutility'.

How could the impact be valued?
It is possible to use stated preference methods to measure the trade-offs travellers make regarding time spent in different travel modes and the associated travel cost. For example, Kolarova *et al.* (2017) estimated how people would choose between public transport, self-driving, autonomous vehicles and driverless taxis, taking into account waiting time, in-vehicle time and cost.

Stated preference methods could also be used to estimate the trade-offs between uses of public transport travel time (using proxies such as the availability of Wi-Fi and sockets) and other trip attributes (such as fare, comfort and overcrowding).

More indirect approaches include:

- Estimate and then value the impacts of travel time use on productivity, learning, wellbeing and social interaction;
- Estimate the impact of travel time uses on choices over number of trips, travel mode and residence and employment location and then value the economic, social and environmental outcomes.

What are the main issues in measuring and valuing this impact?
The valuation of travel time use is currently hampered by the lack of standardisation of definitions of the activities that travellers engage with and by the fact that most of the available evidence comes from rich countries (Keseru and Macharis 2017).

It is also difficult to forecast public transport travel time use in the future, as it is difficult to anticipate the future possibilities for work and non-work activities that individuals can do while travelling, given the rapid technological advances in transport technology and personal electronic devices.

The assessment of the value of walking and cycling time is even more complex, as the activities are less tangible, involving thinking and looking at the surroundings.

There are also practical issues in the use of this indicator in cost-benefit analysis, as it opens the possibility of including travel time with both positive and negative values in the same framework. It is not clear whether these values are additive or compensatory, i.e. if the benefit of productive/enjoyable travel time could be subtracted from the cost of travel time.

Valuing time spent in transport also creates a dilemma for public policy: if public transport travel time has both a cost and a benefit, while car travel time only a cost, this implies a higher policy priority for reducing car travel time.

However, incorporating the value of public transport time in transport appraisal may have other advantages, as it highlights the benefits, for the individual, of using public transport, with possible effects on demand for this travel mode.

3.4 Personal security

In the context of urban transport, personal security is relevant in three different situations:

- When using public transport, including time spent travelling and time waiting at stations and bus stops;
- When using public spaces, such as streets and car parks. Transport infrastructure can also constrain the design of surrounding streets and public spaces, with detrimental effects on personal security (Figure 7);
- When using pedestrian infrastructure such as footbridges and underpasses.

This aspect is especially relevant at night-time, due to lower footfall and poorer visibility. Some groups are also particularly vulnerable, including women, children, older people, ethnic minorities and people working evening and night shifts.

Figure 7: Personal security issues in streets surrounding railway line

How is this impact measured?

In transport project appraisal, this impact is usually measured with qualitative scales. The assessment tends to be more comprehensive for public transport than for walking and cycling.

The assessment of personal security for public transport users is based on the attributes of stations, bus stops and vehicles. This includes lighting, formal surveillance (police or cameras), site layout (e.g. access and visibility between carriages) and facilities (e.g. control rooms, corner mirrors, customer alarms and emergency exits). The assessment of is either objective (for example, expressed as "yes" or "no") or subjective (for example, "area is dimly lit" *vs*. "area is brightly lit").

The assessment of personal security issues faced by pedestrians and cyclists is usually based on environmental variables (lighting and presence of litter, graffiti and fly-posting) and formal and informal surveillance (the latter being assessed by the number of people using the streets at different times of the day). Some of the audit tools for assessing the walking and cycling environment mentioned in Section 3.2 also ask auditors to rate their own overall "perceived sense of crime" and/or include items related to personal security, such as lighting.

How is this impact valued?

The potential effects of transport policies on personal security are usually not monetised as a separate impact. However, some of its aspects are assessed as part of "trip quality" impacts. This is for example the case of Transport for London's *Ambience Benefits Calculator* mentioned in Section 3.2, which takes into account a large number of personal security attributes for users of different travel modes. These attributes are classified using qualitative scales, which are combined with unit monetary values (depending on trip purpose). The source of these unit values is not clear.

How could the impact be valued?
Cities could use estimates coming from previous studies comparing the number of crime incidents before and after a policy intervention. The difference can then be multiplied by estimates of the financial cost per incident. This approach was used in the study of Painter and Farrington (2001) in two British cities. The study analysed the effects of improved street lighting on different types of crime and then combined the estimated crime reductions with unit values of the financial cost of those types of crime.

An alternative is to value policies that improve perceptions about personal security. For example, the study of Willis *et al.* (2005) used contingent valuation to estimate willingness to pay for improved street lighting. This consisted of a bid game in which respondents were asked whether they would pay successively higher amounts (as extra council tax) for the policy (Table 5). The problem with this approach is that it tends to generate many protest answers (people not willing to pay anything), which are usually excluded from the analysis.

Table 5: Percentage of respondents willing to pay for improved street lighting, by bid level and type of area (from Willis et al. 2005)

Bid level (£)	Sample ($N = 1214$)	Urban areas ($n = 420$)	Market towns ($n = 403$)	Villages ($n = 391$)
1	62.4	59.6	69.2	57.6
2.5	64.6	78.0	67.2	48.3
5	49.2	67.2	37.5	40.7
10	38.6	46.0	30.4	38.5
15	39.8	45.2	40.0	33.3
20	28.1	37.9	29.6	16.9
25	35.5	38.6	35.4	32.0

Another possibility is to use surveys to forecast the number of people who are currently dissuaded from using public transport (and do not make the trip at all) due to personal security issues and who would start using it if those issues were solved. The value of these extra trips could then be approximated by the additional fare revenue for the public transport operator, or by using the methods suggested to value new trips, described in Section 2. It may also be possible to forecast the impact of improving personal security in stations on the total customer expenditure in the shops in and around the stations.

What are the main issues in measuring and valuing this impact?
While it is relatively easy to monetise reduced crime rates, it is difficult to estimate the reduction of crime linked to specific policies. In addition, the reduction of number of crime incidents does not necessarily imply a reduction in fear of crime.

In general, the methods available in the literature to monetise personal security issues are more suitable for project evaluation ("what was the impact of policies on crime incidents/fear of crime"?) than for appraisal ("what is the anticipated impact...?"), because the transfer of values obtained in one context to other contexts tends to be problematic.

3.5 Street liveability and place quality

Streets are not only links for movement but also places used by travellers, local residents and workers and visitors (Figure 8). Stations are also places where people spend time, while waiting for trains. The public areas inside station buildings and the public squares outside stations are also increasingly used by non-travellers for shopping and leisure.

Figure 8: Street used as a 'place'

The improvement of the quality of public places has wide benefits in terms of local economic development, urban vitality, promotion of physical activity, mitigation of population exposure to air pollution and noise, social interaction and reduction of crime and vandalism. It is also linked with more intangible benefits, such as enhancing individual wellbeing, local pride, consensus within communities, neighbourhood participation and social cohesion.

However, there are potential conflicts between the "movement" and "place" functions of streets. For example, there is a large amount of evidence that high levels of motorised traffic lead to a loss of 'sense of place' and social activity (Gehl 2010).

How is this impact measured?
The quality of public places can be measured using public attitude surveys covering aspects such as perception of different elements of those places, levels of satisfaction with current state of the places and priorities for improvement.

The quality of public spaces can also be measured by the number and diversity of users and activities. The Gehl Institute (2016) has published a toolkit suggesting metrics obtained by observation or surveys, such as age and gender split, the number of people who have spoken to a person outside of their social group, people who recognise familiar strangers and number of photos of the place posted on online social network.

The audit tools to assess the quality of the walking and cycling environment mentioned in Section 3.2 often cover public spaces along walking routes and public transport waiting areas. The assessment is based on qualitative scales and includes attributes related to facilities, opportunities for activities, accessibility, legibility, maintenance and cleanliness, along with more subjective elements such as "sense of place" and perceived personal security.

How is this impact valued?
Property developers often use metrics such as forecasts of footfall, customer expenditure and impact on property values to inform plans to develop new areas. Some cities, such as Copenhagen, have also used these indicators.

Transport for London has also developed a 'Valuing Urban Realm Toolkit' (not publicly available) to estimate the value of improvements to public places based on user benefit and on changes in housing and retail property market prices.

How could the impact be valued?
Studies commissioned by transport authorities have used stated preference studies to estimate the value of public places. For example, studies for Transport for London (Sheldon *et al.* 2007) (Figure) and the UK Department for Environment, Food and Rural Affairs (DEFTRA 2013) estimated the willingness to pay for improvements in various components of a place, such as surfaces, lighting, benches, trees, litter, graffiti, odour and even more detailed elements such as chewing gum and dog fouling.

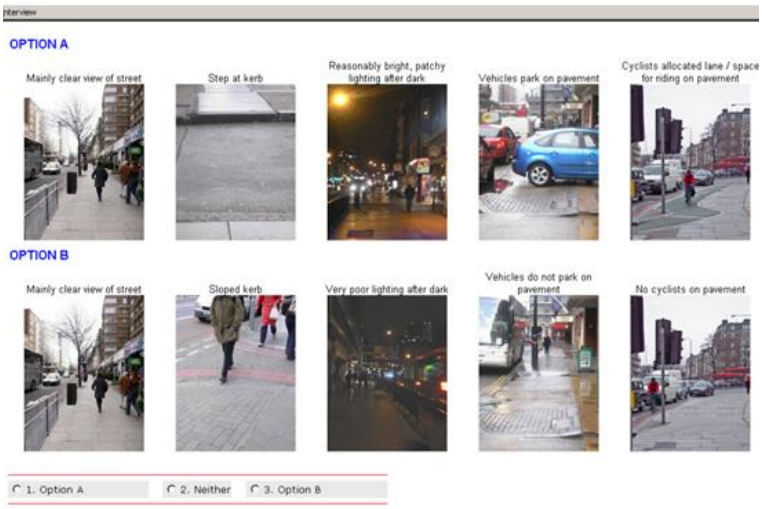

Figure 9: Question in stated preference study about attributes of public places (from Sheldon et al. 2007).

Several studies have also valued the economic outcomes of improvement of public places, using metrics such as property values, private investment, new businesses and retail sales (CABE 2007, SDG 2011, NCSC 2015, Centre for London 2017).

It is also possible to estimate the outcomes of improvements to places, such as community cohesion (Semenza *et al.* 2007) and individual wellbeing (Brown *et al.* 2009) and then value those outcomes. However, it is more difficult to apply this approach to value outcomes such as inclusion and diversity.

What are the main issues in measuring and valuing this impact?
Stated and revealed preferences methods have some limitations, as the overall value of places is probably bigger than the sum of its components captured by those methods.

It is also difficult to capture the full scope of benefits linked to good quality places. These benefits are widespread, since places are used by both regular and sporadic users. In addition, the improvement of several places may change the overall perception people have of the city.

On the other hand, the benefits of good quality places for its users may be perceived as costs for local residents. Centres of night-time activity are a typical example.

The value of places also depends on how these places are used and by whom, which is difficult to forecast.

3.6 Time spent in places

Public spaces used for transport, such as streets and areas in or around public transport nodes, have several uses involving people spending time (for example, for exercise, social interactions and relaxing). Individuals attach utility to spending this time. Cities in Stage 3 of the urban transport policy development process are interested in increasing that utility, by creating opportunities for more people to spend time in public spaces and for people who already use those spaces to spend more time in them. This indicator differs from the previous one (street liveability and quality of places) as it is related directly to the benefits of the activities in places and not to the benefits simply deriving from the existence of good quality places.

How is this impact measured?

There is a long history of research involving observations of how people spend time in public spaces ("also known as "dwell time"), since the studies of Jan Gehl in Copenhagen (Gehl 1971) and William Whyte in New York (Whyte 1980, see also https://archive.org/details/thesociallifeofsmallurbanspaces). This involves recording the number of minutes spent by people doing different activities in different types of places, or before and after a policy intervention. These studies are also done by property developers, who are interested in forecasting the dwell time in the public spaces in planned developments.

This type of information can then be synthesised in a single index. For example, in a study in Boston, Mehta (2009) calculated a "liveliness index" that combined the observed number of people engaged in stationary activities and in social activities with the duration of the activity.

Alternatively, the time spent in public places can also be measured using diary surveys asking people for reported time use (during a day or a week), which will include time spent in public places.

It is also possible to record real-time data of proxy variables for time spent in places, such as the number of (geotagged) posts in social media. As an example, Figure shows the daily number of posts from a public space. This analysis can also be made by time of day and segmented by individual, deriving indicators of the time people spent in that place.

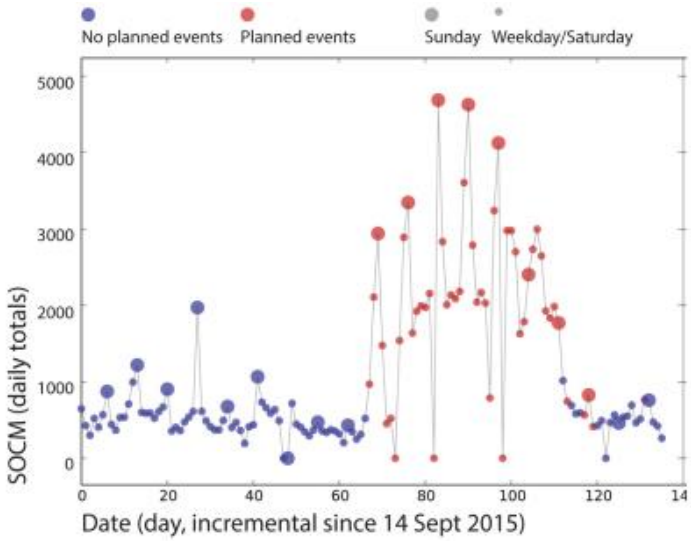

Figure 10: Number of daily social media posts (SOCM) from a public space (from Cheliotis 2016).

How is this impact valued?

This impact is valued by property developers (but seldom by city authorities), by forecasting the impact on retail expenditure of increases in dwell time in public spaces.

How could the impact be valued?
It is relatively easy to make before-and-after comparisons of time people spend in public places, following a temporary or permanent policy intervention. If the time is spent in physical activity, then it is possible to monetise the benefits of increased physical activity (using the methods described in 3.7). For example, D'Haese *et al.* (2015) compared the time spent by children playing in "play streets" closed to car traffic during school holidays and the time spent by children living in other areas. The difference can then be monetised (not done in that study).

The economic cost or the market price of goods and services consumed while spending time in a place can also be used as a proxy for the value of time. This could be for example:

- The per-hour cost of providing services in public places, such as rents of market stalls;
- The per-hour price of facilities enabling certain activities, for example, the price of using park deck chairs and outdoor sports areas;
- Differences between prices of comparable products; for example, food and drinks from a take-away and from a shop with seating area.

Stated preference surveys can also be used to estimate the trade-offs people make between time spent in places and the price of goods and services consumed while spending that time. Another possibility is to estimate the trade-offs between extra time spent in places and extra time spent working (which is associated with extra income).

What are the main issues in measuring and valuing this impact?
It is difficult to forecast how much time people will spend in public places after policy interventions that created a new place or improved the quality of a place. This is because the time spent in places is site-specific and it depends on a large number of determinants, such as people's mobility patterns, the local political and economic context at different times, perceptions of some groups about other groups using the same space, historical, cultural, and social aspects and how the spaces are used in the first few weeks after the intervention.

The values also depend on the type of activities people carry out in public places. This is particularly relevant because urban designers agree that good quality places have a variety of uses. Each of these uses has a different per-minute value. Measuring and aggregating all these values is a complex task.

In addition, the value is likely to be derived from having the activity (vs. not having), or from its regularity and cannot simply be reduced to a "value per minute".

Despite methodological advances, the value of time spent in some activities will remain very hard to measure, for example time chatting with neighbourhoods.

3.7 Health and wellbeing

There are several pathways linking transport with health and wellbeing:

- Walking and cycling are physical activities that promote health;
- Walking and cycling also promote social interaction, which tends to be positively associated with mental and physical health;
- Motorised transport has several negative environmental impacts, such as noise, air pollution and water pollution, which are linked to several health issues;
- Transport also has an impact on stress and mental health, associated for example with travelling in congested and overcrowded conditions, annoyance from exposure to noise, or fear of crossing busy roads.

Changes in health and wellbeing also have wider impacts on short or long-term absence from work, productivity, health care costs and mortality risk.

How is this impact measured?

The impacts of transport on health and wellbeing can be captured using surveys to people affected by different levels of those impacts. These surveys often use standardised questionnaires about physical, emotional and social functioning, bodily pain, vitality and mental health. This approach has been used to study the impacts of living close to busy roads (Yamazaki *et al.* 2005, Gundersen *et al.* 2013) and being exposed to roadside noise (Dratva *et al.* 2010, Oiamo *et al.* 2015).

There is an increased recognition that the health impacts of transport are multidimensional and related to different aspects of the physical, built and social environment. For example, Transport for London has recently introduced the concept of "Healthy Streets", which defines a broad concept of health, measured by 10 indicators (Figure 1).

Figure 11: 'Healthy Streets' indicators (from TfL 2017)

How is this impact valued?

The value of impacts of transport projects on physical activity is included in transport appraisal manuals in several countries. Many use the World Health Organisation's HEAT tool (Health Economic Assessment tool, *WHO 2017,* http://www.heatwalkingcycling.org). This tool calculates the reduced risk of death that results from more regular physical activity and reduced road crashes and air pollution. The result is then multiplied by the unit monetary value of a prevented fatality. This value is based on estimates of individuals' willingness to pay for

policies that reduce their annual risk of dying. The tool also estimates the value of reduced carbon emissions due to shifts from motorised to non-motorised travel modes.

An alternative is to estimate the consequences of changes in health condition on other spheres and value those consequences. An often-used metrics is the financial cost of illness (to the National Health Service). It is also possible to estimate the value of health impacts on work absenteeism (multiplying the number of hours of absence from work by the salary). Transport for London uses this approach in the Sickness Absence Reduction Tool (not publicly available) to estimate the impacts of transport policies on sickness absence.

The value of health impacts of noise and air pollution caused by motorised traffic are used in most countries as indicators of the overall cost of those two impacts and integrated into the calculation of the local environmental cost of transport policies.

There are few methods to estimate health impacts of transport other than physical activity and noise/air pollution. The impacts of transport on mental health and subjective wellbeing are particularly hard to quantify. For example, it is difficult to isolate impacts of transport policies on aspects such as commuting stress, or the psychological effects of living close to busy roads.

How could the impact be valued?
Impacts of transport on mental health and subjective wellbeing could be linked with medical costs.

Alternatively, those impacts could be linked with individual employment status or absence from work, or with social outcomes such as community participation and social cohesion. These outcomes could then be valued.

What are the main issues in measuring and valuing this impact?
In general, it is difficult to build a robust “dose-response function” that isolates the link between roads and health and wellbeing.

It is also difficult to forecast the impacts of policy interventions. The existing techniques tend to be more suitable for evaluation than for appraisal.

There are also issues in the integration of health impacts on the cost-benefit analysis of transport projects, as in theory, increases in walking time can be accounted simultaneously as a health benefit and as a travel time cost.

3.8 Community severance

Community severance is the effect of large transport infrastructure (such as roads and railways) or high motorised traffic volumes and speeds as a physical and psychological barrier limiting the mobility of pedestrians and cyclists and separating communities (Figure).

Figure 12: Example of community severance caused by a large urban road

Severance is linked to wider negative impacts. At the individual level, there is a reduction on levels of accessibility to goods, services and opportunities such as employment, education, health care and leisure. The suppression of walking and cycling trips may also contribute to lower levels of physical activity. In both cases, there is a potential negative impact on health and wellbeing. At the community level, the reduction of walking accessibility affects social outcomes (such as social interaction, social cohesion and segregation) and economic outcomes (such as employment and consumption patterns).

How is this impact measured?
Severance is either not assessed at all or assessed using qualitative scales. For example, in the UK, severance impacts caused by roads are classified as "slight", "moderate", or "severe", based on a large set of information about traffic volumes, types of road, crossing facilities, changes in walking trip lengths, number of people affected and temporal variations.

How is this impact valued?
Severance is only monetised in a small number of countries (e.g. Germany, Italy and Australia). The monetisation in these countries uses a simple formula multiplying time losses for pedestrians by the unit value of time for personal trips.

How could the impact be valued?
The Street Mobility project at University College London developed a toolkit to measure community severance (Mindell *et al.* 2017), including a tool to value policy interventions that mitigate severance (Anciaes and Jones 2017). The tool uses the results of stated preference studies to calculate a severance index based on characteristics of the road design, traffic volumes and speeds and provision of crossing facilities (Figure). An estimated statistical relationship between the severance index and monetary values can then be used to convert reductions in the index into willingness to pay.

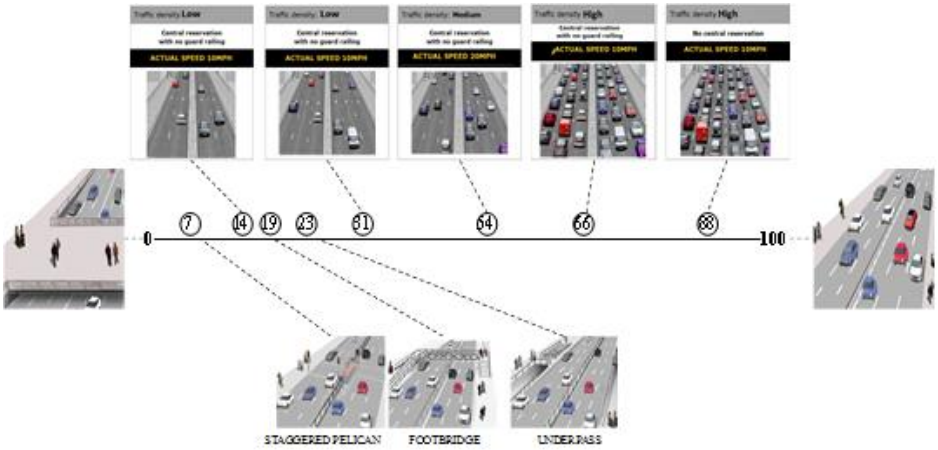

Figure 13: Examples of severance indices assigned to different types of road and crossing facilities (from Anciaes and Jones 2017)

Stated preference models have also been use to estimate the impact of radical policies to remove (rather than mitigate) severance. For example, Grisolía *et al.* (2015) estimated the willingness to pay (as additional council tax) to bury a busy road, with different alternatives for the amenities placed on the release land (also generating values of place quality – a method that complements those presented in Section 3.5).

Revealed preference methods have also been used in several academic studies. For example, Kang and Cervero (2009) and Lee and Sohn (2014) estimated the impact of projects to bury roads and railways on house prices and Kawamura and Mahajan (2005) estimated the associations between motorised traffic volumes and house prices.

The cost of severance can also be estimated by accounting its wider impacts. For example, we can forecast the effects of severance on the number of suppressed walking trips and then monetise the resulting health impacts (Saelensminde 2004).

What are the main issues in measuring and valuing this impact?
There are some conceptual issues in the measurement of community severance, as this impact might be regarded by some of the affected people as a benefit, not a cost. In fact, it is possible that transport infrastructure defines borders separating different communities that do not wish to be connected.

In practice, it is difficult to estimate the impact of barriers on the number of walking trips, as it depends on trip purpose and spatial context (“is there anything on the other side?”)

Existing methods to measure severance capture a ‘snapshot’ of the impact but it is likely that the perception of the impact change over time, as people and land uses adapt to the presence of infrastructure or traffic.

Finally, there is still little evidence on severance to cyclists and on the magnitude and value of “absolute” barriers (i.e. transport infrastructure that can only be crossed in a limited number of places, such as motorways and railways).

3.9 Equity and social inclusion

Equity issues arise because the positive and negative impacts of urban transport policies are not equally distributed among different age, socio-economic and ethnic groups. There is extensive evidence that lower income groups and ethnic minorities tend to be disproportionately exposed to noise and air pollution caused by motorised vehicles. In some cities, those groups also tend to live in areas with lower provision of public transport.

The concept of 'transport poverty' has gained prominence in policy and research in recent years and it describes the geographic, economic, social, or cultural issues restricting access to transport. Lack of access to transport reduces people's accessibility to employment, education, healthcare and recreation, increasing the risk of social exclusion.

There is also a growing consensus that transport policies need to attend to the specific mobility needs of vulnerable groups, for example, by ensuring physical accessibility to the elderly and people with disabilities and promoting the independent mobility of children.

How is this impact measured?
Distributive concerns in transport policies are addressed in some countries (e.g. UK, USA) by disaggregating impacts according to age and social groups (Figure).

Social group and amenities indicators			User Benefits	Noise	Air quality	Accidents	Security	Severance	Accessibility	Affordability	Local Authority	England
Resident population in the impact area	Income distribution quintiles	0-20%	26%	15%	18%					26%	23%	20%
		20-40%	14%	32%	32%					14%	12%	20%
		40-60%	35%	21%	18%					35%	20%	20%
		60-80%	17%	19%	11%					17%	16%	20%
		80-100%	8%	13%	21%					8%	29%	20%
	Children (<16)			6%	12%	10%	24%	9%	16%		18%	21%
	Young people			14%	16%	9%			13%		16%	12%
	Older people					16%	14%	15%	19%		19%	14%
	People with a disability					4%	5%	3%	4%		6%	4%
	Black Minority Ethnic								8%		8%	8%
	No car households							21%	16%		29%	25%
	Households with dependent children								19%		31%	28%
	Indicator population in the impact area		10,000	1,000	3,000	5,000	500	750	15,000	10,000	2,700,000	60,000,000

Figure 14: Example of output of distributional impact appraisal (from DfT 2014)

Another possible metrics of equity is the impact of policies on the relative performance of different travel modes. For example, studies have levels of accessibility (Kwok and Yeah 2004) and commuting time (Kawabata and Shen 2007) of people using different modes within an urban area

The impacts on social inclusion are only partly addressed. For example, impacts on accessibility and affordability of transport services are included in transport appraisal manuals of several countries (although they are only assessed qualitatively). Other aspects, such as social and cultural barriers, tend to be ignored, or addressed in general, descriptive terms.

How is this impact valued?
Equity is not currently valued explicitly in transport appraisal, but is sometimes indirectly addressed by:

- Using 'equity values' rather than actual values. These are often used in the assessment of the values of travel time savings. Equity values are the same for all travellers, regardless of age and income. This approach is currently used in Denmark;

- Weighting values by an index of relative disposable income, to mitigate the impact of income on willingness to pay (Pearce *et al.* 2006, Ch.15).

How could the impact be valued?
Stanley *et al.* (2012) proposed a method to estimate the value of additional trips in reducing social exclusion. The authors estimated a model explaining social exclusion with a set of variables that included income and the number of trips. The value of an additional trip was then estimated as the ratio between the co-efficient of the number of trips and income.

Social exclusion can also be valued by monetising its wider impacts on poverty, unemployment, tax contributions and welfare.

Methods other than cost-benefit analysis could also be used to account for trade-offs in equity and other policy objectives. For example, Thomopoulos *et al.* (2009) proposed a multi-criteria method balancing different priorities regarding equity.

What are the main issues in measuring and valuing this impact?
Equity is a political and ethical issue which is not easy to translate into quantitative indicators. The first question is to define the relevant social groups in the assessment of each impact, which is linked to judgements about the assignment of group rights to certain goods, such as mobility or environmental quality. There are also alternative views regarding the desirable equity goal: equalise benefits and costs, equalise across groups, provide minimum standards to all, or give higher priority to vulnerable groups?

In the medium and long term, residence location cannot be treated as a fixed variable, leading to uncertainty regarding which groups will have the benefits and costs of transport policies. For example, due to gentrification, current residents may be displaced by the market or by redevelopment policies and replaced by wealthier residents in areas where transport and place quality has improved.

Finally, it is not always possible to identify impacts on different income groups. This is mainly because data on income is not collected or the datasets have many missing values, as many people feel uncomfortable stating their income.

3.10 Visual blight

Large transport infrastructure intrudes on the visual field of pedestrians and people at home and is often perceived as aesthetically unpleasant, interfering with people's enjoyment of the city (Figure 5). This impact can be caused by elevated roads and railways, large road intersections and roundabouts, depots and railway junctions, ports, airports, pedestrian infrastructure (such as footbridges) and elements of the road infrastructure such as signs and billboards. "Ugly" places may also decrease perceived personal security and incite crime and vandalism. The sight of high volumes of motorised traffic, especially large vehicles, may also increase feelings of fear and intimidation. Transport also generates light pollution due to the intrusion of car headlights or streetlights on people's homes and the impact of glare from vehicles on pedestrians.

All these visual impacts may have wider consequences on wellbeing and neighbourhood satisfaction.

Figure 15: Example of visual blight caused by overhead roads and pedestrian footbridges

How is this impact measured?
The assessment of major road projects is normally done using "visibility analysis" based on the calculation of "viewsheds" (the area of land that is visible from a location) and indicators of exposure such as proximity, number of people affected and duration. In most cases, the focus is the impacts of the surrounding visual environment on road users, not the impacts of the road itself on people using the surrounding areas (see for example US DOT 2015).

In transport project appraisal manuals, some countries (such as Germany and USA) look in more detail into the impacts of transport projects on areas with natural or historical interest, using qualitative assessments which are then translated into scores used in multi-criteria analysis. Other countries (for example, the UK and Switzerland) use qualitative scales only.

Audit tools to assess pedestrian environment using qualitative scales (such as those mentioned in Section 3.2) can be used to assess visual impacts of infrastructure on pedestrians, as they include several visual attributes of the street environment (such as sightlines, lighting, colour contrast, general visual appeal of the street, quality of building facades and street landscaping and presence of graffiti). Other tools, such as the "Measuring Urban Street Design" framework (Ewing and Clemente 2013) focus on how people feel in public spaces, based on subjective aspects related to the visual experience, such as "imageability", "enclosure" and (adequacy to) "human scale".

How is this impact valued?
There are currently no methods to derive monetary valuations of the visual impact of transport infrastructure. Even exhaustive studies of roads' social and environmental impacts did not attempt valuing these impacts as they are "very difficult to measure and no reliable estimates are available" (CE Delft *et al.* 2011, p.68).

How could the impact be valued?
Some studies have used stated preference methods to estimate the value of removing the visual impacts of large transport infrastructure by building tunnels. For example, Chang *et al.* (2014) found that 25% of the benefit of a railway tunnel could be directly explained by the reduction in visual intrusion. Maddison and Mourato (2001) also used a stated preference survey to estimate the benefit of a tunnel to remove the negative impact of a road near a historical site.

There is also scope for the application of revealed preference methods. For example, the study of Bateman *et al.* (2001) found a significant negative association between property prices and the impact of roads on viewsheds from the properties.

Some studies have used surveys to measure the influence of the sight of roads from one's home on wellbeing and neighbourhood satisfaction (Kaplan 2001, Bayley *et al.* 2004). These two outcomes can then be valued.

What are the main issues in measuring and valuing this impact?
Visual impacts are particularly difficult to quantify and monetise because they are subjective and depend on personal opinions about aesthetics.

There are also problems in transferring values obtained in one site to the appraisal of projects in other sites, because the impacts are highly site-specific.

As with community severance, it is also possible that the perception of the impact changes over time, as people adapt to their visual environment, by changing destinations and walking routes, or by reducing the amount of time they spend in the parts of their homes where the transport infrastructure is visible.

3.11 Synthesis and overall issues

As shown in Table 1 at the beginning of Section 3 and in the detailed description of the Stage 3 indicators, five of the indicators (trip quality, personal security, street liveability/place quality, time spent in places and health/wellbeing) are already monetised. These are therefore the indicators that are easier, or more likely, to be applied in Stage 1 and Stage 2 cities wishing to accelerate to reach Stage 3 of the urban transport policy development process.

For example, the HEAT tool can be used for an appraisal of cycling infrastructure with relatively little data required. As such this is a good starting point for a Stage 1 city to “test the water” with local and regional funding authorities, to see whether the economic benefit of improved health through physical activity resonates with the health sector.

It should be noted that only some of the indicators presented in the previous sections are currently monitored by Stage 3 cities. Even some of the indicators identified as “currently monetised”, which are often included in assessments done by the private sector (especially property developers), are not always included in transport appraisal done by city authorities. This shows that there is still scope for cities to improve their forecasting of the impacts of Stage 3 policies and to illustrate the benefits of those policies, which can help to open up new funding sources.

The main pitfall in the monetisation of these indicators is double counting, because, as shown in Figure , all the Stage 3 indicators are interrelated. For example, street liveability/place quality depends on the visual quality of places, influences the time spent in places and feelings of personal security and promotes equity and social inclusion. There is therefore a need for a framework that separates the role of the different indicators in project appraisal, to ensure that the estimated value of an impact is not duplicating the value already accounted for by a related impact. A possible solution could be to develop a hierarchy, classifying the effects of transport policies into different levels (for example: 'outputs', 'outcomes ‘and 'impacts').

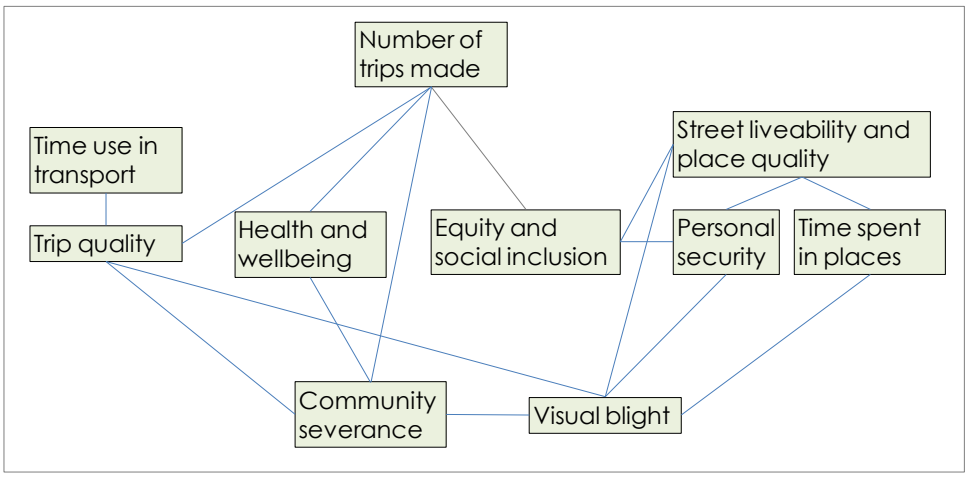

Figure 16: Relationship between different Stage 3 indicators

Stage 3 policies also consider a wide range of interactions between transport modes and social and environmental outcomes. As such, the monetisation of Stage 3 tends to require extensive data collection, which is complex and expensive.

This is compounded by the fact that most of the indicators are multidimensional (as it is obvious from
Table 3, Figure , Figure , Figure 3 and Figure 4). A full assessment of the impact of policies on those indicators would require forecasting changes on a large set of variables or using stated or revealed preference methods with a large number of attributes.

It is also likely that Stage 3 impacts are experienced in different ways by different people, as they capture the qualitative aspects of travelling and the effects of transport on society. This raises questions for the aggregation of the measurements and monetary values of those impacts across society. As mentioned in the cases of street liveability and community severance, some aspects are regarded as a benefit for some groups and as a cost for others. In addition, there is uncertainty in the forecast of future impacts. People's perceptions change over time, especially regarding subjective impacts such as community severance and the visual blight of transport infrastructure.

Cities also need to identify the 'correct' spatial and temporal scale over which to measure the benefits of Stage 3 policies. Policies such as the improvement of trip quality and public places generate benefit not only for the local residents but also for people who only use the city's transport system and public spaces sporadically, or visitors from other cities. Due to changes in residence location and travel mode, the benefits of policies improving trip quality and public places may also accrue to different groups than the ones targeted by the policies.

4. How decisions and priorities on transport investments are made: Stories and insights from the Stage 3 Cities

Facilitated discussions were held between Vectos and city representatives to gain insight into which funding and financing sources are used to invest in a variety of transport and mobility services in the cities. Equally, insight is derived on the way in which decisions are made on prioritising such investments. Findings offer Stage 1 and 2 cities with pathways to follow to help accelerate their progress along the CREATE evolutionary cycle.

The transcripts of the conference calls have provided the 'raw' material which is presented in this Section.

4.1 Berlin

To understand the context of Berlin it is first necessary to look back over the unique historical context of the city as this had significantly influenced mobility development for many years. In particular, prior to reunification, Berlin was actually two cities with very differing approaches which meant that looking back over an extended period was often not possible. The CREATE technical report 4.2 provides a full analysis of this period in Berlin's history.

However, the modern and most relevant development period was from 2000, or just before, when the Master Plan was first developed and published. The Master Plan is a wide ranging document that covers all modes and spatial connections and provided a fully scoped Master Plan for all of the Berlin area, including how Berlin connected to the rest of Germany, Europe and indeed the rest of the world.

Although the main focus of the Master Plan was vision and sustainability targets, it did take account of the high level budget forecast for transport. However, the detail and the final budget provision is determined by a separate exercise conducted through the political approval process.

Post reunification Berlin was considered to be one of the poorer states in Germany but over the past 5 years or so the population of Berlin has grown significantly and the city has become wealthier and more self-sufficient, mainly through increasing tax revenues, thereby creating greater scope for sustainability projects.

Funding itself is a complex mix of federal and regional (Lander states) taxes depending on the type of development and location albeit regional funding provided the majority of financing for sustainability projects. For example, walking and cycling was the responsibility of regional funding but if it connected with a street owned by the federal government then they would pay for the upkeep.

The general income tax system operates at both the federal and regional. Taxes raised at the regional level stay within the region distributed by its government process. However, it was effectively a competitive process as all sectors of local expenditure competed for funding. This process included the annual 'big' negotiation which resulted in the final budget for operating the Berlin transport system, including delivery of sustainability projects.

In summary, Berlin operated within a federal government system with its own party political system.

This system distributed funds to the various government responsibilities that ultimately resulted in a spending forecast and functional budgets. The regional government had the ability to raise financing through borrowing although it did this as a 'total borrowing requirement', hence it is not possible to say that any particular measure was financed in a specific way.

Looking historically, prior to reunification money was invested in West Berlin to 'showcase' the benefits of western capitalism. This is why West Berlin was able to largely extend the metro network between the 60s and 80s. However, reunification funding is now all but finished and the 'regular' funding process described above is the norm.

Indeed, the population growth referred to above has led to not only greater demand for sustainable transport projects, it has also provided the funding such that the amount of money that is available for sustainable mobility has grown considerably and continues to do so.

Also, another significant area of change is how Berlin now positively encourages stakeholder engagement. Regular round-table sessions are held with a wide range of stakeholders to discuss ideas for transport development and try to negotiate a common vision for how it should look over the next 15 years.

As a secondary part of this process stakeholders try to reach consensus on which measures could lead to realising that vision because when agreement is reached the local parliament is much more amenable to providing the necessary budgets.

For the SUMP there is a formal round table, joined by all of the different transport representatives of local parties in the parliament, chamber of commerce, surrounding regions and also lobby groups, including for cars and cyclist. In total, some fifty key stakeholders are part of the SUMP process. This forum also discusses which measures are likely to be the priorities over the next 15 years and considers accountability and budget responsibility.

There is a SUMP meeting annually, where the whole SUMP is reviewed, with major updates occurring every 5 or 6 years. Part of the monitoring of the SUMP includes making decisions on prioritisation or deferment and discussions on new measures that are being implemented but not on the previous agenda.

4.2 Copenhagen

There are essentially two ways to secure public funding for projects:

- Yearly budget discussions with local politicians – once per year they decide how to use the available funds, not just for transport but for all areas of spending and the municipality will put forward proposals for specific funding requests;
- The city administration has its own sources of direct funding and budgets and this is another opportunity to ask the authority to prioritise transport projects although, as in 1) above, there is always competition for otherwise finite resource.

Although this is relatively straight forward in principle, the reality is different. In practice it is a complex system of political approval whereby budget users compete for funding. Funding can be as short as just one year although it is usual to attempt to secure budgets for 2 or 3 years. Large scale construction projects will sometimes last for a longer period. Maintenance and the daily operation of road, parks, signals etc. is part of a long term operating budget.

Local city taxes are the main source of most of the budget funding, including various incomes streams e.g. parking revenue and also from property taxes. Very little is secured from central government sources.

Project prioritisation is also based on a complex set of arrangements but essentially it all stems from an overall vision from which various strategies are derived and this in turn gives rise to prioritised action plans. Also, there are various factors that influence how the visions and plans evolve; politicians are sensitive to developments in society, citizen's changing priorities for example.

Therefore the action plan system is flexible enough to respond to demands from citizens and politicians. However, there isn't always unanimity and sometimes this doesn't work as politicians can disagree with proposals.

The Copenhagen metro uses a complex combination of local and national funding sources. The metro company is owned by City of Copenhagen (50 %), City of Frederiksberg and the State at the Ministry of Transport. The land closest to metro line / stations is owned by company called By&Havn (municipality (95%) and government-owned) which raises funding through the increase in value of land / property they own.

Whereas, all rail infrastructure is nationally owned and therefore entirely centrally funded.

There are also rules for developers to pay for infrastructure close to the buildings they develop and special deals are made on a case by case basis to unlock this investment. .

There are other funding sources that include:

- National funding – provides partial payments (co-funding) for projects e.g. for cycle super highways;
- Private funding –becoming more and more important for when building bigger schemes bridges / big urban realm. Funds made available by companies eg A.P.Møllers Fond (money comes from the MAERSK Company) paid for Opera House and Harbour cycling and walking bridge, via a charitable fund;
- 20% of funding to cycle infrastructure, in the last few years, has come from private sector sources – due to co-funding of three bridges for cyclists and pedestrians.

Despite the complexity there are examples of where the funding process has been simplified. Instead of applying for funding for individual bike lanes in an ad hoc process, now the Bicycle Secretariat applies for 'cycle funding packages' and this has improved delivery significantly.

Public transport is also a complex matrix of ownership and funding. In the past there was one regional company but this changed about 10 years ago such that now there are lots of owners meaning it is now a more complex situation although on the positive side the more sustainable modes are more likely to be funded.

In another significant improvement the municipality is now much better at measuring the effects of actions and quantifying the impacts. This is good for everyone to see or challenge and to determine if the strategy is going in the 'right' direction i.e. the vision and action plans are checked back to the outputs to correlate the desired results are being achieved.

In terms of stakeholders the City and the Region are the key stakeholders, as are citizens because they influence the politicians. But it is otherwise a multi-level matrix of key influencers

that operates both top-down and bottom-up. For example, small innovative companies – start-ups – with creative ideas like new types of bike and car sharing schemes can use this process using the bottom up approach. This is good because it gives citizens access to truly influence the outcome and not everything has to come from the local or national government.

Another example is a new one-way car sharing scheme which is a private initiative with Regional support but it did not require any special permissions or contract. 'Drive Now' are allowed to come into the city, no special contract is required and they are just treated as normal private cars and can park the same as any other citizen which obviously facilitates rapid implementation.

4.3 London

London's transport policy rotates in cycle with Mayoral elections and therefore a new Master Plan is usually developed or published when there is a new Mayor (if the same Mayor is re-elected they may, or may not, choose to update the plan).

Prioritisation in London is a fusion of political direction from the Mayor and professional guidance from TfL. Notwithstanding any personal agenda, the Mayor must operate, at least politically, within the context of national transport policy which then ensures a high level of cross regional consistency.

The Mayor has considerable devolved powers across the entire brief but transport is a major part of the 'job' and where the Mayor holds most power to make most change. Strategic direction and prioritisation is therefore essentially a mayoral function.

The Mayor sets out the vision in the Mayor's Transport Strategy (MTS) and TfL responds to that with the Business Plan (every 5 years). The Business Plan shows how the strategy will be delivered. The latest draft version of the MTS targets an 80% mode share for sustainable modes which is very ambitious.

However, in reality there is never enough funding to do 'everything' so some things will inevitably fall down the priority list. For a major infrastructure scheme, involving many partners, delivered over many years, then it will be subject to a major funding package probably involving multiple funding sources. But if it is a smaller, less capital intensive scheme, it can often be funded from within existing budgets and for this reason can often be prioritised early in the programme.

Indeed, things like extension of the bus network, congestion charging and cycling infrastructure were funded from day to day budgets but the Olympics, Crossrail and the Overground required major funding packages and this brought in funding sources like section 106 and CIL (Community Infrastructure Levy). Indeed, as the cycling strategy is linked to the national cycling objectives it opens the door to national funding support.

To understand the drivers of change in London it is necessary to give some context to the development of transport over the past 40 to 50 years, and the work life of the transport planner.

This can broadly be categorised as follows:

- **Pre-1970s:** Managed decline. It was less complicated with less to do, so was probably an easier environment than we have now. It reflected population loss from London over this period.

- **The 1970s**: The height of the regional authority (Greater London Council) There were far fewer checks and balances to be juggled and with generally less controls it was again, probably, an easier time than we have now.
- **1980s to 2000**: Tended to operate in a political vacuum with a relative lack of direction and city-level governance, this would definitely feel like a major challenge and was therefore, probably, a tougher time than we have now.
- **2000 onwards**: The new Mayor of London takes control and TfL is created – this represents the professionalisation period with a legacy of much to do. However, the to-do-list was very much in tune with the prevailing political agenda and therefore it has been a very productive period in London's transport history.

Key learnings from the past include:

- Avoid the idea that you must just do 'stuff'… whatever you chose to do must have a sound evidence base, even if it is experimental, and it must all contribute to the delivery of the strategic vision and Master Plan, anything else we will be a distraction;
- You will always need political support that recognises the importance of transport as a key driver of environmental sustainability and economic growth;
- Use the power of your vision and Master Plan to persuade the political funding authority to allocate the highest possible allocation of financing to transport – and demonstrate the benefits that this brings;
- Checks and balances are required but progress also needs to be made so streamline planning processes as much as possible. Transport is not just a cost it is a major facilitator to the wealth and wellbeing of a city;
- Potentially a good place to start and focus attention is on regulatory schemes as the technology will often already exist. In relative terms they are much easier to fund and bring in revenue, e.g. Low Emission Zone and congestion charging although local planning constraints could be a major factor.

4.4 Paris

Planning in France operates at regional level and Paris is part of Ile de France which is one of 13 new Regions, this section therefore relates to the IdF Region. There are three main strategic documents for the IdF Region:

Regional Master Plan (SDRIF): It was approved in 2013 and is the main document which contains the urban development strategy, including major transport infrastructure plans for roads and railways up to 2030. The Regional Council is in charge of its elaboration. The previous plan was established in 1994 on the State's lead and was left untouched for 20 years (from 1994-2014). The first Regional Master Plan was implemented in 1960. The SDRIF constitutes a vision of the future, as seen by the region in 2014. The vision may change a few years later, according to the political changes.

Planning Contract: This is an agreement between State and Region regarding programming, financing and funding. It runs until 2020, but will be extended to 2021. It is reviewed every 6 or 7 years. The first contract was introduced in 1982 and the current contract is the 6th edition. The next one should be for the period 2022-2027:

- In the past the key solution was known to be road investment;

- In the recent ones, the priority is public transport (including Bus Rapid Transit);
- In the current contract the split of funding is 20% roads and 80% PT. This demonstrates the evolution of the regional policy cycle.

The Master Plan sets out the rationale and priorities (vision) for investment. The Contract contains the funding envelope for studies and works. The negotiation between state and region for the next contract will commence in 2019. A part of the funding in the Contract is for studies in order to define which will be the most effective investments / priorities for mobility.

Regional Sustainable Urban Mobility Plan ("PDUIF"): It has been approved in 2014, two months after the Regional Master Plan with which it is compatible. It deals with all the mobility issues apart from major infrastructures included in the Master Plan, e.g. cycling, car parking mobility management, urban logistics. It specifies the stakes, the objectives and the action plan to be implemented over the period 2010-2020. It includes 34 actions on 10 themes, actions that should be implemented by the different public stakeholders concerned.

In addition there are 2 annexes: an environmental report that analyses the environmental impact of actions listed in the PDUIF, an accessibility appendix detailing the actions to facilitate the mobility of people with reduced mobility.

Funding Sources

- The Current Planning Contract Envelope (2015-2020, 6 years) is 70% funded by region and 30% state. The total annual budget is €7.3bn with 72% for transport and mobility i.e. €5bn (the balance goes to education etc). The 72% used to be spent in broadly similar amounts on roads and PT but it is now an 80:20 split in favour of PT. There are also planning contracts between the Region and the departments concerning roads and transportation offers that re on counties' leaderships. There are 8 departments in IdF region, among them Paris is both a department and a city.
- Regional transport authority – STIF. This has its own budget for investment but this is more on rolling stock, refurbishments of trains, hybrid and electric buses upgrades. Also for bike parking, inter-modality at interchanges and the Smart Card ticketing system.
- Infrastructure for Grand Paris Express which is the four new lines: specific funding from Societe du Grand Paris SGP. This is €25bn loan financing mainly, with 5 to 10% recovery through a dedicated tax.

Financing Sources

- There is only one example of PPP in the IdF region which is the new Charles de Gaulle Express… a mass transit train line from Paris to CDG airport (expected to be ready before the 2024 Paris Olympics).
- Some loan financing also takes place from EIB via the state e.g. for road building.
- Examples of private operators / sponsors include: car sharing AutoLib, a free car sharing EV service. Run by Bolloré but IdF collaborates in providing on street parking and charging points. There are two scooter sharing services privately funded. Indeed there are no regulations to stop small start-ups to come into the market accept the fact that they must receive an agreement from the concerned public authority. Start-ups try to get grants from municipalities to help e.g. EcoV – Ride Sharing / Carpooling received grant from local authority (Borough level) to pilot.

The funding mix has not changed significantly in the last 30 years. The budget comes from the Versement Transport (hypothecated transport tax): private companies must pay a tax for transport. Each of the seven departments in IdF have their own tax bands. It is applied to all companies with more than 10 staff. The VT represents in 2014 €3.6bn (65% of the STIF budget). The remainder comes from other public subsidies (State, Region, Departments), roughly €1,5bn. Expenditures are devoted for operating to the two railways operators RATP and SNCF (€4bn for both) and €0,8bn for buses in the far suburb of Paris Region, and the rest for investments in new infrastructures. The STIF also borrows to contribute to its investment budget. However, unlocking financing is becoming more difficult because public budgets are more constrained than they were.

One significant change is the way fares are charged – Paris no longer has a zoning system on the whole system. Fare income accounts for about only 30% of the running costs which means fares are heavily subsidised. This was a real politician's response: popular with citizens but difficult for STIF to realise as this means less money to invest in infrastructure. This was a Social-Green party policy but the current party in power has decided to increase the fares by €3.50 per month. However, it is too soon to assess how this will affect ridership.

Key learnings from the past include:

- There must be coherence in mobility planning: you can't promote cycling and car parking at the same time;
- There is a need for consistent delivery: prioritising carpooling for 2 years, then cycling for 2 years is counter-productive when the need is for sustained investment for 20 – 30 years to embed the evolution. Consistency gets you there quicker in the end;
- Paris / France has a very formal way of doing things which obviously has its benefits but it can also be a rigid process meaning that it can be very difficult to accelerate delivery as there are so many partners and stakeholders;
- There is a president of IdF region and a mayor of Paris city. In the past both came from the same party which helps smooth the process. Today they are different parties. And even then you only have 6 years before an election and a new Mayor will often signal a change of priorities. It would be better if a new mayor accepted / trusted some of predecessor's policies and not start from scratch if progress is to be swift.

4.5 Vienna

Vienna has special position within Austria. It is the federal capital, a federal province and a municipality with city legal status. As such Vienna receives a share of national taxes and is able to raise additional local taxes provided they did not duplicate national taxes. As an autonomous authority Vienna is responsible for all aspects of local government and sets annual budgets for all areas of spending, which includes transport and public mobility. As part of this annual process the city authority produces the 'City Investment Master Plan'.

The creation of this plan is part of a process of political negotiation whereby each year the elected representatives gather together and without prior prioritisation allocate funding to each of the spending areas; the outcome becomes the budgets for the coming year.

Although 'double taxing' is not permissible Vienna is able to raise funds through such things as additional taxes on alcohol or waste management. Another source, although it raises

relatively small amounts, is the per capita 'metro' tax on employers to help fund mobility infrastructure. It was also the case that annual budgets were supported by borrowing although this determined at city level.

Furthermore, funds raised within in any given sector e.g. parking revenues, did not automatically stay within that sector, rather it fed into the city budget and are redistributed in accordance with the outcome of the annual negotiation.

The federal system is also broken down into districts that were granted some funding from the Vienna authority and the local, or district authority had the autonomy to determine how these funds would be spent. Improving district cycling facilities would be an example of how this would benefit the local community.

The federal authority would also cooperate with national authorities as some areas of budget responsibility were shared. But rail and motorway infrastructure that was pan-national covered all administrative areas and was therefore the responsibility of the federal government. However, if the city government had 'additional' requirements the city would financially contribute to these additional items. Examples of this would include, additional access to motorways and additional stops on the national railway system. Also there was a 50:50 sharing of responsibility for the construction cost of the Vienna metro service but otherwise everything else, including the tram system, is within the budget responsibility of Vienna.

As a method of funding PPP had been tried on the motorway connecting Vienna to surrounding areas but it had not been a success and was abandoned as traffic volumes did not meet the forecasted values and the private investor got into problems of refinancing. Use of the motorway is based on a usage cost with weekly and annual passes available (flat rate), which entitle users to use all Austrian motorways in the whole conurbation and most of the motorways beyond.

The transport Master Plan set out the cities vision for the future; direction is largely politically led and at this stage it is not fully cost assessed and funded. It can therefore be described as a sort of 'wish list'. In practice, for the most part, politicians will set targets for such things as modal shift and then transport planners and other professionals will come up with the measures that are required to achieve that outcome, i.e. the Master Plan.

Despite the fact that the annual budget negotiation is a very political process, in practice, it does not result in huge funding swings between the various administrative areas. This meant that there is a certain level of year on year consistency which means the long term planning process and major infrastructure projects could take place within a known stable environment.

Key learnings from the past include:

- In the past funding sources tended to be ring-fenced but this is not the case now and the city authority is free to determine funding priorities. This was a crucial and very significant change in Vienna's Master Planning process that had occurred about 20 years ago. The result of the change was that the city authority could allocate funds to any priority irrespective of where in the economy they were raised e.g. money raised in road use no longer has to remain in the roads budget. This freedom to allocate funds to city priorities was not only good for the city it was also good for the transport budget as it has made money available for developments that might not otherwise be funded. It was felt this was

a key enabler (Insight), without which, the transport function would not have made as much progress as it has;

- Another significant change that started to evolve about 30 years ago concerned how transport planning was performed. In the past it was all about technical papers but now it is a very participative process and that is a good thing, especially as trust in technocrats and politicians was eroding. The result is that there is much more challenge in the system than there would have been 30 years ago and that was a good thing too. On the other hand with so many interested parties communication and consultation is a much more protracted process;
- Yet another area of change is the evaluation and prediction of 'outcomes' from any given set of measures is far more complex than it used to be. Now it is a complex matrix and trying to look at outcomes on a city-wide basis and then explain that to stakeholders is much more difficult than it used to be, essentially because it is rarely a clear cut situation;
- One of the key issues with bringing forward change more quickly was the ability to influence and convince stakeholders. Some 20 years ago roundabouts were not common in Austria and their introduction caused much public debate, the same was true of parking management but views have changed and both are now accepted without debate. Indeed, the idea of shared space (reduced speed and more cyclists) was also gaining acceptance;
- As important as the communication and consultation process is, with the sheer number of interest groups and diversity of opinions, it was difficult to see how the process of delivery could accelerate if 'acceptance' was a key criteria. Indeed, there is an example where an established district traffic calming scheme that seemed to have gained acceptance was rejected (and removed) when local politicians allowed a referendum to decide its future.

5. Summary of funding and financing pathways for investment in Stage 3 cities.

This section summarises the findings from the Stage 3 city research, as set out in section 4. For the purposes of this discussion, funding is defined by who ultimately pays for any given development and financing is the process of providing the liquidity that enables a project to be delivered, ergo it follows that they may or may not be the same entity.

This research also sought to identify any new trends or emerging approaches to securing funding and financing programmes, and for public procurement being adopted by the participating cities.

In working through this exercise it very quickly became apparent that all of the five cities had broadly started their journeys in the same place – *namely, as Stage 1 cities with a broad policy focus on enabling car use.* Further, they were all broadly headed in the same direction – *i.e. reducing congestion with an emphasis on 'streets and places' and 'health and lifestyle'.* However, just as quickly, it became equally apparent that each city had its own unique approach to process, methodology and deployment.

On refection this is of course unsurprising as the 'way we go about things' is an accepted metaphor for the prevailing culture which in turn reflects upon our sense of history, time, place, location and, along with a whole host of other factors determines who we are and what we do. One of the common traits of the cities is that they enjoy significant budget and policy autonomy to set their own vision for future transport development.

Another consistent message from all Stage 3 partners was the observation that much of the transport innovation has been deployed in the high priority inner areas. So, whilst we regard our five cities as Stage 3, in reality they are a mixture of Stages 1, 2 and 3.

It is this broad cultural context that is inseparable from public and political life and leads us to conclude that there is no one single approach: there is no 'Master Plan', for Master Planning. There is no template approach that will offer a quick win solution for others to simply follow.

Rather, each city authority must determine its own priorities (measures and funding) that are appropriate to their perception of where they are and what they want to achieve for their citizens, on their watch. This is the single consistent key lesson from each of the Stage 3 Cities. They did it their way and that is how it will continue to be.

We are providing a narrative, with examples, of what has worked for the Stage 3 cities comprising practical experience for real-world use.

5.1 Baseline

Our starting point was the conference calls with the five Stage 3 city partners conducted in August 2017. These structured calls sought to determine a baseline across the cities that would describe how they approached funding transport development plans.

At the macro level we found that there was a very high degree of consistency; to varying degrees the Stage 3 cities reported funding their budgets through the following five sources:

1. **Central grants:** essentially a regional share of national taxes
2. **Local taxes:** in the federal systems regional governments used devolved powers to raise local taxes, for example from employers
3. **Property taxes:** in the form of rates and levies

4. **Direct income:** in the form of fares and supplemental commercial activities
5. **Borrowing:** from commercial sources

Again it is unsurprising that this convergence has occurred, not least because as is noted above, we have seen that the five cities are very much on the same 'journey' and in recent years, there has been ever increasing levels of pan European cooperation and sharing of experiences at all levels.

5.2 Validation of Funding Sources

Having reached this basic conclusion we determined to use peer review as a method of validation and extrapolation. In this respect we have referenced the results from our five cities with the CODATU publication "Who Pays What for Urban Transport" (2014 edition)[1]. The Handbook refers to three principal groups of funding sources, they are:

- **Direct Beneficiaries:** these are the users of public transport services raising income through fares and the users of individual modes raising income from parking and tolls, e.g. congestion charging.
- **Indirect Beneficiaries:** these are property owners, shops and businesses and employers.
- **Public Funds:** these are taxpayers, banks and funding agencies

The CODATU Handbook also demonstrates how funding and financing moves around the matrix before finally ending up in the Urban Transport Budget.

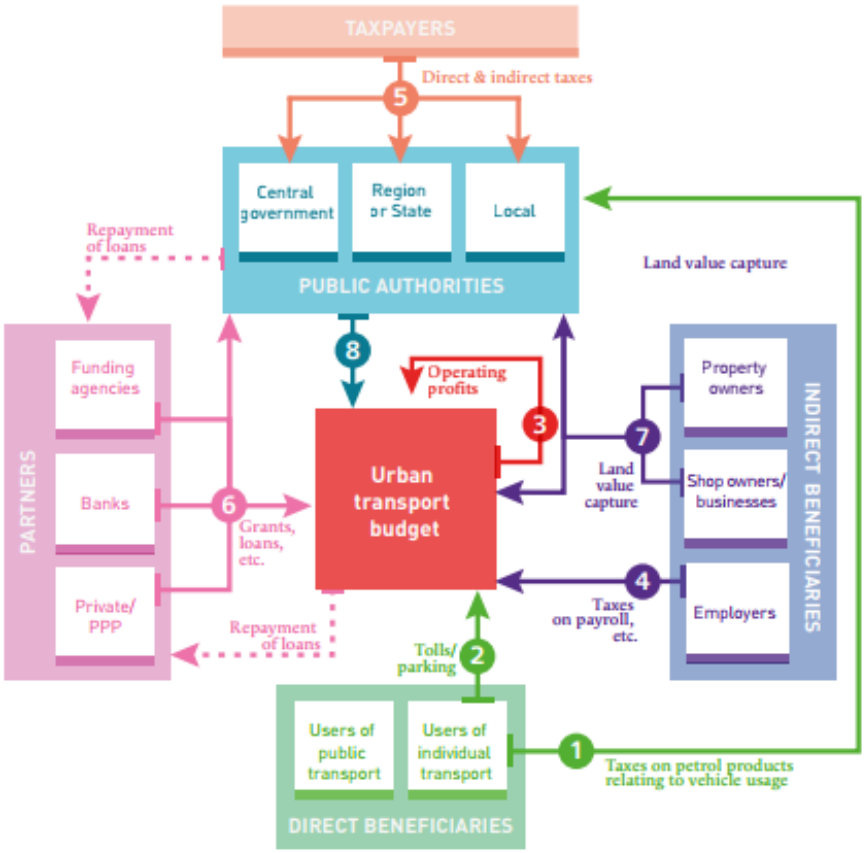

Figure 17: Who Pays What for Urban Transport – 2014 Edition- CODATU

[1] http://www.codatu.org/bibliotheque/doc/who-pays-what-for-urban-transport/

As an overarching model this perfectly captures the overall approach adopted by all of our Stage 3 city partners. Different cities may use different terminology but in essence the very same funding sources are common to all of the Stage 3 cities.

However, as the terminology used is often different, so are the mechanisms that are used to raise funding and therefore the extent to which each of the funding sources raises financing is directly related to the context of each city.

Thus, in a city that is undergoing significant development or regeneration, deploying mechanisms to reflect planning gain will be very successful but in a city where there is relatively little development opportunity, they will have to look elsewhere in the funding matrix to raise the revenues to fund their city Master Plans.

For example, in London, the system known as 'Section 106 Agreements' enables local authorities to raise funds directly from developers for local infrastructure improvements required as a direct consequence of their development (see further reference below).

Not only is this is a very clear example of why Stage 3 cities differ so much, it also provides a very useful insight for Stage 1 cities to understand that the process begins with designing a solution that is right and relevant for their time and place.

The schematic also articulates a very useful checklist for all cities to use as a starting point when considering what is appropriate to them.

Possible mechanisms for funding public investment

1. Road users, private cars, truck and bus operators (with certain exemptions) pay taxes on petroleum products which are allocated to national and local budgets. All or part of these taxes can be allocated to urban transport.
2. The same users may also have to pay for congestion charging, infrastructure tolls and parking which are allocated to the transport authority.
3. Operating income of the system is directly re-invested.
4. Employers pay a tax on payroll, or an increased business tax which is allocated to the transport authority.
5. Taxpayers pay direct and indirect taxes to the national, regional and local budget.
6. Public authorities may have recourse to loans, through national or international institutions. In the framework of a PPP, the private partner contributes funds either to the public authorities, or to the transport authority, or to the transport system in general, dependent on the circumstances.
7. Building owners, land owners, developers, residents and retailers, through various modalities, pay a portion of the property value gains generated by the construction of a transport infrastructure in their vicinity.
8. The public authorities, at the State, regional and local levels, contribute to urban transport funding from their own budget, based on contributions from direct and indirect beneficiaries, taxpayers and international financial agencies.

5.4 Time consistent

With the original CODATU research predating 2009 it seems that this same basic model has prevailed for at least the past decade and in fact our research suggests that it has been around for at least a decade before that.
All of our Stage 3 city partners can articulate ways in which their processes could be improved in one way or another. As a generalisation the systems are thought to be too complex and would benefit from streamlining but despite any perceived shortcomings all cities reported that it essentially works, otherwise they wouldn't be where they are.

Indeed, none of our cities reported any major governance changes on the horizon, not least because the cities are part of a much wider public / political machine and change in isolation for the transport sector would be very difficult if not impossible.

One major downside is that delivery of new projects is often politically tense and protracted which means that the benefits are slower to be realised than might otherwise be the case. However, it seems that the long established processes, as represented in Figure 17, are here for the time being and cities are channelling their energy in to delivering an ever-improving transport system.

As an insight this certainly suggests that it is possible to spend a lot of time engineering, or re-engineering the delivery process at the possible distraction from delivering transport system benefits. Although, of course, it really depends on where you start from because at the very least, the authorities responsible must have the legitimate authority to implement and enforce their decisions.

But as a further insight for all cities, if acceleration of benefit delivery becomes the order of the day then it becomes inescapable that city authorities will need to address complexity in their delivery processes.

5.5 Emerging Trends

Interestingly the UK system of funding infrastructure developments known as a 'Section 106 Agreement' is often pointed to as a very effective method of raising funding through planning gain and indeed it is. However, it is far from new as it was first introduced nearly 20 years ago as part of the 1990 Town & Country Planning Act. Even the Community Infrastructure Levy (CIL) is approaching a decade of deployment having been introduced in 2008 although it was 2010 before it was fully established.

However, with the relative wealth of our five Stage 3 city partners, it is abundantly clear, that they are able to raise finance through borrowing, in particular at acceptable rates because without the ability to borrow none of the Stage 3 cities would be as advanced as they are.

Indeed, it would also seem to be the case that the wealthier more developed cities will enjoy more opportunities to benefit from the broad spectrum of funding opportunities as a result of the scale at which they operate at. This makes it all the more important that Stage 1 cities, are able to access loan funding if they are to make as much progress as they would like to or need to.

Overall, we have not detected any new or emerging funding sources that we could point to as truly innovative in Stage 3 cities which tend to all draw from the same staple sources.

Gross Domestic Product (GDP) Per Capita

Our research has shown that all of the Stage 3 city partners access commercial borrowing at acceptable market rates. Furthermore, we can see that without access to this long term borrowing, which is usually underwritten, either directly or implicitly by their national governments, they would not be able to fund the level of sustainable development that they currently enjoy. It therefore follows that this will be true for the Stage 1 city partners in the CREATE city study group.

As a result we have looked at the GDP per capita for the countries whose governments may underwrite city borrowing and it does reveal, as expected, a polarised difference between the Stage 3 cities at one end of the scale and the Stage 1 cities at the opposite end with Estonia as the main exception. This could therefore act as a long term restraint on economies at the lower end of the GDP scale.

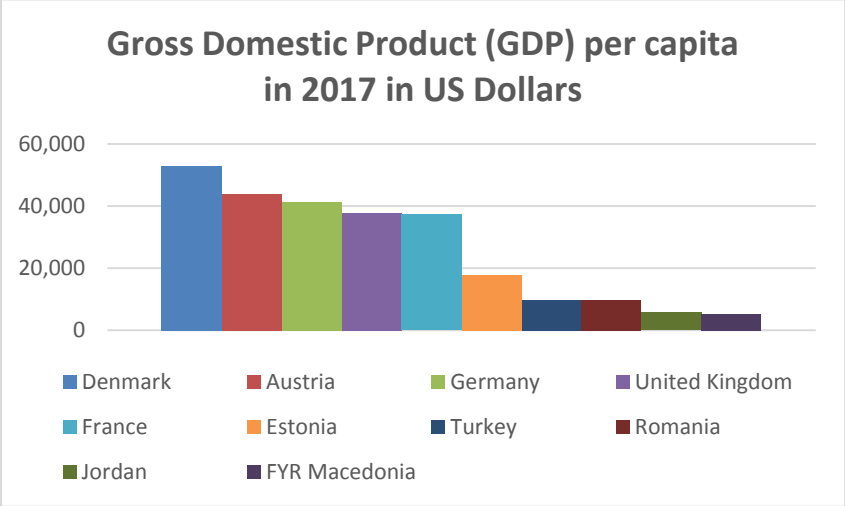

Figure 18: GDP per capita of CREATE countries 2017

The data sources regarding GDP for cities are more complex and more difficult to compare consistently-derived figures. Also the base years are very different. However, for indicative purposes the figures are presented below and support to some extent the country-level data.

Table 6: Indicative GDP by city

Country	Indicative GDP per capita in US Dollars
London	73,000
Copenhagen	70,000
Vienna	58000
Paris	57,000
Berlin	28,000
Bucharest	32,000
Tallinn	31,000
Adana	9,000
Skopje	7,200
Amman	7,370
Sources:	*PriceWaterhouseCoopers UK Economic Outlook November 2009* http://pwc.blogs.com/files/pwc-uk-economic-outlook-nov-09.pdf

Overall therefore, one can conclude that accessing EU funding sources is critical to future development, and certainly to the CREATE concept of accelerated delivery.

5.6 Master Planning and Funding Process

Each Stage 3 city produces its Master Plan which is reviewed at varying intervals and to varying degrees. The Master Plan is produced – almost as a wish list – and then funding is allocated as part of a separate political process of negotiation. However, the frequency of this budgetary process does vary. In the case of Paris and London it is linked to the life cycle of the Master Plan whereas in Berlin and Vienna it is linked to the annual federal cycle of government. At first glance it could appear that the longer cycle of Paris and London is far more desirable but in reality the difference is not so material as in the federal cities there tends not to be significant funding swings year on year.

In this sense the Master Plan is developed in a certain fiscal isolation where transport planners and other professionals provide the technical plans that are needed to deliver the direction as set out by politicians and in particular the city Mayor.

Notwithstanding any differences in budgeting cycles the budgeting process gives rise to the "City Investment Plan". This plan sets the level of funding that will be allocated to the transport sector and along with project level cost benefit evaluation, this ultimately determines what is delivered.

There is usually a presumption that demand (for measures) will exceed cash supply and therefore this acts as a brake on how much can be delivered in any given fiscal period.

In this sense we would not regard the process as a business model in a strict investment appraisal sense as the aim is to spend the budget. It is the case that individual projects are subject to cost benefit analysis but the political context, as noted by Dr Charlotte Halpern in CREATE Deliverable 4.2, does mean that direction and outcomes can be subject to personal political priorities or party-affiliated policy preferences. It is the case however that larger infrastructure projects, requiring funding outside of the local or regional budget, do often need business models (either national, federal or financial institution level). This can be a good or bad thing dependent on one's perspective but if it infers an inconsistent approach to policy that lacks a coherent delivery plan then that will inevitably result in confusion and a far less effective use of available funds. Suffice to say, capital is a finite resource.

Typical Process Map

The process of strategy development, through to project delivery, can therefore be represented in a generic process map format, as illustrated in table 7 below.

Table 7: Typical Process Map

Level 1	-	**Setting the Strategy**		**Output**
		• City Authority / Elected Mayor sets the strategic priorities and targets for the next planning cycle. • The strategy will be informed by political priorities and research and analysis provided by city professionals and other interested parties. • Supported by wide ranging stakeholder consultation and possibly statutory requirements.		Strategic Master Plan
Level 2	-	**Strategic Delivery Planning**	-	**Output**

	• City professionals bring the strategy to 'life' through the creation (or iteration) of a high level delivery plan closely aligned to the strategy. • Includes high level/estimated cost assessment and social benefits. • Continued wide ranging stakeholder consultation.	High level Project Portfolio
Level 3	**Project Appraisal**	**Output**
-	• Feasibility assessments. • First draft detailed business case. • Delivery options assessment. • Final business case submission prior to funding approval within city investment guidelines. • Continued stakeholder consultation esp at impact level.	Signed-off Project Plan
Level 4	**Project Delivery**	**Output**
-	• Detailed planning for project commencement, including procurement, permissions, contracts and work programme.	Ready-to-go Project Schedule
Level 5	**Project Review**	**Output**
-	• Key success criteria, on-going monitoring, feedback loop to future strategy, delivery plans and stakeholders	Post Delivery Evaluation Reports

This demonstrates how the strategy and deployment of projects is a stand-alone process but works within a framework of city governance and the political budget setting process. Thus, in any given year, project delivery can easily be flexed to available funding.

It is also interesting to note that you reach level three in the process map before a detailed benefits case is required. The reason for this is obvious in that as the 'hopper' of projects tends to exceed the available funding, to carry out detailed analysis too early in the process could easily result in wasted resource because by the time the project is scheduled the situation may have changed considerably.

However, as an example of how business case assessments are made, TfL uses the Five Case Model for assessing investment option, as per Figure 19 below.

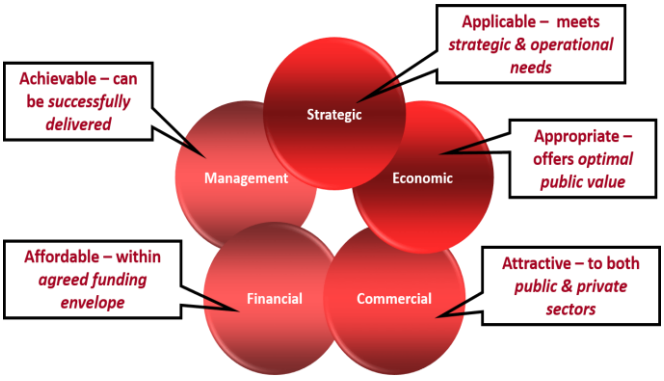

Figure 19: TfL's Five Case Model

It should be noted, however, that major infrastructure schemes such as the metro developments in Paris and Vienna and Crossrail in London follow a different path to fruition and the simple reason for this is the sheer scale and ultra-complexity of the development. In most cases these major schemes are delivered through a Special Purpose Vehicle (SPV).

As such delivery transcends the city authority and requires complex multi-layer funding sources and multi-layer governance involving local and national governments / authorities. These schemes, apart from being a subject in their own right, will utilise funding from all areas of the funding matrix, often involving considerable borrowing.

The example of Crossrail is cited in 5.7 below.

5.7 Funding of major infrastructure schemes – Crossrail example

Crossrail is a major new underground railway line running from east to west London due for completion in 2019. The funding framework for Crossrail was put in place in October 2007 when the UK Prime Minister announced that Crossrail's cost will be met by Government, the Mayor of London and London businesses.

Following the Comprehensive Spending Review in October 2010, a funding envelope of £14.8 bn, including contingency and inflation, was agreed to deliver the Crossrail scheme in its entirety.

The scheme is funded through a complex funding package that includes the following elements:

- Central Government contribution by means of a grant from the Department for Transport;
- Contributions from Transport for London and the Greater London Authority, on behalf of the Mayor for London;
- Funding mechanisms including the Crossrail Business Rate Supplement (BRS), Section 106 Agreements and the Community Infrastructure Levy (CIL);
- Crossrail fare payers will contribute towards the debt raised during construction;
- There are also considerable additional financial contributions from some key beneficiaries of Crossrail, including Network Rail, City of London Corporation and Canary Wharf Group amongst others.

Over 60% of Crossrail's funding will have come from Londoners and London businesses.

5.8 Best Practice

Feedback from all of the Stage 3 city partners consistently reported that this is not a situation where a so called best practice approach would add value. For example, Berlin has looked at congestion charging and rejected it for sound technical reasons. Thus, if a 'best practice' approach dictated that this, or any other measure, represented best practice it would potentially deny cities the ability to determine what was right for them, in their specific context, without the potential loss of best practice status. Using a 'basket' of measures was thought to be a far better approach to Master Planning which would retain the flexibility any given city requires to determine what is right for them. A representative from Stadt Berlin concluded that "best practice tends to dictate the way forward and that is at odds with the individuality of our cities".

Moreover, from an insight perspective, it also seems that the CODATU Handbook has wrestled with the same concern, preferring to use the term 'Good Practice'.

5.9 Stakeholder Communication and Consultation

Again, another big change cited by all of the Stage 3 city partners is the requirement to consult, or at least the amount of consultation required, has increased dramatically in recent times. Two main reasons for this is the significant growth in stakeholder groups and the use of social media which has made the job both easier and more difficult at the same time.

Everybody agreed that there is a very significant positive side to greater involvement but it was also cited as a major obstacle in the sense that it did seem to slow down development of the innovation process.

Indeed, in some cases it was felt that the power of the media was discouraging innovation and experimentation for fear of a “bad press”. This meant that politicians, who are probably risk averse by nature, were certainly less willing to take chances even with seemingly ‘good’ ideas.

One reason for this might be that the relationship between cause and effect has become far less linear. In the past the idea that you could build roads to reduce congestion and improve journey times was universally accepted because it was a simple equation, easy to grasp and it felt intuitively right. However, with advances in the science of transport planning we now know that it is not so simple and the relationship between cause and effect has become a far more complex algorithm than it was in the past.

This has made it much more difficult to persuade stakeholders from across the spectrum to buy-in to the proposed solutions such that they are often perceived as merely money making, anti-car schemes.

An example from Vienna describes a situation whereby a traffic calming project was implemented, with reduced speed limits, that appeared to be accepted as it has been in place for a number of years but was later rejected (and removed) when local politicians allowed a referendum to determine its future.

The answer, from the experience of Transport for London, is to use the power of your vision to persuade and influence at all levels. This requires proactive communication plans at all levels.

Another perspective is that: “one fails to communicate at one’s peril because there is no such thing as no communication, if a void is left it will be filled by others, often by negative rhetoric”.

5.10 Political Champion

All cities pointed to the need for ongoing political support, or indeed, a political champion as a key enabler to making more progress more quickly.

This can certainly be seen with the arrival of the London Mayor and Vienna pointed to the election success of the Green Party giving a new impetus to the sustainability agenda and more progress was made more quickly after they came to power in 2010.

However, it was also thought that the opposite was true in that the loss of the champion can result in a slowing down of progress giving rise to a stop / start scenario with the attendant issues that infers.

Anecdotally it was suggested that if you have a political champion, get as much done as quickly as you can, as they may not be around for very long!

5.11 Validating the ten Indicators of Stage 3 Measures

In Section 3 we set out an in-depth study of the ten Stage 3 indicators as identified by the UCL research. As a means of validating and testing the application of the measures we asked our Stage 3 City partners to rate the relative importance and weighting allocated to each of the measures when assessing project prioritisation; and to indicate where such indicators are rarely or never considered.

This is a relatively informal survey but nevertheless - as we have seen in other areas - there is a high level of consistency amongst the cities' current approach to the project assessment process.

It shows that whilst some Stage 3 indicators are already well considered, there is great potential for even advanced cities to better consider and integrate Stage 3 indicators in their project assessment processes. This suggests there is more scope for planners to better justify Stage 3 policies and measures and consolidate related investment in this field.

The indicators which are currently least considered are: time spent in places (no.6), community severance (no.8) and visual blight (no.10). Equally there is scope to increase the extent by which personal security (no.4) is integrated. Indicators which have some relative importance are: number and length of trips (no.1), trip quality (no.2), time use while travelling (no3), street liveability (no5), health and wellbeing (no.7) and equity and social inclusion (no.9).

Table 8: Validation of Stage 3 Indicators

Stage 3 Indicators (see chapter 3)		**Not Applicable**	**Relative Weighting of Indicators in City Project Assessment Process**				
			1 – Low	**2**	**3**	**4**	**5 – High**
1	Number and length of trips					Copenhagen	London Paris Vienna
2	Trip Quality				Copenhagen London Vienna	Paris	
3	Time use while travelling				London	Paris Vienna	Copenhagen
4	Personal Security			Copenhagen	London Paris Vienna		
5	Street liveability and place quality				Paris	London	Copenhagen Vienna
6	Time spent in places	London Paris Vienna		Copenhagen			
7	Health and wellbeing				Vienna	Copenhagen London	Paris
8	Community severance	Paris Vienna	Copenhagen London				
9	Equity and social inclusion		Copenhagen			London Paris Vienna	
10	Visual blight	Paris Vienna	London		Copenhagen		

5.12 Case Study – "Concession for light rail transit system for the transport of passengers in the City of Skopje"

Introduction

In 2012 the City of Skopje, assisted by various professional partners, brought forward plans to develop a light rail transit system to service the travelling needs of the city inhabitants and the growing number of visitors.

The main source of this case study is the **"Study for concession for light rail transit system for the transport of passengers in the City of Skopje"**.

The Study covers both technical matters and financial assessment plans for delivering the proposed light rail scheme. However, as the focus of D5.2 is the financial and economic analysis this case study does not extend into any of the technical matters or system options.

The total consideration required to deliver the scheme was a not inconsiderable 180.4m EUR. However, it is worth noting that the proposed scheme was exempted from any land acquisition costs as the line was to be built on assets entirely owned by the City of Skopje.

Project Structure

The consultants advising the project considered a number of approaches but concluded, essentially due to limited financial sources *(i.e. banks would provide the majority of the financing)* that a DFBOT[2] system would offer the best shared and secure outcome for all of the project partners.

At the heart of the plan was to set up an SPV to be known as the Skopje Concession Company. The SPV, based on a 'Concession Agreement' with the City of Skopje, would be responsible for all aspects of delivering the project.

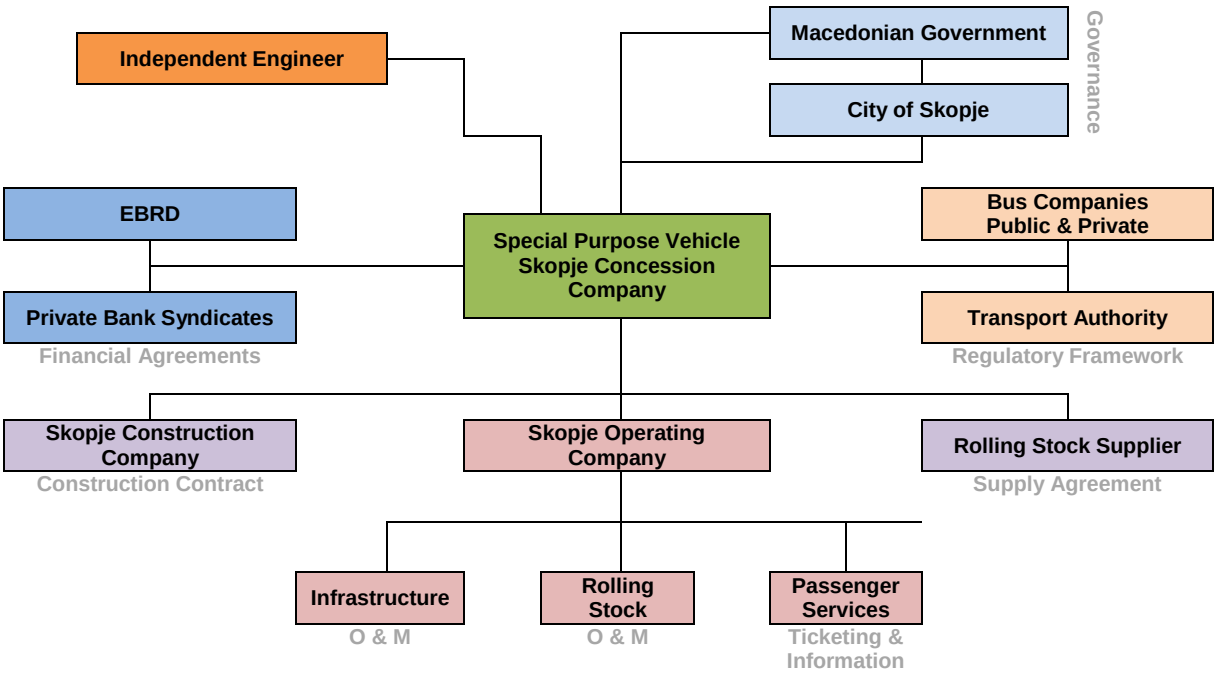

Figure 20 LRT Project Structure

Financial Sources

The Study notes that private loans will incur higher interest rates and suggests that they should be minimised as far as possible but in a later section the Study reports that some 85m

[2] *Hybrid of Build-Operate-Transfer/Design-Build-Finance-Operate*

EUR of the funding will come from a Private Banking Syndicate. Clearly substantial private finance was unavoidable.

The report further indicates discussions were held with EIB and specifically refers to advice from them to not issue Bonds as a means of raising financing. Bonds would have otherwise been a cheaper loan facility but as seen from 2012, EIBs prediction was that interest rates were set to rise and they counselled against using them. This advice was accepted.

The EBRD interest rate is noted at 6% with a 3-year grace period. The private loan incurs an interest rate of 8.5%, also with a 3-year grace period; not as big a gap as I was anticipating but still a significant difference

The scheme was offered over an unusually long 35-year period although this does not appear to have deterred the potential investors.

The financing structure (see below) lists the anticipated Revenue Streams. In CREATE terms it certainly covers land value capture, line-side revenues and obviously ticket revenue. However, it might also have looked at other areas of charges and levies although that may be within the City subsidies; on the other hand, unemployment in Skopje in 2012 was 31%.

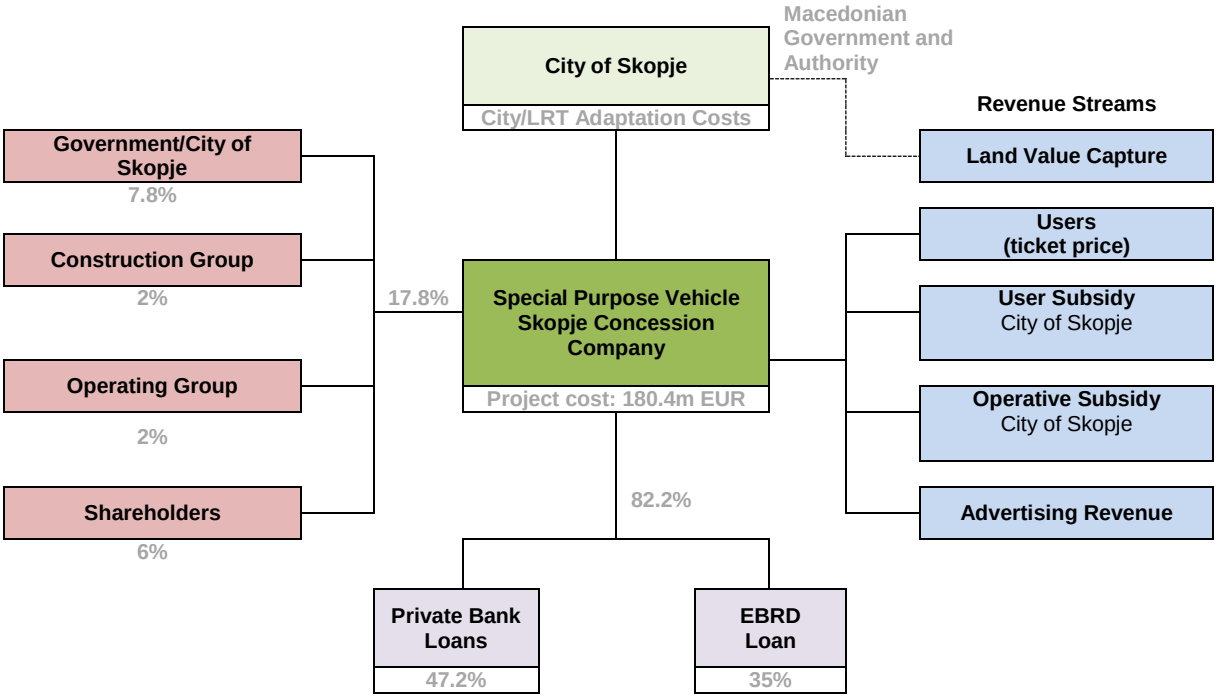

Figure 21 LRT Financing Structure

The contract conditions included various clauses requiring the SPV to guarantee provision of insurance in the case that the loan could not be paid on time, i.e. project assets and reserves could be sequestrated and in the case of serious contractual breaches the Bank Syndicate could assume control of the project and / or retain shares.

The financing translates as follows:

Private Banking Syndicate	47.2%	85.15m Eur
EBRD	35.0%	63.14m Eur

Government / City of Skopje	7.8%	14.07m Eur
Construction Group	2.0%	3.61m Eur
Operating Group	2.0%	3.61m Eur
Shareholders	6.0%	10.82m Eur

It is of only passing interest here but the report does not reveal which banks were members of the syndicate and neither does it go into any great detail concerning the shareholder contribution, save to say that the equity capital will arise from two sources; the issuing of shares and from consortium companies investments.

Financial Analysis Indicators (at 1 EUR ticket price)
The Study is short on detail but in the conclusion of the financial section it states:

• Net Present Value (NPV)	**63.05**	m EUR
• Benefit – Cost Ratio (BCR)	**1.159**	
• Net discounted profit (NPV – PV of equity investment)	**45.01**	m EUR
• Interest rate on Equity	**7.13%**	
• Total subsidy PV	**85.89**	m EUR

The project was duly declared financially viable.

Economic Analysis Indicators
It should be noted that the value-of-time calculation was based on a generic division provided by EIB /ERBD. It was not based on a survey of Skopje passengers nor did it use local values.

• Net Present Value (NPV)	**30.65**	m EUR
• Benefit – Cost Ratio (BCR)	**1.10**	
• Internal Rate of Return	**7.5%**	

The report notes that despite not including benefits arising from CO_2 reduction and potential savings from accident reduction, the BCR was positive.

The Study does place the LRT development in the context of the wider strategic ambitions for the City of Skopje. It also makes Stage 3 type references to health and wellbeing. However, this does not carry through into the financial and economic business case.

Conclusions
1. Using traditional financial assessment methods (CBA / NPV) the Study concludes that that the proposed light rail system was a financially viable proposition.

2. Financing relied mainly on borrowing, provided mostly by private banks (47%) but also with a sizeable contribution from EBRD (35%). EIB were consulted during the preparation phase and offered advice but did not contribute financially.

3. The economic analysis did calculate passenger travel time saving and this was included in the business case. CO_2 reduction was calculated but not monetised. Accident cost savings were not calculated but otherwise thought to be marginal.

4. The Study does place the LRT development in the context of the wider strategic ambitions for the City of Skopje. However, whilst the LRT was a major part of the vision for Skopje the financial and economic analysis does not make any references to what CREATE would recognise as Stage 3 measures (UCL Ten Indicators); the benefits case therefore relied solely on the financial and economic investment analysis.

5. Lending is a risk business and for an infrastructure project of 180m EUR, with near 50% private bank financing, in a country with only a BB+ credit rating (at 2012) it would be surprising if it was anything other than a direct-benefit financial assessment.

6. By their nature Stage 3 developments are relatively small scale compared with major infrastructure projects but there tends to be lots of them. So expenditure can still be significant but even in a country with a good or better credit rating high value major infrastructure projects will be justified on mainly direct-benefit financial assessment and delivered through SPV mechanisms and that is how it should be.

7. It is therefore when developing Stage 3+ type schemes that Stage 3 assessment criteria should come into their own and this is very much consistent with the research conducted as part of deliverable 5.2.

Outcome
The invitation to tender was ultimately not successful and despite initial expressions of interest, only one consortium pursued the opportunity but this came to nothing and no contracts were awarded.

One of the main stumbling blocks was an insistence from consortium partners that the City of Skopje should guarantee certain ridership levels to underwrite minimum ticket revenue. At the time this was something that the City felt that they could not undertake and ultimately it meant that the scheme was unable to progress.

5.13 Case Study – Transport for London delivering Stage 3 Measures

Introduction
Transport for London has a very well developed project delivery process. It covers every aspect of portfolio and project management and is a standardised TfL wide resource; centrally hosted and integrated into the fabric of the organisation.

Indeed, the 'Business Case Development Manual' (*version 103.2017.03*) dated March 2017 is issued by TfL Finance and is freely available from the TfL website. This manual covers the entire life cycle of producing a projects' Business Case although this case study will focus on the financial and economic analysis and specifically, methodologies for assessing the value of certain Stage 3 measures. In this respect the case study will refer to another of TfL's publications published under the title "Valuing the Health Benefits of Transport Schemes". This publication is also freely available from the TfL website.

At the heart of the process is compliance with the UK's Public Service (Social Value) Act 2012 that requires a contracting public authority to consider how a proposed procurement might improve the social, economic and environmental well-being of its area. With health,

well-being and liveability being key ingredients of Stage 3 measures it can be seen how evaluation of such developments has become integral to the everyday work of TfL.

Business Case Development
According to TfL a business case is much more than just a cost benefit ratio. The business case must start with a compelling narrative that demonstrates how any given project contributes to the strategic direction (SUMP/SULP) of the city authority. It must also include a framework for multi-criteria analysis for the prioritisation of multiple competing projects because demand will most often exceed funding.

The process generally starts with a base case where the 'do nothing' option is compared with the effects (not cost alone) of various minimum to maximum possible change options. If the do-nothing option has unacceptable consequences then a business case is required.

Once an issue is raised it is necessary to determine the best way forward and this involves the development of a range of alternative solutions. Having 'competing' options is thought to be the best way of scenario testing to reach the best possible overall solution. Solutions will not be assessed on capital cost alone but will take account of the full life cycle of operating and maintaining any given asset.

Assessing the costs and benefits of a project is the next key step. TfL has a mandate to operate as efficiently as possible and is therefore always keen to seek out cost saving opportunities. However, to contribute to a business case any associated cost saving must be shown to be cashable to the extent that savings are redeployable to fund other projects. Benefits are calculated in relation to the base case at constant prices.

TfL has adopted a tiered approach to business case development. This approach enables them to minimise input to projects and ideas that may never progress and post project completion, compare what actually happened relative to the signed-off full business case.

The three levels of business case are:

- Outline – the outline business case is used principally as a screening tool for initial option selection. It is based on best available information.
- Full – completed only when the project is likely to proceed and once all of the variables, including procurement, are known.
- Outturn – the outturn business case is completed post implementation using actual costs and verified benefits. It is then compared with the 'Full' business case to determine the outturn relative to the predicted benefits.

In order to choose between competing project solutions the decision making process will make a judgement using the Benefit to Cost Ratio (amongst other criteria), which is expressed as:

$$\text{Benefit to Cost Ratio} = \frac{\text{Present Value of Net Social Benefit}^{3}}{\text{PV of Costs} - \text{PV of Revenues}}$$

Valuing the Health Benefits of transport Schemes: HEAT – Health Economic Assessment Tool
TfL has recognised the need to monetise the health benefits of schemes that promote active travel. They could have developed an in-house methodology but have instead adopted the

[3] Monetised social benefits include, changes to passenger time, ambience setting, pollution, health and personal security. Wider economic and social benefits include; regeneration and social inclusion.

much respected HEAT model. HEAT is a relatively straight forward tool developed by the World Health Organisation to specifically monetise the health benefits of walking and cycling. HEAT is also endorsed by the UK Department of Transport and is widely used in many countries and organisations.

TfL acknowledges that road and public realm schemes are increasingly focused on improving access and liveability (Stage 3 criteria) but traditionally business cases are focussed on direct benefits arising from reduced journey times. In short, without a methodology for monetising the health benefits of active travel modes these projects will seldom achieve business case hurdle rates.

However, the inclusion of the wider, indirect benefits associated with health and well-being will often be the tipping point between financial viability and the do-nothing option referred to in the business case section above.

How does HEAT work?
There is a very strong evidence base linking the beneficial effects of walking and cycling to overall health. HEAT therefore calculates the number of deaths per year prevented as a result of the development scheme and monetises the value of each avoided death. It is a mathematical model so once the data has been input the system will calculate the results for the user.

To arrive at the result the HEAT model uses death rates taken from the WHO database and is therefore configurable to local mortality and statistical life values. The model can be run multiple times to test the sensitivity of assumptions derived from the development scheme. This level of configuration means that the results are locally reliable and robust over time. HEAT is essentially a flexible three stage process:

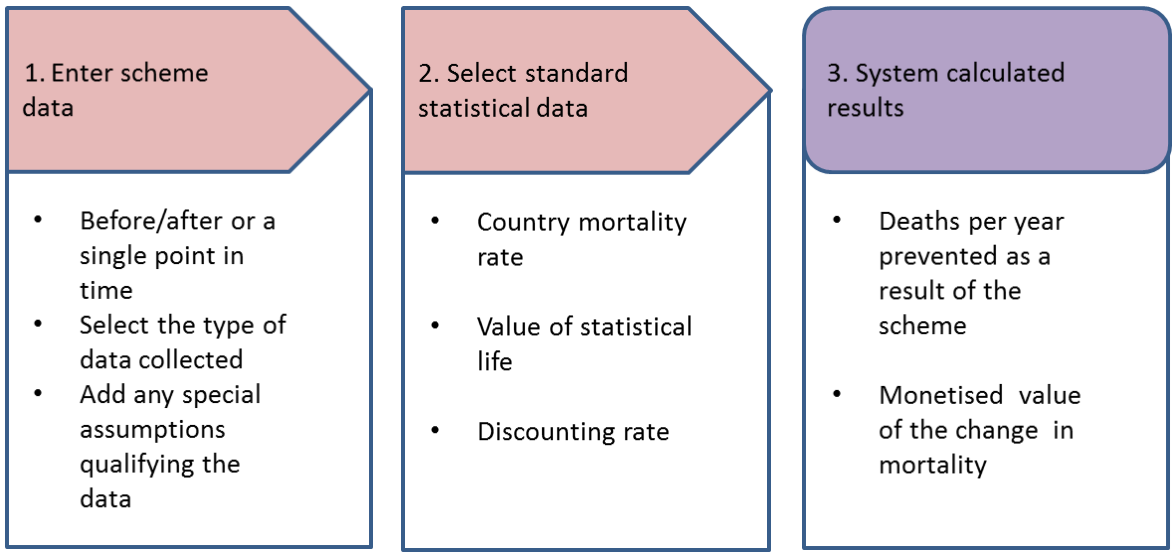

Figure 22: How HEAT works

The HEAT model has many uses and can be used to assess the monetised value of health benefits in any of the following scenarios:

- Predicted benefits based on best available data
- In real time based on actual data
- Retrospectively to assess the benefits of a scheme that has already been delivered

HEAT in practice – Royal College Street, London
Royal College Street is in the London Borough of Camden. In 2012 an infrastructure scheme was devised to improve the public realm and increase the safety of cyclists. The scheme involved new armadillo separated cycle tracks, resurfacing, street scene improvements and new paving. The cost of the scheme was put at £475,000. Data counts for walking and cycling were collected prior to the intervention and the HEAT model was used to calculate the post implementation benefits.

Using the cycling benefits alone the benefits over a 10 year period were estimated at £347,000. This produces a BCR (monetary benefits / project costs) of 0.73:1. This demonstrates that just by taking account of one (very important) element of the business case assessment the project is getting close to breakeven.

SART – Sickness Absence Reduction Tool
Similar to HEAT, there is a significant body of evidence that shows that employees who are physically active experience 25% fewer sickness absence days than colleagues who are inactive. Reducing sickness absence therefore has an economic value to business and potentially welfare services.

The SART model is a methodology for calculating the monetary value of the expected change in activity levels resulting from any given development scheme promoting walking and cycling.

The SART model is not as sophisticated as HEAT in that it applies a flat 25% reduction in sickness absence to anyone who moves from inactivity to a defined level of activity as a result of the project intervention. As a result the quantum of expected benefits from a SART calculation is much smaller than those from a HEAT assessment for the same level of activity change. However, SART can still make a defining contribution to the economics of a development scheme. Furthermore, as HEAT and SART are mutually exclusive the benefits are cumulative without any risk of duplication or double counting.

SART is a 4-stage process, summarised as follows:

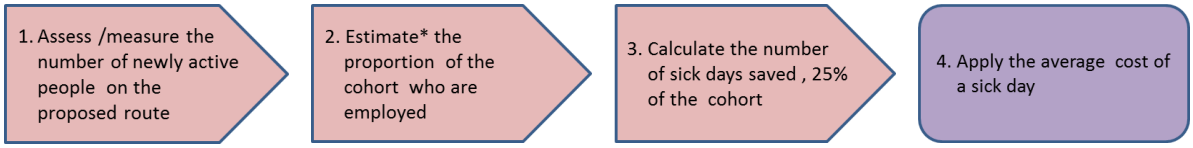

Figure 23: SART Process

Stages 2 to 4 can based on standard data values

SART in practice – Royal College Street, London
When applied to the Royal College Street proposals the SART methodology produced a further benefit of £94,000 over 10 years. Thus, the cumulative effect of cycling and walking totalled a benefit of £441,000 or a new BCR (monetary benefits / project costs) of 0.93:1.

At this point the project is virtually at breakeven using just HEAT and SART. For TfL a neutral BCR is not usually enough to justify a project and a good value-for-money hurdle rate will be nearer 1.5:1. However, the purpose here is to demonstrate the value HEAT and SART calculations can add to a business case assessment. Full details, assumptions and calculations, of the Royal College Street HEAT and SART assessment are contained in the TfL publication 'Valuing the health benefits of transport schemes'.

HEAT and SART Conclusions
The origins of HEAT can be traced back to an extensive cohort study carried out by CREATE partner Copenhagen that followed the lives of its participants for a period of more than 14

years. This study, and many others since, have all found the same basic relationship between physical exercise and the risk of death.

Similarly, and not surprisingly, numerous studies have shown that there is also a link between time lost at work through sickness absence and inactivity levels. Capturing these benefits in a standardised format such as HEAT and SART will often be the difference between a financially viable and non-viable development scheme.

5.14 Financing Stage 3 Projects

Traditionally the assessment of capital projects will be based on a Benefit to Cost ratio and an NPV calculation using an appropriate discount rate and indeed this remains (et al) the best assessment criteria.

However, when assessing Stage 1 type projects the benefit metrics are typically based on reduced travel times and the value that generates for the regional / national economy. But, as modern Stage 3 thinking becomes increasingly incorporated into city SUMP plans we find that capturing the full derived benefits requires a broader interpretation of the benefits case.

From this simplified presentation of the transition from Stage 1 to Stage 3 we can see that as well as the traditional benefits, at the Stage 3 end of the scale, there is an increased emphasis on the health benefits derived from active mobility and improved city living (e.g. air quality).

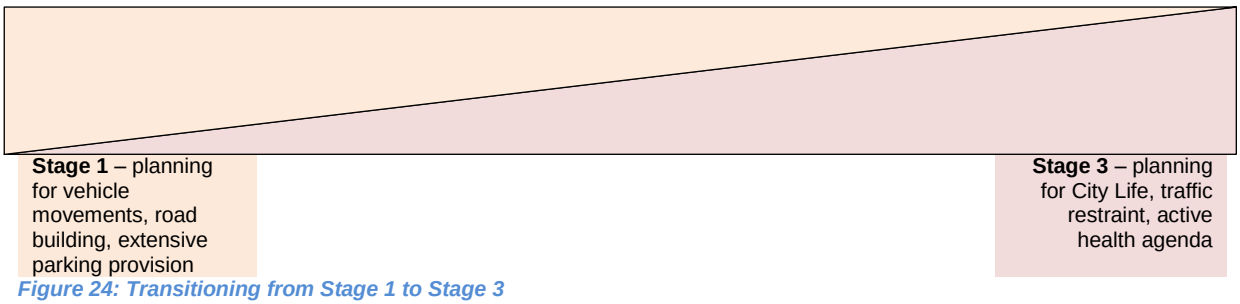

Figure 24: Transitioning from Stage 1 to Stage 3

Capturing these benefits is therefore a key issue because, as is demonstrated in the TfL case study, they are likely to be the difference between a viable and non-viable project proposal. Whilst this places additional onus on the HEAT and SART models it also raises the question of how these benefits are recognised by funding organisations since another of our core findings is that all of our city partners, to varying degrees, rely upon borrowing to supplement capital development budgets.

It is also the case, as we saw with the Skopje LRT proposal, that evolving economies will have a lower credit rating than the more developed economies and this affects their ability to borrow at the best available interest rates.

Consequently there is a dual need to ensure that not only do project sponsors capture the full benefit of their proposals but also that funding agencies, particularly EIB and EBRD recognise the veracity of the health related benefits when considering their funding strategies and evaluation techniques.

In short, for Stage 3 policies to continue to evolve and flourish, lending criteria needs to adapt to the changing policy environment so that we continue to encourage the uptake trend.

6. Funding and financing practices in Stage 1 Cities

6.1 Introduction

Approach
A study has been conducted in order to understand the readiness of Stage 1 cities to accelerate to Stage 2 and Stage 3 policies and measures and hence tackle congestion and reduce the dependency of car ownership. This has included an evaluation of the predominant Stage at which each Stage 1 city finds itself, the financing and funding mechanisms in place and the governance structures which may help or hinder progress.

The way in which Stage 3 cities have invested in Stage 1, 2 and 3 measures over the years is giving us new insight so that other cities might follow suit. However, if the conditions are not right, such recommendations may be interesting for cities but not yet realistically realisable.

Therefore, in order to understand their various "starting points" each of the Stage 1 cities were interviewed by Vectos. Using a standardised discussion guide the interview transcripts were written up into city reports and supplemented by desk top research. This research looked at various funding and financing programmes to illustrate the opportunities and challenges for Stage 1 cities to invest in measures to reduce car dependency and congestion. These include political, regulatory, capacity and funding.

Current starting points. At which Stage is your city?
The first question that was asked in the interviews pertained to the starting Stage of each city. By referencing the Stage 1, 2 and 3 indicators and considering current priorities for investment, each city was able to give their subjective view which is recorded below:

Table 9: Actual City Stages

City	Predominant CREATE Stage	Comments
Amman	1	Emphasis on moving vehicles, car ownership growth, little evidence of Stage 2 or 3 measures and policies. Funding priorities on road and bridge building. Future priorities centre on PT investment.
Adana	1	
Skopje	2	Concurrent support for moving vehicles and moving people with Stage 1 and 2 measures evident. Some signs of Stage 3 especially in city centres (e.g. liveability, reallocating road space from cars). The significant investment in PT infrastructure and fleets indicates that, overall, these 'Stage 1' cities may be more accurately defined as Stage 2
Tallinn	2	
Bucharest	2	

With Bucharest, Tallinn and Skopje all showing examples where road space has been reallocated from car towards other modes like cycling and public transport, this shows these cities have already made progressive steps forward, which is promising for future acceleration to Stage 3. The well documented free public transport system in Tallinn is an innovative Stage 2 measure which symbolically distinguishes itself away from a Stage 1 definition.

Figure 25: Skopje reallocation of road space from car to cycling

Figure 25 shows a new road layout in Skopje, where one car lane (from a total of four) was removed and the space converted into two cycling lanes. Additionally, the pedestrian crossing access was improved. This design has the hallmarks of Stage 3 cities where the design has additional health and environmental impacts such as improved air quality and reduced sedentary behaviour.

This implies Skopje is already integrating Stage 3 type measures into the mix. The design of the road was changed during the implementation Stage after the Mayor was advised by the city planners that a wider road would attract more cars and worsen congestion. This was supported by experiences in other European cities and via the CREATE city exchange programme.

Do the cities have Sustainable Urban Mobility Plans in operation?

- Amman has the Transport and Mobility Master Plan which sets out objectives, such as BRT which is the main priority. It does not constitute a SUMP as defined by the EU.
- Adana has a Strategic Plan which aims for a transition from car to public transport as a listed objective. It does not have an up to date transport plan though.
- Skopje has a form of SUMP but it is based on predict and provide for cars, rather than a future vision for the city.
- Tallinn is in the process of drafting a SUMP with the expectation that it will be politically supported (unlike the current plan).
- Bucharest has a vision-based, multi-modal SUMP (integrated with the Ilfov region) with ambitious targets acting as leverage for financing and funding for component measures.

6.2 FUNDING: Instrument for Pre-Accession Assistance (IPA)

Funding priorities

The Transport Sector Operational Programme, is a major part of the IPA for orienting the financial assistance of the EU to the transport sectors in Turkey and Macedonia. The current programme runs 2014-2020. IPA funds 85% of investments with 15% emanating from local or national levels.

The Operational Programmes offer varying priorities and hence some opportunities for investment in measures in Adana and Skopje, although there is high demand from other cities and many budget commitments will have already been made. The nature of these priorities reveal the starting positions for urban areas in the countries as a whole.

In Turkey there is a priority to transition from individual transportation to sustainable, accessible modes of mass transportation and national and urban levels. This implies that the current starting point is Stage 1 where individual transportation is the main driver of policy. Priorities include a shift towards more balanced modal split (which tallies with EBRD rhetoric) and reduction in traffic congestion and emissions from urban transport.

Therefore the Turkish Operational Programme clearly supports a shift from Stage 1 to Stage 2 measures.

Turkey's Low-Carbon Sustainable Transport Development, Strategy and Action Plan will seek to reduce greenhouse gas emissions through, amongst other things, soft measures. This might be an anchor on which to pitch further Stage 2 and 3 investments.

It is understood that Adana has not yet been in receipt of IPA funding due to the high demand from many other large cities in the country and the relatively limited overall budget (when compared to ESIF). It might be the case therefore than EBRD offer a better angle, if lending requirements are met.

The Macedonian national transport strategy defines priorities for the Operational Programme's urban transport component. These are geared towards improving the movement of people rather than improving the movement of motorised vehicles. This is completely in tune with the CREATE evolutionary cycle supporting a transition from Stage 1 to Stage 2.

In Macedonia, investment from IPA, municipalities and the Ministry of Transport and Communication has constructed and rehabilitated urban pedestrian, bicycle lanes and improved signage. This is responding to one of the Operational Programme priorities of improving mobility in urban areas using green transport. There may be additional opportunities for Stage 2 type investment from this programme until 2020.

6.3 FUNDING: European Structural and Investment Funds (ESIF)

Introduction

The ESIF is administered through Operational Programmes agreed between Member States and the European Commission. The priorities of these programmes give a snap shot as to the opportunities available to cities in terms of funding and whether that funding is intended to be invested in Stage 1, 2 or 3 measures.

Reviewing the Operational Programmes of Estonia and Romania for the 2014-20 period we can see priorities for all three Stage type measures.

Romania priorities range from Stage 1 to 3 including:

- Rehabilitation and modernisation of 2,000 km of roads improving regional connectivity to TEN-T network (Stage 1);
- Sustainable multimodal urban mobility and improving urban public transport (Stage 2);
- Creating 224,000 sqm of additional green spaces in cities (Stage 3).

Estonian priorities centre more around Stage 2:

- Doubling of rail passengers (Stage 2);
- Sustainable transport to limit increase in GHG (Stage 2);
- Integrate different mobility modes and clean urban transport (Stage 2).

In both cases the efforts to integrate mobility modes is a strong Stage 2 measure, moving towards Stage 3. Funding opportunities may therefore exist to accelerate the progression through Stage 2 and the take up of Stage 3 measures with sufficient complimentary justification; namely using the methods and indicators employed by Stage 3 cities.

ESIF evolution in priorities

Looking back on priorities from the 2007-13 programmes, we see the CREATE evolutionary cycle has taken place in EU programmes just as it has in national and local priorities. For instance, in the Romanian Regional Operational Programme for that period, we saw strong Stage 1 priorities such as 200km of ring road rehabilitated, built or modernised. There was also additional funding for parking, with lesser provision for public transportation as the current programme.

In the last period relevant Estonian programme priorities were on transport infrastructure and

improving accessibility by developing public transport and improving connectivity and safety. Major rail and road projects were supported. Investment aims were to reduce travelling times and increase the use of public transport. This is marginally but noticeably less advanced on the CREATE evolutionary cycle than the current programme which talks more about clean urban transport and inter modality. This shows steady progress being made, implying decision makers are making better priorities.

Funding chains. Chain reaction?
The SUMP of Bucharest-Ilfov is not only an enabler of EBRD investment, it is also a tool through which ESIF can be more strategically and significantly administered. The SUMP – like those of the other seven Romanian growth pole cities – was funded through EBRD. Subsequently the Regional Operational Programme has made funds available for each city to swiftly bring forward one such SUMP measure. This has proven to be a good initiative to 'reward' multiple cities by taking a strategic approach and a chance to accelerate their CREATE evolution.

There is an opportunity here therefore for the CREATE Stage 1 city Bucharest to consider what its measure will be and whether this could be an advanced Stage 2 or even a Stage 3 measure to support the acceleration process

The SUMP includes measures and projects to be implemented over next 15 years and includes a traffic model which can be used to assess impact on investments and hence be a useful appraisal tool to justify certain spending. One idea might be to see whether this tool can be used by other cities in the country and the region, to help other Stage 1 cities help justify investment, possibly in cycling infrastructure or reallocating road space from vehicles to public transport.

There is a total budget of €7bn for the 15 year SUMP, half of which is earmarked for developing the tram and metro (due to start construction 2018) and the other half for local authorities.

Such significant resources may have been successfully mobilised thanks to the presence of the SUMP and its multi-layer approval process, completed in March 2017. This included collaboration between the ministry, local authorities, city hall, county council and 40 localities. The vision-based SUMP is proudly designed for citizens rather than for cars and so is a solid foundation for Stage 2 and Stage 3 type policies and measures. It includes the following strategic objectives:
• Accessibility;
• Safety and security;
• Environment;
• Economic efficiency; and
• Quality of urban environment.

It envisages projects in the following domains:
• Capacity building;
• PT improvement;
• Promotion of non-motorised transport, walking and cycling;
• Park and ride; and
• 250km bike network for city and region.

There may be untapped potential for EBRD and EIB financing to support delivery of some of the SUMP measures, both the physical and the organisational – since this 15 year strategic framework might well attract low risk investments. The same applies to the other seven cities and there is an opportunity for CREATE to help provide justification for delivery of certain Stage 3 measures, as part of the single ROP-funded SUMP measures.

6.5 FINANCING: Summary of activity with EIB, EBRD and World Bank

Introduction
There is a precedent for all five Stage 1 cities accessing loan financing from International Finance Institutions (IFIs). They include projects concerning urban infrastructure, public transport fleets and buildings.

This is a positive finding since the research into Stage 3 cities showed that borrowing is an essential part of investing in Stage 2 and 3 measures and policies.

Whilst they do not all pertain to transport and mobility, a precedent for accessing such financing shows that capacity, protocols and permissions are in place - to varying degrees - to help capitalise further on this potential avenue to accelerate the CREATE evolutionary process. There is an opportunity here therefore to exploit. Some examples include:

- Amman French Development Agency Bus Rapid Transit
- Adana EBRD PPP Hospital campus
- Skopje World Bank Municipal services
- Tallinn EIB Public Transport upgrade/ street refurbishment
- Bucharest EBRD Sustainable Urban Mobility Plan

Some cities are more active than others, which can depend on factors such as sovereign and municipal level credit rating as well as the governance and protocols for accessing and administering loans. No successful transport-specific loan applications could be identified in Skopje and Adana, although the Macedonian capital has tried on several occasions to gain financing from EBRD for a new tram service. It is understood that credit rating for Adana is a barrier to such loans.

6.6 FINANCING: European Investment Bank (EIB)

EIB financing
The EIB provides loans and guarantees for transport projects such as urban mobility, rail, aviation, maritime and road projects. Priorities for financing are projects which are climate-friendly, safe, sustainable and innovative. EIB loans cover up to 50% of total project costs and can help to unlock finance from other sources, especially the EU budget such as by acting as the requisite match funding; blending the two together.

They also support research, development and innovation projects aimed at making transport efficient, economic and sustainable. To support the deployment of alternative fuels and cleaner technology in transport, the Cleaner Transport Facility has been launched.

EIB transport priority themes include:
- Urban Mobility: Construction and extension/rehabilitation of public transport networks such as metro and tramway lines and rapid transit bus systems; acquisition of rolling stock and buses; promotion of cycling and pedestrian networks; development of intelligent traffic management and information systems to improve public transport;

- Climate-friendly transport: In line with EU policy, prioritises investment in public transport and railways, supporting the deployment of alternative fuels;
- Sustainable and safe mobility: Economically, socially and environmentally sustainable. Development of sustainable urban transport and urban nodes to significantly improve the quality of life by reducing congestion, pollution, accident rates and travel times.

In the context of CREATE, these priorities feel geared principally towards Stage 2 of the

evolutionary cycle.

EIB has been active in Estonia for many years. In May 2017 a loan agreement for €100m was signed between EIB and Tallinn for a number of small to medium-sized schemes in the areas of municipal infrastructure and mobility. Over the next three years this will help realise the modernisation of the public transport and refurbishment of city streets.

How to better exploit EIB financing
The **JASPERS** service (Joint Assistance to Support Projects in European Regions) is a partnership between the European Commission, the EIB and the EBRD. It delivers capacity building, knowledge sharing and networking activities to increase the administrative capacity of authorities to help improve the quality of the major projects to be submitted for grant financing under the ESIF and IPA. Activities also include support for blending of EU funding with private financing for non-major projects.

JASPERS tends to be involved in contracts above €75m, or a collection of smaller loans for several cities working together. Cities can approach JASPERS informally, or there are national contact points available via the EIB. JASPERS work with cities as they prepare their submissions to make sure they comply with requirements, with a focus on low risk investments. They have provided support to Skopje in their tram tender as well as Tallinn. In Bucharest their involvement helped to mobilise many key actors in the development of the regional SUMP (as well as the many other SUMPs delivered in the Romanian growth poles).

Regarding loan applications, a project tends to fail securing the desired financing where the idea itself is not strong enough, or where the funding mechanisms are not fit for purpose. This might be where an 'off-the-shelf' PPP proposal is put forward for a new tram service which is not tailored to the local circumstances.

Thanks to the fact that many staff are engineers themselves, this allows for the team to conceive design proposals which respond to a Mayor's vision for example and to help to get key stakeholders around the table.

6.7 FINANCING: European Bank of Reconstruction and Development (EBRD)

EBRD financing
The EBRD helps local authorities meet their needs for infrastructure, equipment and services. It does so by providing financing in the form of equity or loans ranging from €5m to €250m. It advocates increased private sector investment such as through Public Private Partnership projects (PPPs) which are deemed to give a better chance of delivering high quality assets on time and within budget (than public alone). Key priorities for financing are to promote commercialisation and corporatisation of services, moving away from the command economy, opening markets to competition and maximising the potential for economic growth.

To be successful, a project must first present its business plan to show that they have strong commercial prospects, involve significant equity contributions from the project sponsor and that it will benefit the local economy. It should also show how it will develop the private sector and satisfy banking and environmental standards – such as through impact assessments.
Through an analysis of this information the Bank makes a preliminary assessment of the project's technical, financial, economic, environmental and institutional feasibility. If positive, it can proceed to the next steps. Those bids that have not been successful, would have fallen down in at least one of these domains.

Full details are available from the EBRD website or directly from the Factsheet[4]

The EBRD offers financing options across a diverse Municipal and Environmental Infrastructure programme including those related to urban and inter-urban transport and mobility.

In the context of CREATE, EBRD financing can be sought by municipalities to take forward Stage 1, Stage 2 and Stage 3 type measures. As such this offers the potential for acceleration or deceleration along the CREATE evolutionary cycle; depending on the city's starting point and political priorities. It also depends on which part of the city is under examination. The more central the location, the closer to Stage 3 one becomes; the more suburban, the more Stage 1 one becomes dominant. This is even evident in advanced Stage 3 cities in Western Europe e.g. Copenhagen.

Table 10: EBRD funding priorities categorised by CREATE Stages

Example of EBRD Programme	CREATE Stage	Details
Municipal and Environmental Infrastructure	**Stage 1**	Investment in key missing road links, new bridges, bypasses (only where bottle necks exist and after solid economic justification)
Urban Transport	**Stage 2**	Urban trains, trams, trolley buses, bus fleet renewal (Diesel, CNG), eTicketing and traffic management
Green Cities Programme	**Stage 3**	To meet environmental challenges and improve people's 'quality of life in cities'

Table 9 above illustrates that, in the context of CREATE, EBRD is simultaneously supporting Stage 1, 2 and 3 measures. This might be seen as contradicting priorities. How can one programme promote quality of life in cities through improved air quality through clean urban transport (Stage 3), but at the same time provide loans for new roads and bridges (Stage 1)?

Does this challenge the CREATE evolutionary cycle?

Municipal and Environmental Infrastructure
The best way to answer this is to look at the EBRD's Municipal and Environmental Infrastructure Strategy (2012) [5] in which are listed specific Urban Transport Sector needs. These are in effect priorities that the bank determines should be reflected in the projects it finances. It is clear that these needs support investments that are principally Stage 2 and Stage 3 measures:

- High-quality public transport alternatives to the private car;
- Balanced modal splits;
- Efficient tariff regimes and automated fare collection systems in public transport;
- Parking management, to lower car travel demand;
- Safe street environments for pedestrians and cyclists;
- Modern, integrated traffic management solutions;
- Raising Social Awareness and promoting inclusion and gender mainstreaming;
- Public service contracts ("PSC") as a crucial contractual instrument used to define services, assign roles and obligations of both the operators and the public sector owner and regulator.

Urban Transport
They also set out the sector's Urban Transport Sustainability Goals, which are equally as encouraging:

- Increase walking, cycling and public transport usage;
- Reduce traffic congestion through traffic reduction measures;
- Increase the energy efficiency of urban transport systems;

[4] http://www.ebrd.com/downloads/research/factsheets/guidetofinancing.pdf
[5] http://www.ebrd.com/downloads/sector/mei/mei.pdf

- Introduce the use of sustainable renewable energy for urban public transport.

The fact that there is provision still for new roads and bridges therefore indicates that the Bank acknowledges that some cities still need the fundamental infrastructure in place (such as roads) in order to develop Stage 2 measures (such as bus lanes and fleets). Equally, cities need to have a public transport network in place (Stage 2) before it can realistically achieve modal shift away from car use and invest more in places, liveability, safety and health (Stage 3).

What this does mean however is that if a city is in the process of moving from Stage 2 to Stage 3 - but then there is a change in political priorities or available resources - the municipality could find itself decelerating or going backwards on the evolutionary cycle, if it were to secure a loan for road building for instance.

Green Cities Programme

The Green Cities Programme was set up in 2016 to support governments, municipalities, municipal-owned and private companies to meet environmental challenges and improve people's quality of life in cities.

The pursuit of better quality of life, resonates strongly with Stage 3 type policies and measures, integrating different sectors to realise common benefits like modernised public transport, air and water quality.

A crucial component of the programme is the Green City Action Plan (GCAP) which assists municipal authorities and key urban stakeholders to identify and prioritise green city actions. The GCAP provides and prioritises potential investments acting as an investment plan for the city to address environmental challenges. To be eligible, cities must have a population of more than 100,000 and initiate a 'trigger' project in municipal infrastructure that addresses climate change or environmental issues. They must then commit to developing a GCAP. The Programme has a total of up to €250m for more than 30 cities; with pilots already being delivered in Georgia, Armenia and Moldova.

Stage 1 cities could therefore consider positioning themselves to participate in this programme, to unlock a €5m loan, by introducing a Stage 3 measure followed by the development of the GCAP.

Example of a Stage 3 policy in CREATE

In 2014 Transport for London launched its Health Action Plan, considered to be the world's first such plan from a transport authority including ten indicators for air quality, physical activity where 'healthy streets' is a stated objective and with supporting key performance indicators. For example, it contains a number of health and environmental KPIs that can be realised through transport investments. This is considered a Stage 3 policy and the commitment reaffirmed by the succeeding Mayor in 2017.

How to better exploit EBRD financing

EBRD and other IFIs have set up project preparation facilities dedicated to helping governments with emerging markets to prepare, tender and deliver proposals such as for infrastructure PPPs. Some cities find the process complex and so there are dedicated units of specialists with funding available to pre-fund PPP project development from feasibility studies all the way through to PPP award.

Similar to EIB funding, one consideration is to blend EU funding with EBRD and private financing. It should be noted that cities have a maximum debt level, over which they cannot receive additional lending. This should be verified before loan applications are made, preferably through EBRD itself; or JASPERS which also advises on making strong proposals to EBRD resources.

Municipalities, transport operators and businesses can make use of the EBRD twinning service to increase capacity and skills. Twinning can take place between a company and a municipality or transport operator to help develop and improve the quality of the public service contract (EBRD loans

backed by Public Service Contracts between city and company) or the commercialisation of public transport services.

The Bank looks favourably on cities which have well-defined transport priorities – such as through SUMPs, as by knowing future plans and the way this links with other policy areas, the investment risk is mitigated. As such, cities that have SUMPs in place could have an advantage over those that do not.

Successfully sourced EBRD Financing
EBRD is helping to upgrade urban transport infrastructure in the Romanian city of Galati with a €22m loan to the municipality. This is targeted to rehabilitate key streets, purchase new trolley buses and introduce a privately-operated automated system for collecting fares. As part of the project the city is developing a SUMP with EU standards. Similar projects have been realised in Sibiu, Iasi, Arad, Brasov and Pitesti through €180m of EBRD investment.

In 2014, the Romanian Government invited EBRD to provide consultancy support in developing SUMPs for the seven Romanian growth pole cities - a SUMP for Bucharest-Ilfov region – supported by JASPERS. This was delivered following an agreement between the EC and Ministry of Regional Development and Public Administration. The obvious benefits of this innovative approach is that these cities are now better equipped to increase the rate of absorption of ESIF and leverage of loan financing from the IFIs, since they can provide strategic direction and priorities for investment, implying lower risk investments.

This example shows the significant potential EBRD (and its strategic partners) can bring in accelerating a city's progress through Stage 2 process through a mixture of physical and strategic policies. This might well be a model that other countries in the region could follow, with collaboration between relevant ministries, municipalities, EBRD, JASPERS and the EC.

Subsequent to the SUMPs being delivered, in 2017 the EBRD launched the €120m Framework for Sustainable Mobility and Access to Road Transport (SMART) in Romanian cities. It aims to provide loans of between €10m and €25m for approximately ten municipalities, counties or transport operators. It seeks upgraded, reformed and improved quality of public transport infrastructure and rolling stock. By mobilising sufficient funding sources it expects to encourage private sector participation. Many contracts have already been signed such as €15m loan to the city of Sibiu.

The SMART framework appears to be clear evidence of the additional financing avenues EBRD are prepared to make available to cities that have clear strategic transport objectives, such as SUMPs. This is a good story to tell other Stage 1 decision makers wanting to accelerate along the CREATE evolutionary cycle.

EBRD is financing a new hospital campus in Adana, Turkey, through an agreed Public Private Partnership. Whilst this is not transport-specific, it shows a precedent for this type of financing arrangement in the city and hence cooperation between relevant stakeholders and importantly investment from the private sector.

6.8 FINANCING: World Bank and other sources

World Bank
The World Bank provides financial and technical assistance to help countries implement sustainable mobility solutions that create lasting benefits to development. Priorities include safer, cleaner, more efficient and accessible transport systems that reduce congestion and pollution, facilitate access to jobs and lower transport energy consumption. A focus is on Urban Passenger Transport: Rail, Bus Rapid Transit Systems and Municipal Parking.

This therefore supports Stage 2 measures. There is less evidence of World Bank activity in the five Stage 1 cities in the field of urban transportation.

The World Bank states that city planners have an opportunity to design sustainable and inclusive transport systems from the start, leapfrogging more polluting and costly modes. In older or larger cities, technology and big data are helping better map travel patterns and needs, engaging citizens and improving the quality and efficiency of transport solutions. This precisely captures the CREATE methodology.

French Development Agency (AFD) - Amman
The BRT will be funded by the AFD. Also they funded the Amman Plan and the Transport and Mobility Master Plan (TMMP) which includes Traffic Management, IT and Public Transport measures. However there is little prioritisation of measures and so far the only measures to be funded centre around roads. The TMMP is based on 2008 household surveys.

Other potential sources of financing - Macedonia
The Western Balkans Investment Framework supports socio-economic development and EU accession through the provision of finance and technical assistance for strategic investments, particularly in transport infrastructure namely road and rail. It is a joint initiative of the EU, International Financial Institutions, bilateral donors and the governments of the Western Balkans.

Juncker Investment Plan for Europe
Cities which are currently unable to secure financing due to perceived investment risks may use the EU budget (such as Horizon 2020 and Connecting Europe Facility) as a guarantee to encourage EIB to finance projects (notably infrastructure and innovation, sustainable transport). This might also encourage private investors. Applications are made directly to the EIB. The deadline for project approvals is set at the beginning of July 2019.

7. Review of Stage 1 city challenges and opportunities for acceleration along the CREATE evolutionary cycle: The funding and financing perspective

7.1 Opportunities in accelerating the CREATE evolutionary cycle

7.1.1 Amman: Sources of funding and financing. Measures implemented and planned

IFIs
The Bus Rapid Transit scheme is being funded by the French Development Agency (AFD). They also funded the Amman Plan and the Transport and Mobility Master Plan (TMMP) which includes Traffic Management, IT and public transport measures**.** However there is little prioritisation of measures and so far the only measures to be funded centre around roads. The TMMP is based on 2008 household surveys.

Amman is currently speaking with a Chinese company to update the TMMP since there have been many changes to the city demographic since 2008: namely the massive increase in refugees; and the increase in women in the workplace.

EBRD is funding port development in Aqaba, a big tourist site on the Red Sea, which is progressive on transport. There may be opportunities for EBRD or other loan financing therefore for Amman as well.

There is little collation of data to help evaluation and justification of investments. Rather, modelling is primarily used to make assessments. As such current modal share is an estimation. There are plans to deliver traffic counting surveys for the first time using international funding to procure services from Jica (Japan International Cooperation Agency).

Local
Amman generally works independently from the government. For instance, the national transport plan was drafted without the inclusion of the urban areas of Amman. This suggests that EBRD or World Bank financing might be better sought directly by Amman (unlike in Tallinn and Skopje which is channelled centrally).

There is a desire to make more use of VISSUM /VISSIM but due to regulations licences can't be bought from companies that are not located in the country. (PTV is based in Netherlands).

The feeling is that it is not finance that is the main barrier to implementing Stage 3 measures, but rather political will and continuity. Quite often when there is a change in personnel in the city, projects can stall since there is a culture of poor communication of respective work and remit.

Between 2010 and 2011, new bus stops were funded by local businesses who in return were offered free advertising space on the shelters themselves.

People and politicians generally prefer to see new roads not public transport. There are two layers of society: those that don't use PT and have no interest in expanding it; and those that do use PT are poor and have a meagre voice.

Measures
The TMMP has many recommendations but they are not necessarily integrated. It is not yet clear what the new Mayor will prioritise although BRT will probably remain on top of the agenda.

In September 2017 Amman hosted the C40 Cities event which brought together cities to discuss resilience against climate change. The Mayor was involved with this which is a positive show of commitment to the broad area of sustainability.

Careem (Dubai-based Uber) has just been given permission to enter the market in Amman although they are still working on licensing issues.

As such Amman is certainly within Stage 1 with plans to shift to Stage 2 measures like the BRT. One challenge however is that public transit is not considered a viable option by many sections of society due to infrequency, perceived class and safety issues. BRT aims especially to carry students to avoid them needing to use cars. It has a completion date of 2019. A new department has been set up to deal with BRT who will start tendering buses soon to run the system. So far progress with local contractors has been slow. All other elements of the TMMP are on hold with BRT getting all priority.

Some pedestrian areas have been started, but with little success: in one case this led to a decrease in retail activity in that area due to lack of parking.

A Parking Management Scheme was introduced around the hospital area. However, there was a lack of enforcement by police so illegal parking remains an issue. Parking enforcement as a whole across the city is poor.

A new eTaxi scheme has been launched in the downtown area which offer cheap fares.
There is a general lack of public awareness raising of new services which may lead to poor take-up.

There are plans for inter-city buses to connect Serka with Amman with a shared terminal affording better interoperability with Amman bus services.

Stakeholders
The municipality is responsible for all public transport in Amman. The Director of Transport has influence over the TMMP as well as the Mayor and the City Manager. But the Director post has been empty for a while so there is no single person advancing measures and there is a complex governance structure. There is an elected council but they are not specialised in transport. The Land Transport Regulatory Commission is responsible for the PT routes and so must be consulted closely. This makes for a tough environment for advances to be made.

The new Mayor was appointed by King Abdullah in August 2017. The King himself is probably the biggest proponent of sustainable development - e.g. solar panels on palaces -but ministries also need convincing.

7.1.2 Adana: Sources of funding and financing. Measures implemented and planned

National and Local
The light rail and bus network are all funded by the municipality. The fares cover some but not all operating costs, especially with concession fares for over 65s who can travel for free at any time of the day.

Central government and the municipality are at different ends of the political spectrum which, like in many other countries, can act as a barrier to unlock central funding.

Other than the operation of bus services and mini buses there is no other main role for the private sector except for the inter-city carpooling app. No car-sharing or carpooling services inside the city yet.

IFIs
Adana has contacted EBRD and World Bank for urban transport financing. However, since Adana does not have an urban transport plan they are not normally eligible. Also the credit rating is not too good for the municipality.

EU
The municipality needs to increase institutional capacity to be able to bid for and fully capitalise on Horizon 2020. As for IPA, Adana has not yet accessed this programme which is managed at the national level. There might be value in contacting directly JASPERS who advise on accessing IPA and the various priorities and processes.

Measures
Adana has no SUMP as yet, rather a municipality strategic plan which sets out the Mayor's five year strategy. These are the priorities:

- Preparing and applying the Transportation Master Plan;
- Supporting environmentally sensitive transport systems (this includes a drive to introduce PNG-converted buses, but an earlier pilot did not prove successful with poor performance so this have been stopped);
- Creating a strong transportation infrastructure;
- Strengthening a transition to rail system and public transportation systems.

Overall the Mayoral priorities are still driven towards big impact physical measures such as bridges and bus fleets, but not yet developing a SUMP.

Adana is firmly at Stage 1. There are no bus lanes in the city. Bus stops are set back from road but these spaces are not used by the driver as it's difficult to get back into traffic again, therefore bus drivers stay on the road causing congestion. They also think that cycle lanes will cause problems for pedestrians as cycle lanes would be painted onto same shared surface. CREATE can help by showing some good examples where this can work.

Walking and cycling are still considered leisure activities and so data not collected here.

There are no real Stage 3 measures evident as yet. There are no specific cycling infrastructure implemented but there are examples where upgrades to existing roads have included some cycling and walking retrofitted lanes. Air quality is not yet a consideration from the transport perspective since data shows that industry is the main cause.

Key Stakeholders and Organisational Structures

- The two key ministries have the most potential steer for Adana's transport priorities: Ministry of Transport and Ministry of Urban Planning and Environment.
- The municipality operates some of the bus services and the 13km light rail.
- Five private companies operate other bus services along with the mini buses

The municipality has been lobbying central government to get funding to extend the light rail but this has not yet succeeded.

7.1.3 Skopje: Sources of funding and financing. Measures implemented and planned

National and local
The national government has funded a new bus fleet for the city. The cost would not have been bearable by the city alone. The municipal budget is a modest €35m per annum and so the city is interested in both grant and loan funding options (central government, EU and IFIs).

Both local and national levels can initiate or flag desired international funding opportunities.

IFIs
There have been two attempts to introduce tramways by reallocating road space from cars but have so far failed to identify implementation partners. The plan was for a 24km track along a single route with 22 trams holding 200 passengers each. The tender was for the design, build and 35 years' operation via PPP at cost of €180m euros.

However, no private funder identified. The city worked closely with the prime minister and the government of Macedonia. EBRD and EIB were approached for funding, but they were not supportive of the tender specification due to the number of years of service required; whilst the recession was a factor too.

The Mayor is instead refocussing attention on an electric bus programme to replace the tram proposal. Buses are less expensive and offer a similar capacity to the tram. A request for funding has been submitted to central government. They have not yet explored loan options from EBRD or EIB. There is an opportunity here to liaise with JASPERS to get advice on lending priorities for EBRD and EIB.

A World Bank sub loan has been received via the Ministry of Finance for municipal services from which Skopje received financing for providing new garbage trucks, following request by the Mayor. Three projects have been funded this way so there is a precedent for transport-related loans.

EU
IPA Operational Programme includes measures for walking and cycling although these have yet to be drawn down.

Skopje has a Local Transport Plan. It is not based on the future vision of the city, it is rather based on the traffic demand forecast (2010-2015 and 2016-2030). Stage 1 and Stage 2 indicators are generally used such as average network speeds, vehicle congestion, day to day variability, PT frequency data and PT, walking and cycling modal split.

Measures
Skopje is delivering a number of progressive Stage 2 type measures, showing evidence of movement along the CREATE evolutionary cycle. It has decided to reallocate road space to bus lanes with approval made, but implementation pending. Equally the bus lanes along corridors in town centre would give priority at traffic signals (DESIGN project). They are currently trialling timing of traffic signals for buses and bus localisation technologies.

Skopje VeloCity was launched in 2014, with the objective to promote cycling as a healthy, low cost and environmentally-friendly transport mode. Targets are set to increase trips to 5% modal share by 2020 and to improve air quality and to reduce congestion. A programme is underway to improve the quality of 50km cycle paths (30km already improved) with a pilot delivered to narrow traffic lanes to release space for cycling.

In the pipeline is a bike share system, extra cycling parking and bollards to stop illegal vehicle parking. This positive Stage 2 to 3 picture is offset however by the building of eight multi-story parking lots in the town centre, showing conflicting priorities.

Key Stakeholders
Skopje city oversees the public company for buses, private owners of buses through two associations and private taxi companies.

Discussions take place between EU institutions and central government in order to prioritise IPA allocations. Decisions are then made between councillors and central government. The total 2014-2020 is €210m with planned initiatives in the FYROM Sector Operation Programme for Transport.

In order to access EBRD and EIB loans there is a similar process involving the Mayor, council and national government, then if approved the council can enter discussions with the IFIs. EBRD municipal loans have been awarded in the past, but they need to adhere to the rules of the programme: need to show feasible, sustainable and decentralised aims.

The Mayor proposes policy, then the council approves (representing citizens), before a request for funding is transmitted to national government.

CREATE is helping to influence the opinion of the Mayor and stakeholders who accept now that building roads creates more traffic. There is a feeling that there is a shift in the opinion of the Mayor towards more sustainable transport but central government is a little bit behind the curve acting as a drag.

For instance, the Ministry of Transport and the Police takes more time to change their point of view on cycling safety. Central government is more old-fashioned still preferring road building and parking. The Traffic Management Control centre is trying to make green waves for cars. The adaptive traffic control system is set to prioritise cars and not pedestrians.

Elsewhere there is an integrated transport smart ticket making available all PT services including privately-run buses. There are no carpooling or car-sharing companies as yet in Skopje. The SocialCar project is building data to allow the promotion of urban carpooling.

7.1.4 Tallinn: Sources of funding and financing. Measures implemented and planned

National and local funding
This is geared towards renewing bus fleets and reallocating road space for bus lanes. There is significant funding in public transport for renewing fleets and infrastructure, such as tram tracks and train stock. There is also road building in the city centre for bus priority lanes and reduced parking.

The national government has announced that the ESIF funding for 2020-2026 will be much less than before (same for the whole region). At the moment almost 40% of transport funding comes from the EU. Estonia's co-financing rate is 15% either by municipalities or national government. The procedure starts by looking at where the co-financing will come from, then priorities are made on the EU funds to be drawn down. Generally this is for new infrastructure and services rather than existing renovations.

Private sector
A bike sharing scheme was launched in November 2016 (100 bikes and 10 locations initially). The city has made available free locations and they allow for free advertising. SIXT is the sponsor (on bikes and stations) and uses same model as London cycle hire scheme. This is a positive precedent of PPPs in Estonia which can be developed, such as in EBRD financing.

Developers are requested to contribute to the costs of increasing capacity of intersections to improve access to new sites. A shopping centre has provided their own free bus service to connect with the harbour and hence increase tourist and resident footfall. This is in coordination with the local authority.

IFIs
JASPERS have visited Tallinn recently to deliver a 3 day SUMP training course free of charge by Mott MacDonald. The €100m EBRD loan allocated for Tallinn Urban Infrastructure 2016-2019 shows this is a significant contributor. National and local government tend to look towards EIB / EBRD loan financing only once EU funding has been exhausted.

EU
These funds are the source of Stage 3 measures (e.g. CIVITAS) and Stage 1 measures (e.g. ESIF) such as big intersections. ESIF also fund tram lines (Stage 2): a section of tram line opens in autumn 2017 connecting the city with airport including a high quality cycling network connecting neighbouring municipalities with Tallinn.

Estonia has sold unused Co2 quotas to Spain (based on 1990 levels for Kyoto has meant a surplus since 1990s) in order to fund:

- Tram rolling stock: Tallinn is now renovating tram lines with their own budget which has possibly unlocked funds thanks to the quotas;
- Electro-mobility programme: National EV charging network in Estonia has 300 EVCPs + 500 EVs for social workers.

Measures
Other progressive measures already implemented show the advances already made in Stage 2 and that there is momentum towards Stage 3:

- Reallocation of road space from cars to PT: Increase in length of bus lanes from 12KM to 24KM in city centre;
- Reallocation of road space from car parking to cycle lanes: In 2016 a central road had 40 on-street parking spaces removed and converted into cycle lanes;
- Cycling infrastructure: Number of cycling routes has increased from 70 to 254 in the city, although the quality could certainly be improved, consisting often of a narrow 1m painted lane on the road surface;
- 30km/h zones: To improve walking environment, 30km/h zones are being implemented in residential areas and the city centre. This is a big step forward since only two years ago this measure was not supported by local government;
- Car sharing: Electric Vehicle Car Share scheme implemented by national government (20 cars).

Conflicting interests
There is an ongoing multi-stakeholder debate regarding the design of a new road connecting the port eastwards to the city to alleviate congestion caused by larger ferries using the port. The Mayor, central government even property developers have strong and opposing views about the extent to which cars should be accommodated versus walking and cycling infrastructure. Funding is agreed (ESIF) and phase 1 underway but phase 2 has been paused (with court proceedings ongoing). The Mayor and some councillors prefer a car-oriented design (increase car space by 50%) to accommodate the boom in freight and ferry passengers to and from Helsinki, to cut the 3km tail backs when ferries loading.

Key Stakeholders and Organisational Structures
Public Transport Operators:

- City-owned transport company (operating with buses, trams, trolley buses) and one private bus operator (for 10% of city PT services). Free since 2013.

- Regional buses: part run according to publicly procured service contracts and part run by commercial operators. Single information system but different ticketing system.
- Trains: nationally-owned company

7.1.5 Bucharest: Sources of funding and financing. Measures implemented and planned

National
Ministry of Regional Development and of Public Administration provides significant funding for infrastructure and regional development projects in the city. They give certification for procurement. Some bank loans are directed through the ministry. It is understood that the main contributor to the local PMB budget (Bucharest Municipality) is the national government.

The Romanian Ministry of Environment gained €10m from the selling by Romania of greenhouse gas emissions certificates. This was channelled into the financing of nearly 100km bicycle lanes in city centre, a very innovative source of funding for clean urban transport.

IFIs
EBRD, EIB and World Bank are other sources of financing and have direct dealings with PMB.

There is a potential opportunity for the Ministry of Environment and Ministry of Water and Forests to work more collaboratively with EBRD, to better exploit financing options available, especially now by drawing on the “low risk” status with the new city-region SUMP which offers higher potential rates of return to growth and investment. A new authority will oversee the SUMP implementation giving it extra credibility.

Benefits could also be made by collaborating with cross-sector stakeholders in the SMART Romania programme. The SUMP mathematical tool also offers the potential to calculate the return on investment. JASPERS is actively involved in Bucharest in drafting of the contract for PT service for RATB.

Private
There is some evidence of funding from private companies for Stage 2 and 3 measures, for example sponsoring of mobility activities within European Mobility Week.

Measures
Overall there is decent progress in Stage 2 measures with momentum towards Stage 3:
- There have been several innovative pilots including of carpooling, car sharing and EV Solaris buses;
- Along Iancului avenue there has been the modernisation of tram lines and cycle lanes together;
- The new cycling lane along Calea Victoriei Avenue has been broadly welcomed, although faced scepticism during the planning phase.

Key Stakeholders and Organisational Structures
Bucharest Municipality (PMB) is the main stakeholder and decision maker on mobility for the city. PMB closely works with the Ilfov County Government (regional authority), such as in the case of the SUMP Bucharest - Ilfov,

NGOs continue to apply pressure on the municipality to speed up walking and cycling investment. Their growing voice, in a consultative environment, could also help their Stage evolution.

In 2012 PMB set up a Mobility Working Group comprising representatives from the municipality, universities, stakeholders, NGOs and companies to discuss how to bring forward cycling and walking measures in the city and other sustainable mobility measures. This was a good source of ideas and multi-sectoral stakeholder cooperation. Although it has ceased to formally function, the organisations still liaise with each other. For example, the University Politehnica of Bucharest provides useful transport data which can help justify investment priorities.

The SUMP contains a mixture of Stage 2 and Stage 3-type indicators including social interaction, health of population, time spent in local area by pedestrians. This is further evidence of evolutionary process from Stage 2 to 3.

The numerous measures are prioritised according to political leadership. But public transport will remain the main priority it is understood, as will be the reorganisation of RATB from public to private ownership; something that may attract further financing from EBRD since this fulfils one of their strategic objectives.

7.2 Innovative Funding and Financing Mechanisms

As highlighted above, Stage 1 cities have unlocked funding and financing from multiple sources, for the delivery of many progressive 2 and 3 measures. In the cases of Bucharest, Skopje and Tallinn this paves the way for continued and accelerated progress along the CREATE curve and the examples in each city can be transferred, adding extra impetus to the CREATE evolution. The strengthening and delivery of associated SUMPs is essential for this success.

Adana and Amman both have aspirations to move from Stage 1 to Stage 2 and external and private level financing has already been established in places. It appears that more work on political engagement is needed, including the development integrated SUMPs, in order to realise full potential of external financing options – notably from IFIs.

In addition to the main funding and financing sources, these cities have also pursued some eye-catching and innovative examples to implement Stage 2 and 3 measures, which could be transferred:

- Developers in Tallinn fund infrastructure improvements to allow access for new residential developments or shopping centres;
- Privately-provided shopping centre bus service in Tallinn connecting with the port;
- Private sponsorship of bike share scheme Tallinn (SIXT);
- Businesses funded new bus stops in Amman, offered free advertising in return;
- Co2 quota trading income spent on tram and cycling infrastructure (Tallinn and Bucharest).

7.3 Challenges in accelerating the CREATE evolutionary cycle

Overall, the lack of funding is cited as a barrier to the rolling out of more Stage 2 and 3 measures, as is a shortage in capacity and skills. From the research and interviews there appears to be a positive correlation between cities that have a strategic transport plan or SUMP in place and attracting substantial EU and IFI investment, principally for Stage 2 type measures. This is not surprising as the priorities for funding in most cases are for low risk investments which tend to be the case when the institution can see the city's forward plan.

In order to maximise external funding and financing therefore, SUMPs should be drafted or updated and strengthened with wide consultation and stakeholder engagement.

Capacity issues can be overcome by using the JASPERS and JESSICA programmes to build strong proposals.

There are some incoherencies of funding and financing priorities:

- ESIF and Operation Programmes includes priorities for infrastructure including road building (Stage 1);
- EBRD, EIB priorities more geared towards PT infrastructure and fleets, also walking, cycling and Stage 3 level indicators, SUMPs (Stage 2 and Stage 3);
- Horizon 2020 prioritises Stage 3 measures;
- Central and local funding match funds EU programmes and so can vary between supporting Stage 1 and 3 Stage 3 priorities;
- ESIF funding is top priority for cities so may have disproportional influence on evolutionary cycle;
- Private sector financing – such as sponsorship of cycle hire (Tallinn) bus stops (Amman) – tends to be geared towards Stage 2 and 3 measures.

There do appear to be some conflicting priorities of Mayors who in many cases are rolling out Stage 1, 2 and 3 measures concurrently. This is mirrored by the funding and financing resources available which see the EU and IFIs provide investment for the full range of measure types. This can both accelerate and decelerate the evolution process.

From discussions with the Stage 1 cities it is felt that Mayors of all cities seem on the whole sympathetic to Stage 3 policies and measures, but convincing citizens is a challenge and pressure from various stakeholders is holding back progress. In some cases, cities wish to make swifter progress along the CREATE evolutionary cycle than national ministries, which can also be a drag factor. CREATE insights should therefore seek to influence national and local decision makers.

It is positive finding however that Regional Operational Programmes in the current 2014-2020 period are more progressive and geared towards Stage 2 and 3 investment, than ROPs 2007-2013. This shows an underlining movement through the CREATE evolutionary cycle.

7.4 Summary

IFI loans offer cities the potential to invest in large scale public transport schemes and hence the chance to accelerate the CREATE evolutionary cycle, by targeting measures which are known to reap rewards on tackling car use and congestion. In some cases, financing is not considered until funding has been exhausted. However, borrowing has been a key driver of the evolution in today's Stage 3 cities and so should be seriously be considered.

EBRD and EIB financing is not fully exploited in some cities. Due in part to non-compliance with programme specifications like low risk (Skopje), the preferred existence of an urban transport plan (Adana), sufficient decentralisation of public transport services (Bucharest) or because applications must be channelled through central government adding layers of administration (Adana).

Adana has not yet accessed the IPA as this is managed at government level and there is stiff competition for grants amongst similar-sized Turkish cities. Adana could also be held back by differing priorities of central government and hence lack of funding for Stage 2 and 3 investment. Adana is an example of how short-circuiting of the CREATE evolutionary cycle is not possible, since there is insufficient public transport alternatives in place to hop from Stage 1 to Stage 3: Instead, acceleration is the proposed path.

Within the IPA, Skopje has objectives for walking and cycling measures but these have not yet been drawn down so an opportunity exists here. The priorities for the IPA are set at a high level meaning they are difficult to access. A new central government was elected in June 2017 so it might be a good time to review options here. Skopje has been refused loans in the past from EBRD and EIB due to the business case not meeting the requirements.

The ongoing development of a new SUMP, with desired political support, will surely act as leverage for Tallinn to draw down greater funds and finance to facilitate an acceleration.

Amman is exploring wider financing sources than IFIs alone, with the French Development Bank and Chinese investors lined up to push forward the key BRT programme as well as the Transport and Mobility Master Plan which included updated data collection. There is precedent for EBRD financing in the country, but it appears that Amman has yet to pursue this avenue.

Whilst addressing some of these aspects will take time, one of the less resource-intensive ways to increase the opportunities for a city is surely to develop a SUMP. It is probably no coincidence that Bucharest has recently unlocked many billions of euros for public transport and other sustainable urban mobility measures, following the launch of their inter-regional SUMP. Equally that the Ministry expects Bucharest and the other seven growth poles to bring forward at least one measure from their SUMPs, funded by the Regional Operational Programme.

Decision makers behind ESIF funding and IFI financing are clearly more supportive of investments in cities which have clear strategic and long terms objectives, which are lower risk.

To access financing, cities need to align themselves with the component programme parameters (e.g. rate of return and decentralisation of PT services) which can be complex and so expert support should be sought, such as through JASPERS. There is scope for cities to make more use of the blending potential of financial and funding where IFI investment can act as the match funding for ESIF.

8. Readiness to exploit Business and Investment Pathways

For all cities, parking enforcement needs to be improved, to allow for the benefits of investments to be realised and Stage progression to take place. In almost all cases this means decentralising responsibility from central government. Technology can also be harnessed to help accelerate various measures like ride sharing, bike sharing and journey planning to make best use of existing services. In most cases, it is the citizens that need convincing of the rationale of progressing to the next Stage which can hold back the desire of political decision-makers. Central government can also be found to be behind the curve.

Amman
The Public Transport & Traffic Planning department is currently responsible for the potential review of the TMMP which may offer opportunities to feed in CREATE intelligence. However an internal restructuring may affect this: A new department is being set up to combine Transport Planning with PT & Traffic Planning.

Amman has successfully sought financing options from several different sources (French Development Agency for BRT and Japan International Cooperation Agency for data collection). A stronger TMMP would also potentially unlock IFI investments.

The city is at Stage 1, but the BRT development will provide an opportunity to combine other progressive Stage 2 measures to support inter-modality and awareness-raising to increase acceptance and patronage especially amongst the younger generation.

Adana
The city is firmly at Stage 1 with investment in public transport, instead of roads and bridges, still an aspiration. The current barriers to progress are both political and financial. National government (Ministry of Transport and Ministry of Urban Planning and Environment) is not setting a Stage 3 agenda and as a result cities like Adana are less able (notably due to lack of funding) to make the leap forward, even with political will. Adana's local transport plan dates back to 1992 and needs updating. Parking enforcement responsibility is at national level which means the city has no authority to fine illegal parking: a clear hindrance.

It is clear from EU cities that trams and metros are really necessary for large cities as foundation for Stage 3 approach but Adana cannot implement without additional central government funding. For now, therefore, the majority of budget goes towards roads, bridges and buses. Perhaps to bridge this gap, IFI investment could be the best course of action, for which a SUMP would probably need to be drafted to show the city's forward plan, making it a less-risk investment.

Skopje
The city has many Stage 2 measures in place and with much road reallocation to cycling infrastructure is moving towards Stage 3 thinking. This provides a solid base from which to accelerate the CREATE evolution, should sufficient funding, financing, capacity and political support be secured.

Skopje's biggest challenges for introducing more Stage 3 measures include:

- Changing citizens' perception of Stage 3 measures because people still prefer to drive. Popular Mayors tend to be those which favour cars which holds back progression at the senior level;
- National government sets the legal framework and safety issues. The police service is completely centralised and so are not joined up with Skopje's cycling and walking measures leaving enforcement sadly lacking. Decentralisation and additional funding needed.

The city adopted its first SUMP in 2011 which is considered to be a 5 year plan. Whilst it is not politically binding, there is scope to review and strengthen the plan which may unlock funding and financing opportunities whose prerequisites are to see a city's strategic planning priorities.

Skopje Mayoral elections took place in the autumn of 2017. The results will determine the direction of travel for mobility policy. It is expected that cycling will figure more prominently.

Tallinn
Overall there is a sense of Stage 1, 2 and 3 measures are being implemented simultaneously. There are examples where capacity for cars is planned to increase through ESIF (Tallinn port); whilst EIB and national programmes are investing in public transport, cycling and other clean urban mobility measures.

Lack of parking enforcement is a significant problem, since like other cities, it is managed at the national level and there are insufficient resources to fund police operations on local roads (e.g. cars driving in bus lanes). Some progress has been made however with the installation of two hi-tech surveillance cameras (2012) to detect improper use of lanes,

Tallinn started developing their SUMP in spring 2017. It will take 2½ years and will cover the period 2019-2035. There have been previous SUMP documents before but they have not been politically-approved. Nonetheless, some elements have been implemented. It will set out the ambition for the city bottom-up for politicians to approve. There is potential therefore to feed in the intelligence from the CREATE project to shape the vision; notably in these two priority areas:

- Exploiting potential parking revenue for SUMP;
- Influencing developers to extend their financial contribution from infrastructure to also include public transport.

The Mayor and local elections of autumn 2017 determine the next path of the CREATE cycle.

Bucharest
The city has produced a pioneering city-region SUMP with the Ilfov region. It has unlocked large sums of funding from EU and national levels. It may have been instrumental in initiating the subsequent EBRD SMART Romania Framework which funds sustainable and energy efficient urban transport. It will help future funding and financing applications. There are many Stage 2 measures in place providing a solid platform from which to push forward and accelerate towards Stage 3. Previous close collaboration with EBRD and JASPERS has served the city well in this regard.

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Congestion Reduction in Europe: Advancing Transport Efficiency

MG-5.3-2014
Tackling urban road congestion

D5.2
Appendix A

A new approch to modelling and appraisal for Stage 3:
A presentation to UK professional and government officials

WP 5 – Combating Congestion and Reducing Car Use in European Cities

Due date	**31 December 2017**
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Prepared by:	**Paulo Anciaes, UCL** **Prof Peter Jones, UCL**
Checked by:	
Verified by:	**Paul Curtis, Vectos**
Status	**Final**
Dissemination Level	**Public (PU)**

Vision-based City Planning: Implications for modelling and appraisal

Peter Jones

Scientific Coordinator

Transport Planning Society and DfT Seminar, ICE 28th February 2018

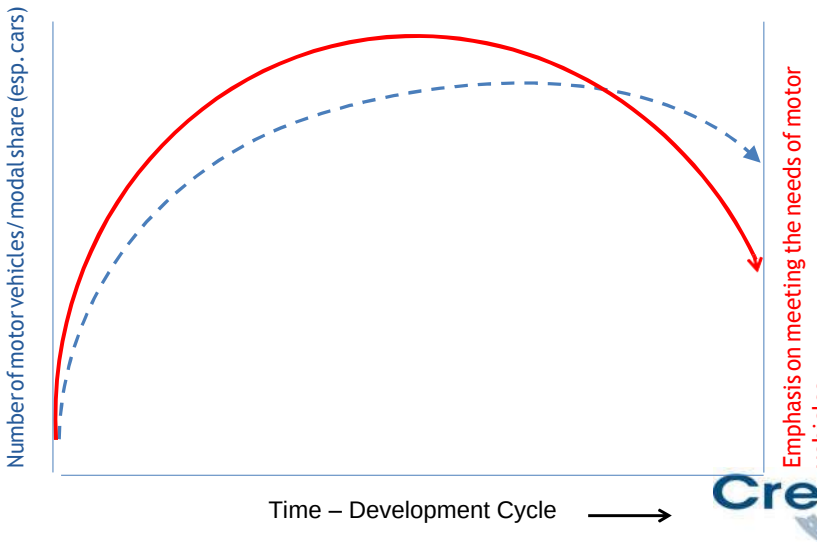
Background

- With the advent of city mayors and the devolution of powers, there is a much stronger emphasis in the UK on planning on the basis of a city '**vision**' – rather than on meeting the forecast outputs of a technocratic process
- This has basic implications for the ways in which **modelling** and **appraisal** methods are **applied** – more so than replacing the methods themselves
- These issues have been triggered by work carried out with Western European capital cities, as part of the H2020 CREATE project

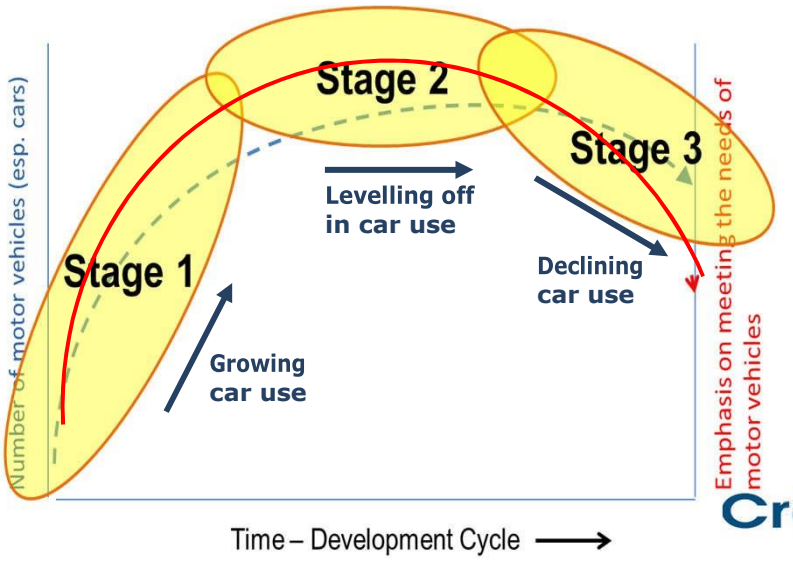
Overview

- Brief introduction to the 'Urban transport policy development process', and trends in urban car use
- Some historical implications for modelling and appraisal
- Vision-based planning and use of models – from 'Predict and Provide' to 'Vision and Validate'
- Vision-based planning and use of appraisal – from 'Existing as baseline' to 'Vision as baseline'
- Likely future policy developments – implications for modelling and appraisal

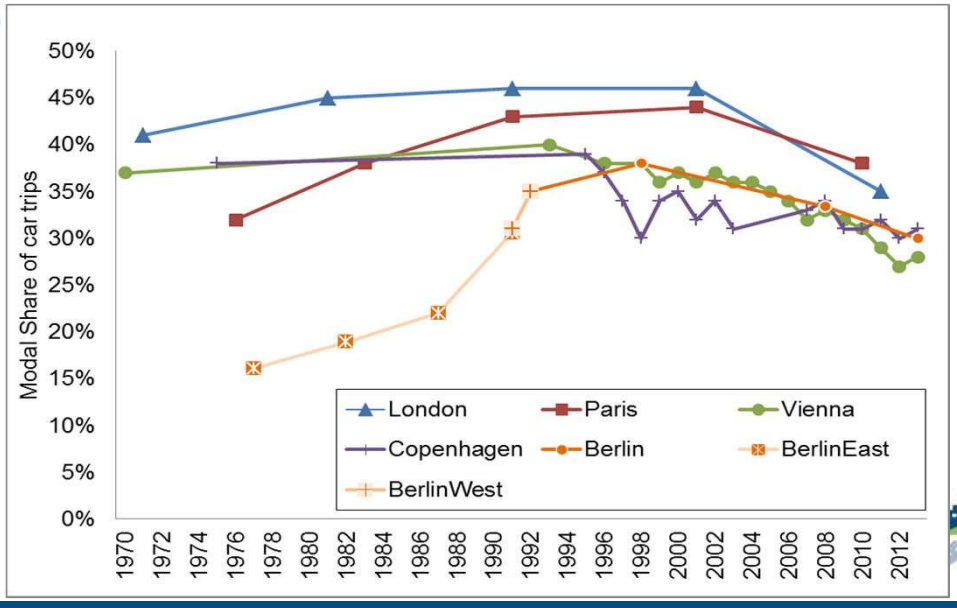
Simplified 'Transport Policy Development Process'



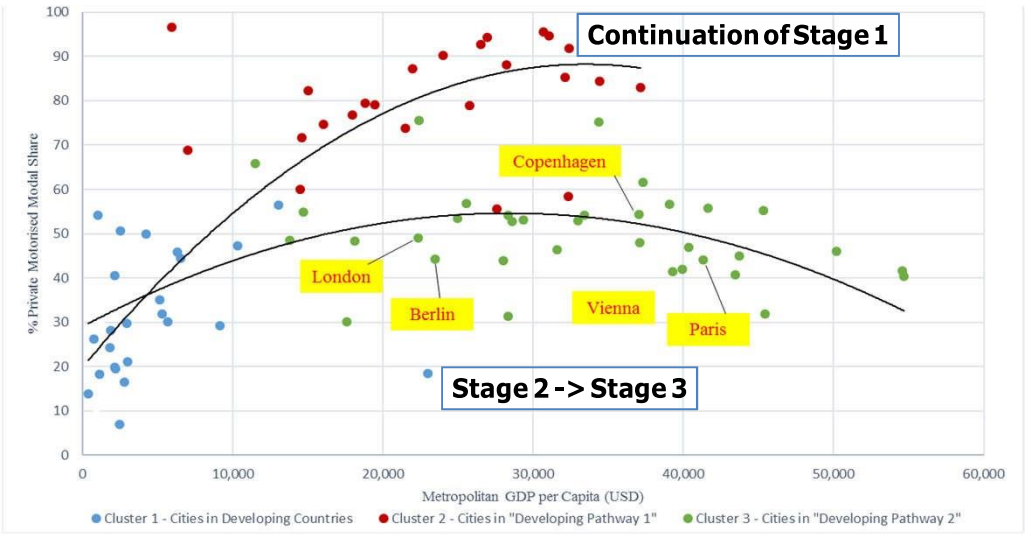
Simplified 'Transport Policy Development Process'



Evidence: Car Driver Modal Shares over Time



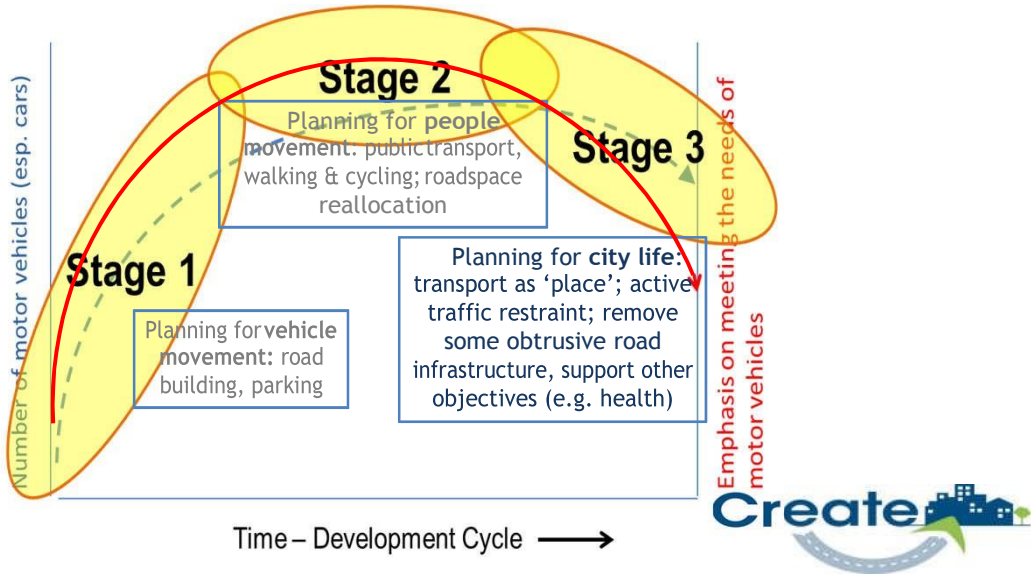
Alternative city trajectories



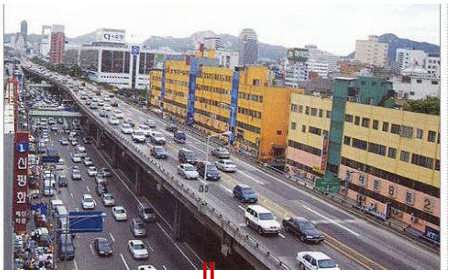
Source: analysis by Roger Teoh, MSc Dissertation Imperial/UCL 2016

UITP data 1995

Simplified 'Transport Policy Development Process'



Stage 3: Motorway Removal and Place Making

	Portland	Seoul
Stage 1		
Stage 3		

Stage 3: Street Redesign

Stage 1	Stage 3
	

1

Stage 3: TfL's London-wide Street Classification

Stage 1: Vehicle trip emphasis

MODEL STRUCTURE

Vehicle trip generation

↓

Vehicle trip distribution

↓

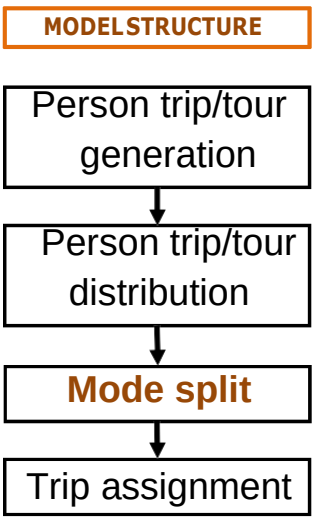
Vehicle trip assignment

- Travel as a disutility, to be minimised

APPRAISAL COMPONENTS

- Road network capacity
- Average network speeds
- Variability in travel times
- Congestion and delays
- Vehicle operating costs
- Parking provision
- Parking search times
- Road traffic accidents
- Air pollution
- Noise pollution

Stage 2: Sustainable mode emphasis



APPRAISAL COMPONENTS

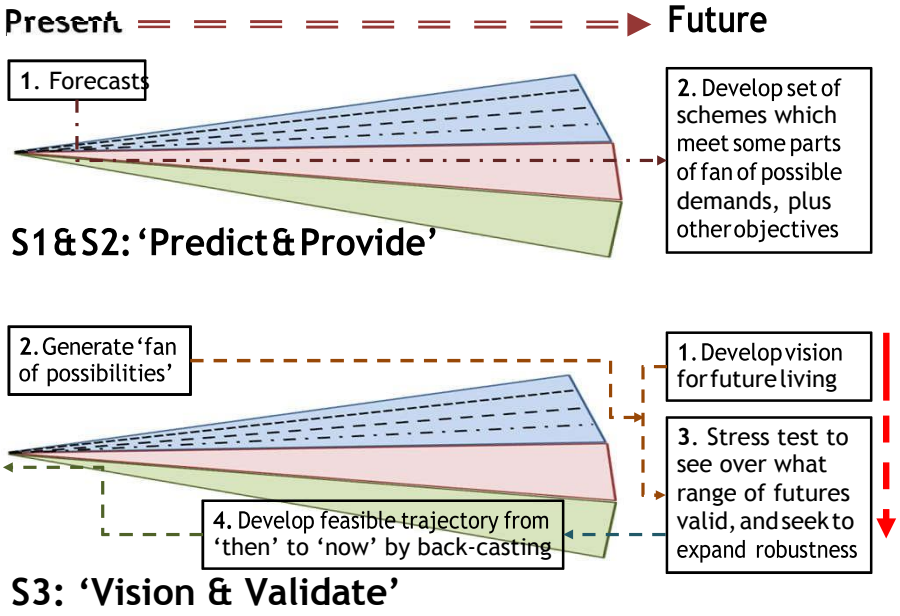
- Efficiency of road use/person
- PT service levels
- Access to PT services
- Walking & cycling provision
- Safety & personal security
- PT+Active travel mode share
- Trip expenditure
- Quality of interchanges
- Door-to-door times, by mode
- CO_2 emissions

Stage 3: Modelling for vision-led planning

- Stage 1 and Stage 2 policies largely based on model forecasts of future travel demand ('Predict & Provide'):
  - How much road capacity is needed?
  - What level of rail capacity do we need to provide?
  - Here uncertainty is 'a problem'
- Stage 3 starts with a city vision that embraces mobility and the public realm - the role of modelling (Vision & Validate) is to:
  - Identify policy packages that will deliver desired outcomes
  - Use uncertainty to 'stress test' packages to make them as robust as possible under different futures

...turning the modelling process 'on its head'

Stage 3: Modelling for vision-led planning



Stage 3: Appraisal for vision-led planning

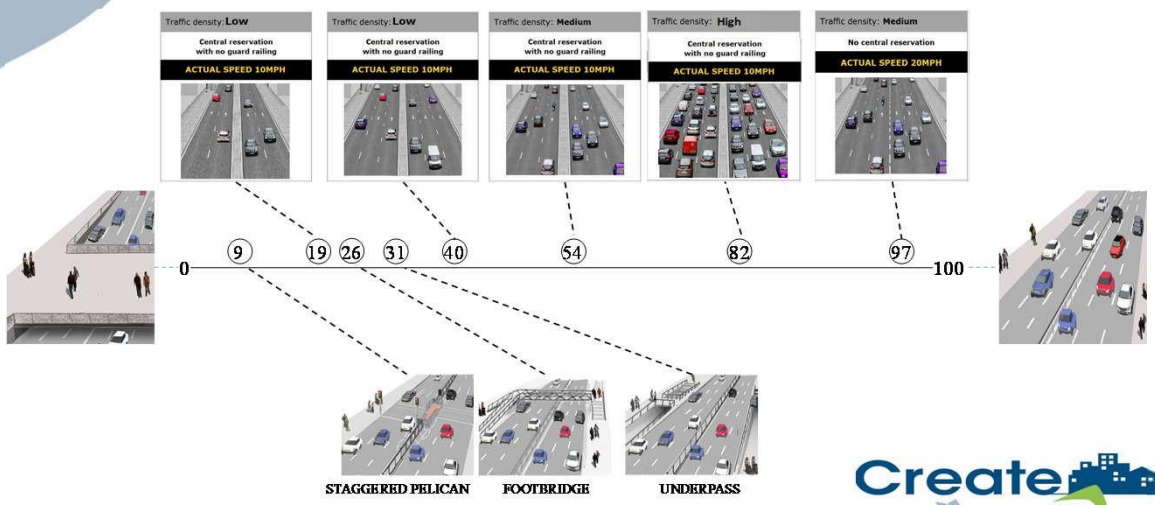
- Stage 3 policies are designed to meet broader outcomes
  -> so need to add new benefit types to the appraisal
- Stage 1 and Stage 2 policies use the 'existing situation' as the baseline
- Stage 3 uses the vision as the baseline:
  -> This is already partly done in some cases (e.g. 20mph zones, LEZs)
  -> This may place greater emphasis on cost-effectiveness rather than cost-benefit appraisal

...turning the appraisal process 'on its head'

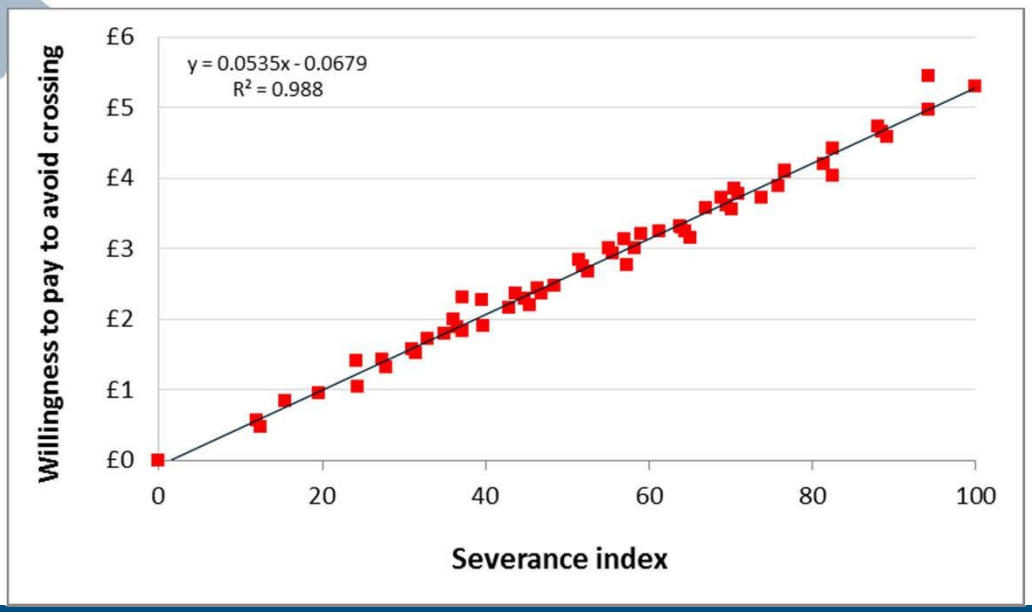
Stage 3: Indicators for vision-led planning

Stage 1	Stage 2	Stage 3
Road network capacity	Efficiency of road use/person	**Quality of transport as place**
Average network speeds	PT service levels	**Levels of street activities**
Variability in travel times	Access to PT services	**Use of time in places**
Congestion and delays	Walking & cycling provision	**Use of time while travelling**
Vehicle operating costs	Safety & personal security	**Expenditure at trip ends**
Parking provision	PT+Active travel mode share	**Health of the population**
Parking search times	Trip expenditure	**Social equity and cohesion**
Road traffic accidents	Quality of interchanges	**Well-being**
Air pollution	Door-to-door times, by mode	**Urban vitality and liveability**
Noise pollution	CO2 emissions	**Community severance**

New indicator: severance caused by different types of roads

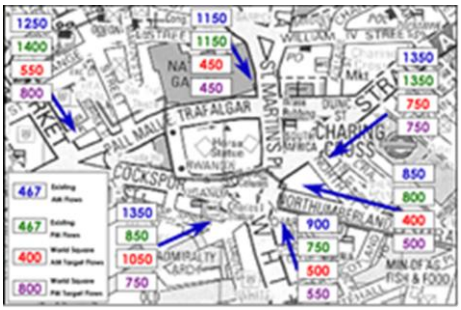


Severance index vs. Willingness to pay (London)



Stage 3: Appraisal for vision-led planning

EXAMPLE: Trafalgar Square



- A 40% reduction in traffic capacity needed in order to meet 'Place standard
- Achieved by downgrading Movement function around the square and restricting approaching traffic levels through revised signal settings

Stage 3: Appraisal for vision-led planning

EXAMPLE: heavy traffic on inner ring road, causing severe severance and air and noise pollution

'Traditional approach': Justify any measures to alter the current situation (e.g. lower speed limit and surface level crossings: are the extra vehicle delays outweighed by reduced severance, noise levels, etc?)

'Vision-led approach': start with reduced speed limit and surface level crossings as 'meeting the standard'. If traffic conditions deteriorate and need to be mitigated, then (i) reassign traffic or, (ii) for example, build a cut-and-cover road and justify this through time savings, etc. compared to conditions if standard adopted.

The Future of Cities

- Three factors are moving cities beyond 'Stage 3':
  - Continued congestion and over-crowding
  - Cross-sector responsibilities of elected mayors
  - 'Big data' and 'Smart city' initiatives
- Towards an emerging urban policy landscape that includes:
  - Recognition of interactions between transport and all sectors – and of travel as a 'derived demand'
  - Administrative structures enabling some cross-sector planning
  - Supported by news ways of thinking

The Future of Cities

- Stage 1 = Car-based city
- Stage 2 = Sustainable-mobility city
- Stage 3 = City as places
- **Stage 4 = Integrated city**

Some early signs:
- MaaS
- Accessibility planning

Implications for modelling: cross-sector, activity based – travel as a 'derived demand'??

Implications for appraisal: cross-sector optimisation and efficiencies, including use of resources??

Thank you!

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http://www.create-mobility.eu

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Congestion Reduction in Europe: Advancing Transport Efficiency

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Appendix B

Place quality

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Checked by:	
Verified by:	**Paul Curtis, Vectos**
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Dissemination Level	**Public (PU)**

B.1 Introduction

This appendix is an in-depth study of Stage 3 indicators related to street liveability and place quality, introduced in Section 3.5 of this deliverable. The first section is a review of relevant studies from the fields of urban design, urban planning, and transport planning literature and aims at answering the following questions:

- What is the meaning of 'place' and what is it describing in the context of street liveability?
- What factors are known to contribute to good or successful places or to improve the quality of place?
- How is the quality of place currently measured and valued?

The second section presents the main conclusions of a workshop that brought together experts from different backgrounds to discuss concepts of place quality and the existing limitations to measure and value that quality.

The third section is an analysis of "Healthy Streets" survey data collected by Transport for London in 80 streets in London. The objective was to understand to what extent perceived street satisfaction and attractiveness can be explained by the features defined by the theoretical concepts and the experts' views presented in the two first sections of the appendix.

B.2 Literature review on place quality

B.2.1 What is place quality?

'Place' is a complex and multidimensional concept, which can be defined from a personal, social, spatial, or political perspective. As such, the use of the concept changes from one discipline to another. In the context of transport planning, place is often defined as the opposite of movement, i.e. as a space where people spend time (Jones *et al.* 2007a). In the context of urban design, places are described more generally as both behavioural settings and physical entities (Carmona *et al.* 2010). Another definition from the urban design literature describes place as the combination of the previous two. Place is then the interaction of the perceptual, social, and functional qualities and physical features (morphology, scale, aesthetics, buildings, street furniture) in urban spaces that can provide a positive experience and adequate environment for people. To emphasize the positive connotation of place, this composition of place is sometimes called sense-of-place, "places for people", "good places" or "successful places". For example, Ewing and Clemente (2013) define sense-of-place as a psychological and physical state that elicits the overall feeling that it is pleasant to be in a certain space. The following sections expand on the concept of place from the perspectives of the road/street network functionalities, the street network and urban morphology

Street network functionalities

The criteria used for designing roads and streets, and the resulting physical characteristics, depend on their intended functionality. If the functionality is to maximize traffic flow in a safe manner, the criteria will be to prevent potential intrusions that will cause friction and interrupt traffic flow. In theory, this means increasing capacity to increase speed, whilst minimizing sources of distraction such as shop fronts. It also means building flyovers to prevent interaction with other roads, or installing railings and barriers to prevent pedestrians intruding on the space of private cars. These are strategies aimed at completely removing sources of intrusion,

or protecting the traffic flow. On the other hand, if the functionality of the roads and streets is to facilitate movement and interaction of people, then traffic flow can be regarded as the intrusion. In this case, sources of distraction are desirable because they provide services that attract walking trips, make the street lively, and provide sources of stimuli that catch people's attention and make the space more attractive (e.g. active frontage, shop fronts, markets or street art). Speeds also need to be reduced, in order to allow safe and convenient walking and standing.

As described elsewhere in this deliverable and other CREATE deliverables, during Stage 1 of the transport policy development process, the main function of the road network was to supply capacity for vehicle movement, which resulted in the construction of large road infrastructure and the neglect of the 'remaining' spaces between buildings and infrastructure. In this context, only some necessary activities were still happening in streets and only well-defined city spaces such as squares and parks were looked after. The separation of professional disciplines reinforced the segregation between cars and pedestrians. Traffic engineers were concerned with traffic and road geometry, architects designed buildings, landscape architects focused on parks and urban planners focused on the overall view. This meant that because there was not a clear responsible for the spaces created in the intersections of these elements, the public life emerging in these spaces, as well as the spaces, were neglected (Gehl and Svarre 2013).

Street network and urban morphology dimension

From the urban design morphological dimension (i.e. the configuration of urban form and space), two types of urban space systems have been identified. The first is the traditional urban space system, in which buildings and blocks define and enclose spaces, and streets are part of a small scale, finely meshed, grid. The second is the modernist space system in which buildings are freestanding objects in a disconnected, amorphous, space and in which streets become roads forming a grid that is large scale and discontinuous (Carmona *et al.* 2010). In this modernist system of spaces, roads are the structural component of the city and their role as movement spaces overcome their role as social spaces. At the block level, a discontinuous, "tree-shaped" road pattern also removes connectivity and the choice that is provided by a fine-meshed grid-like street pattern, integrated and connected at the small-scale (Carmona *et al.* 2010).

The two types of urban space systems are also related to different levels of complexity and different speeds. Humans have a preferred rate at which is comfortable to receive and process information – too little deprives the senses and too much overloads them. To keep slow-moving pedestrians interested, spaces need to have built environment and activities with a high level of complexity. However, fast-moving car users find that complexity in the environment chaotic because they receive and process the same amount of information in less time (Boeing 2017, Crawford 2000). Moreover, speed has effects in urban form at the city-wide scale but with implications for social spaces at the street level. Roads designed only for movement to connect distant areas result in a fragmented city because they perform well at connecting end-to-end points but create a "river effect" that divides side-to-side. On the other hand, streets that prioritize place function, provide social spaces and connect buildings and activities, this means that streets enable side-to-side connection movements and divide end-to-end movements (Hart 2015).

As an example, Figure B.1 shows how the different street types in London (defined by their importance for movement and place) have different levels of complexity and speeds, leading to different types of modes of transport.

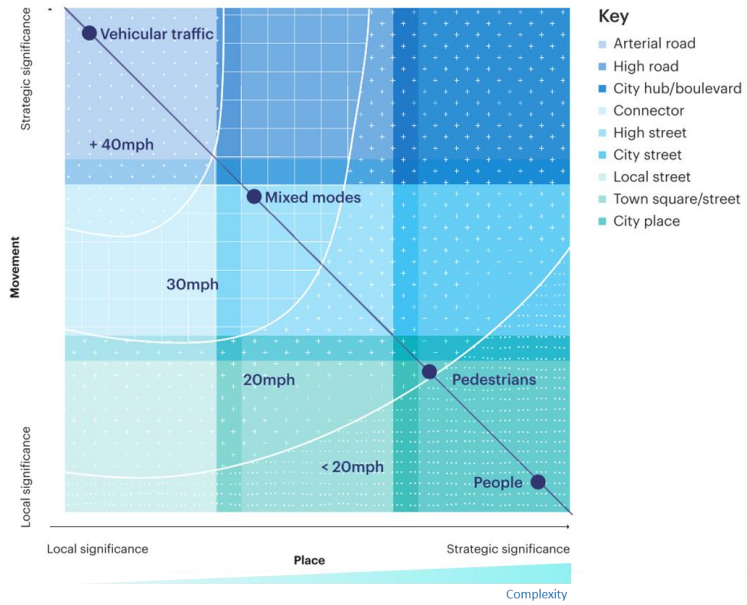


Figure ***B.1 Street-type matrix (Users and speeds). Source: TfL(2013, p.12)***

Moving forward: street network and space network as places

To address the problems caused by a Stage 1 "roads-first" approach, several transport researchers have called for designing multi-functional, mixed-uses and "complete" streets that consider users of all transport modes, including pedestrian of all ages and abilities (Jones *et al.* 2007b). Urban designers have also called for acknowledging that the elements of the built environment that contribute to the cohesiveness of the urban experience cannot exist in isolation, on the contrary, they mostly exist as relationships (Carmona *et al.* 2010).

In Stage 3 of the transport policy development process perspective there is a holistic understanding of street and the experience of everyday travel, in which the focus is on the qualitative aspects of transport and the potential social and environmental impacts. Streets are the scenario where many other social, cultural and economic activities happen and which therefore requires specific built environment conditions that enable and favour them. On this regard, the UK Department for transport' Manual for Streets (DfT 2007) identified five main functions of streets: place, movement, access, parking and drainage, utilities and street lighting. Transport for London's "street types matrix" also acknowledges that streets have a "Movement" and a "Place" function (TfL 2013, p.10). The movement function refers to street serving as links for through movement and responding to the design objective of minimizing travel time. The place function refers to streets as public spaces and destinations in their own right that accommodates dwelling, leisure, and social activities focused on the design objective of encouraging users to spend more time (Jones *et al.* 2007a).

This perspective acknowledges that streets are public spaces in their own right. In fact, the network of public spaces created around the transport network (road network and public transport infrastructure) accounts for a large percentage of total public spaces in cities. In London, 80% of all public spaces are streets, roads, footways, and paths (TfL 2017a). However, for streets to be able to provide their place function, the built environment and streetscape need to have the features that enable the realization of social, cultural and economic interactions and their associated benefits. This joined presence of built environment features and activities that create street vitality is what delivers place quality.

The provision of capacity for private motorised vehicles during Stage 1 of the transport policy development process lead that capacity to be quickly filled by the users that are attracted by

the improvements, causing congestion and a deterioration of the quality of urban design and the social fabric. But the same principle holds true for sustainable transport modes and for urban activities. The provision of streets that are attractive, convenient to use, and with enough capacity (pavements and sitting area), and the reduction in perceived difficulty of doing certain activity (e.g. provide shelter and place to stop) leads the streets to be filled with more people.

B.2.2 What factors improve the quality of public spaces?

Carmona *et al.* (2010) suggest that people create and change their perception of the built environment through interacting with it. Therefore, linked to what can be called the sense, or identity of a place is each person's subjective construction of it, i.e. the experiential sense of place. This experience is mediated by sensations and perceptions. Perceptions of a specific environment can change drastically from one person to another as they are influenced by age, lifestyle and social and cultural background. A well-accepted conceptual framework for defining sense-of-place was proposed by Canter (1977), and expanded by Montgomery (1998), and describes sense-of-place as a function of physical attributes, activities and features of image and meaning. (Figure B.2).

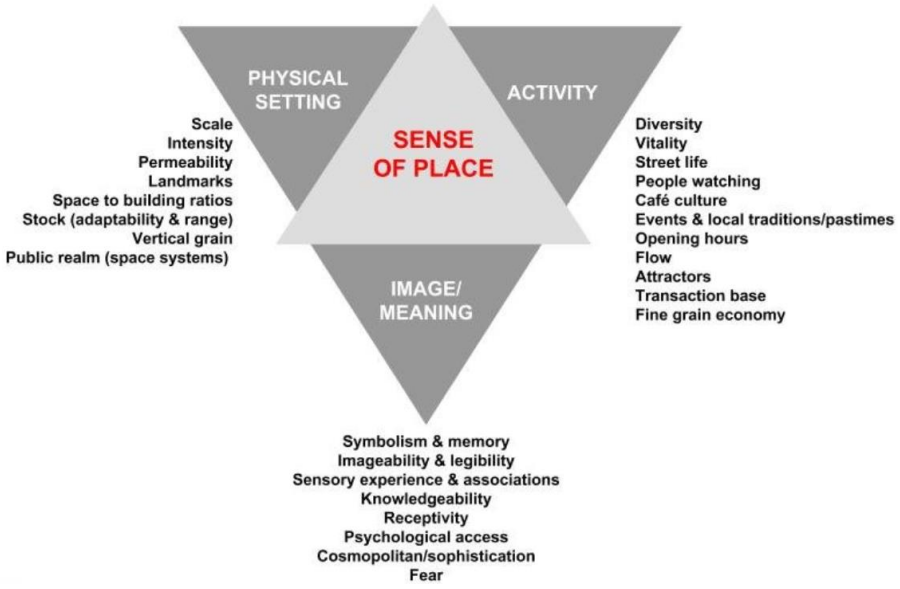


Figure B.2 Sense of Place Source: Carmona et al (2010) adapted from Montgomery (1998)

Place identity lies at the eye of the beholder; it is a social construct and a result of a communication process in time. Physical and material elements of places, especially iconic ones, contribute to create place identity, image and meaning as they provide tangible records of the passage of time. Lynch (1981) identified paths, edges, districts, nodes and landmarks as the physical elements of the environment that help to create a strong image of a place. Similarly, from the perspective of Cognitive Architecture, Sussman and Hollander (2015) identified that the spaces that are good for people are those that understand how people function and are designed to respond to their fundamental biological needs. Some of the characteristics of a built environment that consider human behaviour include aspects such as well-defined corridors (edges), provision of visual stimuli (not sameness nor blankness), acknowledgement of humans' biological bias toward bilateral symmetric shapes and curved lines, and identification of people's narrative capacity which allows them to engage with other people and places and enables the creation of identity.

Gehl (2010) identified two types of activities that can occur in the street: the necessary activities and the optional activities, which can be individual or social (if they are dependent on the presence of others). Necessary activities are mostly movement activities which would

happen regardless of the quality of the built environment (e.g. journeys to work or to shop for groceries) and for which streets are not commonly the destinations. Optional activities, like walking for fresh air or seating on a park bench, fulfil specific desires and make the street and other public spaces a destination in their own right. Optional trips are more likely to happen when good place quality exists. The diversity of street activities, of the people engaging in them and of the times during the day at which they take place, is another key element of street life.

The activities that characterize urban life are a function of the types of interactions and transactions taking place in the street. Montgomery (1998) defines a complex transaction base as the key to successful urban places and highlights that a transactional base of economic activity at different scales, levels and layers is important to create good urban spaces. The author also emphasises that not all transactions are economic as there are also, equally important, cultural and social transactions taking place in cities, including conversations or just watching street life (Jacobs 1961). Successful places and successful public spaces are places that are appealing to people. The presence of people interacting and engaging in diverse activities creates a reinforcing cycle of urban vitality (Gehl and Svarre 2013).

Place quality, or sense of place is, therefore, the result of the interaction of physical characteristics, at the macro/mezzo and micro scale, perceived qualities (overall assessments of the experience of a place with regards to certain elements) and activities, use or behaviour observed in the place. Although perhaps not entirely encapsulating the abstract complexity of place, this simplification is needed in order to understand what elements of a street environment can be measured and assessed to identify its performance as a place (for people). The importance of understanding the physical and perceptual qualities of place is that it is believed that these qualities provide functional and cognitive cues to increase the probability of certain behaviours. Hence, while recognizing that choices are highly individual and complex processes that involves many elements of each person' background, the approach is to design places that appeal to basic general human needs, respond to the specificities of each context and, at the same time, invite people to engage in positive behaviours. The best way to generate specific behaviour is to create the conditions that make those behaviours the most convenient option (Thaler and Sunstein 2008).

Perceived qualities of the built environment

Ewing and Clemente (2013) reviewed urban design literature and identified key perceptual qualities of the built environment that are believed to influence people's behaviours (e.g. decision to walk to a destination, stroll for leisure or linger on streets to socialize). Starting from 51 perceptual qualities, five (imageability, enclosure, human scale, transparency, tidiness) were identified as qualities that, with statistical significance, could explain the perceived conditions of the environment that enabled walking. Furthermore, the authors identified specific physical elements of the built environment that were linked with these qualities (Ewing and Handy 2009, Ewing and Clemente 2013)

Many other researchers and practitioners have tried to understand the qualities of good urban places. The following two tables present a summary of the qualities identified in each study, from the perspective of urban design (Table B.6) and transport and urban planning (Table B.7).

Table B.6 Qualities of built environments (from an urban design perspective)

Lynch (1981)	Jacobs (1961)	Bentley et al. (1985)	Tibbalds (1988)	Buchanan (1988)	Jacobs and Appleyard (1987)	Whyte (1980,1988)
Vitality (support human functions. Including biological and ecological)	Appropriate activity before visual order	'responsive environments (places)'	Places before buildings	Place making Public realms Outdoor rooms	Liveability	Sociable spaces
		Visual appropriateness	Respect history	Dialogue with context and history: re-contain street	Authenticity and meaning	
	Mixed use Mixed age Mixed rent concentration	Variety (proximity and concentration)	Encourage mixed uses and activities		integration of activities – living, working, shopping – in some reasonable proximity	Location near to people's activities, integrated
	The street	Human scale	Scale enclosure			
Access (ability to reach persons, activities, resource. Quantity and diversity)	Permeability (short blocks)	Permeability	Encourage pedestrian permeability/freedom Access for all	Public space and movement systems	Access to opportunities for imagination and joy (extent experience, viewpoints , meet new people, have fun).	Physically and visually accessible
Control (extent users/ residents create and manage access to space/activities	Social mix and consultation	personalisation	Social mix and consultation		Identity and control Community and public life	
Sense (clarity with which it can be perceived and structured. In time and space)		Legibility (understand offered opportunities)	Legible environment	Respect conventions. Articulate meanings. Connect inside and out		
Fit (adaptability of form and capacity of spaces to respond to behaviours)	Robust spaces	Robustness and adaptability (use for different purpose)	Lasting environments			
(as meta criteria) efficiency (related to cost)	Gradual not cataclysmic money	Resource efficiency	Small scale change (incrementally)			
	Activity richness	Richness (sensory experience)	Visual delight (Join it all together)	Natural, rich materials good weathering decoration	Many separate, distinct buildings with complex arrangements and relationships	
(as meta-criteria) Justice (benefits distribution /social equity)	Automobile attrition surveillance (safety)				An environment for all	

Source: Adapted from McGlynn (1993, p.6)

Table B.7 Qualities of the built environment (from transport and urban planning perspective)

Ewing and Handy (2009), Ewing and Clemente (2013)	**TRL (2010) PERS - Public Space**	**TfL (2005) The 5Cs of Good Walking Networks**	**Gehl and Svarre (2013)**	**Project for Public Spaces (2008)**	**TfL (2017b, 2017c) Healthy Streets Indicators**	**Carmona et al. (2017) Healthy Streets Checklist**	**Sussman and Hollander (2015)**
• Coherence • Complexity • Enclosure • Human Scale • Imageability • Legibility • Linkage • Tidiness • Transparency	• Moving in the space • Interpreting the space • Personal Safety • Feeling Comfortable • Sense of Place • Opportunity for Activity	• Connectivity • Convivial • Conspicuous • Comfortable • Convenient	• Protection (crime and violence) • Protection (unpleasant sensory experience) • Opportunities (to walk, stand/stay, sit, see, talk, play and exercise) • Enjoyment (building and spaces) • Enjoyment (design, detail, materials & aesthetic qualities) • Enjoyment (rich multisensory experiences)	• Comfort • Image • Access • Linkage • Uses • Activity • Sociability	• Clean air • Not too noisy • People feel relaxed • Places to stop and rest • Shade and shelter • Things to see and do • People feel safe • Easy to cross • Pedestrians from all walks of life • People choose to walk, cycle and use public transport	• Safety • Directness • Coherence • Comfort • Attractiveness • Adaptability	• Transparency • Enclosure • Pleasurability • Human Scale • Complexity • Narrative

Physical features of the built environment

Ewing and Clemente (2013) identified specific physical elements of the built environment that were linked with the perceived qualities analysed in their research. Initially 169 street level physical features were hypothesised to be relevant for the perceived qualities but only 42 detailed metrics were found to be statistically significant (Table B.8).

Table B.8 Physical features associated with perceived qualities

Perceived quality	Physical Feature	Metric
Coherence	trees and planter	trees spacing and type
	windows	window proportion
	people	moving pedestrians
	urban furniture	street lights (human scale)
Complexity	people	moving pedestrians
	buildings	number of accent colours
	buildings	number of buildings
	buildings	number of dominant building colours
	activities	outdoor dinning
	activities	public art
Enclosure	sight lines	long sight lines
	walls	proportion of street wall
	sky	view of sky
Human scale	buildings	building height
	sigh lines	long sight lines
	urban furniture	miscellaneous street items
	facades	proportion active frontages
	facades	proportion first-floor façade with windows
	trees and planter	small planters
	sky	sky ahead
Imageability	Landmarks	courtyard/plazas/parks
	Landscape	major landscape features
	people	moving pedestrians
	noise	noise level
	buildings	number of buildings with identifiers
	buildings	number of building with non-rectangular silhouettes
	buildings	proportion of historic building frontages
Legibility	trees and planter	trees spacing and type
	buildings	memorable architecture
	buildings	number of buildings with identifiers
	buildings	building/business signs
	activities	public art
	street network	street connections
	sight lines	terminated vista
Linkage	buildings	building height
	activities	outdoor dinning
	facades	proportion of recessed sets of doors
	facades	visible set of doors
Transparency	facades	proportion of active frontages
	facades	proportion of entire façade with windows
	walls	proportion of street wall
	facades	visible set of doors

Source: Adapted from Ewing and Clemente (2013)

There are also variables related with urban morphology and land-uses which characterise the built environment at the macro (city-wide) and mezzo scale but that have an effect on place quality at the street level. These variables have been conceptualized as the "D variables": Density, Diversity, Design, Destination accessibility and Distance to transit (Ewing and Cervero 2001, 2010) (Table B.9).

Table B.9 The D variables

Built Environment Variable	Description
Density	Variable of interest per unit of area (Area can be gross or net)
Diversity	Number of different land uses in a given area and degree to which they are represented in land area, floor area or employment. Entropy models are widely used to measure it
Design (macro-mezzo)	Street network characteristics within an area (include measures such as (average) block size/length. Proportion of intersections per type. Network topology and patterns of network connectivity (e.g. grid system or tree-like patterns)
Design (micro)	Physical variables at the street level that characterise pedestrian-oriented environments (such as sidewalk coverage, average building setback, average street widths, number of pedestrian crossings, street trees and many other physical variables)
Destinations' Accessibility	Ease of access to amenities (trip attractors). It may be regional or local (regional can refer to distance to CBD or number of opportunities within a distance). Gravitation models are commonly used to measure it.
Distance to transit	Measured as the average of shortest street routes from origins to transit stops or stations. Alternatively, it could be density of transit routes, density of stations, distance between transit stops.

Source: Adapted from Ewing and Cervero (2010)

B.2.3 How do we measure place qualities?

The difficulty for measuring place qualities is that, as described in the previous section, the qualities that come together to construct a place vary in scale and nature. Some features are subjective because they are not tangible; they result from the interactions of the different physical elements and the users' perception. Other features are objective or physical because they are tangible and can be counted, monitored, measured, or observed to acknowledge their presence (or absence) in any given space. Activities, behaviours, and patterns of use of the spaces are also objective features of place.

Street audits

Checklists or built environment audits provide a quantitative evaluation of the physical environment at local scale through observation, measuring and counting. Similarly, qualitative characteristics or overall assessment of conditions (e.g. cleanliness, etc.) can be expressed through quantifiable scores that are assigned by surveyors. With the large amount of physical elements interacting on a street, the set of objective characteristics measured in each street can be as exhaustive as desired and therefore potentially very extensive. Several built environment audits exist, most of which have been developed for assessing the conduciveness of the environment to physical activity (walking). However, sections of them or the conceptual framework behind them are linked with place qualities. Some of the most relevant tools are reviewed below.

Irvine Minnesota Inventory

Developed at the University of California, Irvine, the Irvine Minnesota Inventory is an audit tool for measuring built environment features that may be associated to active living. The inventory includes 162 items, which cover four perceived qualities domains and 12 physical features categories as presented in Table B.10. The tool's codebook and inventories are available from https://webfiles.uci.edu/kday/public/index.html

Table B.10 Irvine Minnesota Inventory

Method	Physical features	Perceived qualities
On-street observations	• Crossings • Street (carriageway) characteristics • Views • Land uses type and diversity (of buildings and spaces) • Barriers • Cycle lanes • Steepness • Sidewalks • Street furniture • Buildings and windows • Maintenance • Traffic	• Accessibility • Pleasurability • Human needs and comfort • Perceived safety from traffic and crime
GIS measures (optional)	• Population density • Employment or land use density • Street network intersection pattern • Street width and length	

Source: Adapted from Day *et al.* (2005) and Boarnet *et al.* (2006)

Measurement Instrument for Urban Design Qualities

This tool measures five urban design perceived qualities of streetscapes: imageability, visual enclosure, human scale, transparency, and complexity (Table B.11), selected because of evidence on their significant relationships with walkability and on their potential to be measured objectively and reliably (Clemente *et al.* 2005). The assessment of those perceived qualities is based on scores assigned to 15 physical features that are known to explain ratings of each design quality (Ewing and Handy 2009). The tool's score sheet is available from https://activelivingresearch.org/measurement-instrument-urban-design-quantities-related-walkability

Table B.11 Measurement Instrument for Urban Design Qualities

Physical features	Perceived qualities
• Courtyards plazas and parks • Landscape features • Buildings (historic, with identifiers or non-rectangular shapes) • Outdoor dining • Number of people • Noise level	Imageability
• Sightlines • Street wall (both sides) • Sky	Enclosure
• Sightlines • Windows at street level • Buildings (height) • Small planters • Street furniture	Human scale
• Windows at street level • Street wall • Active uses	Transparency
• Buildings (colours, accents colours, etc.) • Outdoor dining • Public art • Number of people	Complexity

Source: Clemente *et al.* (2005), Ewing and Clemente (2013)

Microscale Audit of Pedestrian Streetscapes (MAPS)

This audit tool was developed to collect data on the pedestrian environment and the conditions that enable walking in neighbourhoods, focusing on microscale (street level) features of the built environment, such as destinations and land uses, streetscapes and aesthetics for routes, segments, crossings and cul-de-sacs (Cain *et al.* 2012). For each element, characteristics of specific features are analysed (e.g. sidewalk width, building heights and setbacks, aesthetics and design, crossings types, barriers, bus stops, bicycle lanes, urban furniture). Items are grouped into subscales which were created based on a conceptual framework that considered the theory, expert consensus, and policy relevance. MAPS items and subscales have been validated in several contexts (Millstein *et al.* 2013, Cain *et al.* 2017). There are three versions of the audit, a full version which includes 120 items intended to be used by researchers, an abbreviated version with 60 items intended for researchers and practitioners, and a "MAPS-mini" which include 15 items and is directed to planning agencies and community groups. Tools and protocols available from http://sallis.ucsd.edu/measure_maps.html

Pedestrian Environment Review System (PERS)

PERS is a street audit developed by the Transport Research Laboratory in the UK, to assess the quality of the pedestrian environment (TRL 2010). The assessment is based on the principle that good street environments satisfy the needs of as many pedestrians as possible, with the needs of the most vulnerable pedestrians used as benchmark. The term "pedestrian" is understood as encompassing all people in the public-realm not using a vehicle and conducting any type of activity, including non-transport activities. The tool provides six review frameworks to assess different types of built environments for pedestrians: links, crossings, routes, public transport waiting areas, interchange spaces, and public spaces. The most relevant frameworks for the purpose of this review are the public spaces and, to a smaller degree, the links framework (*Table B.12*). The Public Space framework has 6 dimensions and 36 indicators. The Link framework has 14 dimensions and 85 indicators. The assessment is done using a seven quality scale from -3 to +3. PERS is a commercial tool. Software and documentation are available for a fee.

Table B.12 Dimensions in the PERS public space and link framework

Public Space Review Framework	Link Review Framework
• Moving in the space	• Effective width
• Interpreting the space	• Dropped Kerbs
• Personal safety	• Gradient
• Feeling comfortable.	• Obstructions
• Sense of place	• Permeability
• Opportunity for activity	• Legibility
	• Lighting
	• Tactile Information
	• Colour contrast
	• Personal security
	• Surface quality
	• User conflict
	• Quality of the environment
	• Maintenance

Healthy Streets Indicators

Transport for London's "healthy streets" approach aims at enabling the city to be healthier, more sustainable, safer, more connected, and more successful (TfL 2017b). The Healthy Streets tool comprises 31 metrics to score a street segment, related to traffic, crossings, footways, surveillance, street furniture, and provision for cyclists and public transport users (Figure B.3). The metrics can be objectively measured (e.g. traffic level and speed, noise and pollution, pavement width, number of crossings at required locations). The tool and its documentation are available from TfL (2017c, 2017d).

Figure B.3 Healthy Streets Check scores (TfL 2017c)

State of Place

The State of Place index synthesizes information about walkability using the Irvine-Minnesota Inventory approach. This index classifies walkability by assessing 280 built environment features in 10 urban design categories, organized in four categories (Table B.13). The data collected from the inventory is analysed using a proprietary algorithm that generates the index score for each street segment (or area) based how convenient, safe, comfortable and pleasurable they are. State of Place is a private company. State of Place index is not publicly available and can only be accessed for a fee.

Table B.13 State of Place index

Physical features Dimensions	**Description/Example Items**	**Categories**
Form	Streetscape quality; how building meets the street	Urban Fabric
Density	Measure of compactness (building concentrations and heights)	
Connectivity	Ease of access within and across blocks	
Parks and public spaces	Presence, quality and accessibility	Destinations
Destinations (proximity to)	Quantity and quality of close (non-residential) destinations. Mixed use	
Recreational facilities	Gym/fitness facilities, outdoor recreational	
Pedestrian and Bicycle amenities	Features that provide comfort (e.g. widths, street furniture, bike racks)	Human Needs & Comfort
Safety (traffic)	Features that affect perceptions	
Aesthetics	Attractiveness and maintenance	Liveliness & Upkeep
Safety (traffic)		

Source: Adapted from Koschinsky *et al.* (2016)

Walk Score

Walk score is a web-based tool that assigns a score to a given location based on ease of access to local destinations (e.g. grocery shops, restaurants, bookstores, banks, schools, fitness centres, and parks) (Figure B.4). The score is based on the analysis on distances to destinations in each category. Maximum points are awarded to destinations within a 5-minute walk. A decay function is used to give points to more distant destinations. No points are given to amenities located beyond a 30-minute walk. The Walk Score method also analyses population density and road network design features such as block length and intersection density. Walk scores can be searched in https://www.walkscore.com. Method details not publicly available

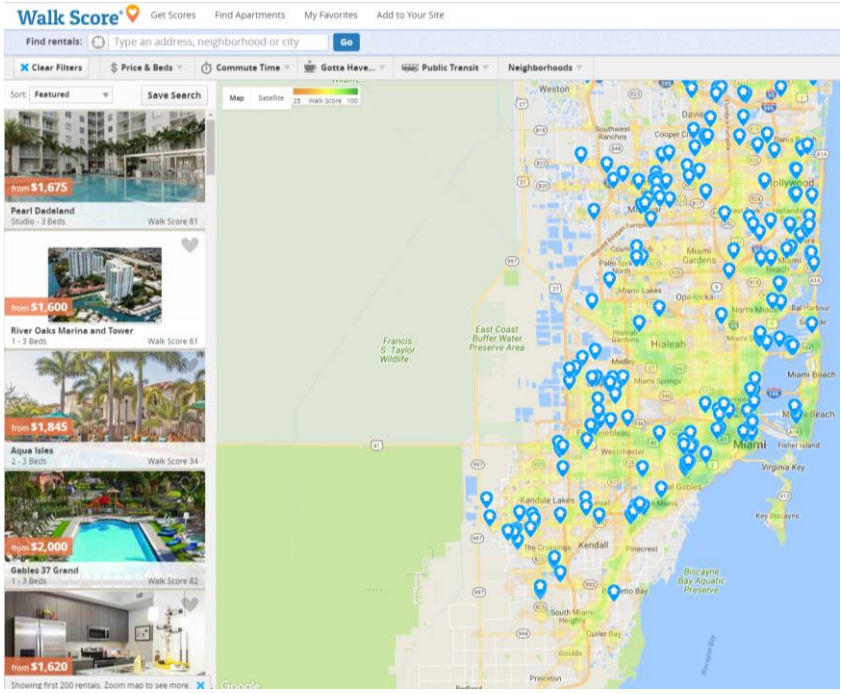


Figure B.4 Walk score example

Studying public life

There are also objective physical measures (observable and countable) that provide evidence on how space is being used or what is the typical behaviour on the street. Of this, counts of people walking, standing or sitting, as well as demographic variables such as diversity for age and culture are important. Tables and chairs on the streets, that indicate the availability of outdoor dining, counts of users of public transport and cycling and counts of traffic flow and measures of pollution or noise levels also provide an indication of the type of activities happening on the street. Recorded crime levels and observed issues of nuisance and maintenance (e.g. litter, other rubbish, broken windows, deteriorated surfaces, etc.) are also relevant measures for capturing street activity.

Through the Public Life Diversity Toolkit, the Gehl Institute (2016) defined tools to study to what extent place quality contributes to socioeconomic mixing and public life diversity. The toolkit defines metrics for Public Life and metrics for Public Space (Table B.14).

Table B.14 Public Life Diversity Toolkit: metrics

Public Life	Public Space
• Data collected from individuals • Observation of social activities in space considering age/gender, duration of stay and sociability • Macro-trends and real-time dynamics of how people move through the city	• Furnishing, landscape and program • Quality of place (protection, comfort and enjoyment) • Neighbourhood price diversity • Building façade activation and entries • Neighbourhood socio-economic mix • Urban connectivity

Final remarks regarding measuring place

This section presented an incremental approach to the concept of place, starting from the early conceptual frameworks or the set of perceived qualities of places that needed to be delivered by good urban design to create successful places, to the actual physical features that contribute to the social construction of those place qualities, and then to tools that measure those physical elements, describing how they are combined to operationalize the perceived qualities of places, some of them in the context of creating positive walking environment and others looking at improvement in the quality of urban life. Of the tools reviewed, the Gehl's Institute's Public Life Diversity Toolkit and TFL's Healthy Street framework were the ones that were specifically aimed at studying streets and the quality of places.

Most street audit methods are based on checklists, and are organised into several categories and several attributes within categories. In some cases this means the tool assumes that a few hundred attributes are going to be assessed. This makes the tools difficult to understand and to use. However, some of the studies reviewed have identified "compact" versions of audits including only the key attributes that capture most of the variation in perceived qualities. This can increase the applicability of the audits, reduce the time it takes to capture the information and ultimately, increase the understanding of quality of place.

B.2.4 How can we value place quality?

Good urban design is linked to economic, social and environmental benefits (CABE 2001). Carmona *et al.* (2017) argue that better places and public spaces have a wide range of benefits, including increases in the space for socializing and enjoyment, increase in incentives to physical activity and the associated health benefits, and impacts in private investment in the area. However, these benefits can come at certain costs which can be associated with changes in local amenities or gentrification, among others.

There is a growing literature on measuring the value of place. The study of CABE (2001) identified two general approaches: qualitative approaches (how the value of good design is perceived by the different stakeholders involved in the production and use of the space and how this perception relates to decision-making and policies) and quantitative approaches (measuring costs and benefits resultant from different levels of design quality to inform financial decisions). More recently, Carmona *et al.* (2017) classified the literature into three type of studies (single parameter studies, wider benefits studies, and "holistic" studies) and present a new "holistic" framework (Figure B.5).

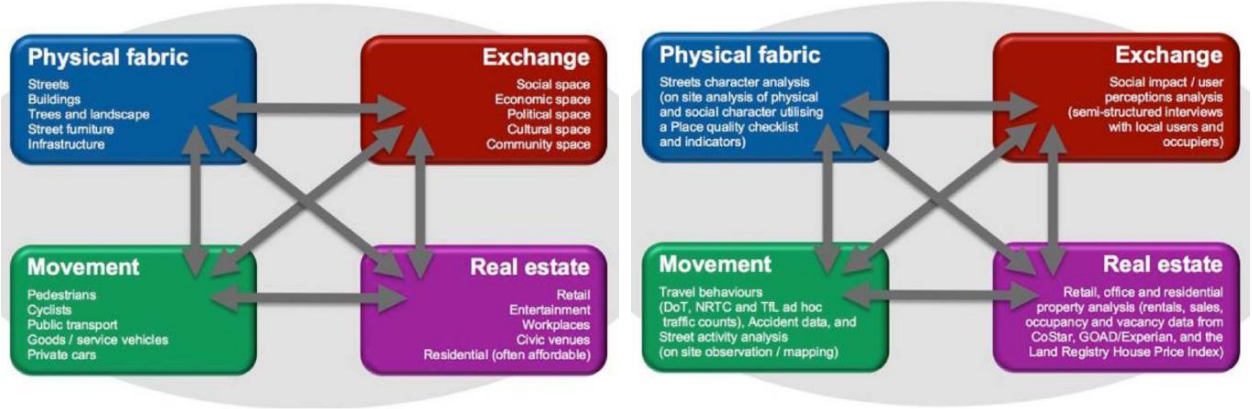


Figure B.5 Holistic Framework for the study of the value of place. Source: Carmona (2017)

Table B.15 presents a summary of the main types of methods that have been used to value place quality. The following sections present more detail into some relevant studies.

Table B.15 Methods that can be used to assess value in the context of street design

Method	Description
Stated preferences	Willingness to pay for improvements in the place
Revealed preferences	Differential of property prices/rents near places with good quality
Asset management accounting	How much it would cost to recreate that place from scratch
Travel cost method	Time and cost incurred in visiting and enjoying a place

DEFRA (2013): Valuing the neighbourhood in which we live

The DEFRA (2013) study was commissioned by the UK Department for Environment, Food and Rural Affairs to assess the importance of the different factors of the local environment and estimate people's willingness to pay for improvements to the factors. Values were estimated for improvements in eleven local environmental quality factors: urban quiet areas; fly-tipping; litter; detritus; fly-posting; graffiti; dog-fouling; chewing gum; trees; light pollution; and odour. The method was a two-stage stated preference survey in which participants had to select between potential improvements to the local environment and financial incentives. Stage one contained a broad range of factors that influence quality of life and Stage two focused on the eleven local environmental factors.

Table B.*16* presents the key results of the research, including the assessment of the current situation for each feature, their importance rating, and the willingness to pay for improvements (in additional council tax per person per month, to improve that factor by a unit on a ten point scale from worst to best). Litter and fly-tipping had the highest importance and the highest level of willingness to pay, £3.95 and £3.71 respectively. Trees had the worst current situation score but are in the middle of the ranking regarding importance and come third, together with odour, in the level of willingness to pay.

Table B.16 Key results of the DEFRA (2013) study

	Current situation (1=worst, 5 best) [1]	Importance rating[2]	Willingness to pay for an improvement (per [3]
Litter	3.43	1	£3.95
Fly-tipping	4.28	2	£3.71
Trees	3.21	5	£2.33
Chewing Gum	3.68	7	£2.17
Odour	3.93	6	£2.33
Dog Fouling	3.37	3	£1.89
Quiet Areas	3.49	4	£1.37
Light Pollution	3.88	10	£0.63
Graffiti	3.40	8	£0.56
Light Intrusion	3.84	9	£0.34
Fly-posting	3.77	11	-[4]

[1] Different aspects were assessed using different scales. For comparability all the results have been placed on a common scale from 1-5. Light pollution and chewing gum were assessed on a scale of 1-3 while litter, light intrusion, trees and fly tipping were assessed on a scale of 1-4.
[2] This priority ordering comes directly from participants responses and so does not exactly match the importance ordering from the willingness to pay estimates.
[3] These estimate the values that an individual would be willing to pay in additional council tax per person per month in order to improve that factor by one unit on a ten point scale from worst to best.
[4] No effect from fly-posting was detected in the study therefore it was not possible to estimate the marginal value of changes.

Source: DEFRA (2013, p.2)

CABE (2007): "Paved with Gold" - The real value of good street design

The study estimated the value that good design of places can generate (compared to average or poor design), based on the assessment of 10 case study streets. The first stage of the research consisted of using the PERS framework to assess the design quality of the 10 case studies. Regression analysis was then used to find the extent to which street quality explains variations in retail rents and housing prices. Each single point increase in the PERS street quality scale corresponded to an increase of £13,600 in residential prices (5.2%) and an increase of £25 per square metre in shop rents per year (4.9%

In a previous study within the same programme of research (Sheldon *et al.* 2007), a stated preference survey was used to estimate willingness to pay for a series of improvements to two streets in London, measured through the PERS framework (Table B.17 and Table B.18). These values were then combined, in the CABE (2007) study, with data on the number of pedestrians using the case study streets, and the average time they spent in the street environment, to estimate the total benefit for the improvements.

Table B.17 Benefits for improvements to links (pence per person per minute) in Sheldon et al. (2007)

Characteristic in PERS	TfL Design Principle	-3	-2	-1	0	1	2	3
Effective width	Create convenient connections	0.00	0.00	0.01	0.01	0.02	0.02	0.03
Dropped kerbs/ gradient	Create convenient connections / Get the detail right	0.00	0.01	0.02	0.04	0.04	0.04	0.04
Obstructions	Create convenient connections	0.00	0.01	0.01	0.02	0.02	0.03	0.03
Permeability	Create clear and easy to understand routes and spaces	0.00	0.03	0.06	0.10	0.11	0.12	0.13
Legibility	Create clear and easy to understand routes and spaces	0.00	0.01	0.02	0.03	0.04	0.05	0.06
Lighting	Get the detail right	0.00	0.02	0.04	0.05	0.06	0.07	0.08
Personal security	Create active and engaging spaces	0.00	0.03	0.06	0.09	0.11	0.13	0.15
Surface quality	Get the detail right	0.00	0.03	0.05	0.08	0.10	0.11	0.11
User Conflict	Create streets and spaces for everyone	0.00	0.03	0.05	0.08	0.10	0.11	0.13
Quality of environment	Get the detail right	0.00	0.06	0.12	0.18	0.21	0.24	0.27
Maintenance	Get the detail right	0.00	0.02	0.04	0.06	0.08	0.09	0.10

Source: Sheldon *et al.* (2007)

Table B.18 Benefits for improvements to public spaces (pence per person per minute) in Sheldon et al. (2007)

Characteristic in PERS	TfL Design Principle	-3	-2	-1	0	1	2	3
Moving in the space	Create convenient connections	0.00	0.04	0.09	0.13	0.15	0.16	0.18
Interpreting the space	Create clear and easy to understand routes and spaces	0.00	0.01	0.02	0.03	0.04	0.05	0.06
Personal safety	Create streets and spaces for everyone / Create active and engaging spaces	0.00	0.04	0.08	0.13	0.17	0.21	0.25
Feeling comfortable	Create streets and spaces for everyone	0.00	0.02	0.05	0.07	0.09	0.12	0.14
Sense of place	Create active and engaging space / Get the detail right	0.00	0.01	0.03	0.04	0.05	0.05	0.06
Opportunity for activity	Create active and engaging spaces	0.00	0.07	0.14	0.22	0.25	0.27	0.30

Source: Sheldon *et al.* (2007)

The results of the Sheldon *et al.* (2007) study were also incorporated in Transport for London's Valuing the Urban Realm toolkit. This toolkit is not publicly available, but has been used, for example, in the study of Boffa Miskell (2017).

ITS and Atkins (2011): Valuation of Townscapes and Pedestrianisation

The objective of this study was to understand users' valuations of townscape improvements and pedestrianisation. The study combined Priority Ranking with stated preference methods and was conducted in four locations in the UK. The results are presented in Table B.19. The authors describe the variations in WTP by locations with how familiar the residents were with those locations and the characteristics of the improvement. Similarly, for the "full pedestrianisation" there is a significant random taste variation across individuals within each location, showing that this policy polarises individuals.

Table B.19 Willingness-to-pay for streetscape improvements in the ITS and Atkins (2001) study

Attribute	Willingness-to-pay, £ per annum			
	Norwich (Base)	York	Otley	Horsforth
Priority: Shared Space	24	68	24	-40
Priority: Full Pedestrianisation	64	64	64	-174
Priority: Limited Vehicle Access	74	74	74	-58
Activity (high)	-30	31	-30	-30
Surface (material Hi; contrast Lo)	30	30	30	30
Surface (material Hi; contrast Hi)	21	21	21	21

Source: ITS and Atkins (2011)

Final remarks regarding methods for valuing place quality

This section presented methods that have been used in recent studies in the UK to estimate the value associated with the improvement of the built environment. All the studies reviewed used stated preference or revealed preference methods. The stated preference studies showed that people tend to perceive the value created by improvements and are willing to pay for them. Similarly, the revealed preference studies, which looked at retail and residential prices, identified positive correlations between increases in place qualities and the observed prices.

In practice, the choice over stated preference and revealed preference studies often depends on data availability. However, as mentioned in the beginning of this section, rather than relying on a single method, it is important to use 'holistic' methods to assess place quality, in order to capture the complexity of the qualities of the built environment and the multiplicity of benefits and value that its improvement can generate. It is also important to consider who is the main beneficiary of the improvements. In many cases street improvements create place-based value that benefits society as a whole, in which case it is necessary to treat the quality of public space and its design as a public good, and not as a "by-product" of development (Carmona *et al.* 2017).

B.3 Main conclusions from seminar about valuing place quality

This section lists the main conclusions from a seminar held at University College London on 19th September 2016 to discuss concepts and methods to value the quality of places.

B.3.1 What is 'place' and what is a good quality place?

- "Place" is the urban realm, the built environment between buildings. It includes, for example, streets, public spaces, outdoor retail (cafés, markets), and station entrances.
- Good quality places are shared: they have a mix of different types of users (for example, people sitting, children playing, passengers waiting for buses).
- Good quality places are inclusive: easy to reach, and where all feel comfortable, regardless of gender, age, socio-economic class, ethnic group, disability, and other personal characteristics.
- Good place-making needs public investment, local stakeholders' involvement, and joined up professional thinking and collaboration.
- The priority given to issues of place quality in the national political agenda in the UK has fluctuated over the years, with the highest point in the early 2000s with the work of CABE (Commission for Architecture and the Built Environment) and other institutions.
- The importance of place is more consistently valued and recognised in cities, where it forms part of a wider 'liveability' and 'well-being' agenda.
- Regulations do not substitute for good design, if they do not consider why and how people use public spaces.
- Good places are more than just public spaces.

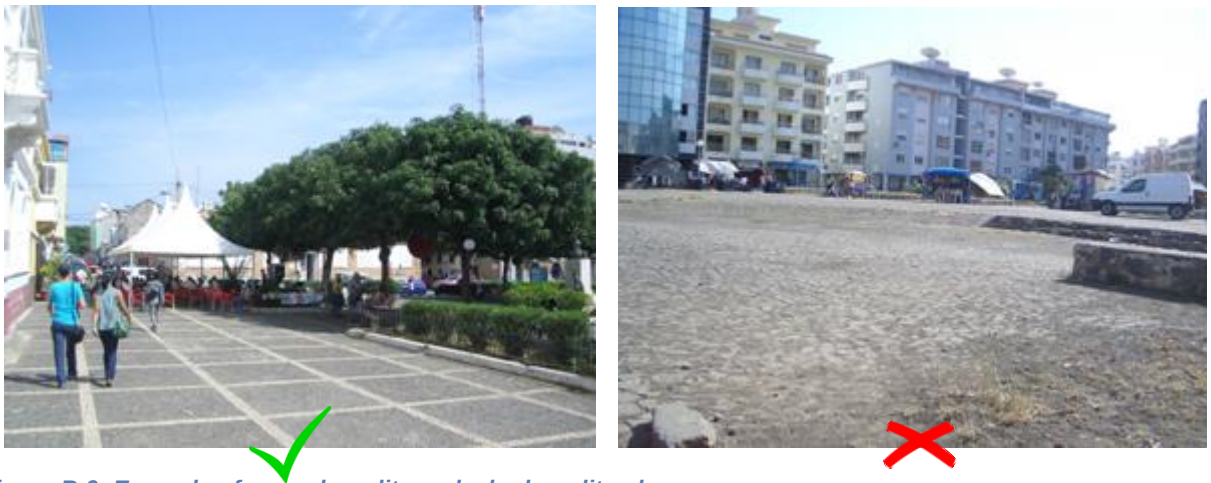


Figure B.6: Example of a good-quality and a bad-quality place

B.3.2 What do we know about the value of 'place'?

1. Good quality places are good for society

- There is evidence that good quality places can stimulate local economic development; reduce congestion, energy use, and pollution; contribute to lower crime rates; and indirectly lead to savings in health care (mental and physical) and social care costs.

- Good quality places also have more intangible, and wider, benefits such as increasing individual wellbeing, local pride, and consensus within communities.

2. 'Place' has market value

- Developers approach places from a commercial perspective: good quality places increase attractiveness, footfall and hence property values. For this reason, in some developments, they may even invest more in place-making than in buildings.

- Academics have used revealed preference analysis to estimate how differences in the quality of places are capitalized in housing or land markets. For example CABE (2007) found that a 1-point increase in street quality (on a 7-point scale) was associated with a 5.2% increase in prices of flats around some streets in London.

3. 'Place' has use value

- The public sector accounts for costs and benefits using a decision framework that goes beyond considerations of commercial profit. The private sector probably underestimates the value of good quality places because the benefits of these places are widespread and cannot all be captured through payments (as many people use the places, not only local residents or workers).

- It is difficult to capture the use value of places. Using travel models, we can estimate the value of time savings for people using streets or public spaces as a link. However, for people using those spaces as places, we need to consider the value of the time spent in those places.

- Stated preference studies have shown that most people are willing to pay for good quality places. For example, ITS and Atkins (2011) estimated that projects for implementing shared space, full pedestrianisation, and limited vehicle access in some towns in the UK had an average value of £23, £21, and £25 per person per year, respectively.

4. The value of 'place' comes from the whole space

- We have methods to estimate the value of the different components of a place; for example, the conditions of pavements, and the presence of positive element such as trees or benches, and negative elements such as litter or graffiti (Sheldon *et al.* 2007, DEFTRA 2013). It is possible to go into great detail and even calculate the value of an additional street bench.

- However, it is the holistic qualities of places, not just the details of design that brings the full value to the people using places. The overall value is bigger than the sum of its components.

5. The value of 'place' does not come only from space

- The value people derive from places is closely related to the type of facilities provided for the local community, the surrounding land uses, and public transport and walking accessibility to reach those places. The “place” function of spaces needs to be enabled. Even well-designed places only bring value if they are used by people – footfall and street activities are key measures of success.

- The design of places must consider how they are used in practice, which depends on people’s mobility patterns at different times. For example, pedestrianized streets have little passive surveillance, which increases fear of crime when shops are closed. For this reason, in some cases, those streets are open to motorised traffic at night-time.

Figure B.7: Public square used for leisure and sport

B.3.3 What do we not know (yet) about the value of 'place'?

1. How does 'place' create value?

- The development of techniques to value places is hampered by the lack of a sound theory on how good quality places contribute to people’s happiness and well-being. What exactly generates value?

- One hypothesis is that the improvement in places generates economic value. There are many studies on the effects of noise and air pollution in land value, but these effects are very localised, while the benefits of good quality places are more widespread.

- The use value of places also generates social value. For example, having different income, age or ethnic groups sharing spaces leads to “agglomeration effects” that bring social benefits, in the same way that having different businesses together bring economic “agglomeration effects”.

2. What should we value?

- The values of places estimated with stated or revealed preference methods may double count some of the values already accounted for in transport appraisal, as pedestrian benefits (for example, as safety or journey ambience).

- A possible way of avoiding this double counting would be to distinguish between value associated with Movement (partly captured already) and value of Place-related activities.

- It is relatively easy to attach a monetary value to impacts of good quality places, such as reduced crime rates. The difficult part is how to estimate the scale of those impacts: to what extent does the presence of more people in public places reduce crime?

- We could estimate how good quality places contribute to wellbeing and then attach a value to the increased wellbeing, in the same way that the impacts of noise and air pollution are currently estimated using dose-response relationships.

3. Whose value?

- In some cases, places have value for their users but are disliked by local residents (e.g. centres of night-time economy activity). Or they may have value for some age groups but not for others. How to weight these different preferences?

- It is possible to estimate different values for different people using the same space at the same time; for example, depending on whether they are using that space as links for movement, or places to spend time.

4. When should we value?

- Ex-ante valuations should be complemented with the evaluation of how people use places after the interventions, using indicators such as the number of people using the places, the activities they take part in, the time they spend there, or, in the case of retail sites, how much they spend per visit. Some of these indicators are already being used by real estate developers and some cities, such as Copenhagen.

- Improvements in the local built environment tend to be followed by gentrification, which means that overall, low income communities are often at a disadvantage by being forced out and so having low levels of access to good quality places. Should we capture these equity aspects when valuing places? How?

5. Where should we value?

- Stated preference studies are context-specific and so the application of values obtained in different areas must be done with caution. However, even when they are not transferrable, values from those studies are still useful as benchmarks. Decision-makers will be more comfortable with the idea of valuing places if they have evidence collected in several contexts.

- A possible approach is to value not individual interventions but a portfolio of interventions. For example, to estimate how the improvement of several places within a city changes the overall

perception people have of that city.

Figure B.8: Place used for leisure

B.3.4 Seminar participants

- Aimee Aguilar Jaber, ITF/OECD
- Alex Phillips, Grosvenor Estate
- Alexis Edwards, Bournemouth
- Andy Cameron, WSP
- Henry Kelly, Department for Transport
- Jeanette Baartman, Transport for London
- Jessica Clift, Transport for London
- John Nellthorp, ITS Leeds
- Mark Ledbury, Department for Transport
- Matthew Carmona, University College London
- Miles Price, British Land
- Nicola Kane, Transport for Greater Manchester
- Paulo Anciaes, Centre for Transport Studies, University College London
- Pedro Abrantes, Urban Transport Group
- Peter Jones, Centre for Transport Studies, University College London
- Rob Sheldon, Accent
- Ryan Taylor, Transport for London
- Steve Perkins, ITF/OECD

B.4 *Healthy Streets* survey analysis

This section is an empirical analysis of the place quality concepts introduced in the previous sections. The analysis aims to understand what elements of the built environment, at the street level, influence the perceived satisfaction of users when being in the street. The analysis looks at data provided by Transport for London from the *Healthy Streets* on-street survey conducted in 80 streets across London (Figure B.9) between 2014 and 2016. The survey questionnaire asked people to rate their overall satisfaction with the street, how attractive and enjoyable they think the street is, and their perception of environmental quality variables such as noise, air quality, cleanliness, easiness to cross, places to rest and for shelter, motorised traffic levels, personal security, quality of trees and green areas, pavements, and walking environment. Information on demographics and trip characteristics was also gathered.

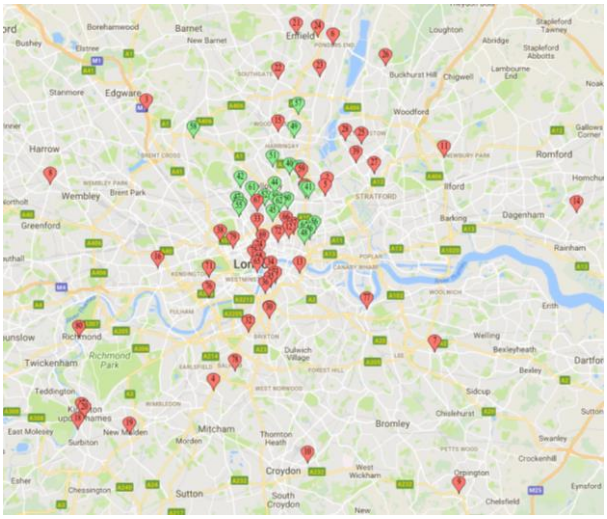


Figure B.9: Streets included in the Healthy Streets survey. Source of base map: Google Maps

The survey consisted of 8453 interviews. In 70% of the streets, 100 or more interviews were conducted (locations with red icons in the map above). In the other 30%, less than 100 interviews were conducted (locations with green icons). Figure B.10 shows the number of interviews in each street.

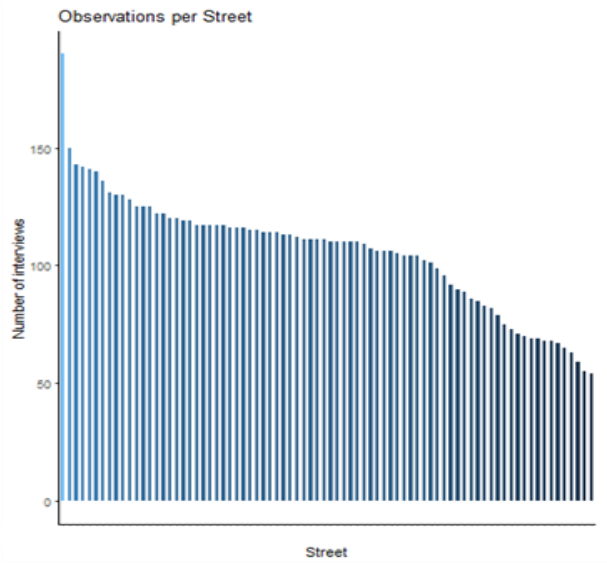
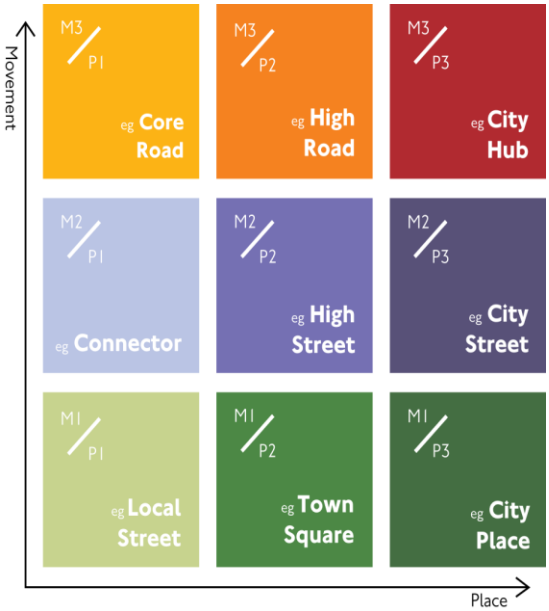


Figure B.10: Observations per street

B.4.1 Survey details

Location Characteristics

London's road network is classified into nine street types, defined by their level of movement (M) and the intensity of their place function (P) (left side of Figure B.11). For example M3/P1 corresponds to roads or motorways with prevalence of the Movement function and a low intensity place function. The Healthy Streets survey was conducted on streets of all types (right side of Figure B.11). City Place type streets (M1/P3) had the smallest amount of interviews (6.9%) and Core Road type (M3/P1) the largest (17.8%). In general, the street types with place function P2 or P3 and movement function M1 or M2 had fewer interviews.



Street type	Number	%
M1P1 Local Street	1035	12.2
M1P2 Town Square	660	7.8
M1P3 City Place	583	6.9
M2P1 Connector	1035	12.2
M2P2 High Street	953	11.3
M2P3 City Street	728	8.6
M3P1 Core Road	1501	17.8
M3P2 High Road	901	10.7
M3P3 City Hub	1060	12.5
Total	8456	100

Figure B.11: Street Type matrix for London (Source: TfL) and distribution of survey interviews by street type

The weather variable was recorded by the interviewer. Sunny (41.2%) and Cloudy (44.2%) were the prevalent weather conditions at the time of the interviews (Table B.20). The observed traffic speed was also recorded by the interviewers. Of 5940 observations of speed on the different locations where the interviews were conducted, 19.1% had high speed traffic, 56.9% had medium traffic speed and 23.4% had low traffic speed (Table B.21).

Table B.20: Weather conditions during interviews

Weather	Number	%
Sunny	3491	41.2
Cloudy	3746	44.2
Light rain	965	11.3
Heavy rain	284	3.3
#Total cases	8456	100

Table B.21: Traffic speed during interviews

Speed of traffic	Number	%
High	1133	19.1
Medium	3381	56.9
Low	1391	23.4
No answer	35	0.6
Total	5940	100

Demographics

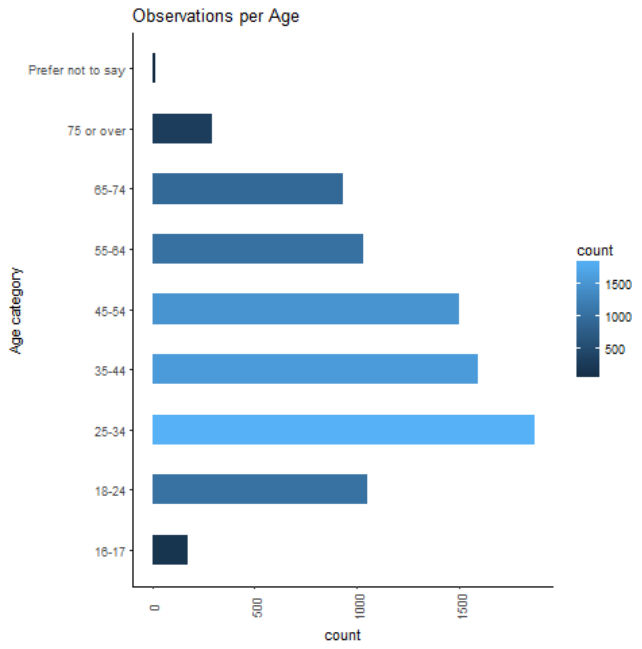
The survey questionnaire included 9 demographic questions. Six of these questions were answered by participants (age category, gender, employment status, long-term physical or mental impairment, place of residence, and country of origin). The other three questions were reported by the interviewer: i) if the respondent was using walking aids (e.g. walking frame, one or two walking sticks, wheelchair, mobility scooter), ii) if the respondent was encumbered with/using items such as shopping bags, shopping trolley, small child or suitcases, among other and iii) if the respondent was accompanied by baby, toddlers, children, elderly or person with special needs.

47.6% of the participants were male and 52.4% were female. The gender distribution of participants per street type is relatively balanced (Table B.22). 22.1% of participants belonged to the 25-34 age category, and 18.8% belonged to the 35-44 category. For the analysis in this report, the age variable was recategorized to achieve a more balanced distribution (right side of Figure B.12). The majority of participants (83.1%) lived in London, 10.7% lived in the UK but outside London and only around 6% were from outside the UK (Table B.23).

Table B.22: Gender distribution of survey participants

Street type	Male		Female	
	Number	%	Number	%
Local Street	536	13.3	499	11.3
Town Square	303	7.5	357	8.1
City Place	270	6.7	313	7.1
Connector	512	12.7	523	11.8
High Street	419	10.4	534	12.1
City Street	343	8.5	385	8.7
Core Road	777	19.3	724	16.3
High Road	398	9.9	503	11.4
City Hub	467	11.6	593	13.4
#Total cases	4025	47.6	4431	52.4

Survey categories



Analysis categories

Age category	Number	%
16-34	3089	36.5
35-54	3093	36.6
55-75+	2256	26.7
Prefer not to say	18	0.2
# total cases	8456	100

Figure B.12: Age distribution of survey participants

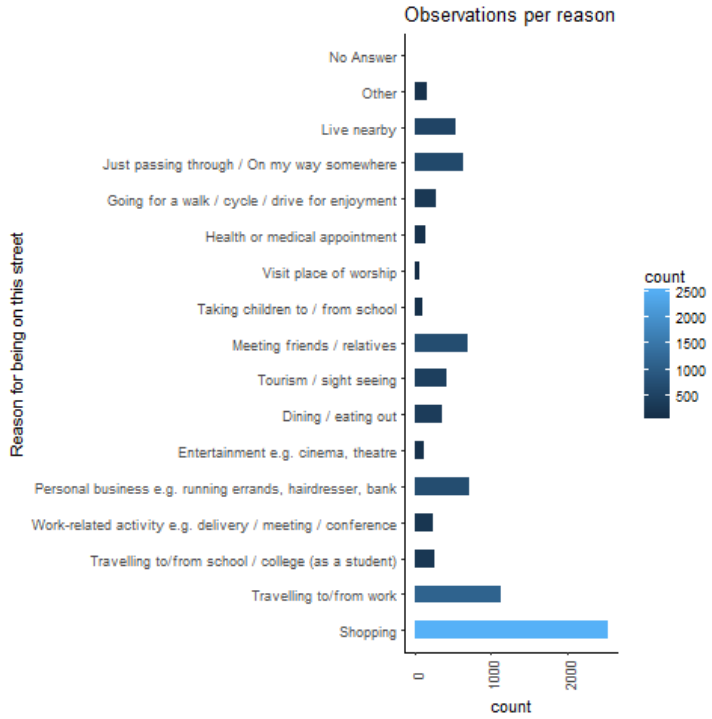
Table B.23: Place of residence of survey participants

Place of residence	Number	%
In London	5276	83.1
In the UK, but outside of London	677	10.7
Outside the UK	373	5.9
Prefer not to say	24	0.4
Total	6350	100

Characteristics of activities and trips

The survey also asked participants about the reason for being on the street on that day, mode of transport used to travel there and frequency of visit. The main reason for being on the street was shopping (30.1%) (Figure B.13). Travelling to/from work was the second most common trip purpose (13.5%). Walking was the most used travel mode to reach the street (53.1%) (Figure B.14). The second most used mode was bus and other public transport modes (38.7%).

Survey categories

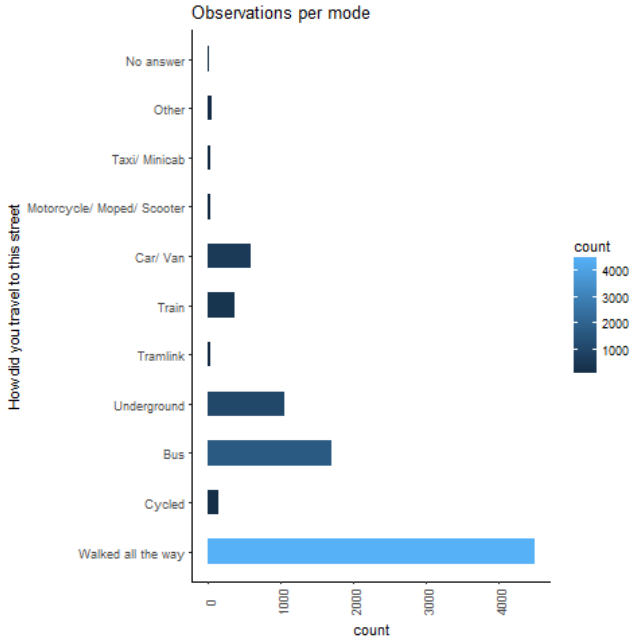


Analysis categories

Reason	Number	%
Shopping	2547	30.1
Work travel to/from or related	1378	16.3
Personal activities	910	10.8
Meeting friends/relatives	707	8.4
Just passing	633	7.5
Live nearby	531	6.3
Dining out/Entertainment	498	5.9
Tourism/sight seeing	425	5.0
Enjoyment walk/cycle/drive	282	3.3
Travelling to/from study	268	3.2
Other	158	1.9
Taking children to/from school	112	1.3
Total	8449	100

Figure B.13: "Reason for being on this street" - categories

Survey categories



Analysis categories

Travel mode	Number	%
Walked all the way	4491	53.1
Public Transport	3274	38.7
Car/Van/Taxi/Minicab	610	7.2
Motorcycle/ Moped/ Scooter	22	0.3
Other	53	0.6
Total	8450	8450

Figure B.14: "How did you travel to this street?" - categories

Perceived qualities of the street environment

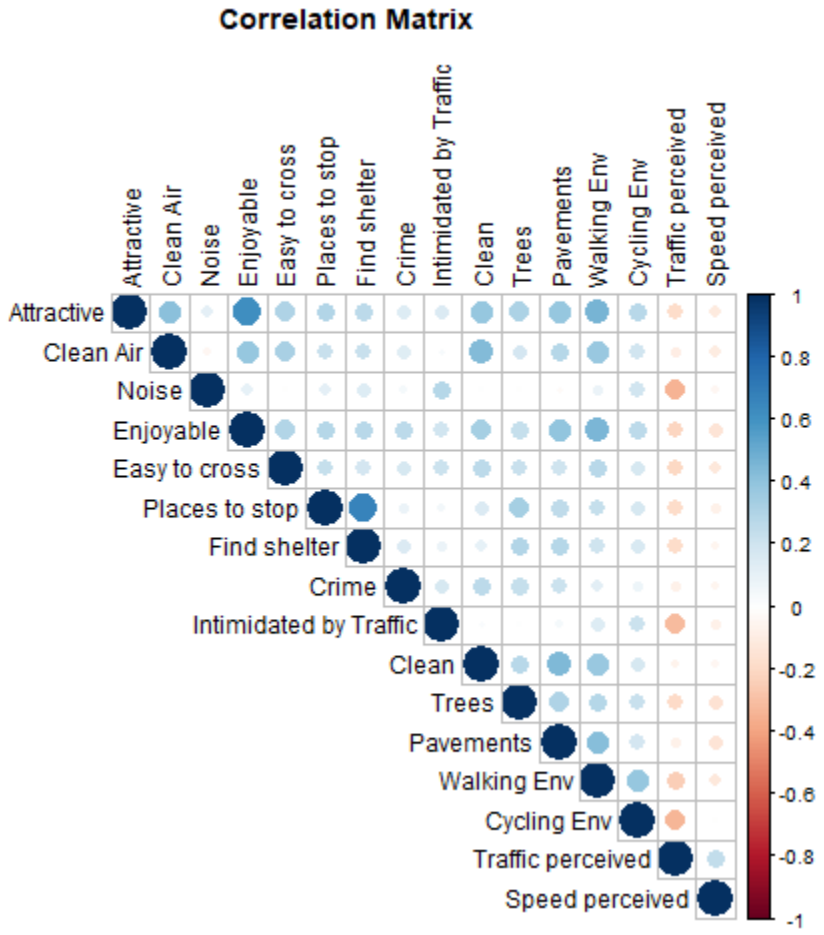
To understand people's perceptions of the street, the survey also included specific questions regarding street features. Some of these questions asked participants to rate features on a scale from 1 ('Not at all') to 10 ('Extremely'). Other questions were rated on different scales (Table B.24).

Table B.24: Variables measuring perceptions of the street environment

Street environment features	Variable name
RATED FROM 1 to 10	
Overall how satisfied are you with this street today?	How Satisfied
How attractive do you find it?	How Attractive
How clean do you think the air on it is?	Clean air
How noisy are you finding it?	Noisy
How enjoyable are you finding it?	How Enjoyable
How easy do you think it is to cross it?	Easy to cross
How easy would it be for you to find somewhere to stop or rest?	Places to stop
How easy would it be for you to find shelter (from sun or rain)?	Find shelter
How safe from crime and anti-social behaviour do you feel on it?	Safe from crime
How intimidated do you feel by the traffic on it?	Intimidated by traffic
How clean and free from litter, dog mess and rubbish do you find it?	Clean
How would you rate the trees, plants and green spaces on it?	Trees and green
How would you rate the quality of the pavements on it?	Pavements
RATED ON OTHER SCALES	
To what extent do you agree that this street provides a good environment for people to walk in?	Good walking environment
As a pedestrian, do you feel the level of motor vehicle traffic is about right, too much or too little?	Traffic perceived
As a pedestrian, do you feel the speed of vehicle traffic is about right, too fast or too slow?	Speed perceived

The objective of our analysis was to understand which elements of the street environment were related to the users' perception of the quality of the street. For this aim, the dependent variable needs to capture the overall perception of the street. Initially, the first question (*How Satisfied are you with this street?)* was selected as dependent variable. The explanatory variables were the other street environment features and the movement and place classification of the streets.

Figure B.15 shows the correlation matrix of the explanatory variables. *Attractive* and *Enjoyable* had high correlation values with each other and with several other variables, especially *Places to stop* and *Find shelter*. A Variance Inflation Factor (VIF) test was conducted to identify possible multicollinearity. The VIF estimates how much the variance of a coefficient is 'inflated' because of linear dependence with other explanatory variables. Although, all the VIF for all variables is below 2.5, which is considered a conservative threshold to identify multicollinearity, the *Attractive*, *Enjoyable*, *Places to Stop* and *Find Shelter* have VIF values higher than 1.9 which is showing that for these variables the coefficient variance is around 90% larger than it would be if they were completely uncorrelated with all the other explanatory variables.



Variables	VIF
Attractive	1.952
Clean Air	1.506
Noise	1.252
Enjoyable	1.907
Easy to cross	1.293
Places to stop	1.957
Find shelter	1.947
Crime	1.213
Intimidated by Traffic	1.265
Clean	1.600
Trees	1.380
Pavements	1.560
Walking Environment	1.663
Cycling Environment	1.338
Traffic perceived	1.457
Speed perceived	1.124

VIF values > 2.5 indicate multicollinearity

Figure B.15 Perceived variables correlation matrix and multicollinearity test

B.4.2 Analysis

A linear regression model for the *Satisfied* variable was specified and fitted. This model identifies which perceived elements of the built environment explain the overall satisfaction score assigned by participants to the street (Table B.25-Model 1). A second model excluded the *Attractive* and *Enjoyable* variables, as they capture an overall assessment of the streets similar to the dependent

variable (Table B.25-Model 2). The variable *Find shelter* was also removed from Model 2 because of the high correlation with the *Places to Stop* variable. The variables related with traffic levels and travel speeds were excluded from the final model because they were not statistically significant in all the considered model specifications.

Models 1 and 2 explain 45.2% and 33.4% of the variation of satisfaction with the street, respectively. Most of the variables were significant in both models. The models show that, all else equal, the more participants agreed with the statement *'this street provides a good environment for people to walk in'*, the highest their satisfaction level. Good rating of the quality of pavements, thinking that the air is clean, and feeling that the street is safe from crime and anti-social behaviour were other significant factors that increase the level of satisfaction with the street in both models.

In Model 2 (but not in Model 1), having a Place function of 3 had a significant and positive effect on the level of satisfaction compared to the reference value of Place function 1. Place 3 is only significant after removing the other overall assessment variables (*Attractive* and *Enjoyable*). This suggests that in Model 1 these variables were capturing part of the good place qualities that people perceive when being on the street. In addition, in Model 1, the *Trees and Green* variable has a negative coefficient, which goes against previous literature that shows that urban green areas and trees have large positive effects on urban environments (LEAF *et al.* 2015, McDonald *et al.* 2017). It is possible that in Model 1 the positive effect of trees is being captured by the *Attractive* or *Enjoyable* variables, because when these variables are removed, in Model 2, the *Trees and Green* variable effect becomes positive.

Table B.25 Models explaining levels of satisfaction with the streets

	Dependent variable:	
	How Satisfied?	
	(1)	(2)
Attractive	0.311*** (0.013)	
Clean Air	0.039*** (0.011)	0.140*** (0.011)
Noise	-0.022** (0.009)	0.003 (0.010)
Enjoyable	0.167*** (0.013)	
Easy to cross	0.060*** (0.009)	0.075*** (0.010)
Places to stop	-0.002 (0.009)	0.023*** (0.008)
Find shelter	-0.004 (0.009)	
Crime	0.071*** (0.011)	0.111*** (0.012)
Intimidated by Traffic	0.036*** (0.008)	0.025*** (0.008)
Clean	0.047*** (0.011)	0.086*** (0.012)
Trees and Green	-0.021*** (0.008)	0.016* (0.009)
Pavements	0.080*** (0.011)	0.147*** (0.012)
Good Walking Environment (Strongly disagree)		
Slightly disagree	0.301*** (0.106)	0.483*** (0.117)
Neither agree nor disagree	0.372*** (0.106)	0.758*** (0.116)
Slightly agree	0.364*** (0.098)	0.927*** (0.107)
Strongly agree	0.489*** (0.107)	1.250*** (0.116)
Don't know	0.093 (0.389)	0.734* (0.429)
Movement function(Movement 1)		
Movement2	0.216*** (0.052)	0.095* (0.057)
Movement3	0.064 (0.054)	-0.050 (0.059)
Place function (Place 1)		
Place2	0.010 (0.049)	0.039 (0.053)
Place3	-0.063 (0.049)	0.156*** (0.053)
Constant	1.596*** (0.127)	2.095*** (0.139)
Observations	5,795	5,833
R2	0.454	0.336
Adjusted R2	0.452	0.334
Residual Std. Error	1.459 (df = 5773)	1.610 (df = 5814)
F Statistic	228.155*** (df = 21; 5773)	163.246*** (df = 18; 5814)
Note:		*p<0.1; **p<0.05; ***p<0.01

Italic indicates name of categorical variables.
Text in parenthesis corresponds to reference category

Model 3 and Model 4 in Table B.26 use the other overall street quality assessment variables: *Attractive* and *Enjoyable* as dependent variables respectively. The explanatory variables are the same used for Model 2.

Table B.26 Models explaining perceptions of streets as attractive and enjoyable

	Dependent variable:	
	How Attractive? (3)	How Enjoyable (4)
Clean Air	0.212*** (0.012)	0.201*** (0.012)
Noise	0.057*** (0.010)	0.031*** (0.010)
Easy to cross	0.021** (0.010)	0.065*** (0.011)
Places to stop	0.052*** (0.008)	0.073*** (0.008)
Safe from Crime	0.061*** (0.012)	0.109*** (0.012)
Intimidated by Traffic	-0.029*** (0.009)	-0.018** (0.009)
Clean	0.091*** (0.012)	0.074*** (0.012)
Trees and Green	0.091*** (0.009)	0.049*** (0.009)
Pavements	0.176*** (0.012)	0.079*** (0.012)
Good walking environment (Strongly disagree)		
Slightly disagree	0.364*** (0.119)	0.426*** (0.120)
Neither agree nor disagree	0.795*** (0.118)	0.872*** (0.119)
Slightly agree	1.188*** (0.109)	1.233*** (0.109)
Strongly agree	1.589*** (0.118)	1.680*** (0.118)
Don't know	1.362*** (0.442)	1.355*** (0.443)
Movement function(Movement 1)		
Movement2	-0.221*** (0.058)	-0.198*** (0.058)
Movement3	-0.218*** (0.060)	-0.201*** (0.060)
Place function(Place 1)		
Place2	0.066 (0.055)	0.158*** (0.055)
Place3	0.445*** (0.054)	0.555*** (0.055)
Constant	0.918*** (0.141)	1.145*** (0.142)
Observations	5,938	5,925
R2	0.425	0.389
Adjusted R2	0.424	0.387
Residual Std. Error	1.660 (df = 5919)	1.664 (df = 5906)
F Statistic	243.537*** (df = 18; 5919)	208.642*** (df = 18; 5906)
Note:		*p<0.1; **p<0.05; ***p<0.01

Italic indicates name of categorical variables.
Text in parenthesis corresponds to reference category

Model 3 explains 42.4% of the variation in the attractiveness rating the participants assigned to the street and all variables, except *Place 2*, are significant. *Clean air* and *Pavements* are the variables with the largest effect on the perceived attractiveness of the street. *Good walking environment* has a positive an increasing effect. The variables related to traffic (Intimidated by traffic and Movement function) has a negative effect on the overall Attractiveness rating. Model 4 explains 38.7% of the variation in the perception of the streets as enjoyable. All the explanatory variables are significant in this model.

Model 3 was then expanded by including variables measuring demographic characteristics (gender, age category, and presence of mobility impairment), characteristics of the trip (reason for being on the street and travel mode) and objective measures of the built environment and street conditions (weather conditions and traffic speed). Additional variables were added, estimated from open source databases:

i) Motorised traffic levels (Annual Average Daily Traffic (AADT) in 2013), calculated from the London Atmospheric Emissions Inventory data (https://data.gov.uk/dataset/london-atmospheric-emissions-inventory-laei-2013)

ii) Public Transport Access Level (PTAL) for 2015. (Source: https://data.london.gov.uk/dataset/public-transport-accessibility-levels). This is an indicator of public transport accessibility based on the walking time from the point-of-interest to the nearest public transport access point; the reliability of the service modes available; the number of services available within the catchment; and the level of

service at the public transport access points (i.e. average waiting time).

The average value of these two variables on each of the streets was estimated. Figure 4 shows PTAL values in London and the mean scores of the *Attractive* variable in each of the 80 streets where the survey was conducted. In central London, which has high PTAL values, the *Attractive* scores are also high. Lower *Attractive* scores do not go below PTAL level four and appear to be predominant in locations outside the central area.

Models 5 and 6 (Table B.27) include demographic and trip characteristics variables and the latter also includes objective traffic and accessibility variables. The Adjusted R^2 for Model 5 and 6 are 42.8% and 43.6%, respectively. The improvement is marginal compared to Model 2.

Gender does not have a significant effect on the rating of street attractiveness. The 55-75+ age category is significant in both models and has a negative effect with respect to the reference category (16-34) which suggest that people on the 55-75+ age category find the streets less attractive than the younger group. Having a mobility impairment has a significant and negative effect. Regarding the reason for being on the street variable, the *Just Passing*, *Personal Activities* and *Walking/cycling/driving for enjoyment* reasons significantly reduce the perceived level of attractiveness compared to shopping, the reference category. In model 5, *Dining out/entertainment* and *Tourism* were significant with a positive effect and in model 6 only Tourism was significant.

After including the Public Transport Accessibility Levels (PTAL) (Model 6), all the categories of the variable *Travel mode used to get to the street* become insignificant and were, therefore, omitted from the model. The effect of PTAL on the level of attractiveness is significant and positive.

In Model 5, Movement functions 2 and 3 were significant and negative, but in Model 6, this effect is captured by the objective variables of traffic (AADT). In Model 5, Place function 3 is significant and positive, compared to the reference value (Place function 1). In model 6, Place function 2 and 3 were significant but the *dining out* variable was no longer significant. This might indicate that the place variable is capturing the effect of being on the street for entertainment, compared to shopping. In general, variables related to traffic were significant and reduced the perceive attractiveness of the street and variables related to good walking environment, including pavement quality, increase the level of perceived attractiveness of streets.

The final model (Table B.28) includes other demographic variables related to place of residence as well as other observed street variables and users' characteristics reported by interviewers. Participants that live *in the UK, but outside of London* were less likely to find the street attractive, compared to those that live in London. An interaction between gender (female) and perceived safety from crime was included and found to have a significant and positive effect. This shows that, on average, the impact of safety from crime on perceived attractiveness of the streets is higher for women than for men. Travelling with large or heavy items such as suitcases or baby pushchair had a significant and negative effect on the reported level of attractiveness of the street. Of the observed characteristics of the street location, medium traffic speed had a negative and significant effect, compared to the reference value of high speed. Finally, sunny weather had a significant positive effect on the perceived attractiveness of the street.

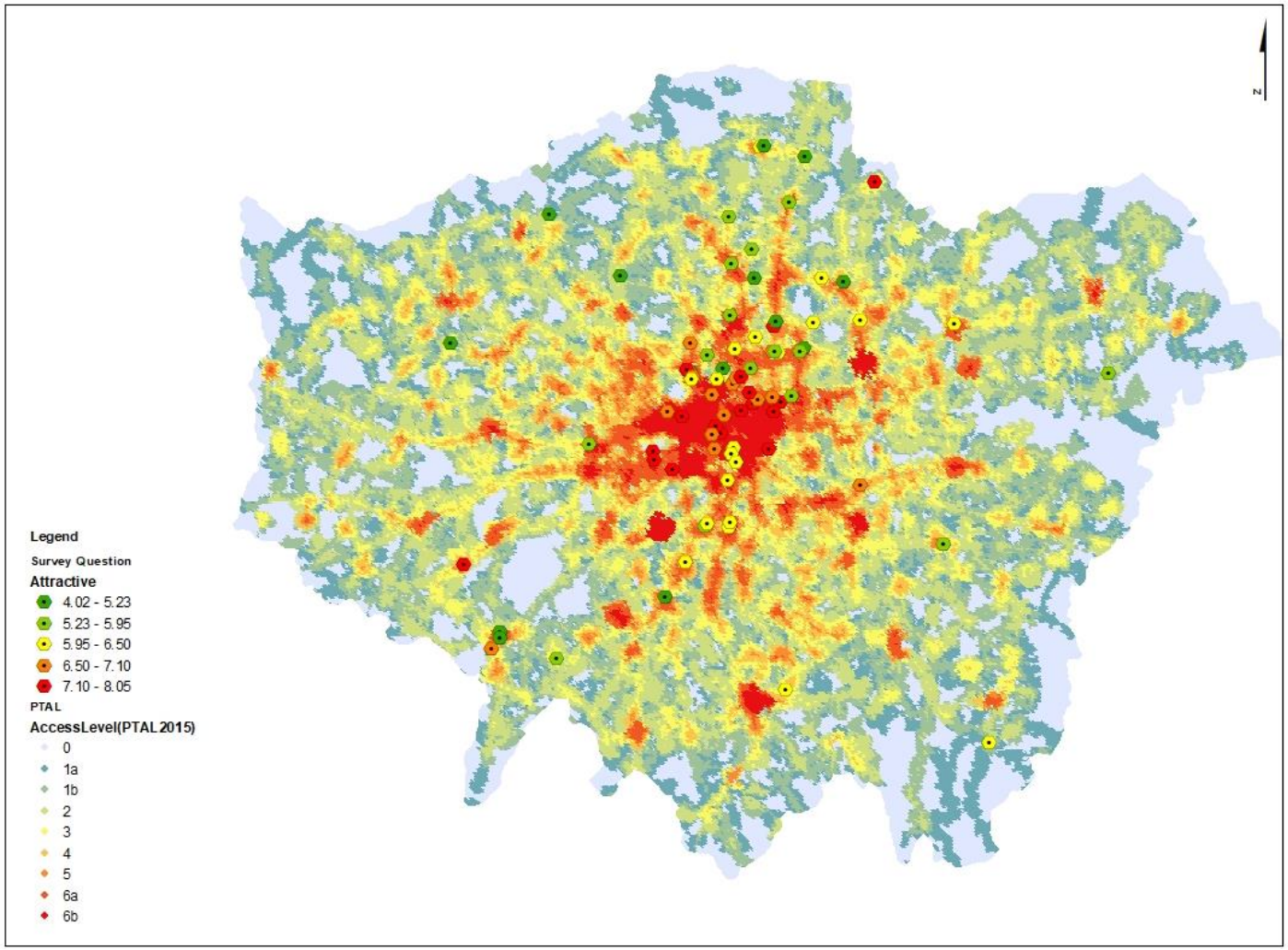


Figure B.16 Public Transport Accessibility Levels (PTAL) and survey locations' average Attractiveness Score

Table B.27 Expanded models explaining perceptions of streets as attractive (I)

	Dependent variable:	
	How Attractive?	
	(5)	(6)
Clean Air	0.211*** (0.012)	0.217*** (0.012)
Noise	0.053*** (0.010)	0.046*** (0.010)
Easy to cross	0.024** (0.010)	0.023** (0.011)
Places to stop	0.049*** (0.008)	0.045*** (0.008)
Safe from Crime	0.061*** (0.012)	0.063*** (0.012)
Intimidated by Traffic	-0.027*** (0.009)	-0.028*** (0.009)
Clean	0.088*** (0.012)	0.085*** (0.012)
Trees and Green	0.095*** (0.009)	0.091*** (0.009)
Pavements	0.170*** (0.012)	0.169*** (0.012)
Good walking environment (Strongly disagree)		
Slightly disagree	0.313*** (0.119)	0.352*** (0.119)
Neither agree nor disagree	0.735*** (0.119)	0.756*** (0.119)
Slightly agree	1.110*** (0.109)	1.135*** (0.109)
Strongly agree	1.506*** (0.119)	1.507*** (0.119)
Don't know	1.287*** (0.442)	1.325*** (0.439)
Movement function (Movement 1)		
Movement2	-0.179*** (0.059)	-0.012 (0.065)
Movement3	-0.203*** (0.061)	-0.022 (0.066)
Place function (Place 1)		
Place2	0.073 (0.056)	0.097* (0.056)
Place3	0.379*** (0.057)	0.267*** (0.059)
Gender (Male)		
Female	0.005 (0.044)	-0.003 (0.044)
Mobility impairment	-0.307** (0.139)	-0.265* (0.139)
Age band (16-34)		
35-54	-0.083 (0.052)	-0.078 (0.052)
55-75+	-0.176*** (0.058)	-0.153*** (0.058)
Prefer not to say	-0.274 (0.463)	-0.362 (0.461)
Reason (Shopping)		
Work travel to/from or related	0.037 (0.072)	-0.046 (0.072)
Just passing	-0.150* (0.081)	-0.161** (0.081)
Personal activities	-0.185** (0.077)	-0.217*** (0.077)
Meeting friends/relatives	0.036 (0.091)	0.002 (0.090)
Live nearby	0.104 (0.091)	0.034 (0.094)
Dining out/Entertainment	0.190* (0.098)	0.104 (0.099)
Tourism/sight seeing	0.206* (0.107)	0.182* (0.108)
Travelling to/from study	-0.007 (0.131)	0.009 (0.131)
Enjoyment walk/cycle/drive	-0.304** (0.146)	-0.331** (0.147)
Taking children to/from school	-0.049 (0.194)	-0.092 (0.193)
Other	-0.113 (0.158)	-0.182 (0.158)
Travel mode (Walking)		
Public Trans	0.080* (0.049)	
Car/Van/Taxi/Minicab	-0.068 (0.084)	
Motorcycle/ Moped/ Scooter	-0.005 (0.431)	
Other	0.573* (0.317)	
PTAL20		0.081*** (0.016)
AADT13		-0.00003*** (0.00001)
Constant	1.074*** (0.157)	1.134*** (0.207)
Observations	5,938	5,829
R2	0.431	0.439
Adjusted R2	0.428	0.436
Residual Std. Error	1.655 (df = 5899)	1.646 (df = 5792)
F Statistic	117.681*** (df = 38; 5899)	126.072*** (df = 36; 5792)

Note: *p<0.1; **p<0.05; ***p<0.01
Italic indicates name of categorical variables.
Text in parenthesis corresponds to reference category

Table B.28 Expanded models explaining perceptions of streets as attractive (II)

Linear Regression Model

	Dependent variable:
	How Attractive?
Clean Air	0.220*** (0.012)
Noise	0.041*** (0.010)
Easy to cross	0.021* (0.011)
Places to stop	0.051*** (0.009)
Safe from Crime	0.039** (0.016)
Intimidated by Traffic	-0.020** (0.009)
Clean	0.080*** (0.013)
Trees and Green	0.101*** (0.009)
Pavements	0.163*** (0.013)
Good walking environment	
(Strongly disagree)	
Slightly disagree	0.375*** (0.122)
Neither agree nor disagree	0.683*** (0.123)
Slightly agree	1.101*** (0.113)
Strongly agree	1.481*** (0.122)
Don't know	1.430*** (0.486)
Movement function (Movement 1)	
Movement2	0.051 (0.068)
Movement3	-0.056 (0.068)
Place function (Place 1)	
Place2	0.064 (0.059)
Place3	0.304*** (0.061)
Gender (Male)	
Female	-0.461*** (0.158)
Mobility impairment	-0.246* (0.145)
Residence (In London)	
In the UK, but outside of London	-0.325*** (0.074)
Outside the UK	-0.084 (0.125)
Prefer not to say	0.515 (0.387)
Age band (16-34)	
35-54	-0.099* (0.054)
55-75+	-0.146** (0.060)
Prefer not to say	-0.333 (0.457)
Carrying Items	
Suitcase/ heavy luggage	-0.691*** (0.200)
Large or awkward item	-0.376* (0.214)
Baby pushchair/ pram	-0.337** (0.142)
Reason (Shopping)	
Work travel to/from or related	-0.042 (0.074)
Just passing	-0.149* (0.084)
Personal activities	-0.183** (0.079)
Meeting friends/relatives	0.035 (0.094)
Live nearby	0.088 (0.098)
Dining out/Entertainment	0.143 (0.101)
Tourism/sight seeing	0.219* (0.130)
Travelling to/from study	0.083 (0.132)
Enjoyment walk/cycle/drive	-0.341** (0.149)
Taking children to/from school	-0.221 (0.207)
Other	-0.212 (0.159)
PTAL20	0.082*** (0.016)
AADT13	-0.00003*** (0.00001)
Observed Speed (High)	
Medium	-0.236*** (0.061)
Low	-0.078 (0.074)
No answer	0.274 (0.297)
Weather (not sunny)	
Sunny	0.225*** (0.046)
Crime*Female	0.064*** (0.021)
Constant	1.370*** (0.235)
Observations	5,437
R2	0.458
Adjusted R2	0.453
Residual Std. Error	1.629 (df = 5389)
F Statistic	96.763*** (df = 47; 5389)
Note:	*p<0.1; **p<0.05; ***p<0.01

B.4.3 Conclusions

The objective of this section was to gain a better understanding of the qualities that have an effect on the place quality of urban streets. We analysed data from the Healthy Streets survey, conducted by TFL, which enquired about people's perceptions of built environment features and street conditions for 80 different locations, covering all the street typologies (i.e. different movement and place functions). Several linear regression models were specified and fitted to explain perceived levels of satisfaction with the street, as well as the level of perceived enjoyability and attractiveness. The models include perceived variables, reported activity or trip variables, observed variables associated with each location (reported by interviewers) and objective variables obtained from other data sources.

The results of the models show that, after controlling for demographics and activities, London streets are perceived to be more attractive when the pavements have good quality and people think that the street provides a good environment to walk. Consistently, as presented in Figure B.17 these are also linked with the place function 3. Of the elements of the natural or built environment, perceiving clean air, good quality of pavements, having places to stops and trees and green space and considering the street clean, easy to cross and safe from crime are all factors that have a significant and positive effect on the perceived attractiveness of a street. Sunny weather, as expected for the context of London, also had a positive and significant effect on the level of perceived attractiveness.

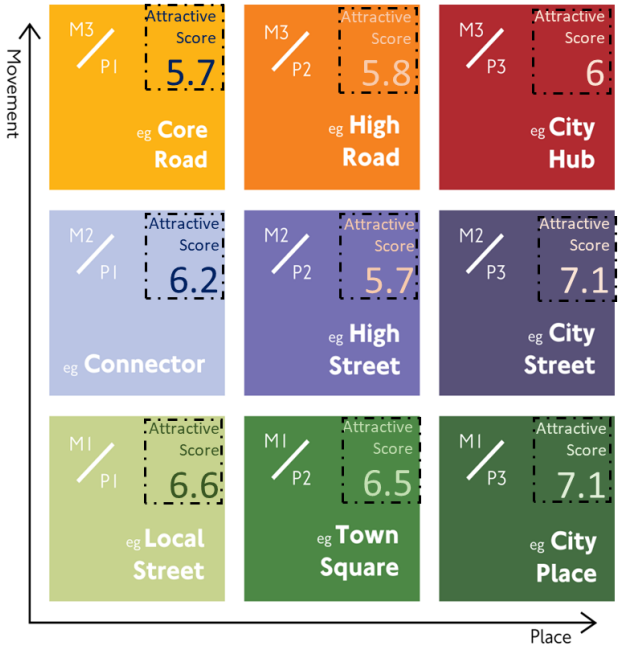


Figure B.17 Street Type matrix for London and Average Attractive Score

The results of the model show that participants who were on the street doing 'optional' activities, such as shopping or tourism found the street more attractive. Conversely, people doing everyday activities such as just passing by, doing personal activities (running errands, visiting health facilities of places of worship, among others) found the street less attractive, compared to those shopping.

Related to the specific conditions of each individual, carrying large items such as suitcases, or baby pushchair also was found to have a negative effect on perceived attractiveness. This is consistent with the idea that the quality of the overall street environment is judged partly by the quality of the walking environment and the level of convenience and comfort with which users can complete their activities and/or journeys.

Regarding demographic variables, having a mobility impairment and being a female have a negative effect on the perceived attractiveness rating for the street. People in the youngest age category, 16-34, found the street to be more attractive than those in older age categories, with those in age category 55-75+ giving the lowest attractiveness ratings. Living in the UK, but not in London, has a negative effect on the perceived level of attractiveness compared to those living in London.

All the variables related with traffic, including objective traffic measured as AADT, high and medium observed traffic speed level and being intimidated by traffic (perceived traffic) have a negative effect on the attractiveness rating of the street.

In general, the models offer insights regarding the objective and subjective features that make a street attractive because they provide evidence of association for the items that repeatedly have been identified in the literature as relevant components of successful places or good place quality. Moreover, the direction of all the significant variables, except for noise, is coherent with the expected direction of the effect as described in the literature (e.g. Clemente *et al.* 2005, Ewing and Handy 2009, Carmona *et al.* 2010, 2017, Gehl and Svarre 2013).

As presented in the first section of this Appendix, the quality of the built environment is usually assessed through observation of street activities or through street audits that look at a large number of physical features on the street and are gathered by experts, not by the users. The Healthy Street survey data used in this analysis, offers a new way of assessing places by gathering, in a structured way, a large sample (more than 5000 observations) of users' perception of several important street features (built environment and activities), as well as demographic characteristics. The analysis of this data contributes to the literature on the topic by assessing variables at different scales: i) the micro-scale perceived variables of the built environment, as reported by users; ii) the micro-scale observed variables of street activities reporter by trained raters (traffic level), context (weather) and user conditions (travelling with items); and iii) the macro-scale objective variables of the built environment (public transport density).

Street attractiveness and place quality are complex and multidimensional concepts which are socially constructed through the interaction of each individual with the surrounding environments and the interaction of the different components of the environment. This probably explains the moderate R^2 in our models. As mentioned in Section 1 of this appendix, there are other objective and perceived qualities of places, and variables related to the actual use of the space, that would need to be considered in order to bring further insights to this topic.

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11. Appendix C – A New Method To Value Community Severance Caused by Roads

CREATE has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 636573

Congestion Reduction in Europe: Advancing Transport Efficiency

MG-5.3-2014
Tackling urban road congestion

D5.2
Appendix C

A new method to value community severance caused by roads

WP 5 – Combating Congestion and Reducing Car Use in European Cities

Due date	**31 December 2017**
Actual delivery date:	**30 April 2018**
Start date of project:	**June 1st 2015**
Duration	**36 months**
Prepared by:	**Paulo Anciaes, UCL** **Prof Peter Jones, UCL**
Checked by:	
Verified by:	**Paul Curtis, Vectos**
Status	**Final**
Dissemination Level	**Public (PU)**

C.1 Introduction

Community severance is the effect of large transport infrastructure (such as roads and railways) or high motorised traffic volumes and speeds as a physical and psychological barrier limiting the mobility of pedestrians and cyclists and separating communities. As mentioned in Section 3.8 of this Deliverable, reducing community severance impacts is a "Stage 3" transport policy, but those impacts are currently only assessed using qualitative scales, if at all.

This appendix develops a new approach to measure and monetise community severance, based on a stated preference study that estimated people's trade-offs between crossing roads with different design and traffic characteristics and using different types of crossing facilities.

C.2 Stated preference survey

The survey was conducted in March 2017 in the areas surrounding two busy roads in London (and was preceded by a series of pilot studies):

- A 3-mile section of the A4 in Hounslow (200 interviews)
- A 0.5-mile section of the A23 in Streatham (150 interviews)

These roads were chosen among other possible roads in London because they are characterised by an insufficient number of pedestrian crossing facilities, the presence of features preventing crossing (such as guard railings) along some of their length, and high traffic density and speeds. Quota sampling was used and the samples contained a balanced number of males and females and of individuals aged below and over 50 years old (Table C.1). The questionnaire was designed to minimise non-trading behaviour (participants choosing the same option in all questions).

Table C.1: Sample composition

	Sample		Population (London)
	n	%	%
Male	165	47%	50%
Female	185	53%	50%
Age: <50	175	50%	76%
Age: >50	175	50%	24%

The main component of the survey questionnaire consisted of three exercises, as follows.

Exercise 1

The objective of the first exercise was to quantify the participants' preferences regarding crossing the road in a place without designated crossing facilities. Three options were presented in each question:

- Option A: Cross the road (with specified characteristics) in a place without crossing facilities
- Option B: Cross in a place where the road is covered over, but adding a specified number of minutes to the trip
- Option C: Don’t make the trip

Table C.2 presents the attributes and levels of the problem (the characteristics of the road in Option A and the walking time in Option B). The design was constrained so that high traffic density was never associated with 30mh or 40mph speeds, in order to reflect road conditions when there is congestion.

Table C.2: Attributes and levels of Exercise 1

Attributes	Levels
Number of lanes in each direction	1
	2
	3
Central reservation	Not Present
	Present (with no guard railings)
Traffic density	Low
	Medium
	High
Traffic speed	10mph (Streatham only)
	20mph
	30mph
	40mph (Osterley only)
Time added to journey	from 2 to 20 minutes, in 2 minute increments

The exercise consisted of eight questions, each one presenting different levels of the road attributes in Option A and additional walking time in Option B. Figure 5 shows an example of the questions, where the road in Option A has two lanes in each direction, no central reservation, medium traffic density, and 30mph speed, and the walking time in Option B is 8 minutes.

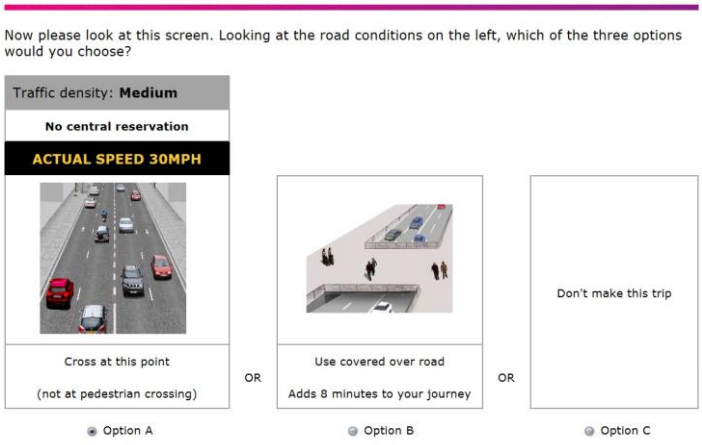


Figure 18: Example of question in Exercise 1

Exercise 2

The objective of the second exercise was to quantify the participants' preferences regarding crossing the road using different types of crossing facilities. Four options were presented in each question:

- Options A and B: Cross the road using a certain type of crossing facility, adding a given number of minutes to the trip
- Option C: Cross in a place where the road is covered over, adding a given number of minutes to the trip
- Option D: Don't make the trip

Table C.3 presents the attributes and levels of the problem (the types of crossing facilities in Options A and B and the walking times in Options A, B, and C). The design was constrained so that the walking times in Option C are always longer than the walking times in Options A and B.

Table C.3: Attributes and levels of Exercise 2

Attributes	Levels
Types of crossing facilities	Straight pelican
	Staggered pelican
	Footbridge
	Underpass
Time added to journey	from 2 to 20 minutes, in 2 minute increments

The exercise consisted of eight questions, each one presenting different types of crossing facilities in Options A and B, and walking times in Options A, B, and C. Figure 19 shows an example of the questions, where the crossing facilities in Option A and B are an underpass and a straight pelican, and the walking times in Options A, B, and C, are respectively 10, 4, and 12 minutes.

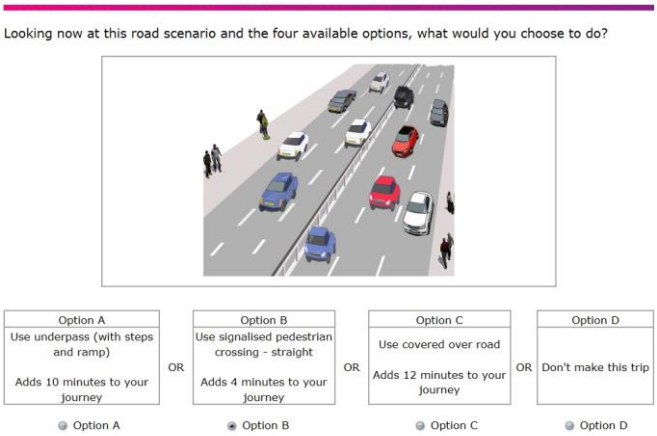


Figure 19: Example of question in Exercise 2

Exercise 3

The objective of the third exercise was to quantify the participants' willingness to pay in order to avoid crossing the road in a place without designated crossing facilities. The scenario involves the participant having the opportunity of paying a lower shopping bill or public transport fare by crossing the road. Participants who stated they crossed the road to access public transport less often than once every 2-3 months or who are aged 60 or older were shown the shopping bill alternative. The other participants were shown the public transport alternative.

Three options were presented in each question:

- Option A: Cross the road (with specified characteristics) in a place without crossing facilities and pay a cheaper public transport fare or shopping bill on the other side
- Option B: Do not cross the road and pay the higher public transport fare or shopping bill on this side of the road

Table C.4 presents the attributes and levels of the problem (the characteristics of the road and the value of the saving in Option A). As in Exercise 1, the design was constrained so that high traffic density was never associated with 30mh or 40mph speeds, in order to account for road congestion. The cost savings presented to participants in the shopping bill segment are double of those presented to participants in the public transport segment, as the former have to cross the road twice.

Table C.4: Attributes and levels of Exercise 3

Attributes	Levels
Number of lanes in each direction	As in Exercise 1
Central reservation	
Traffic density	
Traffic speed	
Saving	Public transport segment: from 20p to £2, in 20p increments Shopping bill segment: from 40p to £4, in 40p increments

The exercise consisted of eight questions, each one presenting different levels of the road attributes and the saving value in Option A. Figure 20 shows an example of the questions, where the road in Option A has two lanes in each direction, a central reservation, low traffic density, and 20mph speed, and the participant can save 60p by crossing the road to use a bus stop on the other side.

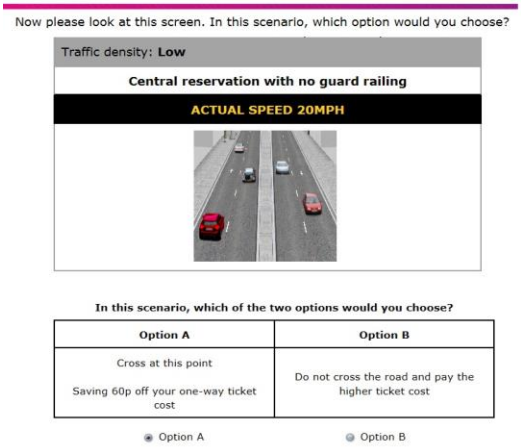


Figure 20: Example of question in Exercise 3

C.3 Models

The choices were analyzed using econometric models. Indicators of severance were then calculated from the estimated coefficients.

Exercise 1

Table shows the results of a mixed logit model estimated using the answers to Exercise 1. The model was estimated on a dataset with one observation for each of the three options in all the eight questions answered by all participants in the two case study areas. The dependent variable is the probability that a specific option was chosen. The explanatory variables are dummy variables representing Options A and Option C, dummy variables representing specific road conditions in Option A, and the number of minutes in Option B. The most benign road conditions (one lane, central reservation, low traffic density, and 10mph speed) were omitted from the model as separate variables, as they are implicit in the general coefficient of Option A.

The first column shows the estimated model coefficients. The coefficients of all the road attributes have the expected sign (negative). This suggests that participants prefer to avoid crossing roads with two or three lanes, no central reservation, medium or high traffic density, and 20, 30, or 40 mph speed, comparing with roads with one lane, a central reservation, low traffic density, and 10mph speed. The relative magnitude of the two lane vs. three-lane roads, medium volume vs. high volume, and 20mph vs. 30mph vs. 40 mph speed are also consistent with prior expectations. The time and "don't cross" coefficients are negative, which means that participants prefer shorter, rather than longer walking times, and to cross the road, rather than avoid making the trip.

The second column shows the ratios between the coefficients of the different road characteristics and the coefficient of walking time. These ratios can be understood as the willingness to walk to avoid crossing a road with those characteristics in a place without crossing facilities. For example, participants are willing to add 4.2 minutes to their trip in order to avoid crossing a road with two lanes in a place without crossing facilities and cross in a place where the road is covered over. They are also willing, on average, to walk 22.3 minutes in order to be able to make the trip (that is, to avoid Option C).

The third column shows the ratios between the coefficients of the different road characteristics and the coefficient of Option C. These ratios can be understood as the disutility of Option A comparing with the disutility of Option C (not making the trip). For example, crossing a road with two lanes in a place without crossing facilities has a disutility which is perceived to be 19% of the disutility of not making the trip. A minute walking has a disutility which is perceived to be 4% of the disutility of not making the trip.

Table C.5: Model results (Exercise 1)

	coefficient	willingness to walk (minutes)	utility relative to Option C
time	-0.42***		0.04
option A (cross)	0.37		
lanes=2	-1.78***	4.2	0.19
lanes=3	-3.81***	9.0	0.40
no reservation	-2.79***	6.6	0.30
density=medium	-1.38***	3.3	0.15
density=high	-4.30***	10.2	0.46
speed=20	-1.44***	3.4	0.15
speed=30	-2.26***	5.4	0.24
speed=40	-3.59***	8.5	0.38
option C (Don't make the trip)	-9.43***	22.3	

Notes: n=262. Significance levels: ***1%, **5%, *10%

Exercise 2

Table shows the results of a mixed logit model using the answers to Exercise 2. The model was estimated on a dataset with one observation for each of the four options in all of the eight questions answered by all participants in the two case study areas. The dependent variable is the probability that option was chosen. The explanatory variables are a dummy variable representing Option D, dummy variables representing the four possible types of crossing facilities presented in Options A or B, and the number of minutes in Option A, B, or C. The type of crossing scenario in Option C (a place where the road is covered over) was omitted from the model to avoid redundancy.

The first column shows the estimated model coefficients. The coefficients of the crossing types have the expected sign (negative). This suggests that participants prefer to avoid using crossing facilities, comparing with the omitted alternative (a place where the road is covered over). The relative magnitude of the coefficients is also consistent with prior expectations: straight pelicans are the most preferred type of facility, followed by staggered pelicans, footbridges, and underpasses. As expected, the time coefficient is negative, which means that participants prefer shorter walking times.

The second column shows the ratios between the coefficients of the different crossing facilities and the coefficient of walking time, i.e. the willingness to walk longer times to avoid using those facilities and cross in a place where the road is covered over. For example, participants are willing to add 1.7 minutes to their trip in order to avoid crossing a road using a straight pelican and cross in a place where the road is covered over. They are also willing to walk 22.4 minutes in order to be able to make the trip (that is, to avoid Option D). This last value is very similar to the one obtained in the previous exercise for the same option (22.7 minutes), showing that participants have consistent preferences.

The third column shows the ratios between the coefficients of the different types of facility and the coefficient of Option D. These ratios can be understood as the disutility of Option A comparing with the disutility of Option D (not making the trip). For example, crossing a road using a straight pelican has a disutility which is perceived to be 8% of the disutility of not making the trip. A minute walking has a disutility which is perceived to be 4% of the disutility of not making the trip, which is the same as the value obtained in the previous exercise, again confirming that participants show consistent preferences across exercises.

Table C.6: Model results (Exercise 2)

	coefficient	willingness to walk (minutes)	utility relative to Option D
time	-0.56***		0.04
straight pelican	-0.98***	1.7	0.08
staggered pelican	-1.10***	2.0	0.09
footbridge	-3.10***	5.5	0.25
underpass	-3.74***	6.7	0.30
option D (Don't make the trip)	-12.54***	22.4	

Notes: n=350. Significance levels: ***1%, **5%, *10%

Exercise 3

Table 29 shows the results of a random-effects logit model based on the answers to Exercise 3. The model was estimated on a dataset with one observation representing Option A (varying cost savings) in all the eight questions answered by all participants in the two case study areas. The dependent variable is the probability that Option A was chosen. The explanatory variables are dummy variables representing specific road conditions and the value of the saving in Option A. The most benign road conditions (one lane, central reservation, low traffic density, and 10mph speed) were omitted from the model to avoid redundancy.

The first column shows the model coefficients. Once again, all the coefficients of road attributes have the expected sign and magnitude. The savings coefficient is positive, which means that participants prefer higher savings, as expected.

The second column shows the ratios between the coefficients of the different crossing facilities and the coefficient of the savings value. These ratios can be understood as the willingness to pay (or more precisely, the willingness to forego a cost saving) to avoid crossing the road in a place without crossing facilities. For example, participants are willing to pay 80p in order to avoid crossing a road with two lanes in a place without crossing facilities.

Table 29: Model results (Exercise 3)

	coefficient	willingness to pay (£)
saving	1.57***	
lanes=2	-1.33***	0.8
lanes=3	-2.70***	1.7
no reservation	-2.22***	1.4
density=medium	-0.90**	0.6
density=high	-2.87***	1.8
speed=20	-0.75*	0.5
speed=30	-1.48**	0.9
speed=40	-2.48***	1.6
constant	1.68***	

Notes: n=275. Significance levels: ***1%, **5%, *10%

C.4 Severance indicator of road conditions and willingness to walk and to pay to avoid crossing the road

The results of Exercise 1 can be used to estimate an indicator of the severance caused by roads with different characteristics (in terms of number of lanes, presence of a central reservation, traffic density, and traffic speed). The index represents the disutility participants derive from crossing the road as a proportion of the disutility of not making the trip. This index can be estimated by adding the model coefficients representing the specified road conditions and dividing that sum by the coefficient of Option C.

The minimum value of the indicator is 0, in the case where participants do not attach any disutility to crossing where the road is covered over, that is, when all coefficients related to Option A are equal to zero. Values above 100 represent the case where participants attach less utility to crossing the road in a place without facilities than to not making the trip. This means that the road is perceived as an absolute barrier, not worth crossing. In this analysis, the values have been transformed to a 0-100 scale, for analytical convenience and because only a few types of road have a disutility higher than the disutility of not making the trip.

The willingness to walk and willingness to pay to avoid crossing roads with different characteristics can be calculated in a similar fashion, by adding the coefficients representing the specified road conditions and dividing that sum by the coefficient of walking time (in Exercise 1) and the coefficient of the financial saving (in Exercise 3).

Table shows the results of the severance index and of the willingness to walk and to pay for all possible combinations of road attributes presented in the exercises.

The index for the roads with the best possible characteristics (one lane, central reservation, low traffic density, and 10mph speed) is 0, which means that participants attach the same utility to crossing that type of road in a place without facilities and to crossing in a place where the road is covered over. It should be noted that the value is not 0 by definition, but because the estimated coefficient of Option A (which represents roads with the most benign conditions for pedestrians) is not statistically different from 0. The road with the highest index has three lanes, no central reservation, high traffic density, and 20 mph speed.

The values of the willingness to walk vary between 0 and 29.2 minutes and the values of the willingness to pay vary between £0.00 and £5.45.

The results can be disaggregated by age and gender. Table shows the values of the severance index for men, women, and two age groups. The values are generally higher for women and older people.

Table C.8: Severance indices, willingness to walk, and willingness to pay, by type of road

			Roads with 1 lane			Roads with 2 lanes			Roads with 3 lanes		
Central Reservation	**Traffic density**	**Traffic speed (mph)**	**Severance index**	**Willingness to walk (minutes)**	**Willingness to pay (£)**	**Severance index**	**Willingness to walk (minutes)**	**Willingness to pay (£)**	**Severance index**	**Willingness to walk (minutes)**	**Willingness to pay (£)**
Yes	low	10	0	0.0	0.00	14	4.2	0.85	31	9.0	1.72
		20	12	3.4	0.48	26	7.6	1.33	43	12.4	2.20
		30	18	5.4	0.95	33	9.6	1.79	49	14.4	2.67
		40	29	8.5	1.58	44	12.7	2.43	60	17.5	3.31
	medium	10	11	3.3	0.57	26	7.5	1.42	42	12.3	2.30
		20	23	6.7	1.05	37	10.9	1.90	54	15.7	2.78
		30	30	8.6	1.52	44	12.8	2.37	60	17.6	3.24
		40	40	11.8	2.16	55	16.0	3.01	84	24.5	4.50
	high	10	35	10.2	1.83	49	14.4	2.68	66	19.2	3.56
		20	47	13.6	2.31	61	17.8	3.16	77	22.6	4.04
No	low	10	23	6.6	1.42	37	10.8	2.26	53	15.6	3.14
		20	34	10.0	1.89	49	14.2	2.74	65	19.0	3.62
		30	41	12.0	2.36	55	16.2	3.21	72	21.0	4.08
		40	52	15.1	3.00	66	19.3	3.85	83	24.1	4.72
	medium	10	34	9.9	1.99	48	14.1	2.84	65	18.9	3.71
		20	45	13.3	2.47	60	17.5	3.32	76	22.3	4.19
		30	52	15.2	2.93	67	19.4	3.78	83	24.2	4.66
		40	63	18.4	3.57	77	22.6	4.42	94	27.4	5.30
	high	10	57	16.8	3.25	72	21.0	4.10	88	25.8	4.97
		20	69	20.2	3.73	84	24.4	4.58	100	29.2	5.45

Table C.9: Severance indices, by type of road, age, and gender

			Roads with 1 lane					Roads with 2 lanes					Roads with 3 lanes				
central res.	**Traffic density**	**Traffic speed (mph)**	**All**	**Male**	**Female**	**Age <50**	**Age >50**	**All**	**Male**	**Female**	**Age <50**	**Age >50**	**All**	**Male**	**Female**	**Age >50**	**Age <50**
Yes	low	10	0	0	0	0	0	14	15	14	14	15	31	30	31	30	32
		20	12	12	11	12	12	26	27	25	26	26	43	42	43	42	43
		30	18	18	18	18	19	33	33	32	32	33	49	49	50	48	50
		40	29	29	29	29	30	44	44	43	43	44	60	60	60	59	61
	medium	10	11	11	12	11	11	26	25	26	25	26	42	41	43	41	43
		20	23	23	23	23	23	37	38	37	37	38	54	53	54	53	55
		30	30	29	30	29	30	44	44	44	43	45	60	59	62	59	62
		40	40	40	41	39	41	55	55	55	54	56	84	83	85	84	84
	high	10	35	34	35	36	34	49	49	49	50	48	66	65	67	66	65
		20	47	47	46	48	45	61	61	60	62	60	77	77	78	78	77
No	low	10	23	23	22	22	23	37	38	36	36	38	53	53	54	52	55
		20	34	35	33	34	35	49	50	47	48	49	65	66	65	64	66
		30	41	41	40	40	42	55	56	55	54	56	72	72	72	70	73
		40	52	52	51	51	53	66	67	65	65	67	83	83	83	81	84
	medium	10	34	34	34	33	34	48	48	48	47	49	65	64	65	63	66
		20	45	46	45	45	46	60	61	59	59	61	76	76	76	75	78
		30	52	52	52	51	53	67	67	66	65	68	83	82	84	81	85
		40	63	63	63	62	64	77	78	77	76	79	94	93	94	92	96
	high	10	57	58	57	58	57	72	72	71	72	71	88	88	89	88	88
		20	69	70	69	70	68	84	85	83	84	83	100	100	100	100	100

C.5 Severance indicator *vs.* pedestrian behaviour

The results of Exercise 1 can also be used to calculate the probabilities that someone will cross the road, walk to a place where the road is covered over, or avoid the trip, for different road characteristics and distances to the nearest crossing. These probabilities can then be plotted against the values of the severance indicator (Figure C.). It was found that 10 minutes is the distance along the road (i.e. adding 20 minutes to the journey in all) above which the majority of participants do not choose to walk to a place where the road is covered over, in the worst possible road scenario.

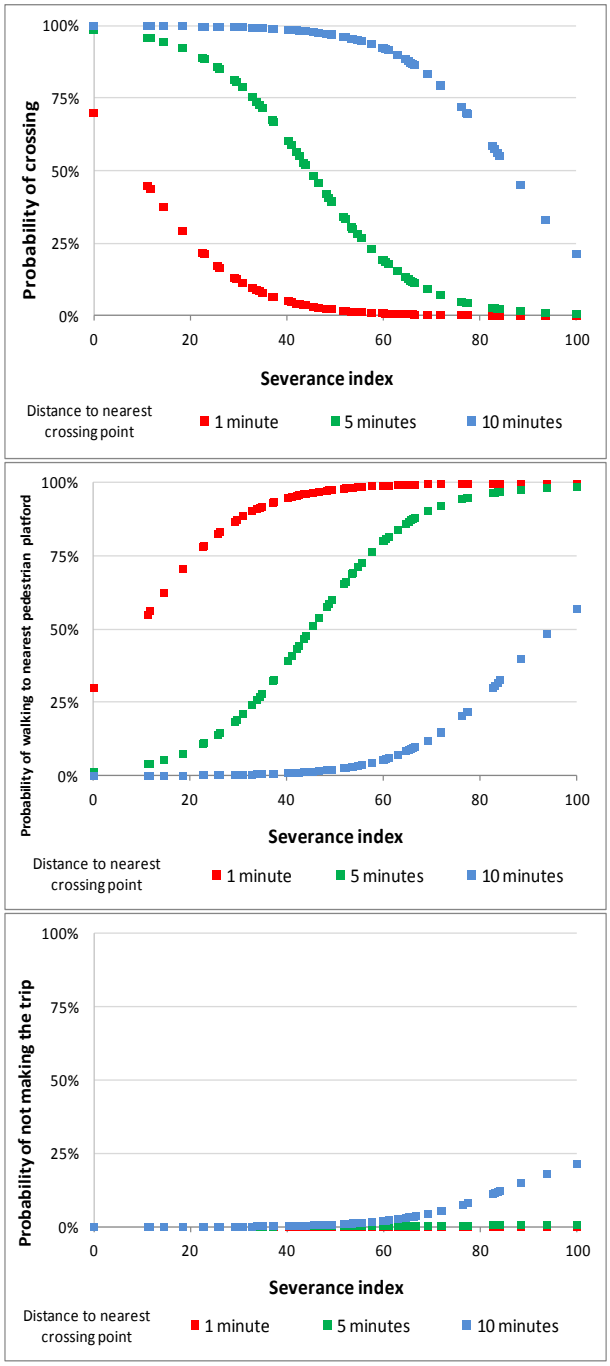


Figure C.4: Relationship between estimated severance indices and pedestrian behaviour

C.6 Severance indicator *vs.* willingness to pay

It is also possible to measure the relationship between the estimated severance indicators for different types of road conditions (from the first exercise), and the willingness to pay (from the third exercise). Figure 21 shows that the relationship is almost linear, which once more confirms that participants have consistent preferences across exercises.

Plotting willingness to walk against willingness to pay (Figure C.6) produces an identical curve, with a slope equal to 0.1926, which corresponds to an implicit value of walking time of 19.26p per minute. This value is broadly consistent with WebTAG's recommended values of travel time savings (10.1-11.4p per minute for non-work trips by any mode and 20.2-22.8p per minute when walking is used as a means of inter-change between modes of transport – before adjusting for inflation).

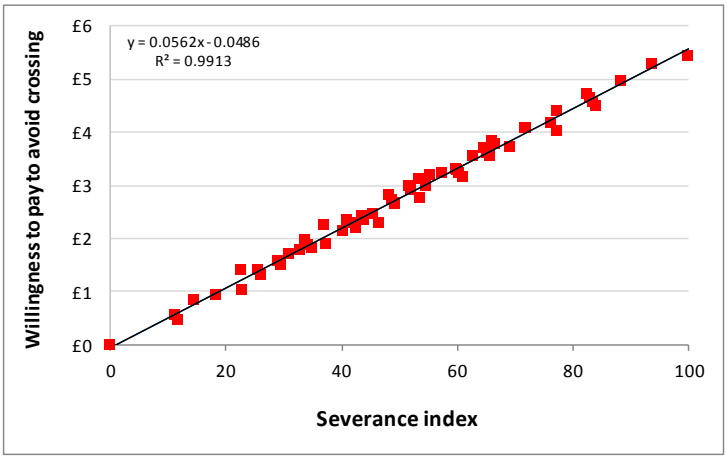


Figure 21: Relationship between estimated severance indices and willingness to pay

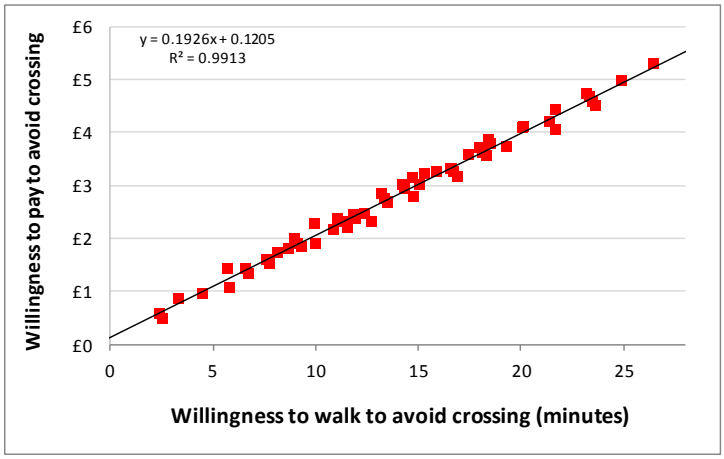


Figure C.6: Relationship between estimated willingness to walk and willingness to pay

In order to further check the consistency of the values obtained from the surveys, Figure below shows the willingness to pay to avoid encountering each increment of road conditions, above the based level (i.e. 10mph, low density, 1 lane and median strip). As can be seen, these incremental values also fall along an almost straight line, with an R^2 value of 0.9777.

We tested for interaction effects between the variables. The only significant interaction was "40mph with no central reservation", but only at the 10% level and in one of the model specifications, so it was excluded from the final model.

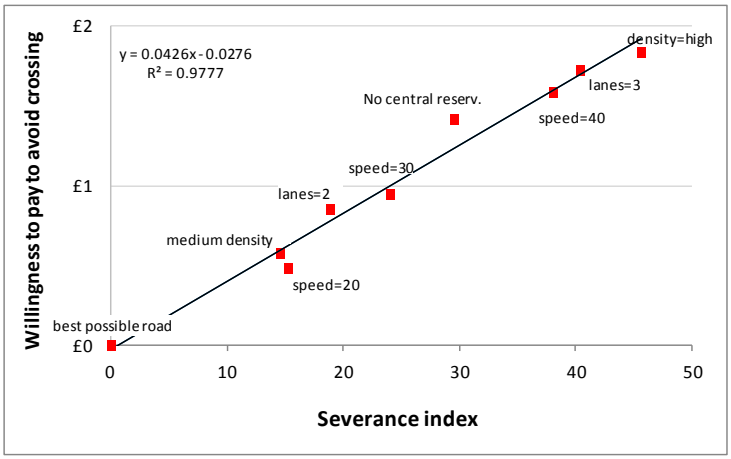


Figure C.7: Relationship between estimated severance indices and willingness to pay

C.7 Severance indicator and willingness to pay to avoid crossing facilities

The results of Exercise 2 can also be used to estimate severance indices for different types of crossing facilities. The index is expressed in the same units as the Community Severance Index defined above, since the values are relative to the same base best and worst scenarios (which are, respectively, crossing the road in a place where the road is covered over, and not making the trip). As such, it is possible to compare severance caused by roads with specific types of crossing facilities and by roads with no facilities and specific design and traffic characteristics. The results are shown in the first column of Table 30. As expected, the indices are lower than most of the indices for roads with no facilities, shown in Table. However, footbridges and underpasses have a higher index than some of the 1-lane road scenarios.

The relationship shown in Figure C.7 can then be used to estimate the willingness to pay to avoid using specific types of crossing from the values of the severance index associated with those facilities. The results are shown in the second column of Table 30, and vary between 29p (for straight pelicans) and £1.23 (for underpasses).

Table 30: Severance index and estimated willingness to pay by type of crossing

	Severance index	Estimated willingness to pay (£)
straight pelican	6%	£0.29
staggered pelican	7%	£0.33
footbridge	19%	£1.01
underpass	23%	£1.23

Table 31 disaggregates severance indicators and willingness to pay by age and gender.

Table 31: Severance index and estimated willingness to pay by age, gender, and type of crossing

	Severance index				Estimated willingness to pay (£)			
	Male	Female	Age >50	Age <50	Male	Female	Age <50	Age >50
straight pelican	6	6	6	6	£0.31	£0.23	£0.37	£0.29
staggered pelican	8	6	7	7	£0.38	£0.23	£0.42	£0.32
footbridge	18	20	16	22	£0.87	£1.24	£0.87	£1.21
underpass	22	24	22	24	£1.07	£1.51	£1.16	£1.30

C.8 Severance indicator of road conditions considering type and distance to crossing facilities

The indicator of severance mentioned above considers only the road and traffic conditions at a specific place. However, the overall level of severance experienced by pedestrians also depends on the distance to the nearest crossing facility and the type of that facility.

The index can be scaled by assuming that when the distance to the nearest crossing point is 10 minutes (adding 20 minutes to the total journey time - the distance above which the majority of participants will choose not to walk, even for the worst possible road conditions), the indicator has the value calculated taking into account only the road conditions, and then this decreases proportionately as the distance to the crossing point decreases, until the distance is 0. In this case, the indicator has the same value as the indicator for the type of crossing point (0% in the case of a place where the road is covered over, and the values in Table C.5 when there is a crossing facility). Figure shows the example of the relationship between the scaled severance index and the distance to nearest crossing point, in the case of a road where the severance index that considers only the road conditions is 83.

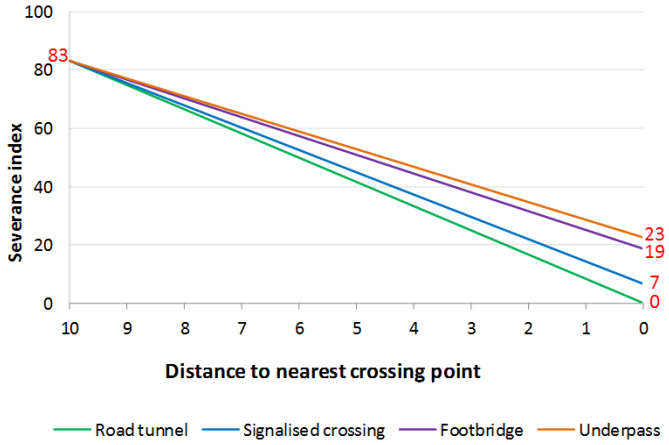
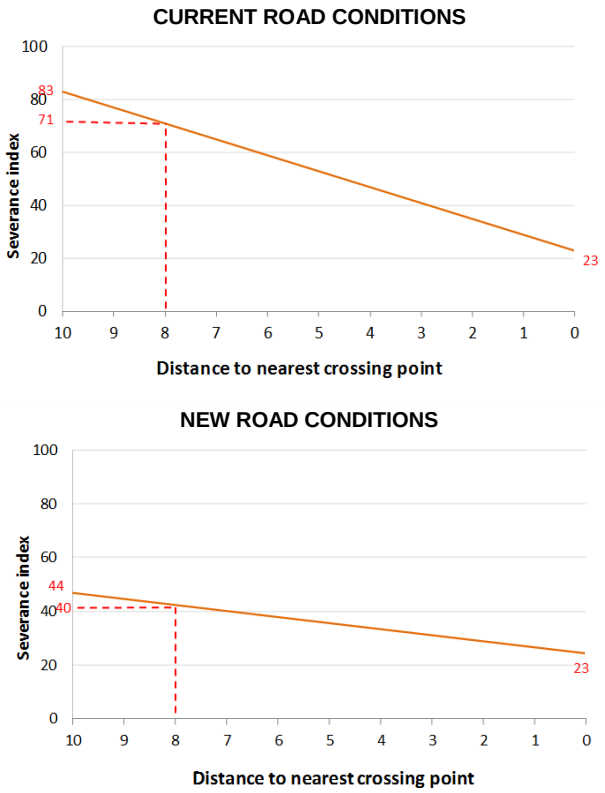


Figure C.8: Scaled index

C.9 Example of application

This section is an example of the calculation of the total benefit of a policy to reduce the number of lanes of a road from 3 to 2 in each direction, and adding a central reservation. It is assumed that the traffic volume is medium and the traffic speed is 30mph, and the nearest crossing point is an underpass at 8 minutes distance.

The severance index that considers only the road conditions is 83 in the pre-policy scenario and 44 in the post-policy scenario. The scaled index, considering the existing underpass and the distance to reach it, is 71 in the pre-policy scenario and 40 in the post-policy scenario (Figures 22), applying the relationship shown in Figure.



Figures 22 and C.10: Change in the scaled severance indicator

The corresponding willingness to pay values are £3.94 and £2.20 in the pre- and post-policy scenarios, respectively (Figure 23), using the relationship shown in Figure 21.

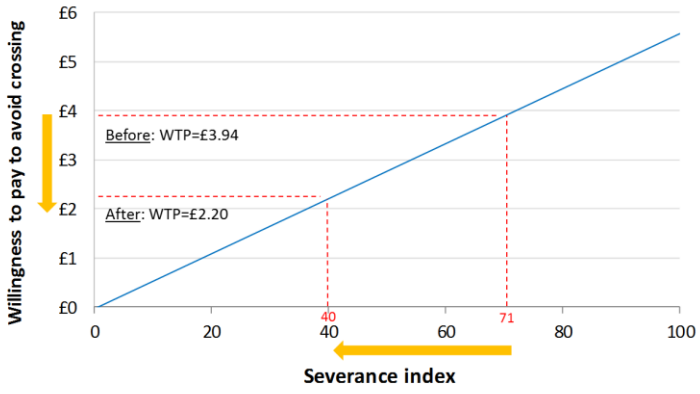


Figure 23: Change in willingness to pay

The corresponding probabilities of making the trip are 95% and 99.7% in the pre- and post-policy scenarios, respectively (Figure 24), using the relationship shown in Figure C. for the case where the nearest pedestrian crossing point is 10 minutes away (the value for which most participants will not walk to that crossing point, even for the worse possible road).

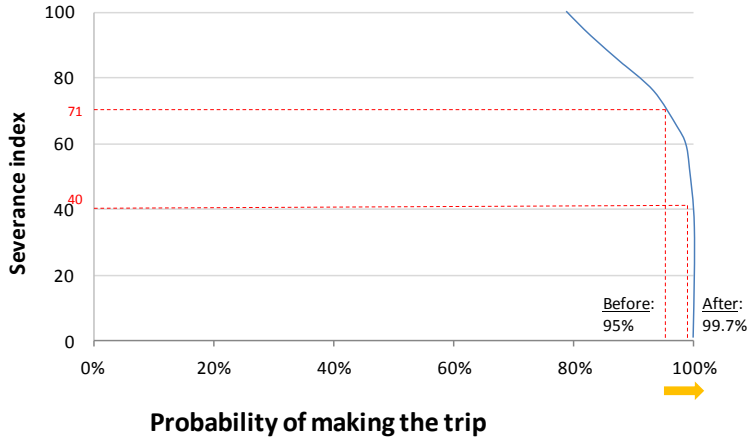


Figure 24: Change in the probability of making the trip

Figure shows how the total benefit of policy interventions can then be calculated. Area A is the reduction of severance cost for existing trips ((£3.94-£2.20) * 95% = £1.65). Area B is the benefit of new trips (£2.20 +0.5*(£3.94-£2.20)) * (99.7%-95%) = £0.14). The total benefit per trip is £1.79. This value then needs to be multiplied by the maximum potential number of walking trips of local residents, based on the characteristics of the local population and the catchment areas of nearby trip attractors (such as schools, supermarkets, parks, or railway stations).

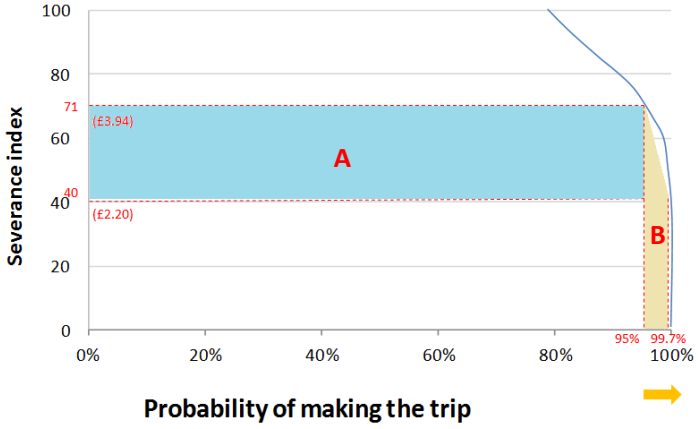


Figure C.13: Calculation of total benefit of policy interventions to reduce severance

C.10 Tool to measure and value severance

These results will be included in an interactive tool that we plan to develop, illustrated in Figure 25. This tool estimates the reduction in the severance index and the total benefit associated with interventions such as removing guard railing from a road, burying the road, reducing the number of lanes, adding a central reservation, reducing traffic volume, reducing traffic speed, adding new crossing facilities or modifying the type of existing facilities.

The tool will also generate outputs disaggregated by population group.

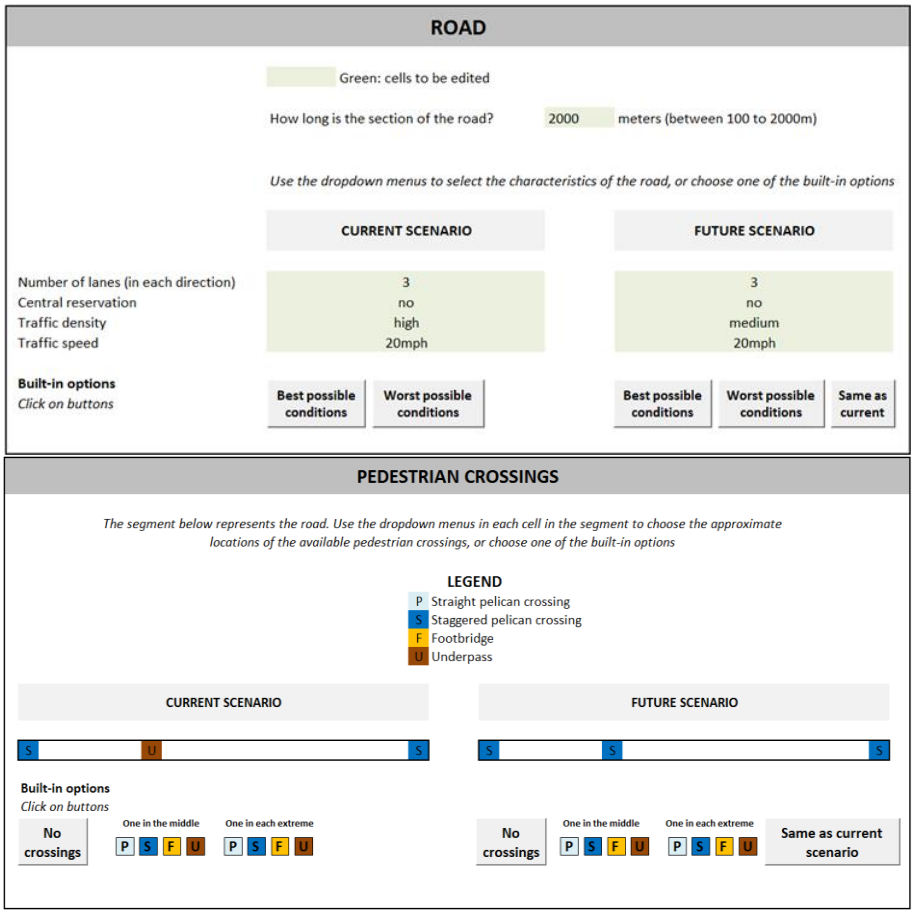


Figure 25: Examples of input pages of severance tool (proposed for development)

The effects of different types of interventions on the number of walking trips will also be linked with wider impacts on health, social inclusion, and vitality of local retail. These impacts can be monetized linking the tool with other existing tools (such as the Health Economic Assessment Tool), and results of previous studies.

C.11 Further work

Further work is needed to use the community severance estimates presented here in practical applications. In particular, to:

- Obtain results based on a large sample, representative at the national level. The results obtained so far were based on relatively small samples (350 interviews) in two London case studies.
- Link the estimates of the proportional change in the number of walking trips following a policy intervention with estimates of the potential number of walking trips (taking into account information on local population and local facilities), in order to derive the aggregate impact of interventions on the number of walking trips.