The London Land-Use and Transport Interaction Model (LonLUTI)

October 2014
Introduction

This document introduces Transport for London’s (TfL’s) Land-Use and Transport Interaction Model (LonLUTI). It explains the basic concepts of transport modelling and the role of LonLUTI in the suite of models developed and maintained in TfL Planning. There is also information about the development of LonLUTI, its range of uses and the steps required by anyone who wants to use the model.

A more comprehensive set of documents is also available which explain LonLUTI’s development in more detail. In addition, TfL Planning can help with any queries. Contact details are on page 19.
Investment in transport can bring about a wide range of economic, social and environmental benefits, both locally and nationally. Introducing new routes, improving highways, building stations and bridges and charging fares and tolls are all investment options that may make it easier for people to move around, or help address the problems of road congestion and public transport crowding.

However, with limited financial resources and a variety of potential options, how can we tell which transport improvements are the best to invest in? To answer this, we need to predict the impact of each potential transport scheme on people’s travel decisions and the consequent congestion and crowding impacts as London’s population and workforce continues to grow and change. Transport models are a source of help and guidance when carrying out such predictions.

The decisions that an individual makes when considering travel options can be summarised as follows:

- Shall I travel at all?
- Do I need to own a car?
- Where shall I travel to?
- Which mode of transport shall I use?
- Which route shall I take?
- What time of day shall I travel?
Transport models are developed to predict some or all of these decisions, with different models often combining to provide an overall picture. They are highly specialised mathematical representations of transport networks that require substantial training to develop the expertise to apply them correctly.

TfL’s models aim to represent the behaviour of drivers, passengers, cyclists and pedestrians as they negotiate the city’s vast transport network. They also show the way transport interventions such as alterations to services and capacity affect travel decisions and the consequent performance of the network. They cover all the main modes of travel including car, taxi, bus, Underground, Docklands Light Railway, London Overground and National Rail as well as freight transport. They help TfL in planning to meet London’s future transport needs and identify which transport interventions are likely to be most effective in meeting goals set in the Mayor’s Transport Strategy.
TfL’s suite of models

Our models aim to represent all the different decisions that an individual makes when planning a journey. A selection of these models is shown below indicating how data such as demand (the number of trips between each origin and destination) is passed between models.

The models described here are often referred to as strategic models, which are used for forecasting the long-term impacts of schemes over wide areas. TfL also owns and operates other models, sometimes known as tactical or operational models, which are used for assessing the short-term impacts. These models include the ONE model and microsimulation models developed using the VISSIM and Legion software packages. This booklet focuses on strategic models only, information on TfL’s tactical and operational models is available separately.
• **The London Transportation Studies Model (LTS):** A model which uses population and employment forecasts and other inputs to predict the number of trips to be made in London in the future, where people travel to and from, when they travel and which transport mode they use.

• **The London Land-Use and Transport Interaction Model (LonLUTI):** A model which predicts the use of land for different human activities depending on Government policies and transport investment.

• **Railplan Public Transport Assignment Model:** A public transport model that predicts the public transport mode (eg. rail, underground, bus) and route that a person chooses to get to their destination, as well as the associated crowding impacts.

• **The Highway Assignment Models (HAMs):** Five models covering the whole of London which predict the routes that drivers choose and the associated congestion and delay impacts on London’s roads.

• **The London Regional Demand Model (LoRDM) (still under development):** A demand balancing model which is similar to LTS but uses the HAMs and Railplan for modelling the choice of route.
LonLUTI is a land-use and transport interaction model covering London and the South East. LonLUTI assesses the land-use impact of transport schemes and provides a rigorous analysis of the demographic, economic and transport impacts of land-use proposals. The term ‘land-use’ in this context refers mainly to activities that use space – in particular, where people live and work. Land-use models are generally less concerned with the physical use of land itself: in many cases ‘space’ is measured in terms of the quantities of floorspace rather than of land. It is important to recognise that the land-use system is never static and that transport is only one of the factors affecting it.

The model can be summarised as consisting of four components, illustrated below. The economic, urban and migration models form the land-use model LonLUM. LonLUM is linked to the transport model, which is LTS.
The transport and urban models work at the level of zones; the migration and economic models work at the broader level of areas (large groups of zones). The LonLUTI zone and area system covers the whole of Great Britain with more detail in Greater London and the East and South East, as shown below.
The LonLUTI modelling system is one in which nearly everything affects everything else to a greater or lesser extent, either immediately or gradually. The pattern of land-use largely determines travel patterns and the patterns of accessibility or congestion (calculated in the transport model) influence how the land is then used.

The transport model (LTS)
The transport model takes inputs that describe activities (different categories of residents and jobs) by location, for a given year. It predicts travel by highway and public transport. In doing so, it estimates the time and cost of travel between locations, allowing for congestion caused by the predicted traffic.

The economic model
The economic model predicts the growth (or decline) of the sectors of the economy in each of the areas modelled. Its inputs include predictions of overall growth in output and productivity. The predictions by sector and area are influenced by costs of transport (from the transport model), consumer demand for goods and services (from the urban model), and commercial rents (from the urban model). Forecast changes in employment by sector and area are passed to the urban model.

The urban model
The urban model predicts the location of households and jobs within the areas that are modelled in detail. Locations are strongly influenced by the supply of floorspace, which is an input to the model. Each floorspace type represents a distinct property market; for example, it is assumed that planning regulations will prevent offices being used as residential dwellings and vice versa. Location choices are also influenced by environmental variables and by accessibility, with different measures of accessibility influencing different activities. Households are influenced by accessibility to workplaces and services. Businesses are influenced by accessibility to potential workers and customers.

The locations of households and jobs are fed back to the transport model to generate travel predictions. Household numbers are also used to calculate consumer demand for goods and services in each area, for use in the economic model. The rents arising from competition for property in each area affect both the economic and migration models. Information on job opportunities contributes to the migration model.
The migration model
The migration model predicts migration between areas in the model (movements within areas of the model are predicted in the urban model). The inputs to this model include job opportunities and housing costs from the urban model. Job opportunities are a strong incentive to migration; housing costs are a generally weak disincentive.

Modelled years and time periods
LonLUTI represents average hourly conditions for three key time periods during the day. The periods are:

- AM Peak (07:00–10:00)
- Inter Peak (10:00–16:00)
- PM Peak (16:00–19:00)

The model base year is 2011. Future year models are available in five-year steps from 2016 to 2041. The models for these years include up-to-date plans for infrastructure schemes and the latest population, employment and economic predictions.

Software and skills
Operating the model requires skills and experience of using bespoke software, familiarity with the MS-DOS environment, and a good understanding of LonLUTI’s methodology, model assumptions, data preparation and interpretation of results.

TfL Planning runs training courses for TfL staff wanting to use LonLUTI.
How was LonLUTI developed?

In 2007, the TfL Demand Forecasting Review report recommended the implementation of a land-use and transport interaction model for London and its adjoining regions. David Simmonds Consultancy Ltd was commissioned to develop this. The first LonLUTI model, LonLUTI 1.0, was completed in 2008 and incorporated data from an earlier application (LASER 4.0), adopting the same zoning system. This was linked to LTS version B5.4, and used for a variety of purposes from early 2009 to the end of 2010.

In late 2010, TfL commissioned an improved version of LonLUTI. This included linking to a more recent version of LTS (B6.2) and representing 2007 rather than 2001, making use of data prepared for LTS B6 and other sources. The LonLUTI forecasting process was extended to 2041 in line with LTS’s forecast years.

Following completion of the LTS 2011 model, LonLUTI has also been updated to 2011. This work incorporates the 2011 Census data and recent Greater London Authority (GLA) population and employment projections.

A review of forecasting assumptions was undertaken and the latest population, employment and economic forecasts were used to produce a set of future year models representing 2011 to 2041.

LonLUTI undergoes continual development to meet ever-changing needs and policy requirements. Changes can be made to meet the specific requirements of a study.

LonLUTI has been developed with careful adherence to industry guidelines and led or reviewed by experts in the field of transport modelling. In particular, the Department for Transport’s Transport Analysis Guidance (WebTAG) was followed to ensure the models produced are robust and reliable. Experts from consultancies and TfL staff formed a team of experienced transport modellers that has focused on delivering LonLUTI to the highest standards possible.

Details of the work undertaken have been documented in a number of reports; these are available upon request.
To understand the potential application of LonLUTI, it is perhaps important to first understand its limitations. Land-use and transport interaction models cannot represent accurately every land-use and every journey made by every person. Also, they are not precise in the way they replicate the interaction between each instance of land-use and the behaviour of each person and vehicle. There are many factors that affect people’s travel behaviour and the day-to-day variation in demand and journey times. Even with an extensive set of observed data, these factors are random and impossible to predict. Attempting to develop a model that represents these variations perfectly is unrealistic and is sometimes referred to as ‘over-fitting’.

Understanding the limitations of a model is vital to making best use of it and taking advantage of its strengths. The reasonable level of expectation from LonLUTI is that it is able to provide a rigorous analysis of the demographic, economic and transport impacts of land-use proposals.

When LonLUTI is used for a new project, it is usually necessary to review the model to ensure it is fit for the purposes required. The table gives examples of when to use LonLUTI and where appropriate, suggests alternatives.

- LonLUTI would be a highly useful tool for this study
- LonLUTI could be used for this study but an understanding of its limitations in this case would be important
- LonLUTI is not the best tool for assessing the impacts of this study but could provide some supporting analysis
<table>
<thead>
<tr>
<th>Type of study</th>
<th>Key strengths of LonLUTI in this case</th>
<th>Key limitations of LonLUTI in this case</th>
<th>Other tools to consider</th>
<th>Summary advice</th>
</tr>
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<tbody>
<tr>
<td>Assessment of land-use planning</td>
<td>Can provide a reasoned, quantified assessment of how land-use planning or housing programmes would affect land-use development and transport for different population and employment groups</td>
<td>Limited by the size of model zones</td>
<td>Surveys, experts’ opinions</td>
<td></td>
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<tr>
<td>Assessment of new strategic public transport or highway schemes</td>
<td>Can assess how transport improvements or changes in travel costs would shift the distribution of activities in an urban area</td>
<td>Detail of model outputs is limited by LTS, particularly outside GLA and the M25 and for areas away from major highways</td>
<td>Railplan, HAMs (ideally linked to LonLUM)</td>
<td></td>
</tr>
<tr>
<td>Opportunity Area Planning Framework</td>
<td>Assessing regeneration impacts of new opportunity areas</td>
<td>Very small opportunity areas or individual developments may not be assessed in detail</td>
<td>Micro-simulation</td>
<td></td>
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<tr>
<td>Land-use regulation policy</td>
<td>Can estimate impacts of developments and redevelopments, likely impacts on households or jobs, and household density and vacancy rates</td>
<td>Future land-use and permissible development sites need to be identified before using the model</td>
<td></td>
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<tr>
<td>Applying a new toll on a bridge</td>
<td>Strategic changes in route choice and more localised congestion impacts are modelled in LTS; LonLUM will respond by reallocating households and jobs</td>
<td>The modelling of new tolls requires some surveys and preparatory work before considering the modelling aspect. The model will not be very effective if the tolls have only a small impact</td>
<td>HAMs, spreadsheet assessment</td>
<td></td>
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<tr>
<td>Modelling the impact of a new cycle scheme</td>
<td>New cycling matrices have been included in LTS; LonLUM will respond to changes in generalised costs of travel by reallocating households and jobs</td>
<td>The modelling of cycling is still in its early stages and is a topic of discussion across the industry</td>
<td>HAMs</td>
<td></td>
</tr>
<tr>
<td>Very local transport schemes such as installing a new pedestrian crossing</td>
<td></td>
<td>Changes are too local to be represented in the model</td>
<td>HAMs, micro-simulation</td>
<td></td>
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What information can be extracted from LonLUTI?

LonLUTI provides land-use data as input to LTS, which in turn feeds transport data into LonLUTI. Therefore, the outputs provide a distribution of land-uses that are modified over time by transport changes.

LonLUTI can be used to extract a wide range of information. It is common to compare the data extracted from a number of modelled scenarios to assess the impact of a transport scheme or land-use development. In the first instance, statistics that indicate the impact of land-use changes can be extracted from the model and analysed. LonLUTI is particularly useful in assessing the wider impacts of interventions traditional transport models do not cover.

LonLUTI processes outputs in a way that combines two functions:

- Aggregating aspects of the model database – the aggregation is fixed in some cases and defined by the user in others.
- Presenting the aggregated information in simple formats that can be read by a wide variety of other software.

The LonLUTI output interface can be used to produce summary tables of annual outputs from the base year (2011) up to a forecast year (for example, 2041).

The key outputs include total population and the number of households, children, resident workers, non-working adults, retired people and jobs. The model can also produce more detailed information by zone and individual activity, for example, number of jobs or households by a particular type of land-use.

Total floorspace by land-use type in each zone and for each year can also be extracted, as well as greenfield and brownfield development floorspace, floorspace rent, permissible development floorspace, occupied and vacant floorspace, occupied floorspace density, quality of floorspace, and floorspace redevelopments and intensifications.
How can I use LonLUTI?

LonLUTI is available for use in appropriate studies at TfL. The model requires specialist knowledge and can be run by TfL, David Simmonds Consultancy and SYSTRA.

Licensing
DELTA and TRIPS licences and a TRIPS dongle are required to run the model. The DELTA licence costs around £3,500 per year. There is currently no fee for the TRIPS licence and dongle.
Typical LonLUTI project life cycle
This figure gives an example of a project life cycle which involves the use of LonLUTI. It emphasises the interaction that often occurs between the modelling task and the other appraisal and assessment associated with the project. Timescales on each project tend to vary from a matter of weeks to many months, depending on the scope and complexity.

### Inception
- Consideration of modelling work required
- Consideration of whether LonLUTI or any other models would be appropriate

### Implementation of modelling task
- Carry out a model review and allow time for data collection and/or model refinements if necessary
- Plan project programme, ensuring that all modelling outputs required for other appraisal and assessment can be provided in good time
- Allow for iteration with other appraisal and assessment
- Ensure that the required model outputs and analysis are clearly defined

### Implementation of other appraisal and assessment
- Plan project programme, ensuring that all modelling inputs can be provided in good time
- Allow for iteration with modelling task

### Reporting
- Make use of modelling expertise to ensure that model results are interpreted correctly
- Be clear about the modelling methods used
- State any limitations associated with the modelling conclusions drawn

### Review
- Discuss the project as a whole and its use of the model
- Consider what went well and what could be improved
- Return any new versions of the model to TfL at project close
More information and contacts

For queries about LonLUTI, please contact the Strategic Analysis team in TfL Planning using one of the email addresses below:

For all general LonLUTI queries
DemandModelling@tfl.gov.uk

For licensing and accreditation queries
StrategicModelling@tfl.gov.uk