e ESSAY



SMART CITIES

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From Smart City to Space Syntax: An Analytical Language to Plan and Design Cities

Function follows flow and form—people movement in London.
Image: Space Syntax

The concept of the "Smart City" has been useful to highlight how cities and towns can be developed using digital technology, but the time may have come for a new approach.

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Smart City as Drivers for Future Urban Change and Policymaking

"Smart City" has become a contentious term—early projects were often expensive, did not fully deliver and embedded top-down models in city operations. Nevertheless, the term remains widely used as shorthand for the use of digital technology in planning and operating cities. But a new approach to Smart Cities is being facilitated by developments in technology as well as changes to wider social, political, environmental and economic contexts. In particular, the COVID-19 pandemic has led to a re-evaluation of many accepted norms, especially around mobility and work, making now a good time to consider what we want our towns and cities to be like and the potential of technology to deliver policy objectives.

A Smart City uses technology to make urban life better for people. This means using data and modelling techniques to understand how the planning and operations of the urban environment influence the everyday behaviours of people, and how this then leads to social, economic and environmental outcomes. For example, regular driving to work is associated with a higher risk of negative health outcomes, worse air quality, traffic congestion and carbon emissions.

The physical and spatial makeup of towns and cities plays a fundamental role in shaping human activity patterns—for example, the way streets, land use, densities and public transport combine to make it easier to walk to work or school. Understanding the influence of the urban environment makes it easier to set realistic and long-term policy objectives.

Urban policymaking is being transformed by two key factors, namely climate and health. In the UK alone:

- Around 75% of England's local authorities have declared a climate emergency and are developing road maps to reach zero carbon
- The Welsh Assembly has adopted the Well-being of Future Generations Act, requiring all decisions to consider long-term impacts
- Cities including London are voluntarily reporting on UN Sustainable Development Goals
- The National Health Service has published a long-term plan based around prevention, place and technology

This means thinking about cities as systems of systems: of street connections, land use attractions, transport links and service infrastructures.

These same drivers are guiding the development of new Smart Cities technologies. At the same time, many new digital solutions are being developed by networks of SMEs, rather than corporate giants, in ways that allow integration and cross-pollination. Instead of creating a one-size-fits-all solution that is expensive and potentially difficult to adapt, future Smart City solutions are being constructed from an interoperable ecosystem of tools and datasets.

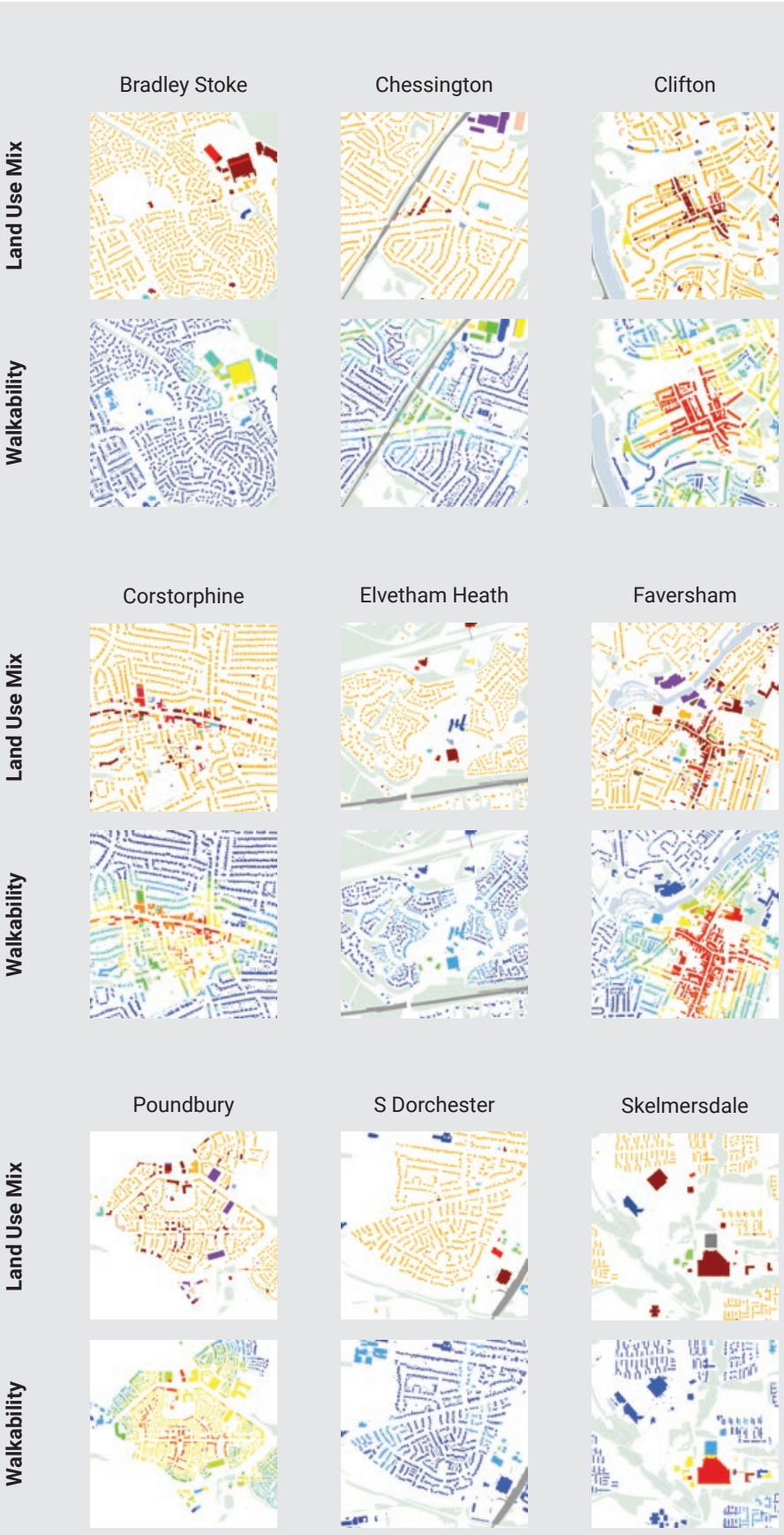
Other new developments concern project lifecycles: any project, from idea to outcome, must go through several stages, including policymaking, planning and design to construction, operations and maintenance. At each stage, evidence-based analysis and outcomes-focused predictive modelling can help decision-makers. Many previous Smart City solutions (and many Digital Twin solutions) have focused on the later stages only of the project timeline, for example managing city traffic lights using live traffic flow data. Such solutions can improve performance but will not fundamentally address the reasons why so many people are driving in the first place.

Understanding why and where something happens requires not only technology solutions but domain expertise to explain the way cities work. This means thinking about cities as systems of systems: of street connections, land-use attractions, transport links and service infrastructures. This allows the analysis of how each system works in isolation, and in combination with the others. The UK National Digital Twin programme proposes an ecosystem of connected digital twins to foster better outcomes from our built environment. To make early policy and planning decisions, while still enabling operational decisions to be made later on, it advocates the use of interoperable technologies that match suitable levels of data and processing power to each stage of the project. Its urban modelling systems, such as the Integrated Urban Model, make it possible to use aggregated, anonymised data to help planners in three key policy activities:

- Recognising existing problem areas and targeting physical interventions in response
- Designing better new places which support different behaviours
- Identifying how to mitigate existing physical conditions through non-physical methods

For example, Space Syntax's Walkability Index of the UK uses an Integrated Urban Model to highlight the physical factors required to encourage low-carbon mobility.

Walkability Index National Modelling System (*above*); close-up of land use mix and walkability analyses (*right*).
Image: Space Syntax


Bradley Stoke
Chessington
Clifton
Land Use Mix
Walkability
Corstorphine
Elvetham Heath
Faversham
Land Use Mix
Walkability
Poundbury
S Dorchester
Skelmersdale
Land Use Mix
Walkability

Nur-Sultan Masterplan.
Image: Space Syntax

> Impact assessments can be undertaken on accessibility that take into consideration the social, economic and environmental effects of development on mobility, land value, resilience and health.

From Smart City to the Science of Cities: Space Syntax

Beyond technology and tools to improve infrastructure, there is a need for "smart" physical planning. We can call this Smart Planning, but in many ways, there are many layers to consider that are not as direct as a Smart City approach.

Integrated Urban Modelling, together with other data-driven tools and methods, acknowledges that the city is complex with many interdependent components. It drives well-informed decision-making through systematic evaluation and predictive analytics assessments. It approaches the city through a street network lens—based on graph theory to understand movement flow and behaviour theory to examine accessibility. Through this model, impact assessments can be undertaken on accessibility that take into consideration the social, economic and environmental effects of development on mobility, land value, resilience and health.

For example, Space Syntax has applied its approach to the city of Nur-Sultan, Kazakhstan. Deploying a unique, "data-driven design" approach, Space Syntax has led an international team of consultants to improve, intensify and grow the capital city of Kazakhstan.

The city's 2030 masterplan covers three scales: city-wide strategies, opportunity area masterplans and local, tactical interventions. City-

Nur-Sultan Masterplan movement patterns.
Image: Space Syntax

wide strategies include the use of forecasts of population and employment growth to improve and intensify the city in key areas before extending it. Space Syntax created a bespoke Geographic Information System (GIS) plugin, allowing city users to access advanced analytic tools, to ultimately deploy improvements at scale across the city.

Through scenario modelling, the masterplan demonstrates how the three key objectives can be delivered through a target set of development proposals:

- Improved liveability: enabling 20% more residents to be able to walk to key services, activating parks as vibrant social spaces, and using urban form and massing to create a sheltered and comfortable environment at street level
- Improved sustainability: developing policy roadmaps that would enable the city to reach its emission and recycling rates, and tapping into renewable sources of energy generation
- Creating conditions for healthy lifestyles: supporting daily activity, reducing average car dependence by 10%, and offering equal access to employment by active and public transport as by car

Advanced analysis was used to identify spatial conditions associated with these outcomes in cities around the world, before translating these findings into a set of design principles. Digital and parametric design processes were used to translate these principles into spatial propositions which were continually analysed and refined.

In order to apply these tools and analysis effectively, it is essential that key urban concepts, such as Walkable Urban Centres and people movement flow, are properly addressed.

Smart Planning 01: Understanding TODs vs WUCs

Sometimes confused for being the same thing, Transit Oriented Developments (TODs) and Walkable Urban Centres (WUCs) are two distinctly different urban creatures. TODs create efficiencies of urban movement, such as reducing car dependency by providing proximity for residents and office workers to public transport infrastructure. WUCs sit at the heart of communities, providing mixed-use environments that foster social, economic and cultural productivity.

These and other projects give rise to a number of reflections on the subject of TOD design. These are not limited to the social, economic and environmental opportunities to be found in developing at close density to public transport nodes. Indeed, there are other significant concerns such as the physical relationship between TODs and WUCs. In particular, the mistake often being made is to assume that any TOD can also be an effective WUC.

The key challenge of rail-based TODs is that railway tracks and railway station buildings are large objects such that, unless carefully (and usually expensively) handled, get in the way of everyday urban movements. Large stations can block the flows of people through cities and railway tracks can sever movement routes. The addition of car parks and service routes adds further challenges to the maintenance of the two most important physical/spatial characteristics of WUCs:

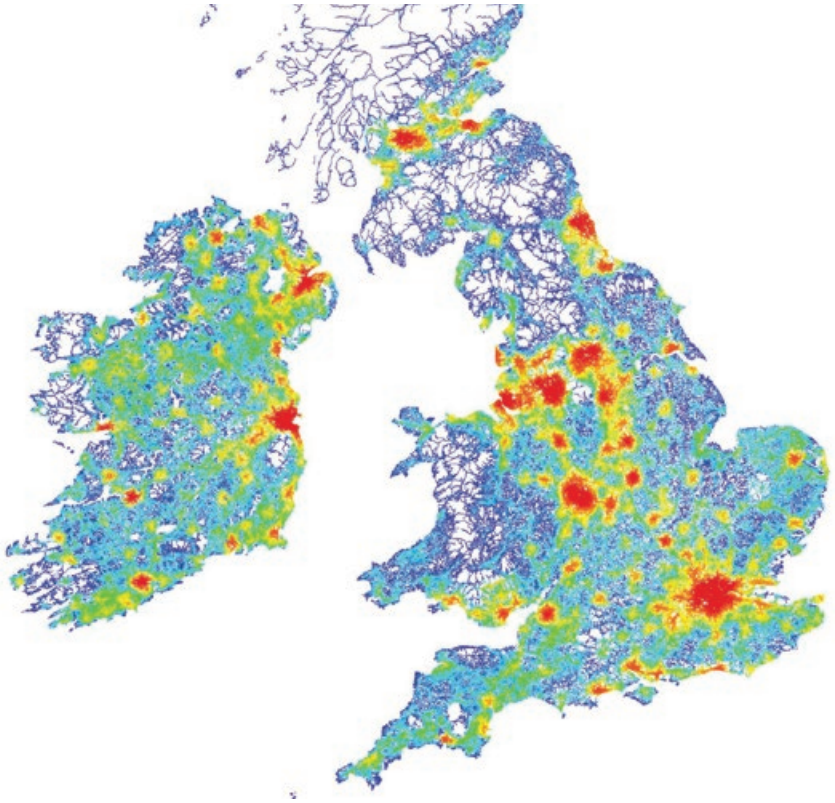
a. *Seamless spatial linkage* in the form of continuously connected street networks, the spatial device that facilitates movement to, through and around centres

b. *Continuous active frontages* at street level that provide the architectural vehicle for land-use attractions to interface with moving people

As a result, TODs either need to be placed beneath or above those everyday urban flows or close to the continuously connected and animated flows of a WUC. The key questions can be framed around:

- **Density:** Is there enough density to justify the investment required to cover the tracks so that the urban centre can be integrated with the transit station? If not, the urban centre should be close to but not integrated with the transit station.
- **Connectivity:** How do the urban centre and the transit centre connect to each other? Whether directly above or close to each other, seamless connectivity is essential.
- **Integration:** How do the WUC and TOD integrate with their wider context? It is essential to have a walkable grid of streets that connect the WUC and TOD to all the other land uses around them.

This anaylsis of transit oriented developments shows movement patterns from transport to the surrounding land uses.
Image: Space Syntax



The Integrated Urban Model shows the potential of human activity and vibrancy based on the street network.
Image: Space Syntax

Smart Planning 02: Understanding Movement Flow and Pedestrian Activity

> The actual function of places—as opposed to their intended function—follows the flows set up by the spatial form of those places, independent of their designers' wishes.

Many places work in ways not originally intended. The artist's impression is often unrealised, with public spaces less well-used than in drawings, shops not getting the footfall shown in illustrations, tracks worn into green spaces painted as pristine in renderings.

The actual function of places—as opposed to their intended function—follows the flows set up by the spatial form of those places, independent of their designers' wishes.

It is risky to think that form follows function, and not appreciate that a place functions according to the flows shaped by its physical form. If this relationship is not understood, there is a high risk that urban layout structures will be designed inappropriately and end up with problematic functions.

With software that forecasts flows by analysing physical forms, and with design principles shaped by decades of experience, Space Syntax has been able to reduce risks from the design process. Physical city structures can be analysed, pedestrian flows simulated, and planners can anticipate the functioning of schemes at the earliest stage of design. They can then feedback the recommended changes in order to optimise flows and close the gap between intended and actual functions.