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Congestion Reduction in Europe: Advancing Transport Efficiency

MG-5.3-2014
Tackling urban road congestion

D5.2
Appendix B

Place quality

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

Due date	**31 December 2017**
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Checked by:	**Xxxx**
Verified by:	**xxxx**
Status	**Final**
Dissemination Level	**Public (PU)**

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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.

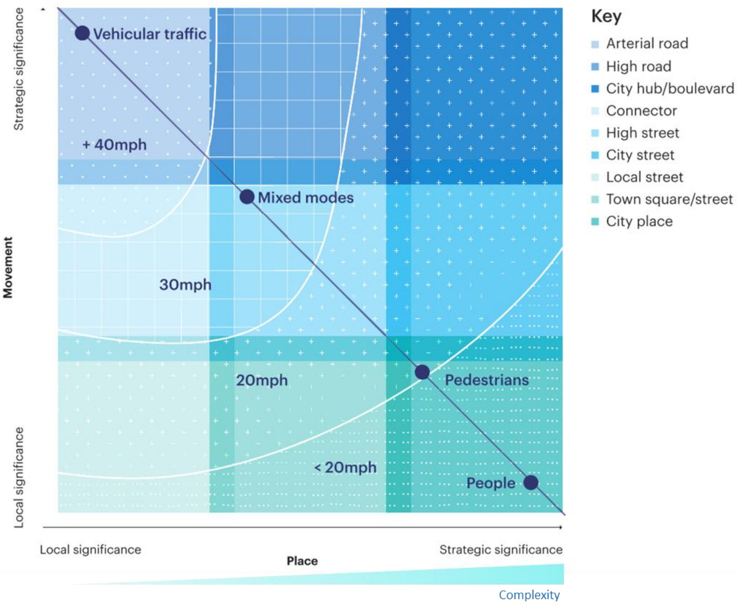


Figure B.1 Street-type matrix (Users and speeds). Source: TfL(2013, p.12)

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).

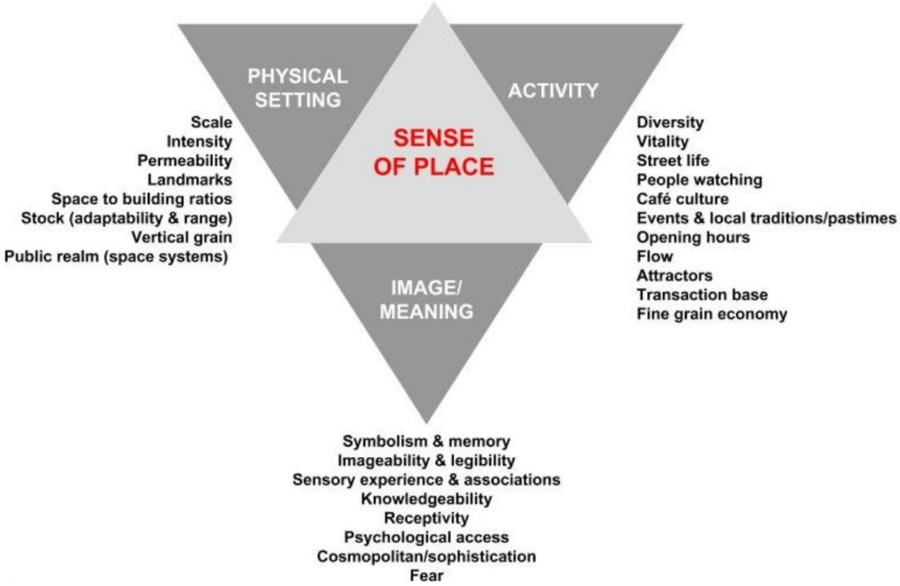


Figure B.2 Sense of Place Source: Carmona et al (2010) adapted from Montgomery (1998)

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.1) and transport and urban planning (Table B.2).

Table B.1 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 the 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.2 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.3).

Table B.3 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.4).

Table B.4 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.5. The tool's codebook and inventories are available from https://webfiles.uci.edu/kday/public/index.html

Table B.5 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.6), 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.6 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.7*). 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.7 Dimensions in the PERS public space and link framework

Public Space Review Framework	Link Review Framework
• Moving in the space • Interpreting the space • Personal safety • Feeling comfortable. • Sense of place • Opportunity for activity	• Effective width • Dropped Kerbs • Gradient • Obstructions • Permeability • 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).

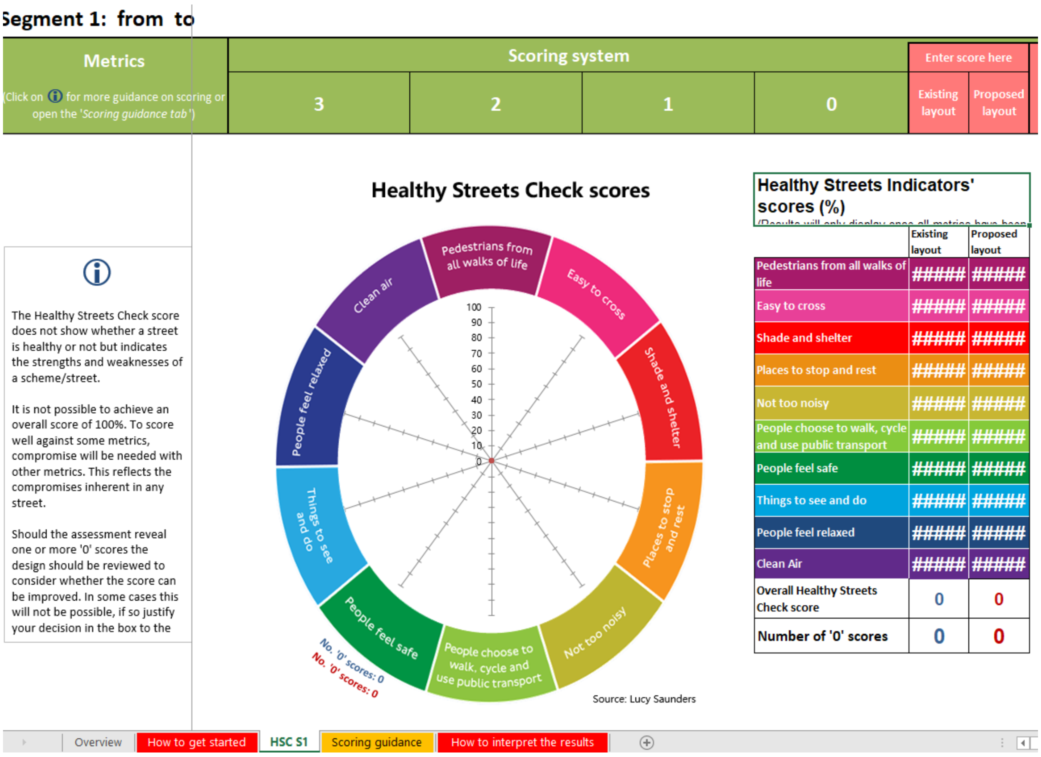


Figure B.3 Healthy Streets Check scores (TfL 2017c)

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.8). 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.8 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

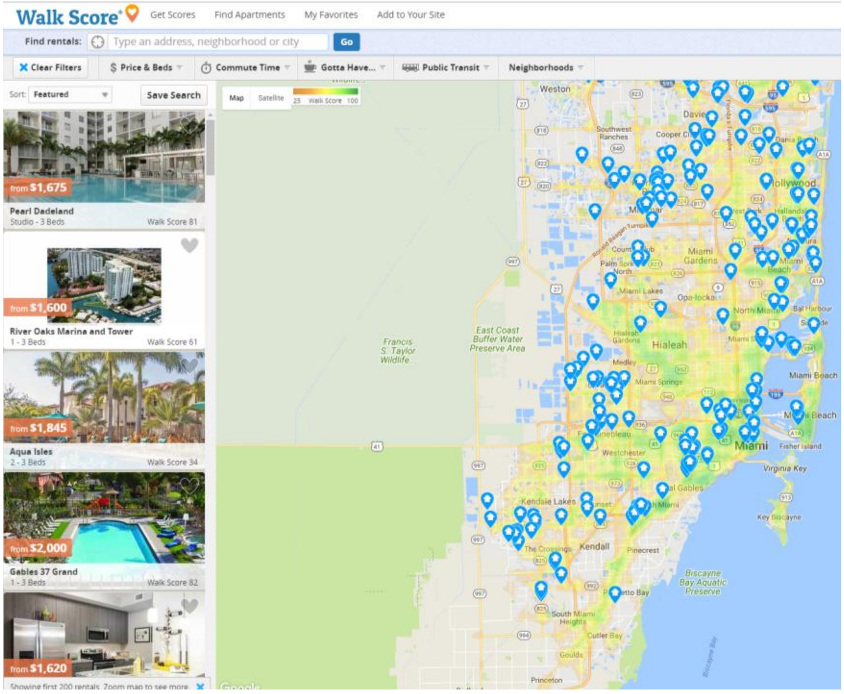


Figure B.4 Walk score example

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.9).

Table B.9 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).

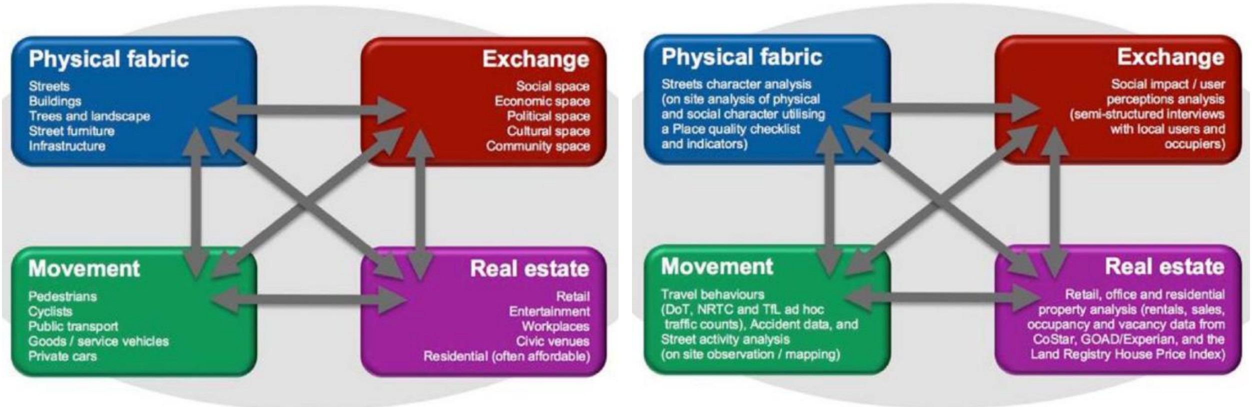


Figure B.5 Holistic Framework for the study of the value of place. Source: Carmona (2017)

Table B.10 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.10 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.*11* 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.11 Key results of the DEFRA (2013) study

	Current situation (1=worst, 5 best) [1]	Importance rating[2]	Willingness to pay for an improvement (per
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.12 and Table B.13). 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.12 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.13 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.14. 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.14 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.

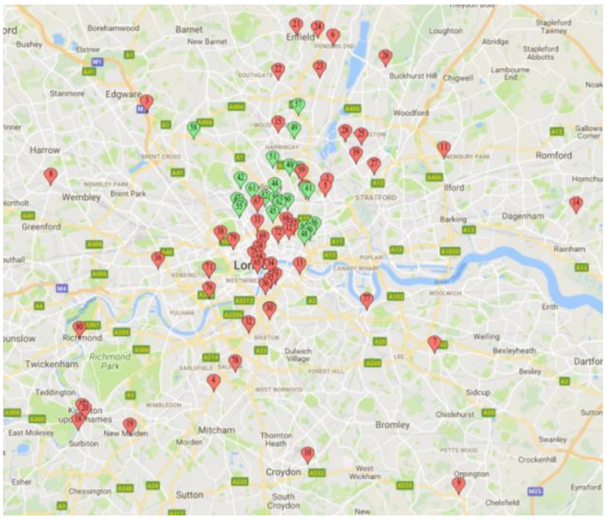


Figure B.9: Streets included in the Healthy Streets survey. Source of base map: Google Maps

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.

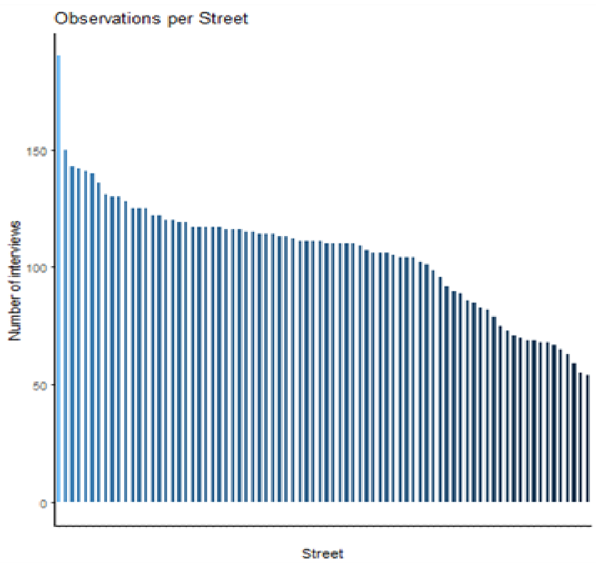
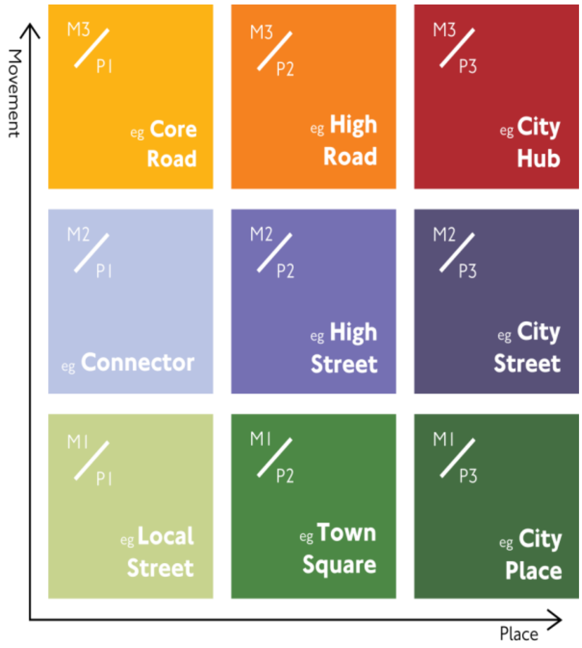


Figure B.10: Observations per street

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.15). 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.16).

Table B.15: 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.16: 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

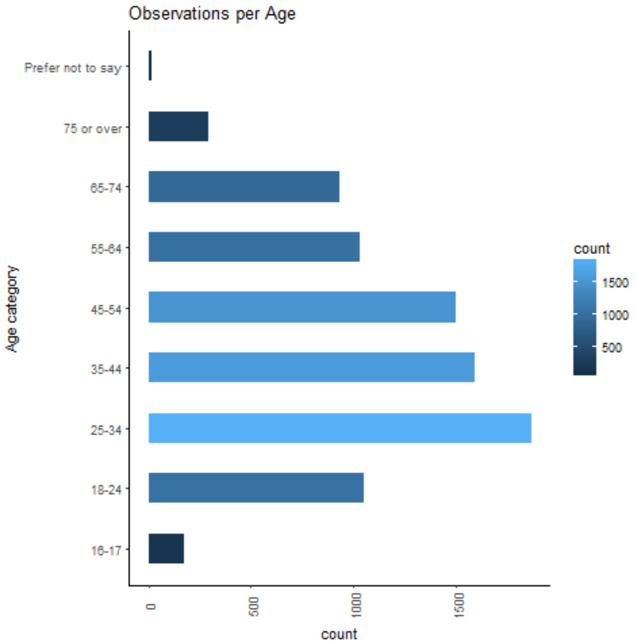
The survey questionnaire included 9 demographic questions. Six of these questions were answered by participants (age category, gender, employment status, long-term physical or mental impairment, place of residence, and country of origin). The other three questions were reported by the interviewer: i) 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.17). 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.18).

Table B.17: 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

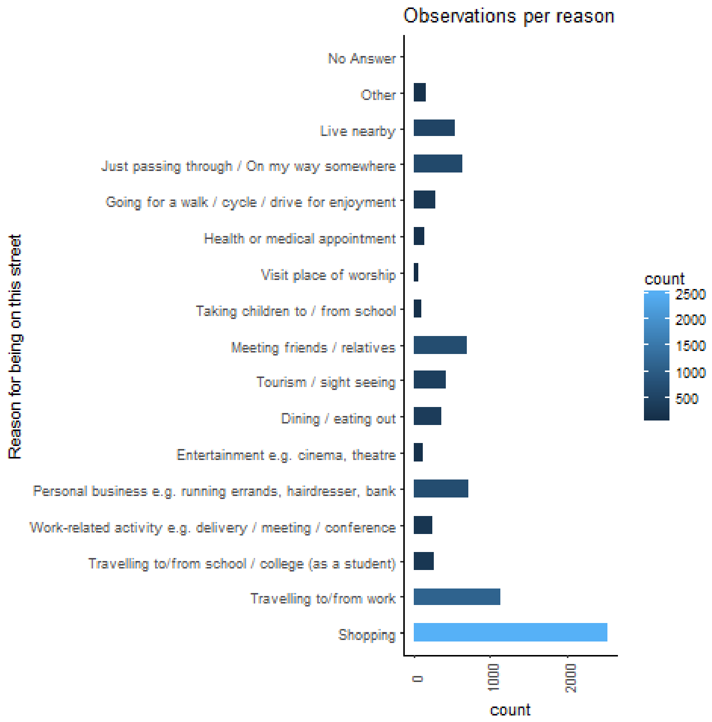
Table B.18: Place of residence of survey participants

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

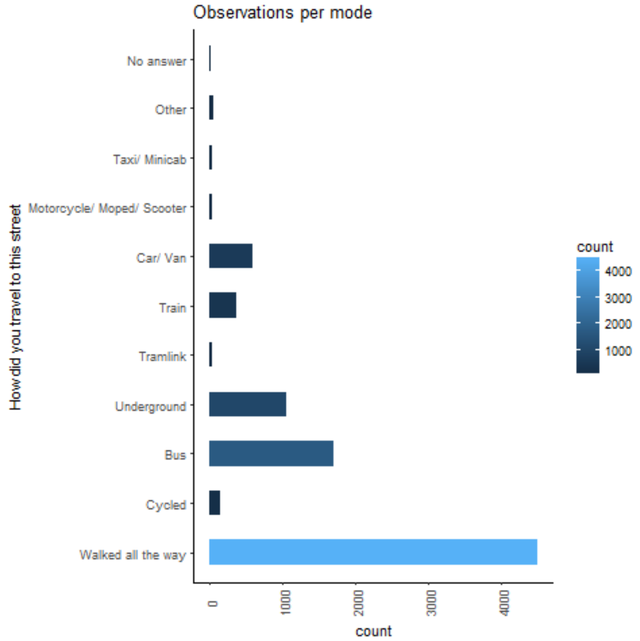


Analysis categories

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

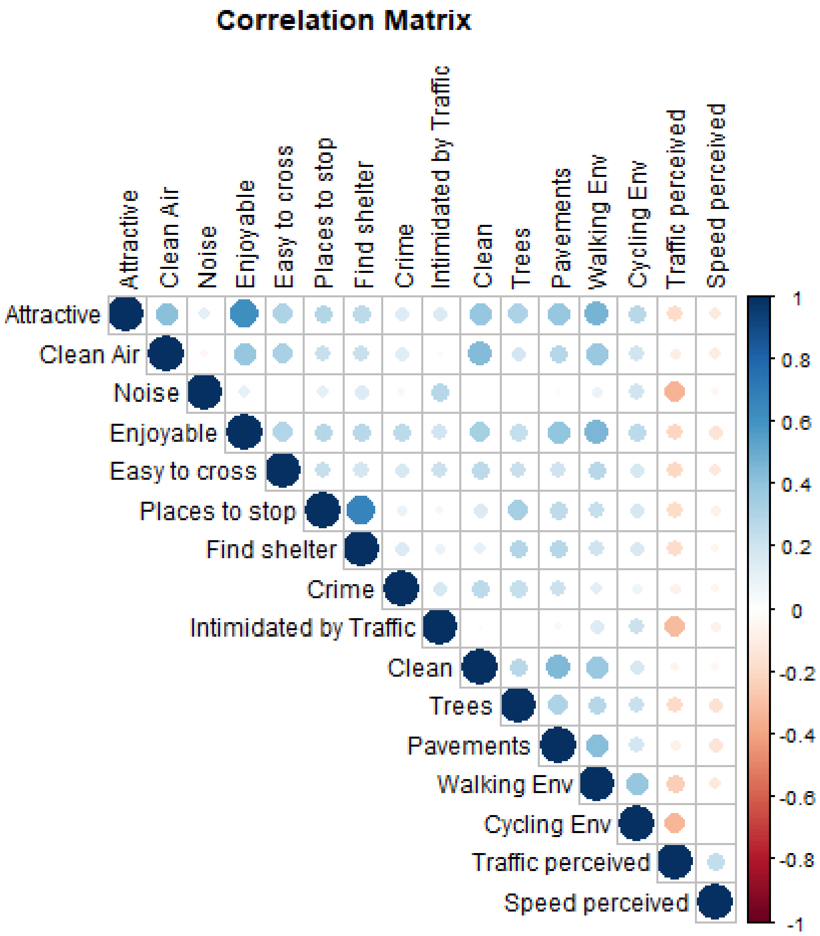
To understand people's perceptions of the street, the survey also included specific questions regarding street features. Some of these questions asked participants to rate features on a scale from 1 ('Not at all') to 10 ('Extremely'). Other questions were rated on different scales (Table B.19).

Table B.19: 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.20-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.20-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.20 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.21 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.21 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.22) 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.23) 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.

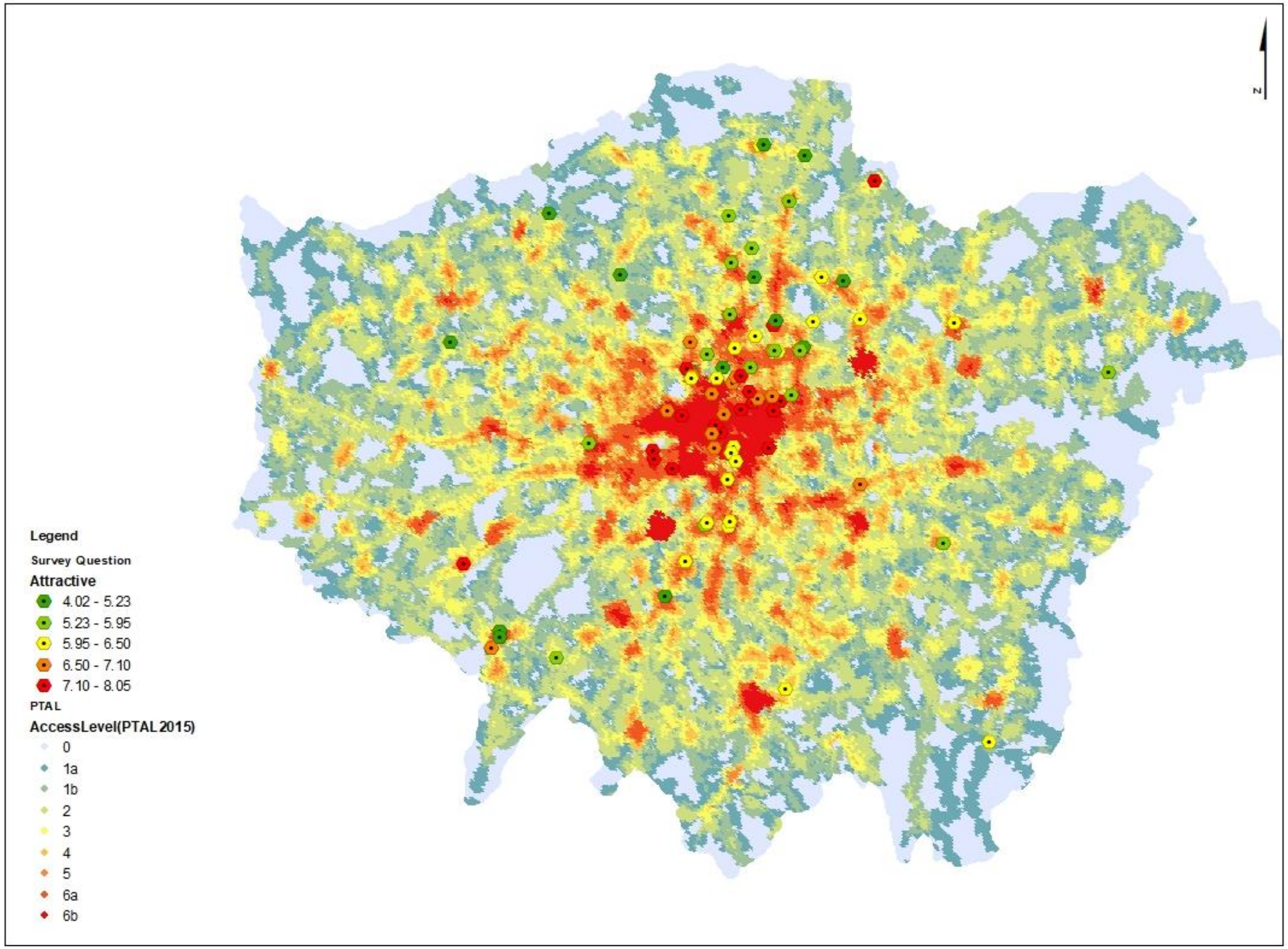


Figure B.16 Public Transport Accessibility Levels (PTAL) and survey locations' average Attractiveness Score

Table B.22 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.23 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.

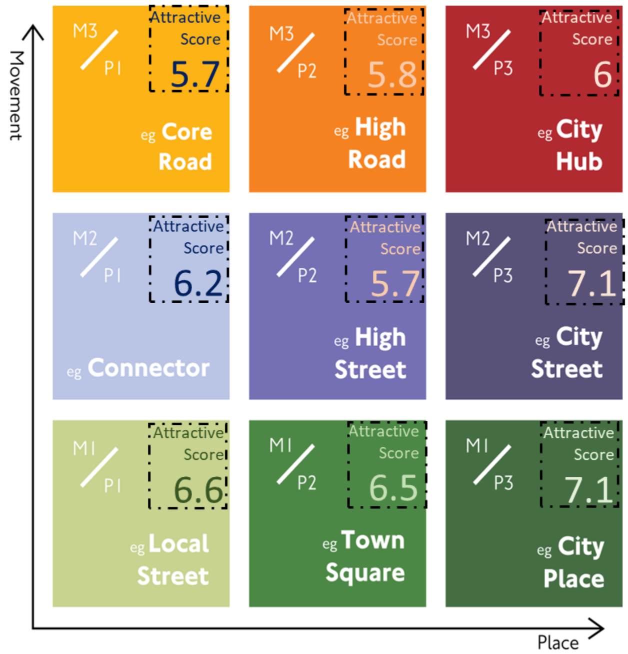


Figure B.17 Street Type matrix for London and Average Attractive Score

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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