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BUILDING AN INTEGRATED URBAN MODEL PLATFORM:

The case of the City of London

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ABSTRACT

Cities are comprised of many interconnected and overlapping systems; so analysis and management of cities should be approached holistically. The city is primarily for people, thus the analysis, planning, and design of cities should focus on the outcomes that affect the lives of the people that use them.

To explore the potential of a holistic, multidimensional approach, an Integrated Urban Model (IUM) concept was previously developed to create spatial strategies for Jeddah, Saudi Arabia (Karimi, Parham and Acharya, 2015). The IUM used spatial network models weighted by estimated land-use based trip generation/attraction values to appraise proposals for development; this utilised the principal of Origin-Destination Weighted Choice (Karimi, Parham, Friedrich and Ferguson, 2013) to weight segment choice by the origin and destination values of paths that pass through it. The IUM approach allowed the impact of land use and spatial configuration to be assessed within one model, providing a clearer view of how people interact with space than modelling each element individually.

The IUM concept from the Jeddah project was built upon for the City of London Corporation to become a long-term framework for multi-dimensional holistic urban modelling; forming a key planning and design tool that can adapt to new ideas and datasets. The paper outlines the general framework of an Integrated Urban Model, before exploring how this framework was used in real-world practice for the City of London's pedestrian movement model.

KEYWORDS

Planning process, sub-regional plans, integrated urban models, weighted space syntax analysis, planning option testing, densification.

1. DEVELOPING AN INTEGRATED URBAN MODELLING FRAMEWORK

The IUM platform is built around the spatial network of the area. This forms the foundation of the analysis; all other data layers are aggregated or disaggregated and translated to link with the spatial network model.

The spatial network model on its own allows certain key network properties to be calculated, including:

- Betweenness Centrality/'Choice' (Angular cost)
- Closeness Centrality/'Integration' (Angular cost)
- Metric catchments (Metric cost)

Land use and transport data are key data layers to integrate with the spatial network model, as these are the most significant drivers of activity, along with the spatial configuration of spaces. The potential for further holistic analysis is enhanced when other data layers are carefully integrated and linked to the platform. For example, census data can be used to assess how spatial configuration and land use patterns in neighbourhoods relate to residential travel behaviour. A site allocation for employment land uses can be assessed based on access to residents with certain skills and the impact of development proposals on pavement crowding risk can be evaluated.

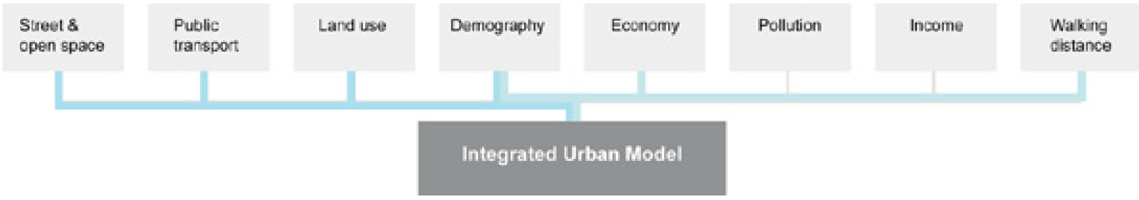

Figure 1 - Typical data inputs into the Integrated Urban Model

A key to providing meaningful insight to such holistic systems is to translate complex multi-system relationships into human-based outcomes. How do different systems in a city influence people and vice versa? Do plans increase or decrease the quality of life? Does a city allow opportunities and choices for people in work and leisure?

In practice, using an IUM can be more than a simple model. Maintaining a persistent IUM framework with up to date data can perform as a hub for urban data and analysis for many disciplines, supporting interlinked urban planning and design and policy decisions with a suitably multi-dimensional approach. An IUM framework was built for the City of London and provided a useful opportunity to test and develop the methodology in practice.

2. CASE STUDY - CITY OF LONDON PEDESTRIAN MODEL

For the City of London Corporation, a district-wide model was commissioned to analyse and forecast pedestrian movement at a strategic level in the City. The model is designed to be a key input and assessment tool for strategic planning and city management duties such as the Local Plan, Development Control, Urban Design, Air Quality, and Highways. The key focus of this model was testing the impacts of developments and transport changes on pedestrian movement patterns and levels, including a predictive model for a future scenario of 2026, assisting the City in developing their future planning strategy.

Given that pedestrian movement was the key metric, the currency with which the layers in the model interacted is the unit of people. All elements of the model were converted where possible into matching measures of people flow (per hour or another time period); this ensured that the input and output were directly relatable to human-based outcomes.

Each address point unit or transport stop was assigned an estimate of people entering and exiting for the model periods. Where available, this was estimated based on land use and floor space figures, as well as using research on the trip generation characteristics of certain land uses.

The land use and transport origin and destination values were assigned onto their closest spatial segments. The angular choice values are then calculated based on various radii of metric distance for comparison. The calculated choice values on each spatial segment were multiplied by the weight of the origin and destination values of the journey passing through a segment (Karimi et al 2013). This integration of models combines the movement potential of a street by virtue of its network connectivity and the movement potential of a street by virtue of its location on the shortest path between modelled land uses.

This model output was validated against historic pedestrian movement data collected through a number of pedestrian movement surveys undertaken over a 5 year period for Space Syntax's various previous projects. The best fitting choice radius for the spatial network analysis was assessed based on the relationship with the recorded movement data. On balance the integrated weighted choice value tended to relate more strongly to pedestrian movement than the basic spatial choice value, suggesting that the land use/transport influence is a significant element in assessing pedestrian movement potential in cities.

It is important to note that the dataset was limited in sample size at around 400 locations, did not cover the entire street network evenly, and had a significant variation in survey dates. Therefore there was an inherent limit in the accuracy of the recorded data and its representation of reality, which in turn limits the accuracy of any correlation or calibration.

Given the limitations, the model still provides a new insight into the strategic hierarchy of spaces in the City of London, the key being its ability to respond to land use and transport changes. Due to its ability to predict, the model was used to develop a future forecast model for the year 2026. Land use and spatial network changes were modelled based on planning application data. Changes in transport entry and exit volumes were estimated based on a general estimate for future population uplift.

Figure 2 - Cumulative impact of future development and transport change on pedestrian movement on Bishopsgate, City of London

The example in Figure 2 demonstrates how the IUM reveals the result of multiple cumulative impacts; Bishopsgate is predicted to experience increased pedestrian movement due to both the proximity to the cluster of high-rise developments and the spatial importance of Bishopsgate as a route between new developments and major destinations such as Liverpool Street station and Bank. Using the model the City can better plan for and manage this impact through their various responsibilities and duties, such as changing height limits, land use balances, urban design and street improvements amongst many others.

The model was built almost entirely on secondary data; including desktop study, existing mapping data, government records and survey data. However, the model still manages to be a very useful and legible indication of how the City of London's streets and spaces are used by pedestrians now and in the future. This strong foundation can be built upon by collecting high-quality primary data on pedestrian movement, land use, and other human behavioural metrics to bring more resolution and accuracy to the model.

Since the IUM is a set of discrete but linked layers of data and models, it is flexible and capable of taking on new information and data as it becomes available. Ongoing development of the City's IUM includes assessing pavement capacity against the model's predicted increase in pedestrian movement, identifying risk areas that require more detailed study. The framework can therefore also be a starting point, providing high-level indications for the need for detailed studies and projects, ensuring that limited funding and resources can be allocated on the basis of objectively-assessed risks and opportunities.

A comprehensive IUM provides a clarity and authority which can cut across complex and subjective interactions concerning how space is developed and used. The positive and negative externalities of decisions can be estimated in a standardised and legible way, ensuring a fairness and reliability for stakeholders, building trust, increasing cooperation and understanding and improving planning and policy process outcomes for people.

3. CONCLUSION – OPPORTUNITIES OF IUM FRAMEWORK

The IUM framework is an ideal way of tying together many separate but linked dynamics of the city. It can simply enhance the insight of space syntax analysis, but it can also become a comprehensive framework that links the interactions of various urban systems. Through analysis and research the IUM can help assess the human-oriented outcomes of planning and designing these urban systems. The City of London is now utilising this methodology in their day to day planning and management for one of the most dense and economically active areas of London.

Urban data such as land uses, transport journeys and censuses are becoming more open and readily available. Use of mobile phone or automated sensors can bring a systematic overview of human movement patterns, refining theories of spatial interaction and increasing the confidence in predicting and planning.

Rapidly advancing open source technologies, including OpenStreetMap, Spatial Databases and GIS, make construction of such models relatively fast, transparent and straightforward. Development of software which can collate, combine and integrate disparate data layers into models is ongoing, and offers the chance for the IUM framework to respond more quickly to new theories, discoveries and realities while retaining a central legibility and link to human outcomes.

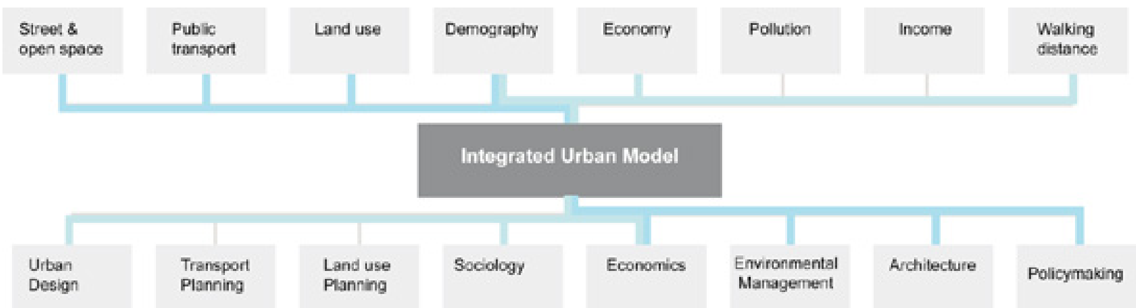

Figure 3 - Disciplines that can use the IUM to collaborate with each other

nformation taken from the model is never isolated to one topic and will always allow a user to understand how one element affects the other. By integrating different elements of cities, it also integrates different disciplines (Figure 3), allowing holistic planning to truly be utilised in a multi-dimensional context.

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