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Smart cities – Guide to the role of the planning and development process

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Contents

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Foreword

This Published Document (PD) was sponsored by the UK Department for Business, Innovation & Skills (BIS). Its development was facilitated by BSI Standards Limited and it was published under licence from The British Standards Institution. It came into effect on 31 October 2014.

Acknowledgement is given to Michael Mulquin of IS Communications Ltd, as the technical author, and the following organizations that were involved in the development of this PD as members of the steering group:

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- City of Gothenburg
- ECS Limited
- Government BIM Task Group
- Living PlanIT

This PD is not to be regarded as a British Standard. It will be withdrawn upon publication of its content in, or as, a British Standard.

The PD process enables a guide to be rapidly developed in order to fulfil an immediate need in industry. A PD can be considered for further development as a British Standard, or constitute part of the UK input into the development of a European or International Standard.

Relationship with other publications

This PD is issued as part of a suite of BSI publications related to smart cities:

- PAS 180, *Smart cities – Vocabulary*, which defines terms for smart cities, including smart cities concepts across different infrastructure and systems elements and used across all service delivery channels;
- PAS 181, *Smart city framework – Guide to establishing strategies for smart cities and communities*, which gives guidance on a good practice framework for decision-makers in smart cities and communities (from the public, private

and voluntary sectors) to develop, agree and deliver smart city strategies that can transform their cities' ability to meet future challenges and deliver future aspirations;

- PAS 182, *Smart city concept model – Guide to establishing a model for data interoperability*, which provides a framework that can normalize and classify information from many sources so that data sets can be discovered and combined to gain a better picture of the needs and behaviours of a city's citizens (residents and businesses); [1)]
- PD 8100, an overview document that will provide guidance on how to effectively communicate the value of smart cities to key decision-makers; [1)]

Use of this document

As a guide, this PD takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

For the purpose of this PD, "major development" is defined in accordance with the Town and Country Planning (Development Management Procedure) (England) Order 2010, rule 2 [1]:

> "(c) the provision of dwellinghouses where—
>
> (i) the number of dwellinghouses to be provided is 10 or more; or
>
> (ii) the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the development falls within sub-paragraph (c)(i);
>
> (d) the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or
>
> (e) development carried out on a site having an area of 1 hectare or more;"

Presentational conventions

The guidance in this standard is presented in roman (i.e. upright) type. Any recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Spelling conforms to *The Shorter Oxford English Dictionary.* If a word has more than one spelling, the first spelling in the dictionary is used.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a PD cannot confer immunity from legal obligations.

1) In preparation.

0 Introduction

0.1 General

smart city

effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens

[SOURCE: PAS 180:2014, **3.1.62**]

In the UK, more than eight out of ten people now live in urban areas. Yet cities increasingly need to be able to do more with less, to compete in a globally-interconnected economy, and to provide for the well-being of their citizens in a truly sustainable way. In short, cities need to become smarter.

The purpose of this PD is to support this process by providing guidance for ensuring that developments and infrastructure projects are designed and built in a way that facilitates the city's progress towards becoming smarter.

Designing smartness into developments and infrastructure projects could provide cities with the clarity they need to think strategically about how smart urban planning and design can help the city as a whole to function better.

It could also provide an opportunity to test new business models and processes comparatively cheaply and easily and use this to demonstrate the viability of replicating them citywide.

This PD also aims to help the wider development community understand how they might better position their proposals to fit in with the local authority's wider strategic aims and, by adding value to the people and businesses that will be using their development, make it more desirable and profitable.

This PD provides guidance on:

- five key areas where the planning and development process can support smart city aspirations and where smart city approaches can improve the planning and development process; and
- opportunities that can be exploited at the different stages of the planning and development process.

A summary of the recommendations in this PD, listed in relation to the roles they apply to, is provided at Annex A.

0.2 Smart city approaches and place-making

Smart city approaches build on and transform a key element of modern urban planning and design – the concept of place-making.

It has long been recognized that urban planning and design cannot simply focus on the hard infrastructure of buildings, roads and so on, but needs to give just as much attention to soft infrastructure.

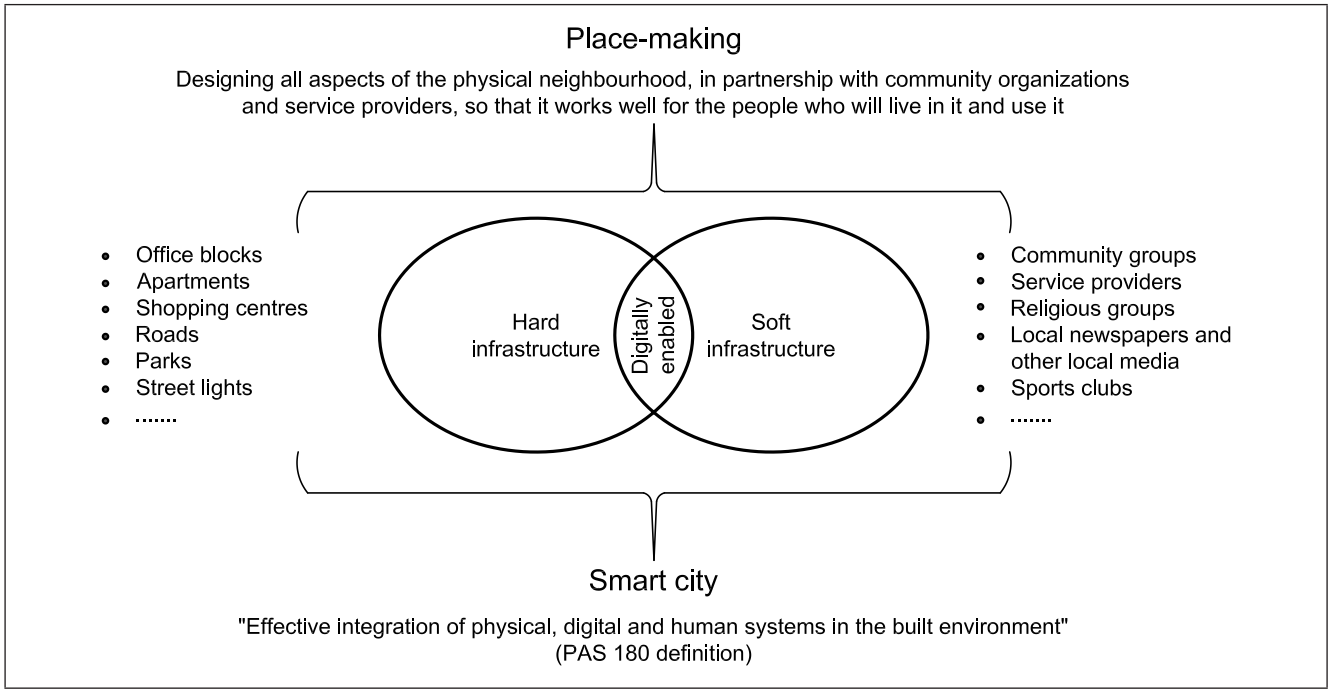
Soft infrastructure refers to the social systems that enable society to function. Buildings on their own, no matter how well-designed, cannot make an area attractive, vibrant and economically sustainable; the activities of service providers, businesses and community organizations are just as important. Therefore the overall plans for city development need to include measures that support both the hard and soft infrastructures.

The concept of place-making has been a key part of urban planning and design for several decades. Place-making recognizes that the physical design of a neighbourhood needs to facilitate positive interaction between people and make it easy for them to navigate through it. In other words, the neighbourhood as a whole needs to be designed in order to work for the people who live in and use it.

This has led to a multi-faceted approach to the planning, design, implementation and management of urban environments that supports local players in collectively using their influence and abilities to create attractive, prosperous and safe communities.

Smart city approaches bring a step change to this by adding in the digital dimension. Figure 1 indicates how digitally enabling the hard and soft infrastructure in a neighbourhood, a key requirement for smart city applications, can enhance and support the place-making agenda.

Figure 1 **Urban planning and design in a smart cities context**



Place-making is now, therefore, even more important in urban planning and design, as the potential offered by digital technologies and communications to take new soft infrastructure approaches to improve place becomes increasingly clear.

For instance, smart city approaches and services could support place-making by:

- utilizing digital modelling, so that the hard infrastructure in the new development or infrastructure project can be used to engage residents, users and citizens in designing a more attractive neighbourhood;
- utilizing the ability to automatically provide people with relevant information about transport options that affect travel patterns and habits (e.g. shared transport, public transport, bikes and walking), which could mitigate the need to invest in road infrastructure;

- enabling much greater amounts of data, including real-time data, to be collected, integrated and used to support neighbourhood management and service delivery, for the benefit of residents and visitors;
- utilizing communications/social media to:
  - aid in making a community more cohesive and safer for its citizens;
  - support local initiatives to change behaviours, for instance ones relating to waste and energy – thus avoiding or lessening the need to make changes to physical infrastructures.

0.3 Why this PD is needed

This PD is needed for the following reasons.

- It is easier and cheaper to put in place the foundations for a smart city within a development or infrastructure project at the planning and implementation stage.
- Developments and infrastructure projects often provide cost-effective opportunities to test and trial smart city products and services, and the business models and processes required to fund and operate them, before rolling them out citywide.
- The smart use of data and digital modelling can not only enable neighbourhoods to be better designed for the people who use them, but can also enable significant savings in the implementation, ongoing management and service delivery stages.

The **impact** of a failure to take these opportunities is:

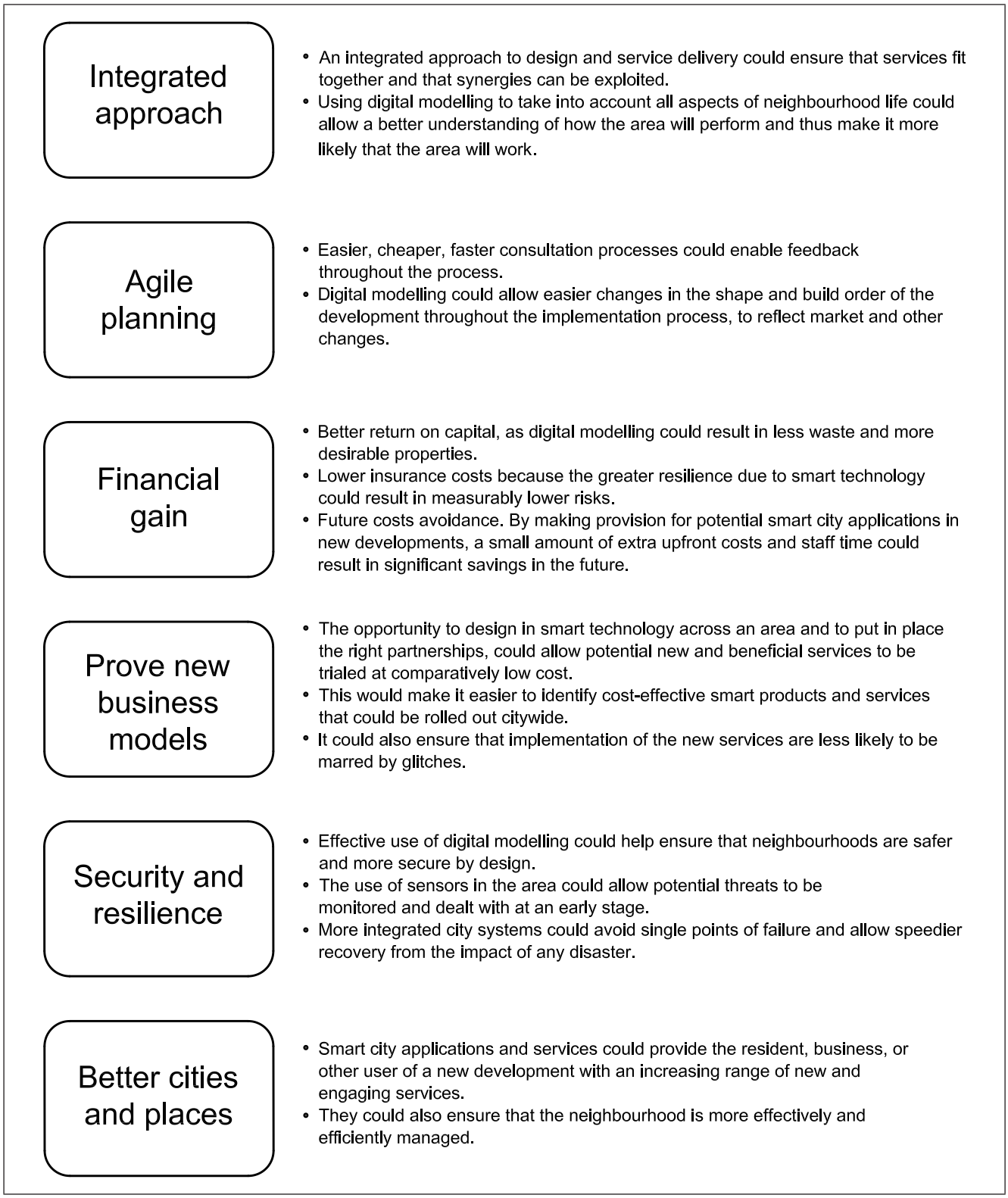
- the added complexity of having to re-write contracts, and re-define management and funding arrangements in order to support the provision of smart city products and services later on;
- the cost of having to rectify faults in the way a new neighbourhood or area is designed that could have been picked up in the early stages through the use of digital modelling;
- the cost of having to retrofit vital smart technology;
- the missed opportunity for using new urban developments and infrastructure projects to learn important lessons that can inform wider smart city strategies.

This PD aims to demonstrate how these issues can be **resolved** by providing guidance on five key areas identified in **0.5** and detailed in Clause **4**, all of which are aspects of adopting an integrated approach to the city. It also provides guidance for each stage of the planning and development process.

0.4 Benefits

Figure 2 outlines the potential process and output benefits that could come from ensuring that developments and infrastructure projects are using smart urban planning and design.

Figure 2 **Benefits of smart urban planning and design**



0.5 Key areas

This PD identifies five key areas where the planning and development process can support smart city aspirations.

1) **Build the partnerships to deliver holistic solutions**

   Cities need to put in place the right agreements and partnership arrangements to enable all the key city agencies to work together so that the soft infrastructure in the city is working and opportunities for place-making can be effectively exploited.

2) **Build the foundation for widespread exploitation of data**

   Cities need to put in place agreements between organizations regarding data handling and technical infrastructure to allow the information that can be generated in the city to be directed and utilized in order to support both the day-to-day management of the city and long-term plans.

3) **Use digital modelling to deliver a people-centred physical environment**

   Cities need to make sure that the physical environment of the city and its neighbourhoods is designed to support the citizen, business and visitor in achieving their goals and in supporting collaboration and innovation.

4) **Put in place an enabling digital and communications infrastructure**

   Cities need to put in place the digital and communications infrastructure to support new services and allow real-time data to be generated, delivered to where it is needed, and utilized to help the city work better.

5) **Develop and test new business models and processes**

   Cities need to be willing to implement the new and transformational business models that are made possible by increased access to data and closer integration between city systems, and to change existing processes in order to capitalize on these.

These five key areas provide the framework for Clause **4** of this PD.

1 Scope

This PD gives guidance on how the planning and implementation of development and infrastructure projects can equip cities to benefit from the potential of smart technologies and approaches.

It is relevant to major developments, major infrastructure projects, refurbishment programmes, streetworks and improvements to the public realm.

It considers how each stage of the planning and development process could support smart city opportunities and benefit from good practice in smart urban planning and design.

It identifies some key areas where developments and infrastructure projects could be planned and implemented in a way that supports the city as a whole in becoming smarter. It sets out what needs to be done at each stage, with an indication of where to go for further help.

This PD is for use by those involved in the planning and implementation of developments and infrastructure projects, including:

- city leadership;
- planning policy makers;
- planning case officers;
- regeneration officers; and
- developers and the consultants who work with them.

It points to good practice in a UK context, and identifies the tools to use to implement this good practice.

2 Terms and definitions

For the purpose of this PD, the terms and definitions given in PAS 180 and the following apply.

2.1 city
area that is mostly urban in nature which may include more than one administrative boundary

2.2 community
group of people and institutions located in a specific geographic area

2.3 neighbourhood
geographic area of a city in which a community is located

2.4 place-making
multi-dimensioned planning, design and management of public spaces with the intention of creating public spaces that promote people's health, happiness, and well-being

2.5 smart city
effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens

[SOURCE: PAS 180:2014, **3.1.62**]

3 Contemporary challenges for urban development

3.1 Types of development and infrastructure project

This guide addresses the planning and implementation of developments and infrastructure projects. It mainly focuses on major developments as defined in the Foreword to this PD, but also refers to the opportunities offered by refurbishment programmes, major infrastructure projects, and streetworks and improvements to the public realm.

Each of these needs to be tackled in a different way, but each offers similar opportunities to contribute to the progress of the city towards becoming smarter, and forms part of a coherent whole.

The larger a major development is, the greater the opportunity to use it to support and progress smart city aspirations. Because of this, the recommendations in this PD relating to major developments are particularly of value to mixed use developments involving several hundred or more residential and business units, along with some retail.

Detailed descriptions of the types of developments and infrastructure projects this PD applies to are given at Annex B.

3.2 Challenges

City leadership and planning policy makers face a number of challenges in planning developments and infrastructure projects for the city. These include the need to:

- work across public sector boundaries, within and around the metropolitan area;
- align national, regional and local priorities, managing the tension between central and local control;

- clarify roles between public institutions and private/commercial sector providers, notably in utility and transport systems (linear infrastructure);
- develop and adopt new business and operational models;
- integrate buildings into communities;
- exploit data to full effect;
- build in flexibility for change of use;
- accommodate growth and address the pressures of natural resources and public investment;
- accommodate demographic change (e.g. ageing, population shrinkage, specific demographic groups (e.g. the blind, single-person households));
- ensure the provision of sufficient affordable housing to meet current and foreseeable needs.

3.3 Roles in meeting the challenges

The planning and development process involves a number of roles. Those that are likely to have greatest influence in ensuring that developments and infrastructure projects support smart city aspirations, and to which this PD is specifically addressed, are as follows.

- **City leadership.** Leaders within the city can promote the role of urban planning and design in supporting smart city aspirations. They can ensure that smart city-related requirements placed on a development or infrastructure project gain support within the local authority and with the citizen.
- **Planning policy makers,** who set the policies and shape of the city for the developer to adhere to. They can ensure that the requirements they place on developers regarding smart cities are both practical and also consistent with the longer-term development of the city. They can also ensure that the smart city plans provide a clear framework to provide the certainty needed for viable business plans relating to the delivery of smart city products and services.
- **Planning case officers,** who can identify how their work can support smart city aspirations. They often need to negotiate with developers over a long period of time and so it is important that their line managers, supported by city leadership, make it clear to them that the guidance contained in this PD is within the scope of their responsibilities, so that they are able to give this the priority it deserves at every stage of negotiations.
- **Regeneration officers,** who might also be involved in negotiations with developers with the role of ensuring that the development and infrastructure projects support the economic development and regeneration goals of the city. They can identify how the inclusion of smart city applications will support these specific goals.
- **Developers and the consultants who work with them,** who need to understand the local authority's smart city aspirations and work with them to design smartness into their development in a way that could potentially add value to their development and open up for them new forms of revenue generation.

There are a number of other roles that might find this PD useful, including:

- other local authority staff, such as building control officers, transport planners, parking officers, waste and recycling officers, ecology and environmental officers, conservation officers and social services staff;

- local democratic structures such as management of devolved neighbourhood budgets, area committees and neighbourhood forums;
- partnerships such as local enterprise partnerships;
- the citizen, both as a respondent to consultations regarding new developments, and, more generally, in their role as holding the council democratically accountable.

4 Key areas for supporting smart city aspirations

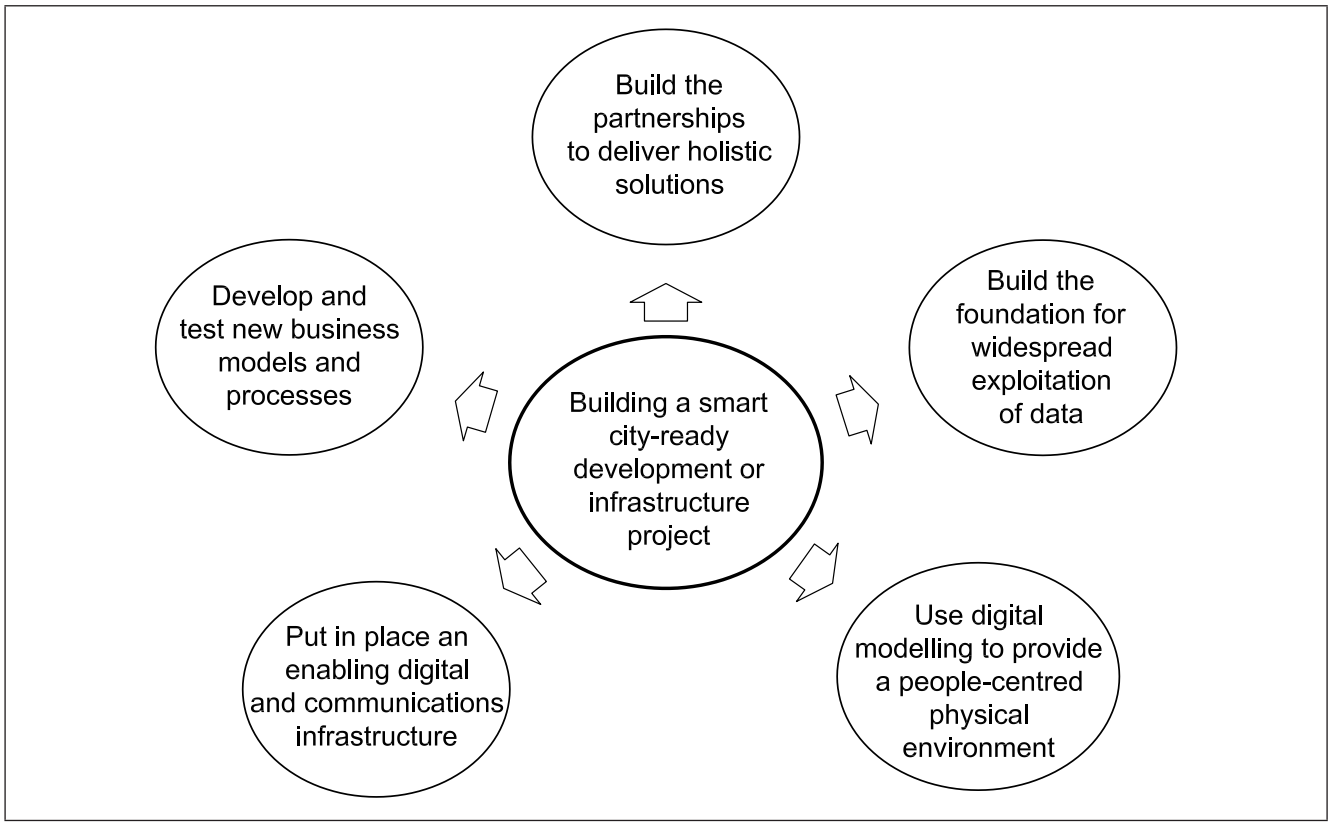
4.1 General

This clause is based on the realization that the game has changed in the planning context and incremental improvements no longer work. With the challenges that cities are facing at the present time, along with the enhanced role that technology can play in tackling those challenges, planners and city leaders need to grasp the new opportunities that smart city approaches can bring.

It provides guidance on the five key areas identified in **0.5** and shown in Figure 3, where the planning and development process can support smart city aspirations. This is not meant to be exhaustive – there are many other areas that could be covered. However, the issues here have been identified as particularly suitable to be addressed in the context of developments and infrastructure projects.

This clause provides information on their relevance to developments and infrastructure projects and recommends what steps need to be taken to ensure that the opportunities to use these as stepping stones to a smarter city are fully exploited.

Figure 3 **Five key areas for supporting smart city developments**



4.2 Build the partnerships to deliver holistic solutions

4.2.1 The context

The integration of city systems is central to smart city aspirations. City systems have traditionally been operated in silos and managed independently from each other, resulting in:

- the inability to support synergies between different services;
- the potential for changes in one system to inadvertently cause problems in another;
- unnecessary complexity and problems for the citizen as they try to navigate around the services they need to use;
- missed opportunities to use change to support place-making.

The complexity of individual city systems means that for the foreseeable future, each will continue to need to be managed by a separate specialist organization. However, closer collaboration between these organizations to allow holistic, citizen-centric service delivery, enabled by smart technology, is a key requirement for a smarter city.

Developments and infrastructure projects provide an excellent opportunity to begin this partnership-building work for the following reasons.

- A new development involves the installation of new infrastructures and the setting up of new systems to deliver services. This provides the opportunity to rethink how those systems can be delivered.
- There are many organizations that have a clear role within a new development, in terms of providing services to the citizens and businesses that will live or be based there. For example, utility companies, passenger transport and logistics companies, health and social care organizations.
- The new development allows for the opportunity of installing new digital and communications infrastructures to support a more integrated delivery.

So this provides an ideal opportunity for organizations providing services within the city to review how they might be able to work together in new ways to share infrastructure as appropriate and to collaborate more closely in delivering services.

Currently, co-ordination work on new developments is often left to the developer, who sets up one-to-one or one-to-few conversations with other stakeholders such as utility companies, neighbourhood committees, interested parties and funders. However, the developer only has a limited perspective in what could be achieved by such collaboration, and is focused on its own, largely short-term, commercial objectives.

4.2.2 The goals

The local authority could enable significant added value by bringing these individual conversations into a single forum, and by brokering public, private and community sector collaborations. In this way there would be the potential for existing services to be enhanced, new services to citizens and businesses to be developed and the opportunities for place-making to be identified.

This is particularly important in the case of major infrastructure projects where the benefits are only realized over a long period and by a number of different agencies. Here it is vital to find a way of sharing the costs among the service providers who would benefit from them.

For example, one project might be to fit out all of the homes in a development with a dedicated communications system to support the delivery of a range of

services from the public and private sector. This might enable the delivery of, for example, real-time bus information, energy management services, telecare and telehealth applications and personalized educational services.

Such an infrastructure could benefit a wide range of different public and private sector service providers, and therefore capital and ongoing revenue costs would need to be allocated in a fair and transparent way. It might be that a consortium could be set up, representing the main beneficiary agencies, to procure the infrastructure. Or it might be easier for one supplier to work with all the different agencies to develop a long-term service delivery contract with each and for the supplier to cover the up-front costs.

In either case, the local authority would have a key role, either in setting up the consortium, or in taking a brokerage role, in bringing all the agencies together.

Building partnerships between agencies in this way could build a strong foundation for the more strategic work of helping the city as a whole to become smarter.

4.2.3 The challenges

There are three key challenges here, which are as follows.

- *Taking an integrated view:* Currently, each of these agencies tends to take an independent view of what can be done and collaborate only as far as they consider it necessary.
- *Engaging leadership:* Even where partnerships can be put together to deliver change in a new development, it is possible that the working group would be made up of second-tier staff, with insufficient commitment from senior management.
- *Legacy systems:* It is also true that, even though developments and infrastructure projects provide the opportunity for identifying new ways of working, there is still the need to integrate these with the legacy organizational and technical systems that each agency will be using in the rest of the city.

It is therefore vital that each organization involved sees the work on a new development as a genuine opportunity for transformational challenge.

4.2.4 The recommendations

4.2.4.1 The city leadership should prepare an integrated service masterplan alongside their physical masterplan to capture the opportunities of digital technology and data to enable transformation. This should include contribution from stakeholders from the wider society.

4.2.4.2 The city leadership should identify all of the agencies that will have a role in building the initial infrastructure within a new development or in providing services to the citizens, businesses or visitors that will use it, as soon as a new area for development within the city is identified.

4.2.4.3 The city leadership should set up a working group as early as possible in the planning and development process, made up of key staff from each identified agency to identify synergies, opportunities for joint working and place-making and the smart technology that could support this. These should have objective and/or external facilitation.

4.2.4.4 External experts should be included in working groups, particularly those aiming to identify the role of technology in enabling service transformation.

4.2.4.5 The working group should identify actions related to the new development that provide practical benefit both to the agencies involved and to the citizen or business that they serve. These actions should be scalable up to a citywide level.

4.3 Build the foundation for widespread exploitation of data

4.3.1 The context

In the last two years, we have collected more data than in the entire history of human kind. It would be coincidence if we were using this in the most efficient and effective manner.

Increasingly, new developments and infrastructure projects have data collection and communications facilities built in. This is because digital technologies are increasingly being used to brief, design, procure, deliver and operate building environments, energy distribution, etc. The name given to this process is building information modelling (BIM).

Off-the-shelf solutions using proprietary technology can be cost-effective when only one particular use-model is being considered. However, standards-based technology that is interoperable with products and offerings from a range of suppliers could provide the flexibility to open up new service opportunities in the future.

What is BIM?

BIM describes an approach to the construction and ongoing management of built environment assets (buildings, roads, dams, etc.) that uses data and 3D geometry modelling to improve the design, construction and overall performance of those assets during their entire life cycle, and therefore to generate significant savings and productivity returns.

It uses an integrated suite of technologies and processes, centred around a component-based 3D representation of each element of the built environment asset.

The growing sophistication of this approach is often described in terms of four stages:

Level 0, really the precursor of BIM, is the use of computer aided design (CAD) to speed up and make more accurate the design of buildings and other assets within the built environment, and to allow different design approaches to be more easily compared and contrasted.

Level 1 builds on CAD by enabling the many different agencies involved in the design and construction of a building to work seamlessly together. It does this by enabling the digital models of the different aspects of the building used by the companies involved in its design, supply of components, and construction, to be linked together. This allows the effect of any changes in the physical design implemented by one stakeholder to be immediately seen by the other stakeholders on their own plans.

Level 2 allows data to be linked to the relevant individual components and areas within the plans. The visual representation of each component within a building could, for instance, have information embedded within it regarding the product and its placement, including, for instance, its material, specification, fire rating, U-value, fittings, finishes, costs, carbon content and any other specific requirements. This makes it far easier to explore options and determine the optimal solutions for complying with budgetary or other requirements.

Level 3 opens the concept of whole life analysis and optimization of single assets and then the integration over many assets to create either smart portfolios, cities, grids or strategies.

Smart city approaches in the built environment take BIM one step further, by aggregating data from individual buildings or campuses to allow new neighbourhoods to be better designed and existing ones to be better managed.

For more information on BIM see: www.bimtaskgroup.org

In order for BIM to be applied effectively to a project and be Level 2 compliant the client has to procure the required data from the supply chain as part of the procurement process. By doing this, significant savings on the build and lifetime costs of the project can be achieved.

A standards development programme is being managed by BSI, in partnership with the Government BIM task group, to enable these benefits. At the time of the publication, the relevant standards are PAS 1192-2 and PAS 1192-3, which can be obtained as free-to-download PDFs from the BSI website (http://shop.bsigroup.com/bim).

Requiring developers to use a BIM approach that complies with Level 2 and the BSI standards can make data available for reuse including aggregation across a neighbourhood, or even over a city, in order to support wider city planning and city management.

Providing a citywide data store, with data from different sources being accessible in a single place, with a common set of conditions for accessing and using it, could make useful data more easily available and thus more likely to be used.

In this way, open data can become a catalyst for open innovation, where citizens or SMEs are able to see opportunities for new and added value services that the agencies concerned might have missed.

4.3.2 The goal

For a city to be smarter, it is vital for as much useful data to be generated as possible and for that data to be provided in a useable format to whoever could use it for the benefit of the citizen or the city as a whole.

One way to do that would be to simply invite agencies to provide their data to a common store. However, there is comparatively little incentive for them to do this as there would be no clear benefit to them.

However, the opportunity of a new development is that it enables more data to be gathered longer term because of the comparatively low cost of, for example, installing sensor networks when the development is being built. There is a clearer benefit in agencies sharing their data in order to help the development as a whole to be better designed and for them to find it easier to deliver services within it.

So, the goal is to enable all relevant data generated within a development or infrastructure project to be made available so that it could be combined with other datasets and data streams, with appropriate safeguards, to help with the wider management of the development and to enable the development of new services to benefit the local community.

At the least, this would require that the data be transferable into open formats and that cost-effective arrangements are in place to allow that data to be quickly and easily available, when appropriate uses for it are identified.

Case study: Bringing a "Wow!" into city planning – How Gothenburg combined and visualized data

General

Issues of urban development are typically multi-dimensional and economic, social, cultural and ecological aspects all need to be dealt with in an integrated way. It is just as important to pay attention to scale as different areas of a city can show different characteristics.

In order to be able to address these multi-faceted problems, access to relevant data is vital. However, the key challenge is not so much a lack of data, but rather how to bring the data together in a way that allows the interconnectedness of these different dimensions to be illustrated, explained and explored.

Some years ago, the Urban Analysis and Statistics unit at the city office of Gothenburg, Sweden, concluded that the need for a common and holistic understanding could not be met by dense spreadsheets, lengthy reports or slides with three-bullet-point-summaries. A new approach was needed.

The result was a software tool, which offered a dynamic and intuitive visualization of large quantities of complex data, thus making it comprehensible, accessible and engaging. It introduced meaning to what previously was bland data.

One key use, for instance, was to put together an animated view of how the socioeconomic segregation between regions, municipalities and city districts varied over a time span of 15 years. The ability to relate two variables to each other, for instance, income and education, and animate them over time, proved a powerful way to help people truly understand what they already had heard so often before, but had not been able to see so clearly.

Visualization had a "wow" effect, and this was a common reaction no matter whether the audience was leading politicians or secondary school pupils. The tool became a powerful support for strategic discussions on sustainable development.

Benefits for Gothenburg

This therefore proved an exciting and useful tool for departments to share and combine data within the city. Data that before was confined at best to numerous spreadsheets is now easily available, compared and visualized online.

The revelation that occurred when Gothenburg mapped municipality and district income and education levels highlighted the severe issue of exclusion, and had a significant impact on decisions on transport policy and programmes, and on housing strategy.

Creating a common understanding and picture of this issue across departmental borders would have been much more difficult to achieve without the ability to combine and visualize the data.

Making use of the vast quantities of public data that the city collects in a more open and user-friendly format has offered Gothenburg a host of benefits – not least of which is the ability to engage the public in the process of developing their city.

This could provide a concrete reason for the city to make a clear commitment to a citywide, open data-sharing process to provide a context for this. It could also provide a reason to develop practical, citywide, commercial models to allow useful data to be made widely available, including managing the data in a way that ensures its integrity and compliance with data protection regulations.

It could also allow clear criteria to be developed as to the purposes for which the relevant data generated within a development could be made available, specifically including support for smart city aspirations such as:

- reducing energy consumption within that development, or in related areas of a city;
- supporting more efficient transport systems;
- encouraging greater use of cycling or walking.

In summary, development and infrastructure projects provide opportunities to trial the processes and the business models that would then enable these to be delivered citywide.

4.3.3 The challenges

There are four key challenges here, which are as follows.

- *Additional costs:* There are likely to be extra costs involved in ensuring that data being collected for internal use by an agency is done so in an open, standards-based format that would enable it to be made more widely available. This is particularly true if an agency is already using a proprietary system for collecting this data and would need to change or modify this for that particular development.
- *Data security and privacy:* There is also the challenge of maintaining data security and privacy in a way that will give confidence, both to those providing the data and to any individual to which that data relates.
- *Workable commercial arrangements:* Even when purely considering data related to a single development, putting together effective commercial arrangements for the use of data might not be an easy issue to solve for the following reasons.
  - The data would be generated and owned by a variety of different agencies and would need to be combined together, in many instances, in order to make it more widely useful. The income from that data would therefore need to be distributed fairly to a number of different agencies. Fair recompense to those data owners would need to reflect both the costs of making that data available and the value that the data would have to others, as part of the overall package.
  - Arrangements would need to take account of the difference between the use of data by large companies using proven business models, to that by small companies or citizen organizations using the data for innovative new applications, or specifically to benefit the citizen. The business models for opening up data, and the requirements to ensure that data is used legally and protected securely, would therefore need to reflect this range of potential customers of the data.
- *Data capture issues:* Another challenge is the lack of a consistent approach to capturing data at every scale in a city. Specifically the issue is the lack of integration between the data modelling processes that are used by city planners and those used by architects.

Architects typically use BIM whereas planners typically use geographic information systems (GIS). Some professionals still use neither and rely on non-digital means of analysis and visual representation.

The BIM systems used by architects were initially designed to handle data at the level of the building or small cluster of buildings, but these are now being developed to take in the neighbourhood or even potentially the city as a whole.

Planners use GIS systems to review issues such as transport plans and changing land values, by working from citywide viewpoints downwards, but often only to the three- or four-digit postcode levels.

This situation creates two challenges. First, the challenge of different professionals using different data modelling systems. Second, the challenge of the scale gap between the micro, building-focused scale of the architect and the macro, city-focused scale of the planner. What falls into this gap is the meso-scale of the urban street, where so much of the important social and economic life of the city occurs.

Clearly the requirement is for planners and architects to use a common approach and to fill the scale gap. This would allow for the development of a data modelling system that allows information regarding all of the buildings in a block to be brought together, then all the blocks in a neighbourhood to be brought together, then all the neighbourhoods within a district to be brought together and so on, thus allowing modelling to be done at every relevant level of scale.

This relates to a range of other data issues as well, such as asset management approaches and visualization tools.

The city therefore needs a consistent way of capturing data that will allow data regarding different key city issues to be brought together at every level of scale. Of course, all of these challenges are relevant to wider smart city aspirations and once they are solved for a particular development, the applications could be useful citywide.

4.3.4 The recommendations

4.3.4.1 The city leadership should make a clear commitment to a citywide, open data-sharing process.

4.3.4.2 The city leadership should work with key agencies to develop practical, citywide, commercial models to allow useful data to be made widely available. This includes managing the data in a way that ensures its integrity and compliance with data protection regulations.

4.3.4.3 Planning policy makers should ensure that all new developments use standards-based BIM methodologies (see **4.3.1**).

4.3.4.4 Planning policy makers should ensure that the way data is handled and used in the planning and design processes is completely scalable, so as to allow data integration and modelling to take place at every level, from the individual building through to citywide.

4.3.4.5 City leadership should agree criteria as to the purposes for which the data generated within a development may be made available. These should specifically include support for smart city aspirations.

4.3.4.6 Planning case officers and regeneration officers should specify open, standards-based data formats and technology interfaces and criteria for making data available in requirements for developers and in contracts with companies managing infrastructure on behalf of the local authority, once the city leadership have agreed criteria as to the purpose for which data generated within a development may be made available.

4.3.4.7 The city leadership should use the opportunities that are offered by developments and infrastructure projects to test the processes and the business models for this to enable subsequent citywide scale-up.

4.3.4.8 The city leadership should perform a data mapping exercise to develop a picture of the data landscape, including: sources, quality, ownership, temporal factors and sensitivity.

4.3.4.9 The city leadership should access social media data and undertake sentiment analysis as an input to the planning and development process and reinforce place-making.

4.3.4.10 The city leadership should run multi-stakeholder workshops to explore use cases where data is used to deliver different forms of value.

4.4 Use digital modelling to deliver a people-centred physical environment

4.4.1 The context

Many of the challenges that face cities today relate to the rapid changes that are taking place in city life and the need to anticipate these. These challenges include:

- changes in lifestyles and expectations of citizens;
- the shift in service delivery provision, both public and private; and
- changes in business models used to support urban development and the need for them to further adapt in order to accommodate digital opportunities.

As it is difficult to predict future needs accurately, flexibility is key and a range of scenarios need to be explored in the planning process.

It is important to remember that smart cities are about more than simply the use of technology. Planning developments and infrastructure projects in a way that promotes the exchange of ideas, knowledge and skills between citizens and businesses could help citizens and businesses to exploit smart technology applications provided in the area and help to create a sense of place.

The only way to do justice to the complexity of challenges cities face is to utilize the best data available for how the city works today, on how to design the physical environment in order to promote collaboration and innovation, and on how cities are likely to change. Only in this way can developments and infrastructure projects be designed in a cost-effective way that works for today, while supporting likely and beneficial options for the future.

Of course, data has always been used in the design of developments and infrastructure projects. For instance, demographic data has been used to identify the sort of housing that is likely to be attractive to local people. Surveys and other methods of collecting travel movement data have been used to understand how to design neighbourhoods in order to promote traffic and pedestrian flow.

However, up until recently, it has been expensive and time-consuming to conduct research, as this has normally involved large-scale surveys involving face-to-face interviews. These are not only expensive, but can be unreliable, in that people do not always report honestly on their behaviour.

Now, though, reliable information on people's actual behaviour can be gathered using, for instance, mobile phone data to discover how and when people move through an area and even, by inference, what mode of transport they use. This can be supplemented through a range of other sources, such as data from congestion charging zones, and smart ticketing systems such as Transport for London's Oyster card.

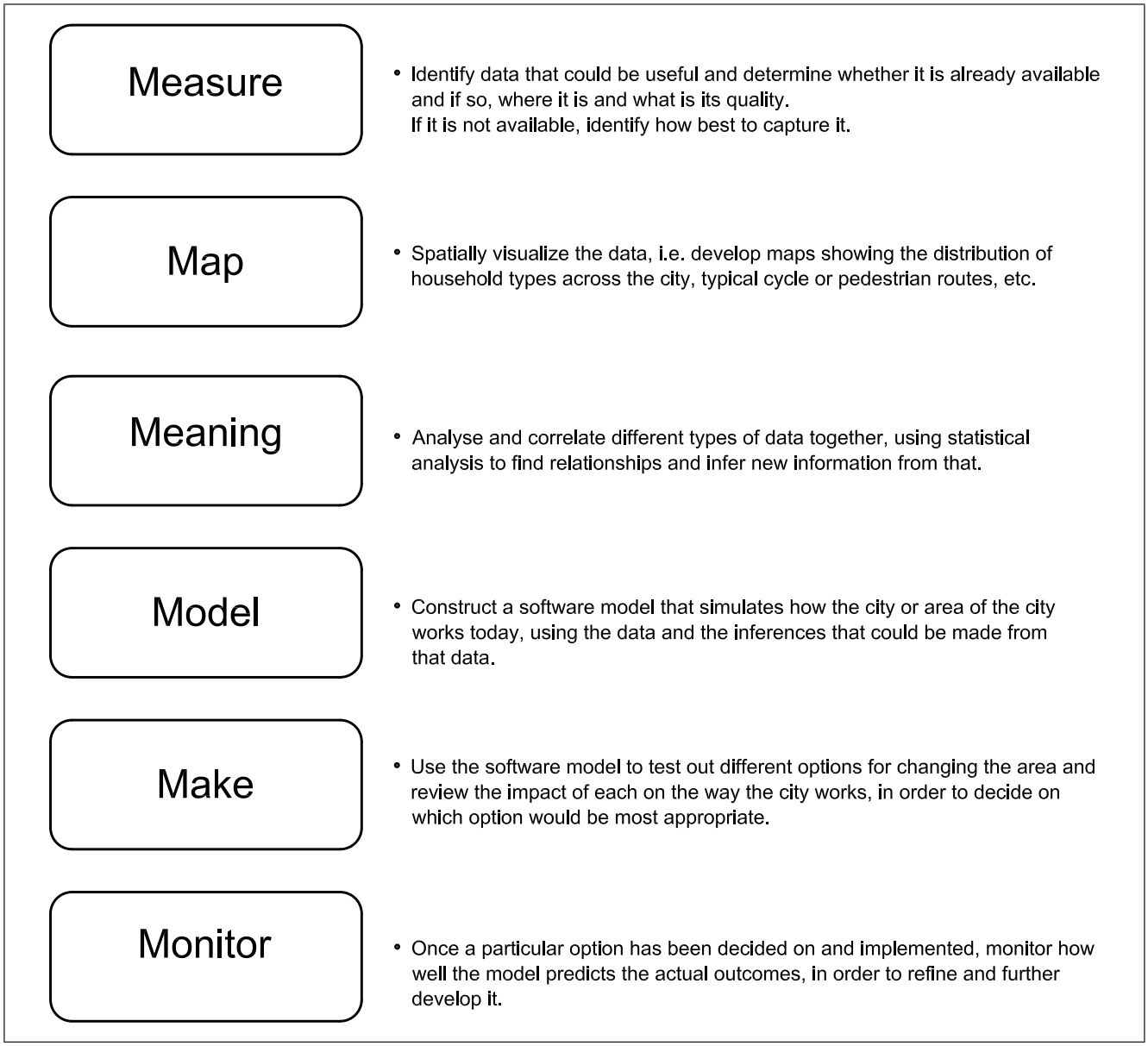
In fact, there is now an enormous amount of data available that can give insight into how people behave and that is potentially cheaper and easier to collect.

The RIBA/ARUP paper, *Designing with data: shaping our future cities* [2], identifies four main approaches to working with data for architects, urban designers and planners:

- using data to help designers meet user needs;
- experimentation and modelling using data;
- analysing data to improve local and national policy making and implementation; and
- using data to improve transparency to speed up development processes.

A more detailed way of looking at the process is shown in Figure 4. The BIM 3 strategy also offers a pragmatic solution to this challenge, identifying new market opportunities and contractual models.

Figure 4 **Methods for planning and designing with data**



Even though using digital technology to simply gather and visualize the data is valuable, the most important potential benefits that planners or developers want to achieve are likely to be the result of a number of different factors combined. For instance, property developers and planners are interested in increasing land value and this will be based on a combination of a number of different factors, for instance low carbon, low crime, good schools, and convenient transport links.

A model is therefore needed to understand the relative roles of each of these factors and thus to be able to weigh up the pros and cons of various options in delivering the outputs that are important to the planners and developers.

Differences in the ways planning and development can use digital modelling

Planning is about two issues:

- location;
- how different locations connect together.

In other words, it is about deciding how things are organized within a particular space and how spaces are connected together. To be effective, therefore, planning needs to be based on how people behave and how they move and interact and might be interrupted within a specific space.

This is a key area where digital modelling can help.

Development, on the other hand, is about how the market affects the implementation of planning.

In other words, the key question is how financially attractive it is for developers to build particular types of buildings within a particular area. Markets, of course change over time with, for instance, sometimes office developments being more profitable to build and sometimes residential. These changes might well affect the order and timescales in which parts of a development can be built and the quality of construction.

Digital modelling has a key role here as well, in allowing the various consequences of changing the order of construction to be better understood and to allow the most practical options to be identified.

4.4.2 The goals

Local authorities already have a great deal of data available, the goal is to use it effectively. Using data effectively to design places, not just individual buildings, can result in developments that not only work better for the citizen but also benefit the local economy.

To promote interaction between citizens, new developments and infrastructure projects could be equipped with spaces and buildings for this purpose and focused efforts made from the time that the first citizens and businesses move in to support them in benefiting from those facilities.

Data about the way people move through spaces and what visual clues can help to guide them could, for instance, make it easier to direct potential customers towards retail areas offering products and services they are interested in. This could make such areas more profitable and, in turn, lead indirectly to greater income for both local authorities and developers. Being able to provide evidence that, for instance, retail developments could attract large numbers of visits from potential customers, could enable the developers to sell or rent out their developments at greater profit.

Because of the benefits to both local authorities and developers, local authorities are in a position to ask more of private sector developers. Local authorities could

therefore also not only use the best analytics themselves but demand the same of the private sector.

It would be helpful if the local authority develops its own model of how the city, or a particular area of the city, is working at the moment. It could then test different designs from developers to evaluate their likely impact on the wider city and use that to make evidence-based planning decisions and as grounds to negotiate design changes with developers.

> A good example is the model that is being developed by the City of London to describe pedestrian movement within the city in a way that will enable it to test how particular development proposals would affect this.
>
> This is a good start and it could be extended further. Models that enable a better understanding of pedestrian movement in the city would be helpful in themselves. However, for instance, when modelling design changes to affect pedestrian traffic, it would also be important to understand the knock-on effects on, for instance, bus travel and retail trade in the area.
>
> This is why sophisticated models are needed. Fortunately a lot of experience has been gained in recent years in the methods and tools to develop models that are comprehensive enough to enable the overall impacts of different options to be thoroughly and reliably tested against each other.

The use of digital modelling could enable the following.

- More accurate forecasts of movement patterns – where, when, why and how people will travel.
- Better land use plans, e.g. enabling shops and retail areas to be located in places where the appropriate people are moving through using an appropriate form of transport to make it easy for them to attract potential customers.
- Safety issues to be anticipated, e.g. lonely walkways, blind corners, areas that are cut off and might end up as ghettos.
- More accurate predictions of the impact of development proposals on the value of the land; in other words, the ability to predict which areas are going to increase in value and by how much. This is potentially important because tax increment financing could allow local authorities to borrow the money needed to support a new development on the basis of the increased land values and therefore the increased taxes that would result. The use of reliable metrics and tools could allow projected land value to be based on real evidence and not simply on the opinions of consultants.
- More accurate carbon impact modelling, which is an increasingly important part of planning.
- An understanding of why assets, environments and people behave the way they do.
- Identification of strategies to improve the performance of assets, environments and people.

Another benefit of the use of digital modelling in planning is that digitally-enabled visualization could form a key part of engaging non-technical stakeholders in the consultation process, provided the developers submit their digital design to the local authority in a format that enables it to be used in the creation of a digital map of the city.

It would also be helpful for data recorded for use in urban planning and design, whether by planners or developers and the consultants that work with them, to be made widely available. This would both allow the impact of the development

on the way the wider city works to be assessed from a variety of perspectives, and would also provide the basis for ongoing monitoring on how accurate the modelling is in predicting the ways the development will be used. The data could be displayed in a number of ways such as using a GIS platform, internet-based platform and/or a city operating system.

4.4.3 The challenges

There are five key challenges here, which are as follows.

- *Identification of useful data:* While the benefits of greater use of data in urban planning and design are clear, work still needs to be undertaken in identifying what data is most useful, how it could be most easily collected and made available and what exactly it could be used for. There is a need for local authority planning case officers, developers and masterplanners to work together to make this happen. The first step needs to be to identify what questions need to be answered.
- *Good practice is often ignored:* In terms of using the data effectively, there is a great deal of advice available. For example, the Homes and Communities Agency's *Urban Design Compendium* [3] published in 2000 is full of principles about how to plan places. However, such advice has largely not been followed and opportunities for place-making have been missed.
- *Lack of software tools:* One reason for this is that, partly because of the limited use of data in the past, few software tools are available to enable planners and designers to use the data effectively and the tools that do exist are often expensive. In turn, because few designers and planners are using them, these tools have a low profile and many potential users are not aware of what is available.
- *Lack of appreciation of the potential of digital design:* Another reason is that, while all successful architects and planners use computers to help them in their work, many use them simply to help them do what they do already. Comparatively few realize that digital technology can also enable them to design in a different and more effective and creative way.

  Of course, this is changing as the younger generation of architects and planners, who have had experience of a more interactive relationship with technology, become more influential in their professions.
- *Too narrow a focus on cashflow:* A further challenge is that developers need to focus on their cashflow and so normally build all or most of the residential or business units before starting on community facilities. It is true that there is no value in building coffee shops and community facilities before there are sufficient numbers of people in the neighbourhood to use them. However, it is important to ensure that there are properly supported spaces provided, that encourage the building of the local community, as the new residents or businesses start to move in.

  For developers, the message is that the provision of such facilities will make the area significantly more attractive to potential purchasers.

4.4.4 The recommendations

4.4.4.1 Planning policy makers should put in place policies that drive developers to use a digital modelling process.

4.4.4.2 Planning case officers should work together with developers and masterplanners to identify what data would be useful to them, where they could access that data and how they could ensure its accuracy.

4.4.4.3 Planning policy makers should ensure that the way data is handled and used in the planning and design processes is completely scalable, so as to allow data integration and modelling to take place at every level, from the individual building through to citywide.

4.4.4.4 Planning policy makers should consider developing their own model of how the city, or the particular area of the city, is working at the moment so that they can use that to test proposals from developers.

4.4.4.5 Planning case officers, regeneration officers and developers should use digital modelling in communicating via online, social media and other technologies to encourage the widest engagement with the plans by decision-makers, local and business communities and citizens.

4.4.4.6 Planning case officers and regeneration officers should require developers to submit their digital design to the local authority in a format that can be used in the creation of a digital model of the city.

4.4.4.7 Planning policy makers and developers and the consultants that work with them should make data recorded for use in urban planning and design more widely available as a basis for analysis. This could be achieved in a number of ways such as using a GIS platform, an internet-based platform and/or a city operating system.

4.4.4.8 Developers should take into account the need for spaces for people to communicate, exchanges ideas and collaborate, all of which are important ingredients for place-making, in their digital modelling and design. Appropriate spaces should be available from the earliest stages of development. These might include community and leisure centres, but the role of coffee shops and pubs is also important.

4.5 Put in place an enabling digital and communications infrastructure

4.5.1 The context

A smart city harnesses the power of data and the opportunities of system automation to help simplify city management and make it more effective. This requires sensors to be embedded around the city infrastructure to collect data, and actuators to use the information from those sensors to help automatically manage key parts of city systems. It also requires a ubiquitous wired and wireless communications system, able to take data from the sensors to where it can be utilized.

However, this is rarely considered in the design and implementation of developments and infrastructure projects. For instance, even though the quality of broadband provision is increasingly important to residential and business customers, there are still developments being built where the quality of broadband provided is poor.

Similarly, many development and infrastructure projects do not take into account the fact that households and businesses have an increasing range of devices that rely on good connectivity and do not include in-building wired networking to support data management around the building. Even less frequently is energy and environment management equipment included in new homes and buildings.

Even where these opportunities to add value to the homes and business premises are taken into account, and good connectivity is provided throughout the development, it is rare for that connectivity to be extended to support neighbourhood wireless access points and sensor networks, or to support traffic management and CCTV systems.

Digging and retrofitting communications networks can represent anything up to 80% of the cost of installation, so it is likely to be cost-effective to ensure that adequate provision for these potential additional services is built into the development at the construction stage.

The provision of a good in-home and to-the-home communications infrastructure, opens up the opportunity for a range of customized services to be delivered to the home. This offers the potential for a wider range of uses for these buildings and therefore a longer service life, thus contributing to the sustainability of the area.

4.5.2 The goals

To support smart city aspirations, residential and business developments need to be equipped throughout with wired and wireless connectivity, to the highest current standards, and with the capacity to expand to meet any foreseeable growth in those standards.

Communications networks that are installed to provide high-speed broadband to homes or business premises need to be designed to also support existing and potential smart city applications. This might include, for instance, ensuring that the network could be extended to connect to street furniture to support the installation of sensors and wireless access points. It might also include the provision of a second line into the home, dedicated to the delivery of public and private sector services such as telecare, energy management and home security.

Fitting new and refurbished buildings with accessible ducting and equipment to support not only current but anticipated needs for in-home data networks for entertainment, homeworking and home environment management, could support smart city services in the future without the need to retrofit.

The Department for Communities and Local Government publication, *Data ducting infrastructure for new homes: guidance note* [4] provides further guidance on the

laying of ducting on development sites and within dwellings for the provision of data services. It does not, however, cover the additional functionality required to support many smart city applications.

4.5.3 The challenges

There are four key challenges here, which are as follows.

- *Added complexity and risk:* On the whole, developers are fairly conservative and tend to rely on tried and tested business models. Understandably, they can be averse to adding any complexity into established processes. Adding a smart city-ready communications infrastructure into a development, while offering advantages, also brings added complexity and risk.

  The business case for installation of multi-functional communications networks is complicated by the fact that it depends on merging the case for provision of broadband to the home or business with the case for the provision of smart city services. This adds complexity and risk to the process.

  Also, while the business case for the provision of broadband to the home or business is increasingly recognized, that for the installation of in-home networking is less so.

- *Inappropriate technology choices:* Increasingly developers are incorporating technology into new buildings. However, these are likely to be narrowly focused on enabling them to charge higher prices to purchasers and the technology choices made might not be appropriate for the wider aims of the city. They may also not take into consideration the potential of being able to scale up to meet increasing requirements in the future.

- *Lack of trained installers:* Although the installation of in-home networking is comparatively simple and could be carried out, for instance, by electricians, few electricians have been trained on how to do this and so more expensive engineers often need to be employed on this work, making it unnecessarily costly.

- *The infrastructure needs to be managed:* In order for the approach of installing a communications infrastructure that anticipates future needs to be successful, management arrangements need to be set up for any ducting or spaces and equipment provided in order to support potential smart city services.

4.5.4 The recommendations

4.5.4.1 The city leadership should commission a study into what ICT infrastructure is needed citywide to underpin the move towards becoming a smart city and to map out existing ICT system resources across the city. This would identify those resources with the greatest potential for reuse, identify gaps and provide the foundation for a strategy to fill them.

4.5.4.2 The city leadership should set up governance processes and usage policies for ICT infrastructure, aimed at maximizing asset reuse by city partners.

4.5.4.3 The city leadership should set up processes to maintain and make available records of where the necessary infrastructure is, and what it is, in an acceptable open data GIS format. This information should be made available to any agency that might be able to utilize it for the benefit of the city and the citizen.

4.5.4.4 Planning case officers and regeneration officers should begin negotiations with developers early on to ensure that standards-based equipment and communications infrastructure needed to support potential smart city products and services, or at least ducting and spaces for these, are planned for and installed at construction stage.

4.5.4.5 Planning case officers and regeneration officers should require developers to incorporate and submit a digital infrastructure specification, as they do for other utilities. They should require developers to explain their rationale for technology choice, in order to assist the assessment by planning case officers and regeneration officers. Any proposed development or infrastructure project should demonstrate how it has taken into account the sustainability, scalability and resilience of technology infrastructure as a key asset over an extended timeframe.

4.5.4.6 Planning case officers and regeneration officers should take an enabling role in supporting the long-term management of any such infrastructure. This includes agreeing with the developer or installer how it is to be owned, procured, managed and potentially transferred in order to allow and facilitate sharing and joint usage. It also includes the general criteria for how it is to be used, the charging arrangements for use and arrangements for dispute resolution, as well as how best to maintain access for competitors and what arrangements need to be made to allow for emerging technologies.

4.6 Develop and test new business models and processes

4.6.1 The context

Cities today face many challenges, requiring urgent solutions, with limited resources to deal with them.

One example is transport, which is a challenge common to virtually all cities. Typically the challenges that are faced include the following.

- *Congestion and delays*. This results in not only time being wasted, but also in frustration and stress for the traveller.
- *Expensive infrastructure solutions*. The only way to cope with the congestion and delays seems to be to build new roads, or metro or tramlines, all of which take time to build and are expensive.
- *Pollution and a high carbon footprint*. This is due to large numbers of private cars being used to transport one or two individuals.

Clearly traditional solutions are no longer able to deal effectively with city problems, as they become increasingly complex and inter-related.

Another challenge is the financial constraints that cities are under, which make it difficult for cities to make the upfront investments required to deal with the long-term issues they face.

Another challenge is that existing procurement processes used by local authorities are often too rigid. When the local authority is acting as procurer for infrastructure, such as improvements to public realm, street lighting and major refurbishment programmes, the procurement processes are usually managed by one specific part of the local authority, with a brief to achieve specific objectives at the least possible cost.

> One example of the consequences of a lack of integration is a city where the council is working with a mobile phone company to support the roll-out of 4G by placing small wireless cells on lamp posts.
>
> However, management of the streetlights has previously been outsourced; the lights go off at a certain time and the contractors see no benefit in keeping the power on to enable the 4G services.

There is a great need therefore to review these processes and to integrate these procurements with smart city planning, in the expectation of identifying opportunities to provide wider smart city benefits at little extra cost.

It is clear that the only way to tackle these challenges is to identify transformational solutions, along with transformational business models to allow cities to pay for them.

4.6.2 The goals

One goal is to identify lower cost solutions that are quicker to implement. For instance, there are other ways to tackle road congestion, transport delays and pollution/high carbon footprint, apart from building new transport infrastructure. These include, for example:

- increasing the use of public transport, by providing travellers with better information regarding their transport options, and more reliable expectations regarding journey times;
- shifting to better management across multiple modes;
- providing for alternative, cleaner and greener modes of transport.

Putting together a portfolio of such smart city projects could eliminate the need for expensive new relief roads, while providing a much speedier solution.

Digital solutions can be speedy to implement, low-cost and provide added benefits. For instance, developments and infrastructure projects with smartness embedded into them could provide citizens with the opportunity to be better engaged within the city and have the opportunity to socially innovate.

When the local authority contracts out services related to the management of a development or infrastructure project, the contracts with service providers need to be set up to enable additional functionality to be added later at a transparent cost. For example, contracts for the provision and maintenance of street lighting making provision for the potential extension of the contract to cover the provision of wireless broadband, or air quality and movement sensors later on.

Management systems for developments and infrastructure projects also need to be flexible in order to cope with changing demands. For instance, in the past some residential developments were provided with community heating systems, but the systems were not set up to allow for individual billing. Communal billing no longer meets with the aspirations of the current residents. Because provision was not made for individual billing originally, it is difficult now to offer this service.

Other key goals in this area include:

- developing and using procurement processes that allow the bidders to propose added value solutions;
- ensuring that contracts are written in a way that allows easy re-negotiation if additional services are identified, or if there is a need to deliver those services in a different way.

Another goal is to identify new business models that offer lower upfront costs and risks, for example:

- using long-term service revenues to pay for the capital costs of necessary infrastructure provision;
- using the increases in land value as a result of the smart facilities that will be offered to pay for the infrastructure.

New business models could provide win-win solutions, where cities get better services for less and industry gets the opportunity to provide additional services. As an example, a contract could be let for the construction of a new neighbourhood, and for providing services to the residents and businesses over a thirty-year period. Such a contract would incentivize the developer to include smart technology in order to provide lower costs and more effective services.

The level of payment for the service delivery aspect of the contract could be set at a figure slightly lower than existing costs, but where the developer and the local authority share any savings gained beyond that level.

For the local authority this could potentially provide significant cost savings, without any upfront costs. For the developer this would provide a dependable source of income over a long period of time to help balance out the risks and uncertainties of bidding for construction contracts in a fluctuating market.

In other words, when it comes to smart city products and services, it might be necessary to explore new business models as part of the planning process in order to ensure viability.

Case study: Digital by default – process and plans

An example of a new approach to large-scale developments can be found in the $36 billion Suape investment cluster in Brazil led through a strategic alliance between Convida (the developer), Living PlanIT (technology platform provider and urban development advisor), the state of Pernambuco, Brazil and UK Trade & Investment. The developments include both large scale mixed use communities (125 000 residents+) and industrial logistics complexes (combined 374 million square feet).

Convida has agreed to adopt PAS 181:2014, because of the value it sees in the following.

- A holistic approach, covering the economic, social, environmental and technical factors in business models, methodology, project lifecycle design and implementation and specifically the architecture of a multi-faceted infrastructure to link buildings, public realm, mobility and the territorial management of all conceivable resources.
- The new, transformational, scalable and replicable business models that are made possible by this approach and the use of multi-faceted infrastructure and data simulation and modelling. Use of an open standards computing, storage, communications, sensing and control platform to provide the basis for enhanced machine learning (how to act upon what is sensed), diversification of analytics (sensing and control creates diversified source of urban data and significant scale), and diversification of applications (leveraging source and analysed data) further enables highly efficient regional and community management.

Convida has designed, and is building and managing the infrastructure for the whole area, while other developers are responsible for individual buildings or clusters. This allows synergies between the different utilities to be exploited, for instance to use water to store heat or energy. It also provides economies of scale, for instance allowing building management systems to be hosted centrally.

The inherent efficiencies of the model is resulting in:

- reduction in capital expenditure, which then allows incremental development – more square metres to be monetized;
- reduction in operational expenditure for the developer, operators, tenants and residents;
- increases in net operating income and diversification of revenue streams;
- increases in the value of the underlying assets and reduction in capital rates;
- the development of supply chains that support development and create employment;
- the infrastructure becoming a platform for urban innovation, promoting ecosystems of collaborators that invent, perfect, and deploy solutions on the platform and export of these solutions to world markets.

4.6.3 The challenges

There is one key challenge here, which is as follows.

The added complexity: Taking a wider view of individual city systems that sees them within the context of smart city aspirations adds significant complexity to the planning process. Tackling problems from a smart city perspective means looking at the implications of, for instance, how changes to the physical layout of

areas of the city and the look and feel of place, impacts on economic development (for instance the accessibility of small businesses in the high street), on air quality and long-term health outcomes.

Thus planners are faced with more complex and uncertain circumstances to design for. The challenges are not only physical; they are also substantially behavioural.

However, with the increasing sophistication of smart city solutions and the ability for increasingly accurate modelling to quantify the risks and rewards, it is becoming feasible for private sector providers to have a much greater certainty regarding the costs of every aspect of service delivery.

4.6.4 The recommendations

4.6.4.1 The city leadership should ensure that the necessary in-house expertise and capacity to assist in embedding smart objectives into the business case is developed, by encouraging officers to undertake training in this area and to keep in touch with best practice globally.

4.6.4.2 Planning policy makers should take into account new and smart solutions, rather than simply following traditional options. They should be able to demonstrate in their plans that they have not only provided for traditional demands, but also considered those that might be created by online business models and other social technologies.

4.6.4.3 The city leadership should ensure that the local authority develops procurement processes that allow it opportunity to work with the supplier to seek to identify new business opportunities that could enhance the commercial case for additional functionality.

4.6.4.4 The city leadership should ensure that when the local authority contracts out services related to the management of a development or infrastructure project, the contracts with service providers should be set up to enable additional functionality to be added later at a fair and transparent cost.

4.6.4.5 Planning case officers and regeneration officers should ensure that when management systems are put in place for developments and infrastructure projects, the systems are flexible enough to cope with changing demands.

4.6.4.6 Planning case officers and regeneration officers should ensure that, when procuring outside agencies to help with the delivery of services, as many services as possible should be bundled together, as this will allow more potential for transformational solutions.

5 Planning and development process and its role in creating smarter cities

5.1 General

In order for the planning and development process to effectively support smart city aspirations, there needs to be a golden thread that leads all the way from the requirements of a particular development or a neighbourhood plan up to the highest level strategic plan.

This clause provides recommendations for each stage of the planning development process, in order to ensure that the key opportunities are not missed.

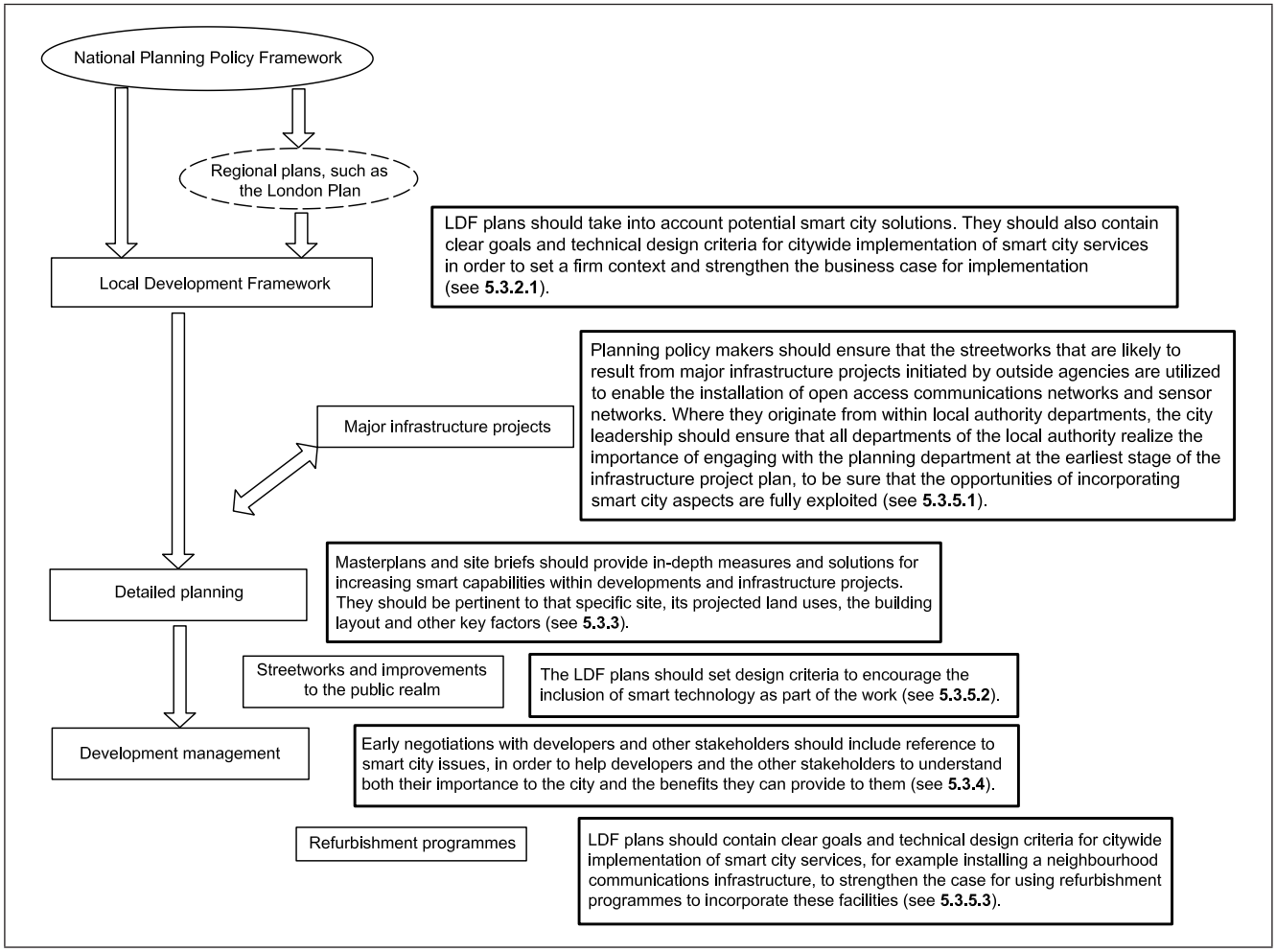
5.2 Stages

In general terms, the stages of the planning and development process (as set out in Figure 5) are:

- developing the local development framework (LDF), which needs to be done in conformance with the *National Planning Policy Framework* (NPPF) [5] and any regional planning documents;
- developing further documents such as supplementary planning documents (SPDs), masterplans and planning briefs;
- development management, i.e. negotiations with developers and statutory consultations in relation to developments and infrastructure projects in the city.

A summary of key recommendations for each stage of the planning and development process is given in Figure 5.

Figure 5 **Planning and development process – key recommendations**



For major developments, the planning and development process can take a long time and it is therefore necessary to monitor innovations in smart city technologies and practice in order to ensure that the latest standards are included both when these developments are ready to start and also as they progress.

In addition, there are number of infrastructure-related projects that are initiated outside the local authority planning process, including the following.

- Major infrastructure projects, such as new railway lines or roads. These may be the result of national government decisions, or may be originated by another department within the local authority. Here the local authority planning department works with the agency planning the new infrastructure to ensure that, for instance, station design is appropriate for the local area and that pedestrian and other local feeder transport links are properly integrated within the overall plans for the neighbourhood.
- Streetworks and improvements to the public realm are generally included within local masterplans and planning briefs but may also be part of a citywide renewal of infrastructure, or major utility works, and therefore not part of the conventional city planning and development process.
- Refurbishment programmes are usually initiated by a social or private landlord. However, where the LDF includes citywide goals, these can influence the way the refurbishment programme is carried out.

5.3 What can be done at each stage of the planning and development process

5.3.1 General

This subclause gives recommendations for each stage of the planning and development process. A detailed description of the process is provided at Annex C.

5.3.2 Local development framework recommendations

5.3.2.1 Citywide

Consideration of smart city solutions: The LDF should take into consideration the potential benefits of emerging smart city solutions in the way the key development areas within the city are designed. Statements and aspirations should be included to encourage developers to make developments smart city-ready and identify potential smart measures, in their broadest sense, at an early stage.

Inclusion of clear goals and technical design criteria: Planning policy makers should set overall goals and standards and management systems relating to the smart city aspirations of the city that provide clarity and certainty for developers. For instance, where a city sets clear aims and process regarding facilitating a citywide, open-access high-speed data communications network or setting up and managing a citywide open data store, this makes it clear to developers what is required and makes it easier for them to identify the business case.

5.3.2.2 Area wide

The other opportunity at this stage relates to areas of the city where there is a planning framework to manage change that can be written in a way that ensures that developments and infrastructure projects are built as smart city-ready.

Land use-specific guidance: Relevant documents, i.e. at the development plan document (DPD) level, should provide more in-depth identification of those smart measures identified in the core strategy. The land allocations for areas should indicate the sorts of approaches required for smart city implementation. For example, where land is allocated for a dense commercial office environment, then allowance needs to be made for the potential opportunities of smart grid

to manage the electricity supply with more granularity, the range of IT provisions that might be required by business, both now and in the future, and even building orientation to enable smarter energy resilience.

However, such documents are guidance and not mandatory, so while they provide a way to encourage good practice, they cannot be enforced.

Use digital modelling to identify options: One other challenge here is that the implementation timescales are not always completely in the hands of the local authority. While the strategic plan sets the context for what sort of new buildings can be built and where, there is a dependency on developers coming forward with proposals before anything can be built, and that depends partly on the state of the market at the time. Planning policy makers should therefore develop area plans using digital modelling to identify the various possible implementation options, making it feasible for each individual stage to be built so as to play its part in the overall progress of the area towards smartness.

5.3.3 Detailed planning stages recommendations

Site-specific guidance: Planning policy makers should take the opportunity to include more detailed smart city guidance at this stage, in line with the strategy set out at the LDF stage, but including issues particular to the local context.

Masterplans and site briefs should provide in-depth measures and solutions for increasing smart capabilities within developments and infrastructure projects. They should be pertinent to that specific site, its projected land uses, the building layout and other key factors.

5.3.4 Development management recommendations

Early engagement: Negotiations with developers regarding smart city aspects should begin early in the process to gain their full cooperation. If smart city issues are only addressed at the final stage, when the developer is applying for planning permission, the process then becomes simply a legal one, focused on meeting requirements and regulations. With a well thought-out, published place-based/soft infrastructure objective, early engagement with developers can lead to a shared vision for the development and allow sensible requirements for smart approaches to be discussed and brought into a scheme. However, even here, market conditions may adversely affect the developer's appetite for incorporating smart city concepts or the timescale for implementing them.

There are many factors which limit the ability of the local authority to exert pressure on developers regarding the incorporation of smart city options. Where the local authority owns the land, it does have significantly greater influence as, in those cases, the local authority can either become the developer (or project manager in the case of infrastructure) or sell the land subject to smart city conditions. Where land is owned privately, and the local authority considers it essential, compulsory purchase orders can be used to spur smart city development and thus allow the local authority to have greater influence.

Building a shared understanding: Early negotiations with developers and other stakeholders should therefore include reference to smart city issues in order to help developers and the other stakeholders to understand both their importance to the city and the benefits they can provide to them. Those benefits could include being able to brand the development as smart, and thus increasing the value of the development. Gaining agreement early on, or maybe even as part of a planning performance agreement, could help ensure that there is no attempt to water down the arrangements over the course of the development and that any issues about implementation can be more easily solved.

Signposting this PD: The local authority should have a proactive relationship with the developers regarding these issues and it is suggested that they signpost this PD to them for early consideration, in order to guide their designs and proposals.

Engaging with all stakeholders: It is also important to remember that other stakeholders have a role in implementing smart city infrastructure and therefore need to be involved early on. For instance, utility companies need to undertake work on sites and public spaces. Early negotiations should take place with them as well to ensure that they incorporate provisions for smart city objectives in their work as far as possible.

5.3.5 Opportunities of infrastructure projects outside the planning and development process

5.3.5.1 Major infrastructure projects recommendations

Opportunity to install new infrastructure: While many major infrastructure projects are not initiated by the city council but by outside agencies, there is a need for them to be embedded into the wider neighbourhood and therefore an opportunity for them to act as a catalyst of change. Planning policy makers should ensure that the streetworks that are likely to result from such projects are utilized to enable the installation of open access communications networks and sensor networks.

Early engagement of the planning department in all new infrastructure plans: Even when significant infrastructure projects are initiated by the local authority, they might not necessarily be managed within the planning process, but be driven by other departments of the council. For instance the economic development department might gain funding to re-route road systems to support local businesses in an area and may finalize many of the details before referring it to the planning department. Because of this, the city leadership should ensure that all departments of the local authority realize the importance of engaging with the planning department at the earliest stage of the infrastructure project plan, to be sure that the opportunities of incorporating smart city aspects are fully exploited.

5.3.5.2 Streetworks and improvements to the public realm recommendations

Opportunity to install new infrastructure: In many cases, these could facilitate the low-cost installation of connectivity, sensors and actuators, as part of the wider work.

The LDF plans should therefore set design criteria to encourage the inclusion of smart technology as part of the work.

5.3.5.3 Refurbishment programmes recommendations

Opportunity to install new infrastructure: Here, the focus is on the internal refurbishment of the buildings, and this might seem to limit the opportunities to add smartness to the environment. However, because a refurbishment programme effectively allows large numbers of buildings to be aggregated together, it does provide the opportunity for the provision of some smart city projects and services.

For instance, the fact that potentially large numbers of buildings in a particular area are being worked on, could make it cost effective to install a neighbourhood communications infrastructure, as well as including smart home/smart building systems within each of the buildings. The individual smart home/smart building systems could then be linked, to enable appropriate data from the individual buildings to be brought together, to support better neighbourhood management.

For refurbishment programmes, the LDF plans should contain clear goals and technical design criteria for citywide implementation of smart city services, for example installing a neighbourhood communications infrastructure, to strengthen the case for using refurbishment programmes to incorporate these facilities.

6 Equipping the local authority

6.1 General

The case has been made that smart city approaches need to have a key role in the planning and development process and that the planning and development process needs to play a key role in the city council's plans for ensuring that the city becomes smarter.

In order for this to happen, planning policy makers, planning case officers and regeneration officers need to have ready access to the city leadership's smart city plans and access to expert advice. City leadership, and, in particular, the political leadership, needs to be briefed as to the new implications that smart city approaches bring to the planning and development process.

6.2 Recommendations

6.2.1 Making it easy for planning and regeneration officers to discover smart city plans

Planning policy makers, planning case officers and regeneration officers need access to the smart city plans of other parts of the local authority so that they can understand how these might link with the plans for developments and infrastructure projects. If this is not available, it can lead to a lack of overall perspective that would be a blockage to rolling out smart city applications.

Within the local authority there should be at least one officer whose role it is to maintain a clear overview of all smart city activity within the city, and to liaise between the different initiatives to ensure a coherent and integrated programme.

Such an officer should ensure that they communicate on a regular basis with the key people in the planning and regeneration departments of the council so that all opportunities provided by new development and infrastructure projects can be embedded in the planning and development process.

6.2.2 Access to expert advice

Planning policy makers, planning case officers and regeneration officers need to be able to access the relevant expertise to understand the opportunities and constraints offered by digital technology.

The city leadership, therefore, should ensure that planning policy makers, planning case officers and regeneration officers have clear guidelines, political support and an effective policy mechanism to enable them to ensure that developments are smart city-ready. They should have access to independent, well-briefed technology experts to be able to understand what is required, and have the tools and information to be able to discuss issues professionally with developers.

It would be helpful to develop a mechanism for cities to work together to develop effective ways to share knowledge and support collaboration and the co-production of new projects and services, so that each city is not having to reinvent the wheel.

Not only would such collaboration help support better planning decisions but it would also help build a sense of momentum and make it easier for local authorities to adopt these new ways of doing things and for developers to begin to see them as the normal way that things are done.

6.2.3 Ensuring political understanding and commitment

The city leadership should hold smart city awareness sessions for elected members. These sessions should cover the opportunities offered by developments and infrastructure projects.

It is vital that the elected members of the local authority understand the importance of the move towards making their city smarter and the key role that developments and infrastructure projects can play in this.

This is because many of these recommendations involve a certain amount of upfront investment, either from the city council or from the developers, in order to gain longer term benefits.

Elected members are responsible for ensuring that public resources are spent in the most effective way and that sensible and practical requirements are placed on developers within the planning and development process. They therefore need to be able to accurately weigh up the potential benefits of these investments against other ways that the funding could be spent or against other requirements that could be placed on developers.

Of course, in general, elected members need to be driving the move towards their city becoming smarter. What is important is that this is not left to just one or two champions within the city council, but that all elected members understand the relevance of their city becoming smarter to their particular area of responsibility.

7 Conclusion

7.1 General

This PD covers a range of practical steps that can help ensure that development and infrastructure projects can support the city in its path to become smarter.

Some of the key messages covered are summarized in **7.2** to **7.7**. Smart city activities relevant to this PD are listed at Annex D.

7.2 Place-making

Smart city approaches can enhance the place-making agenda. The use of data and smart city technologies, along with the more efficient joint working between organizations that digital technology can enable, opens up a new landscape in developing places that work well for people.

7.3 New approaches required

The ever-increasing pressures on cities and the many new options offered by the digital world, means that the game has changed. There is a need for new behaviours, culture and skills. One way to address this is to develop integrated services masterplans, alongside conventional masterplanning exercises. These could identify how best to exploit the opportunities provided by new developments and infrastructure projects in order to develop transformational service delivery options.

7.4 Grasping the opportunity

The smart city approach provides opportunities to address conventional city challenges in new ways, for example, as follows.

- It recognizes the power of ICT and its key role in supporting soft infrastructure.
- It acknowledges that, in many cases, smart approaches could be significantly cheaper than conventional ones. Even where smart city approaches might involve some extra upfront expense, this would be in order to gain savings on the overall lifecycle costs.

It is vital to review the implications of smart city approaches very early in the planning and development process so these opportunities are not missed.

7.5 Try – Prove – Scale up

An important opportunity offered by new developments is that of being able to trial and test the value of new solutions, new business models and new processes. Once the evidence is gained of their value in a new development or infrastructure project, it could be easier to scale them up citywide.

7.6 Requires leadership

To grasp the transformational opportunities offered by incorporating smart city thinking into planning and implementation of new developments and infrastructure projects requires leadership. City leaders, including paid staff, political leadership, and citizen-based action groups need to be willing to take risks and not to be afraid of failure. The greatest failure might be to settle for the so-called safe path and potentially condemn the city to a path of slow decline.

7.7 Engage society

A benefit of smart city applications is that they offer an active role to the citizen and make it easier to gain contributions from stakeholders that would not traditionally be involved in the planning and development process. A smart city is one that uses digital technology to help engage all of its citizens and other stakeholders to collaborate to make the city as a whole work.

Annex A (informative) Summary of recommendations

A.1 City leadership

a) The city leadership should prepare an integrated service masterplan alongside their physical masterplan to capture the opportunities of digital technology and data to enable transformation. This should include contribution from stakeholders from the wider society (see **4.2.4.1**).

b) The city leadership should identify all of the agencies that will have a role in building the initial infrastructure within a new development or in providing services to the citizens, businesses or visitors that will use it, as soon as a new area for development within the city is identified (see **4.2.4.2**).

c) The city leadership should set up a working group as early as possible in the planning and development process, made up of key staff from each identified agency to identify synergies, opportunities for joint working and place-making and the smart technology that could support this. These should have objective and/or external facilitation (see **4.2.4.3**).

d) External experts should be included in working groups, particularly those aiming to identify the role of technology in enabling service transformation (see **4.2.4.4**).

e) The working group should identify actions related to the new development that provide practical benefit both to the agencies involved and to the citizen or business that they serve. These actions should be scalable up to a citywide level (see **4.2.4.5**).

f) The city leadership should make a clear commitment to a citywide, open data-sharing process (see **4.3.4.1**).

g) The city leadership should work with key agencies to develop practical, citywide, commercial models to allow useful data to be made widely available. This includes managing the data in a way that ensures its integrity and compliance with data protection regulations (see **4.3.4.2**).

h) City leadership should agree criteria as to the purposes for which the data generated within a development may be made available. These should specifically include support for smart city aspirations (see **4.3.4.5**).

i) The city leadership should use the opportunities that are offered by developments and infrastructure projects to test the processes and the business models for this to enable subsequent citywide scale-up (see **4.3.4.7**).

j) The city leadership should perform a data mapping exercise to develop a picture of the data landscape, including: sources, quality, ownership, temporal factors and sensitivity (see **4.3.4.8**).

k) The city leadership should access social media data and undertake sentiment analysis as an input to the planning and development process and reinforce place-making (see **4.3.4.9**).

l) The city leadership should run multi-stakeholder workshops to explore use cases where data is used to deliver different forms of value (see **4.3.4.10**).

m) The city leadership should commission a study into what ICT infrastructure is needed citywide to underpin the move towards becoming a smart city and to map out existing ICT system resources across the city. This would identify those resources with the greatest potential for reuse, identify gaps and provide the foundation for a strategy to fill them (see **4.5.4.1**).

n) The city leadership should set up governance processes and usage policies for ICT infrastructure, aimed at maximizing asset reuse by city partners (see **4.5.4.2**).

o) The city leadership should set up processes to maintain and make available records of where the necessary infrastructure is, and what it is, in an acceptable GIS format. This information should be made available to any agency that might be able to utilize it for the benefit of the city and the citizen (see **4.5.4.3**).

p) The city leadership should ensure that the necessary in-house expertise and capacity to assist in embedding smart objectives into the business case is developed, by encouraging officers to undertake training in this area and to keep in touch with best practice globally (see **4.6.4.1**).

q) The city leadership should ensure that the local authority develops procurement processes that allow it opportunity to work with the supplier to seek to identify new business opportunities that could enhance the commercial case for additional functionality (see **4.6.4.3**).

r) The city leadership should ensure that when the local authority contracts out services related to the management of a development or infrastructure project, the contracts with service providers should be set up to enable additional functionality to be added later at a fair and transparent cost (see **4.6.4.4**).

s) Within the local authority, there should be at least one officer whose role it is to maintain a clear overview of all smart city activity within the city, and to liaise between the different initiatives to ensure a coherent and integrated programme (see **6.2.1**).

t) Such an officer should ensure that they communicate on a regular basis with the key people in the planning and regeneration departments of the council so that all opportunities provided by new development and infrastructure projects can be embedded in the planning and development process (see **6.2.1**).

u) The city leadership should ensure that planning case officers and regeneration officers have clear guidelines, political support and an effective policy mechanism to enable them to ensure that developments are smart city-ready. They should have access to independent, well-briefed technology experts to be able to understand what is required, and have the tools and information to be able to discuss issues professionally with developers (see **6.2.2**).

v) The city leadership should hold smart city awareness sessions for elected members. The sessions should cover the opportunities offered by developments and infrastructure projects (see **6.2.3**).

w) City leadership should ensure that all departments of the local authority realize the importance of engaging with the planning department at the earliest stages of the infrastructure project plan, to be sure that the opportunities of incorporating smart city aspects are fully exploited (see **5.3.5.1**).

A.2 Planning policy makers

a) Planning policy makers should ensure that the way data is handled and used in the planning and development process is completely scalable, so as to allow data integration and modelling to take place at every level, from the individual building through to citywide (see **4.3.4.4** and **4.4.4.3**).

b) Planning policy makers should put in place policies that drive developers to use a digital modelling process (see **4.4.4.1**).

c) Planning policy makers should consider developing their own model of how the city, or the particular area of the city, is working at the moment so that they can use that to test proposals from developers (see **4.4.4.4**).

d) Planning policy makers and developers and the consultants that work with them should make data recorded for use in urban planning and design more

widely available as a basis for analysis. This could be achieved in a number of ways such as using a GIS platform, an internet-based platform and/or a city operating system (see **4.4.4.7**).

e) Planning policy makers should take into account new and smart solutions, rather than simply following traditional options. They should be able to demonstrate in their plans that they have not only provided for traditional demands, but also considered those that might be created by online business models and other social technologies (see **4.6.4.2**).

f) The LDF should take into consideration the potential benefits of emerging smart city solutions in the way the key development areas within the city are designed. Statements and aspirations should be included to encourage developers to make developments smart city-ready and identify potential smart measures, in their broadest sense, at an early stage (see **5.3.2.1**).

g) Planning policy makers should set overall goals and standards and management systems relating to the smart city aspirations of the city that provide clarity and certainty for developers. For instance, where a city sets clear aims and process regarding facilitating a citywide, open-access high-speed communications network or setting up and managing a citywide open data store, this makes it clear to developers what is required and makes it easier for them to identify the business case (see **5.3.2.1**).

h) Relevant documents, i.e. at the DPD level, should provide more in-depth identification of those smart measures identified in the core strategy. The land allocations for areas should indicate the sorts of approaches required for smart city implementation (see **5.3.2.2**).

i) Planning policy makers should develop area plans using digital modelling to identify the various possible implementation options, making it feasible for each individual stage to be built so as to play its part in the overall progress of the area towards smartness (see **5.3.2.2**).

j) Planning policy makers should take the opportunity to include more detailed smart city guidance at the detailed planning stage, in line with the strategy set out at the LDF stage, but including issues particular to the local context (see **5.3.3**).

k) Masterplans and site briefs should provide in-depth measures and solutions for increasing smart capabilities within developments and infrastructure projects. They should be pertinent to that specific site, its projected land uses, the building layout and other key factors (see **5.3.3**).

l) Planning policy makers should ensure that the streetworks that are likely to result from major infrastructure projects initiated by outside agencies are utilized to enable the installation of open access communications networks and sensor networks (see **5.3.5.1**).

m) The local authority should have a proactive relationship with the developers regarding smart city issues and it is suggested that they signpost this PD to them for early consideration, in order to guide their designs and proposals (see **5.3.4**).

n) For streetworks and improvements to the public realm, the LDF plans should set design criteria to encourage the inclusion of smart technology as part of the work (see **5.3.5.2**).

o) For refurbishment programmes, the LDF plans should contain clear goals and technical design criteria for citywide implementation of smart city services, for example installing a neighbourhood communications infrastructure, to strengthen the case for using refurbishment programmes to incorporate these facilities (see **5.3.5.3**).

A.3 Planning case officers and regeneration officers

a) Planning case officers and regeneration officers should specify open, standards-based data formats and technology interfaces and criteria for making data available in requirements for developers and in contracts with companies managing infrastructure on behalf of the local authority, once the city leadership have agreed criteria as to the purpose for which data generated within a development may be made available (see **4.3.4.6**).

b) Planning policy makers should ensure that all new developments use standards-based BIM methodologies (see **4.3.1** and **4.3.4.3**).

c) Planning case officers should work together with developers and masterplanners to identify what data would be useful to them, where they could access that data and how they could ensure its accuracy (see **4.4.4.2**).

d) Planning case officers, regeneration officers and developers should use digital modelling in communicating via online, social media and other technologies to encourage the widest engagement with the plans by decision-makers, local and business communities and citizens (see **4.4.4.5**).

e) Planning case officers and regeneration officers should require developers to submit their digital design to the local authority in a format that can be used in the creation of a digital model of the city (see **4.4.4.6**).

f) Planning case officers and regeneration officers should begin negotiations with developers early on to ensure that standards-based equipment and communications infrastructure needed to support potential smart city products and services, or at least ducting and spaces for these, are planned for and installed at construction stage (see **4.5.4.4**).

g) Planning case officers and regeneration officers should require developers to incorporate and submit a digital infrastructure specification, as they do for other utilities. To help with this process, planning case officers and regeneration officers should require developers to explain their rationale for technology choice, in order to assist their assessment. Any proposed development or infrastructure project should demonstrate how it has taken into account the sustainability, scalability and resilience of technology infrastructure as a key asset over an extended timeframe (see **4.5.4.5**).

h) Planning case officers and regeneration officers should take an enabling role in supporting the long-term management of any proposed development or infrastructure project. This includes agreeing with the developer or installer how it is to be owned, procured, managed and potentially transferred in order to allow and facilitate sharing and joint usage. It also includes the general criteria for how it is to be used, the charging arrangements for use and arrangements for dispute resolution, as well as how best to maintain access for competitors and what arrangements need to be made to allow for emerging technologies (see **4.5.4.6**).

i) Planning case officers and regeneration officers should ensure that when management systems are put in place for developments and infrastructure projects, the systems are flexible enough to cope with changing demands (see **4.6.4.5**).

j) Planning case officers and regeneration officers should ensure that, when procuring outside agencies to help with the delivery of services, as many services as possible should be bundled together, as this will allow more potential for transformational solutions (see **4.6.4.6**).

k) Negotiations with developers regarding smart city aspects should begin early in the process to gain their full cooperation (see **5.3.4**).

l) Early negotiations with developers and other stakeholders during development management should include reference to smart city issues, in order to help developers and the other stakeholders to understand, both their importance to the city and the benefits they can provide to them (see **5.3.4**).

m) Early negotiations should take place with other stakeholders (e.g. utility companies) to ensure that they incorporate provisions for smart city objectives in their work as far as possible (see **5.3.4**).

A.4 Developers

a) Planning case officers should work together with developers and masterplanners to identify what data would be useful to them, where they could access that data and how they could ensure its accuracy (see **4.4.4.2**).

b) Planning case officers, regeneration officers and developers should use digital modelling in communicating via online, social media and other technologies to encourage the widest engagement with the plans by decision-makers, local and business communities and citizens (see **4.4.4.5**).

c) Planning policy makers and developers and the consultants that work with them should make data recorded for use in urban planning and design more widely available as a basis for analysis. This could be achieved in a number of ways such as using a GIS platform, an internet-based platform and/or a city operating system (see **4.4.4.7**).

d) Developers should take into account the need for spaces for people to communicate, exchanges ideas and collaborate, all of which are important ingredients for place-making, in their digital modelling and design. Appropriate spaces should be available from the earliest stages of development. These might include community and leisure centres, but the role of coffee shops and pubs is also important (see **4.4.4.8**).

Annex B (informative) Types of development and infrastructure project

B.1 Major development

A major development can be residential, commercial, or for mixed use. It can be developed as urban extensions, on brownfield sites within existing urban areas, or as standalone developments such as new garden cities.

Even with the minimum of 10 new homes, there is value in considering how the infrastructures to support them can be aggregated to provide synergy, but with larger developments there is the opportunity to remake whole neighbourhoods in smart ways.

B.2 Major infrastructure project

Major infrastructure projects include the development of new railway, tram or metro lines and stations, ports and airports, particularly when linked to cities or to urban areas, power stations, wind farms, new bypasses or ring roads, cycle paths, natural gas pipelines, sewer systems and flood control work.

B.3 Streetworks and improvements to the public realm

Streetworks and improvements to the public realm are where there is extensive re-modelling of the external environment. Examples include:

- streetworks to lay new utility infrastructure;
- renewal of street lighting;
- installation of new district heating schemes;
- new road layouts; and
- improvements to the public realm, often related to the development of creative spaces within a city, focused on culture, art and leisure.

B.4 Refurbishment programme

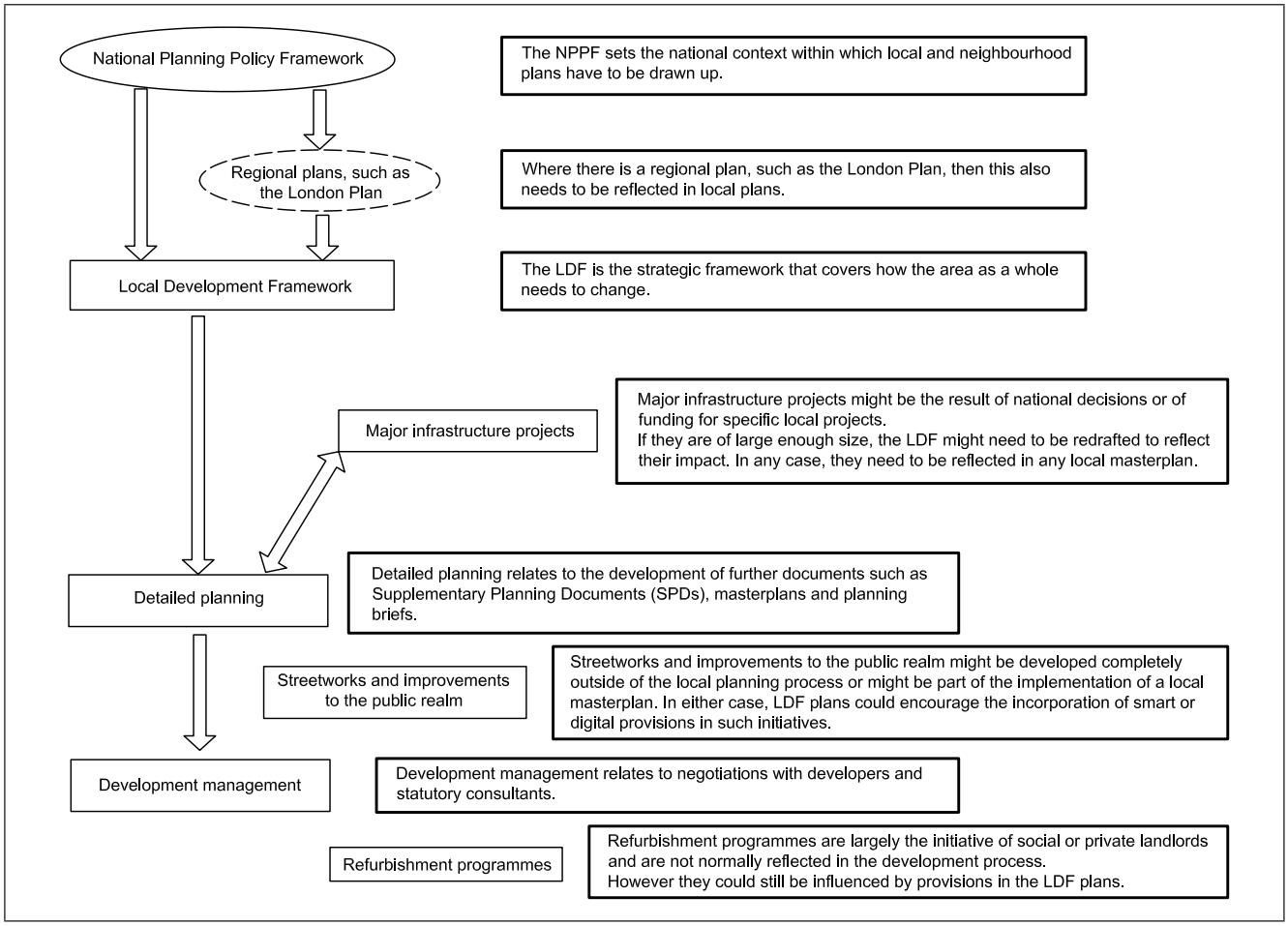
A refurbishment programme includes work on, for example, social housing stock and commercial buildings, either to improve and upgrade the facilities, such as improving the insulation of the buildings, or in order to make the area as a whole more attractive.

Annex C (informative) Planning and development process

C.1 General

An overview of the planning and development process is given in Figure 6.

Figure 6 **Planning and development process – overview**



C.2 Local development framework

The LDF sets out the overall development strategy along with more detailed policies for a local authority. It includes the requirements for section 106 agreements, or its newer equivalent the Community Infrastructure Levy (CIL)[2)]. These requirements are then detailed in either supplementary planning guidelines or in a CIL charging schedule, which indicates to potential developers the costs they will be expected to pay.

In some cases it might be relevant to include some of the upfront costs of the installation of smart technology within the section 106 or CIL requirements.

The LDF also identifies and allocates specific development sites for different forms of development, including house building, places of employment and retail.

If it is felt necessary, the LDF may also contain:

- area action plans; and
- other DPDs that provide detailed policies on key issues in a locality that need to be given full statutory weight in the planning and development process.

There is also government provision for neighbourhood plans which offer local communities the opportunity to create their own plans within the LDF. Neighbourhood plans might provide another way to bring smart city thinking into the planning and development process, as local communities that have decided to take a pro-active approach to local developments are likely to be actively looking for innovative options that might benefit their neighbourhood. However, these plans still need to be signed off by the local authority and be in line with their policies.

The LDF needs to comply with the NPPF [5], a high-level national document published in 2012 which provides overall guidance for local authorities in developing their own plans.

In London, the London Plan also needs to be taken into consideration, which is a much more detailed document than the NPPF. The London boroughs' own local plans need to conform to the London Plan and agreed with the Greater London Authority (GLA). The Mayor of London identifies the key areas of growth in London as opportunity areas and these need to be reflected in the spatial strategies of the London boroughs.

C.3 Detailed planning stages

Once the LDF for an area is completed, the next stage is to prepare supporting documents, such as masterplans and planning briefs. These are more focused on regeneration, the way places are designed and what is practical given market conditions at the time. This is the stage to focus on the detail of the physical infrastructure.

Where the local authority wishes to proactively shape the developments in an area, it may develop its own masterplan (or in the case of relatively small sites, a planning brief) in the form of a supplementary planning document (SPD). This provides non-statutory guidance on important local issues, for example design. The process is usually, but not always, managed by the planning policy team within the authority. The aim here is to set the development strategy and then to support a planning application process.

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2) The money raised from section 106 agreements or the Community Infrastructure Levy may be used to fund additional infrastructure related to the development that the council, local community and neighbourhoods might want, such as new or safer road schemes, parking improvements or a new health centre.

In some cases, however, the actual masterplan is created by the developer as part of the process of applying for planning permission. The process starts with the developer engaging in pre-application discussions with the planning case officer. This enables the developer to receive guidance on the requirements of the local planning authority, any issues that need to be addressed as part of its application and the key organizations to consult as part of the process.

Within the local authority these might include the highways department, regarding issues such as road capacity and parking and environmental health, regarding issues such as contamination, air quality and noise. Outside of the local authority there are other organizations that might need to be consulted, for instance the Highways Agency, the Environment Agency, the utility companies and English Heritage. Within London, the developer might also need to consult with Transport for London, the GLA, and the Port of London Authority.

C.4 Development management

When a developer decides that it is interested in building on a particular piece of land, it enters into a process of negotiations with the local authority planning department.

Once the developer feels confident that its plans are consistent with the local authority's plans and policies and that it has addressed the main issues raised during the pre-application process, it submits the planning application either as an outline (masterplan) or as a detailed plan (usually for smaller sites). The application is then subject to public consultation, which is run by the planning case officer.

If this is favourable and the application is considered to conform to the relevant planning policies (national, strategic and local), then planning permission is usually granted, normally by a planning committee comprising elected councillors of the local authority. This would include any section 106/CIL obligations.

Developments comprising several hundred or thousands of new homes or the equivalent in non-residential floor space (or a mixture of the two in mixed use developments) can take a number of years to complete. Standards and requirements are likely to change over that period and so there might be a number of issues that need to be re-negotiated over the period of development, including those that might require revised or new planning applications. Alternatively, conditions in the planning consent that require standards to be revised over time might be a sensible approach.

Where key potential development sites can be seen to support the local authority's regeneration or economic development priorities, then the regeneration department might take a proactive role in this process. For instance, the regeneration department might commission its own masterplans of key areas in order to understand how the sites could be developed in a way that would best contribute to the council's objectives. In some cases it might seek to secure outline planning permission for the masterplan.

The regeneration department might also actively market the site to developers. It might work in partnership with developers to help them build links with possible partners that would enhance the proposition. It might also work with the developers to ensure that their submission for planning consent was fully in line with the local authority's objectives and therefore that planning permission could be gained more easily or might even enter into a joint venture or long-term partnership with the developer.

However, the regeneration department would undertake all of these different activities in close partnership with the planning department, and in particular with the relevant planning case officer.

Annex D
(informative)

Smart city activities relevant to this PD

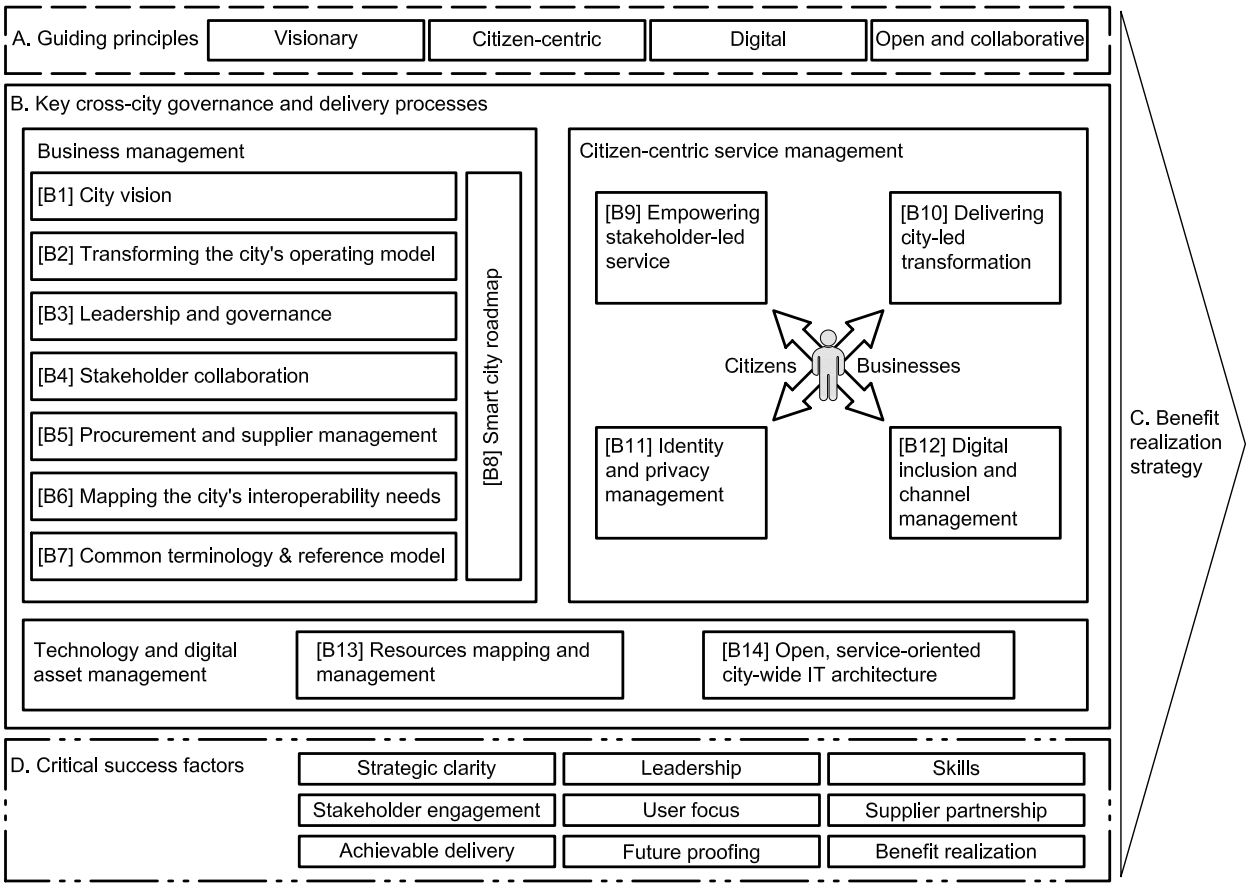
It is recognized that this document can be no more than an introduction to the subject of smart city planning and development. However, there are a number of further sources of more detailed help and guidance in the UK.

This PD is part of a suite of documents that BSI is publishing to provide guidance on different aspects of smart city implementation. There are also a number of other useful initiatives that are helping to support and develop the smart city market in the UK.

The other documents in the smart cities suite are outlined in the Foreword to this PD. Of them, PAS 181, *Smart city framework – Guide to establishing strategies for smart cities and communities* is especially relevant in terms of providing further and more detailed guidance. It is a guide intended for use by leaders, at all levels and from all sectors, of smart city programmes. It provides practical guidance reflecting current good practice as identified by a broad range of public, private and voluntary sector practitioners engaged in facilitating UK smart cities.

Figure 7, taken from PAS 181, shows the high-level structure of the smart city framework (SCF) PAS 181 gives guidance on.

Figure 7 **High-level structure of the SCF**



[SOURCE: PAS 181:2014, Figure 1]

In addition, within the UK and Europe there are a number of key initiatives that are developing support for smart city implantations.

The **Future Cities Catapult** is a global centre of excellence on urban innovation funded by the UK Government and based in London. It provides a focal point for cities, businesses and universities to come together to develop solutions to the future needs of our cities. See: https://futurecities.catapult.org.uk/home

The **Technology Strategy Board's (TSB) Future Cities Programme** has the vision of helping UK firms to develop the products and services to meet the changing needs of cities, and to sell them to the world. The TSB is a business-led executive non-departmental public body, established by the government. Its mission is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve quality of life.

A major programme that was funded by the TSB was the **Future Cities Demonstrator**. This programme was launched in June 2012 and provided funding to 29 UK cities to work with partners to develop feasibility studies on developing smart city approaches. The feasibility studies themselves are public documents and provide practical inspiration and ideas. They can be found at: https://connect.innovateuk.org/web/future-cities-special-interest-group/feasibility-studies

Arup was commissioned by the TSB to analyse the feasibility studies and this report: *Solutions for Cities* can be found at: https://www.innovateuk.org/documents/1524978/2138994/Solutions+for+Cities+-+An+analysis+of+the+Feasibility+Studies+from+the+Future+Cities+Demonstrator+Programme/5d8ad270-4623-4057-a0e8-2e303033122f

As a result of this programme, Glasgow City Council was granted £24 million to implement its ideas and Peterborough city council, Bristol City Council and the Greater London Authority were each granted £3 million to take their plans further. These are all seen as demonstrator projects and the city councils concerned will all be sharing the lessons they have learned as part of the project.

The **Smart City Forum** has been set up by the UK Government to bring together leaders of cities, industry and academia to develop an effective strategy to enable the UK to take a leading role globally in this area. See: https://www.gov.uk/government/news/uk-set-to-lead-the-way-for-smart-cities

The **Foresight Future of Cities Project** is an initiative, based in the Government Office for Science, whose role is to establish the present state of system of cities and city systems in the context of the history of their evolution and then develop scenarios of how cities might look and function through to 2040 and to 2065. Work has started and over the next two years this will provide an authoritative review of how cities are likely to change over the next few decades. More information can be found at: https://www.gov.uk/government/collections/future-of-cities

The European Innovation Partnership for Smart Cities and Communities is a partnership of key stakeholders, facilitated by the European Commission, to work together to identify innovative solutions to the major environmental, societal and health challenges facing European cities today. See: http://ec.europa.eu/eip/smartcities/index_en.htm. A number of working groups are being set up to develop practical solutions to common city challenges.

The European Smart City Stakeholder Platform is funded by the European Commission to be a one stop shop for all things relating to smart cities. It encourages smart city proposals and projects to be outlined and provides a platform for the discussion of smart city issues. See: http://eu-smartcities.eu/

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

PAS 180, *Smart cities – Vocabulary*

PAS 181, *Smart city framework – Guide to establishing strategies for smart cities and communities*

PAS 1192-2, *Specification for information management for the capital/delivery phase of construction projects using building information modelling*

PAS 1192-3, *Specification for information management for the operational phase of assets using building information modelling*

Other publications

[1] GREAT BRITAIN. Town and Country Planning (Development Management Procedure) (England) Order 2010. London: The Stationery Office.

[2] ROYAL INSTITUTE OF BRITSH ARCHITECTS, ARUP. *Designing with data: shaping our future cities*. Royal Institute of British Architects and Arup, 2013. Available from: http://www.architecture.com/TheRIBA/AboutUs/InfluencingPolicy/Designingwithdata.aspx/

[3] HOMES AND COMMUNITIES AGENCY. *Urban Design Compendium*. Third edition. Homes and Communities Agency, 2013. Available from: http://www.homesandcommunities.co.uk/urban-design-compendium?page_id=&page=1

[4] DEPARTMENT FOR COMMUNITIES AND LOCAL GOVERNMENT. *Data ducting infrastructure for new homes: guidance note*. Department for Communities and Local Government, 2008. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/11496/dataducting.pdf

[5] DEPARTMENT FOR COMMUNITIES AND LOCAL GOVERNMENT. *National Planning Policy Framework*. Department for Communities and Local Government, 2012. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

Further reading

BS 1192, *Collaborative production of architectural, engineering and construction information*

BS ISO/IEC 27001, *Information technology – Security techniques – Information security management systems – Requirements*

ISO 55001, *Asset management – Management systems – Requirements*

PAS 55-1, *Specification for the optimized management of physical assets*

PAS 55-2, *Guidelines for the application of PAS 55-1*

PAS 91, *Construction prequalification questionnaires*

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