# Future cities in the making: overcoming barriers to information modelling in socially responsible cities

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## Abstract

Building and City Information Modelling (BIM and CIM) could potentially facilitate better planning outcomes, more efficient service provision, and more inclusive community engagement. In doing so, these technologies could help deliver on some of the goals common amongst aspiring smart cities, using data to improve efficiency, services and quality of life. However, BIM and CIM uptake has been slow, and most cities do not incorporate BIM or CIM in their planning processes. Looking beyond BIM and CIM, planning systems worldwide have been slow to adapt to the digital future: most planning systems have not yet digitalised, and lack the tools and incentives to help local authorities and planners make use of emerging technologies. This research explores the barriers to and opportunities for using BIM and CIM in planning in the UK, and probes the ethical questions around how cities and local authorities can use data while protecting citizens' right to privacy.

***Keywords*** – City Information Modelling; Building Information Modelling; smart cities; planning systems; data privacy and security

## 1 Introduction

Building and City Information Modelling (BIM and CIM) could potentially facilitate better spatial planning outcomes, with more efficient service provision, more joined up plan making, and more inclusive community engagement. In doing so, these technologies could help deliver on some of the goals common amongst aspiring smart cities: using data to improve efficiency, services sustainability and quality of life. However, most cities do not incorporate BIM or CIM into their planning processes (Allmendinger and Sielker, 2018). In general, planning systems around the world have been slow to digitilise, and lack the tools and incentives to help local authorities and planners make use of emerging technologies beyond e-planning portals (Sielker and Allmendinger, 2018). This research explores the barriers to and opportunities for using BIM and CIM in planning in the UK, and probes the ethical questions around how cities and local authorities can use data while protecting citizens' right to privacy, and ensuring inclusivity and fair value share from data exploitation.

BIM is defined as a set of digital tools, processes and standards for information management used to capture and store the data associated with a construction project so that it can be shared by everyone working on the build and those responsible for the assets' subsequent operation (Centre for Digital Built Britain, 2018, p. 17). BIM's role in architecture, engineering and construction (AEC) fields is well recognised, and governments across the globe, including in the UK, have put measures in place to increase the use of BIM in construction projects. BIM and CIM can transform strategic planning processes as they can build on the advantages of 3D visualisations on the one hand, and incorporate regional, geographic and asset information similar to the functioning of geographic information systems on the other. However, the information aggregated through BIM models is not typically passed on to planning departments. Similarly, few governments have gathered experience in adding planning relevant information to BIM models. In general, the interface between information modelling and the two main phases of planning in the UK (development of a strategic local development plan, and the planning permission application process), remains largely undefined. The potential role for using BIM models in planning is still evolving, and is less well understood.

In the UK, the Department for Business, Energy & Industrial Strategy founded the Centre for Digital Built Britain the custodian of the UK BIM Programme. BIM is a key part of the UK's Digital Built Britain Strategy, which "aims to create a digitally-enabled information landscape to allow the optimisation of the built environment throughout the construction, manufacturing, maintenance, operations and decommissioning phases' (CSIC & IfM, 2017, p. 1). Against this background, this research focuses on BIM in

the planning context, investigating the barriers to and opportunities for using BIM in the planning process, and exploring ways that the planning system might further support BIM roll-out.

Additionally, as cities and local authorities begin to experiment with information modelling techniques and explore other, data-reliant ways of improving their services and sustainability, they are confronted with a host of questions about data usage. How can they safeguard the right to privacy in a digitalising environment? How can they track data flows and store data? How can they address data ownership? How can they create trustworthy systems to manage the vast amount of data that digital tools such as BIM and CIM involve? In a digitalising environment, cities and local authorities must define new answers to questions about their role and citizens' roles in managing data flows, protecting privacy, and promoting inclusivity.

This research takes a case study approach to understand how different types of local authorities in the UK are addressing these questions. Data was collected through interviews with stakeholders and decision makers across the built environment, through literature and policy analysis. The case study areas we selected have different governance structures, are of different sizes, exist within the English and Scottish planning systems, are facing different economic and demographic trends, and consequently have different planning challenges. By looking at a diverse cross-section of cities and planning contexts, we are able to shed light on the various types of barriers local governments face to using IM specifically and linking BIM and CIM with e-planning approaches, and digitalisation more broadly. There are numerous explanations of what it is that is hampering a faster take-up of information modelling, which include lack of resources, skills or technical solutions. By looking at current activities of local authorities in regard to digitalization and connectivity, and the interface with planning, this research allows to identify ways to overcome contemporary barriers by highlighting successful initiatives. Finally, this project reflects on the relationship between the human right to privacy and the new right to the city in the context of increased digitalisation and use of personal data in the built environment.

The paper is structured as follows. First, in section two, the paper presents an overview of the barriers to BIM implementation in the UK in the spatial planning context. In section three, the paper presents some of the preliminary findings from three case studies, illustrating the different types of challenges localities face, based on contextual factors such as governance structures, population density, and development trajectories (e.g. rapid population growth that creates a need for new housing and infrastructure, or major urban regeneration needs). Finally, in section four, the paper reflects on the main policy areas that need attention to support the use of data-driven emerging technologies in planning and support cities and local authorities to live up to their responsibility for ethical data management.

# 2 Barriers to BIM implementation in planning in the UK

BIM has uses both in the creation of a local plan, and in the planning application process (e.g. Future Cities Catapult, 2017; Thompson et al., 2016). These potential use cases can deliver cost and time savings, more joined-up planning approaches, greater transparency, and more collaboration and community engagement. However, in spite of the potential benefits, local authorities are largely not utilising these digital tools. This research fills a void by showing the barriers that prevent local governments from reaping the benefits of using BIM in planning processes. Through talking with stakeholders in the planning process, we identified general barriers common across many of localities, which fall into four general categories (Table 1): (1)governance/organizational, (2) technical, (3)resources and (4) legal.

Although the barriers can be divided into separate categories, barriers are often interrelated both within and between categories, as the following sections illustrate. The examples given below are not exhaustive; however, they demonstrate the interconnections between barriers, providing an illustration of some of the barriers that local governments face to digitalisation and information modelling in planning.

*Table 1. Barriers to BIM implementation in planning*

| Governance/ organisational | Technical |
|---|---|
| Lack of leadership | Connectivity barriers |
| Organizational mindset | Data quality issues |
| Workflow barriers | Lack of standardization |
| Proprietary systems/data | Need for bespoke solutions |
| Resistance/skepticism | Non-interoperability |
| Technology partners | Data storage and bandwidth |
| Planning as a regulatory and statutory discipline and lack of strategic planning | Monopoly of software solutions |
| Institutional conflicts | Level of detail |
| **Resource** | **Legal/ethical** |
| Staffing barriers | Data ethics issues |
| Monetary barriers | Data security issues |
| Investment in soft-/hardware | Lack of knowledge on data flows |
| Lack of BIM awareness Skills/knowledge | Legal barriers (e.g. for data sharing) |
| Individual and organizational leadership | Lack of legal understanding and apprehension to not comply with law |
| Path dependent experience with digital solutions | Data privacy and uncertainty over Brexit implications |

*Source: own elaboration*

## 2.1 Governance/organisational barriers

Some barriers to BIM use in planning relate to elements of the governance and organisational structures responsible for planning. For example, in some localities, different bodies are responsible for delivering on housing, transportation, and the area's local plan. This is of particular importance in the UK with limited opportunities for regions and cities to use strategic planning as an enabler to realise bigger visions (Allmendinger 2016).

The planning systems in the UK are characterized by individual citizens or companies applying for planning permission, and a strong role for building standards regulations. The local development plans give a guidance framework for potential uses. However, the detailed planning is part of the planning application. Further, planning departments have been hit considerably by budget cut-downs.

A fragmented governance structure creates barriers to using IM and other digital tools in planning in several ways. Data-driven insights are enabled by analysing multiple datasets together, like looking at air quality data, traffic congestion data, or public transit data for example. However, having a number of separate delivery and governance bodies responsible for different aspects of planning can create data silos, making it difficult to bring datasets together, particularly because data is sometimes treated as proprietary. With multiple organisations involved, the question of who is to pay for and organise the implementation of IM systems is also complicated, and requires extra coordination that may be out of reach for time and resource pressed local bodies. Even within one organization, it takes a considerable amount of time to get the governance for coordination between different departments in place. A digital agenda needs strong leadership, both politically and through relevant hierarchies.

## 2.2 Technical barriers

Barriers are often interconnected, with one barrier leading to the creation of others. In the example above, fragmented organisational and governance structures can lead to technical and legal barriers, which are also connected to resource barriers. As one might expect, separate organisations make decisions around technology partners and software procurement independently, meaning that organisations that want to share data may be operating with different back ends that may or may not be interoperable. As an example, to date Idox is the most prominent provider of e-planning platform solutions in the UK (including Uniform and Enterprise modules for different part of the statutory process). These need to have a connector to BIM software provided by for example revit or Bentley. Additionally, practices for capturing and storing data may not be standardized and involve third parties. This may inflict with legal barriers, e.g. GDPR. Lack of standardisation represents a technical problem, but it may have its origins in governance and organisational barriers.

## 2.3 Resource barriers

There are several barriers that fall into the category of resources that are instrumental for a successful implementation of the digital agenda in ACE through planning and city development. These foremost include staffing, financial, skills and knowledge barriers as well as capacities and willingness for leadership.

## 2.4 Legal barriers

When different delivery and governmental bodies are responsible for different but complimentary datasets, they are sometimes concerned with legal implications of sharing their information as data they handle may be confidential or protected. At the same time, sometimes the reluctance to

share is not due to actual legal prohibitions, but rather, due to a lack of understanding as to what is legally allowed. This is fortified by an anxiety to not comply with the law, and hence a tendency to better not to anything than making mistakes that might impact the authority's reputation. Rather than risking a breach of privacy law, or investing valuable time in investigating the legalities of sharing, organisations opt away from sharing. This represents a resource barrier, pointing to a need for better legal education/guidance for those in charge of managing data. As an example, Historic Environment Scotland has to comply with more than 50 legislations, statutes, codes of practice and policies in relation to IT and Information Security Requirements. There is a need to clarify some intricacies of data sharing agreements to provide a safe legal space.

# 3 Case study findings

For this project, three case study areas were studied in depth to provide insights on how different planning systems and contexts impact on BIM implementation barriers and opportunities. The City of Bristol was chosen as a case study because it represents a large British city with a growing economy and population, and substantial regeneration projects underway. Studying Bristol provides insights that may be relevant to other large cities, other growing areas, and large regeneration efforts. Cambridge was selected as a second case study because it is a smaller city, with a local authority size that is less than a third of the size of Bristol's. Like Bristol, it is also experiencing some of the highest economic and demographic growth rates in the country. However, unlike Bristol, regeneration in Cambridge is not a focus, and to accommodate continued growth Cambridge will need to focus on building new housing stock and expanding its transportation infrastructure. The final case study area is Scotland. Scotland was selected because it has a different planning system from England, as the planning systems for the devolved nations are distinct. Additionally, it was selected as an area to provide an understanding of the challenges and opportunities for BIM implementation and the use of digital tool in planning in more rural settings, as some of the areas focused on in this study have extremely low population densities (Table ).

*Table 2. Size and population density of case study areas*

| Case Study | Local Authority Name | Pop. Size | Pop. density |
|---|---|---|---|
| Bristol | City of Bristol | 459252 | 4186 |
| Cambridge | City of Cambridge | 124919 | 3069 |
| Scotland | South Ayrshire | 112470 | 92 |
| Scotland | Highlands | 234770 | 10 |

(National Records of Scotland, 2019; Office for National Statistics, 2018)

## 3.1 Bristol: the importance of aligned and collaborative governance structures

### 3.1.1 Bristol context

Bristol has been a Unitary Authority since 1996, which means that the local authority has a single tier, and is responsible for all local government functions within its area. This is distinct from the two-tier system of local government which still exists in most of England, where local government functions are divided between county councils and district or borough councils. As of 2012, Bristol also started to directly elect a Mayor. The current Mayor has spearheaded a collaborative planning process, known as the One Bristol Plan, bringing together the city's business, charitable, academic and public sectors to make a collaborative plan for the city reaching to 2050.

The Bristol City Council set up a joint venture with the University of Bristol to create Bristol Is Open, an organisation responsible for delivering a city-scale testbed for smart city solutions.

### 3.1.2 Insights from Bristol

Data collection for the Bristol case study is still ongoing. However, preliminary results indicate that a combination of having central leadership, and a collaborative city-wide planning effort have helped in making organisations involved with planning for the city amenable to sharing data with one another and with Bristol Is Open. The city's 'one dig' policy illustrates the level of interdepartmental collaboration—when digging up the road to install, for example, a new heat network, the city also puts in new fiber for broadband connections. Inclusivity also appears to be a central concern in the city's smart initiatives, with high-level attention paid to how areas that lack fiber connectivity tend to be more deprived neighbourhoods. The Bristol case illustrates the power of aligned and collaborative governance. Future work will probe the use of digital tools in planning, and specifically barriers and opportunities to use BIM for strategic planning purposes. Vice versa it remains to be analysed further how IM systems can support the planning of an individual asset or wider regeneration endeavors, by linking it to the information relevant for planning permissions.

## 3.2 Cambridge: ambitious growth plans in a complex governance environment

### 3.2.1 Cambridge context

Cambridge has a more complex governance structure (Figure 1) It has a two-tier government system, with a country council sitting above the district councils. Additionally, as of May 2017, it became one of England's nine combined authorities, with Peterborough and Cambridgeshire joining forces under the leadership of a directly elected Mayor. Furthermore, the area signed a City Deal in 2014, which provides the area with potentially hundreds of millions of pounds to be invested in the transportation and housing infrastructure that the rapidly growing area requires to sustain its growth. The Greater Cambridge Partnership (GCP) was created as a delivery body for the City Deal, and is now responsible for transportation infrastructure delivery, though now for housing.

The Smart Cambridge programme is a work stream within the GCP that is looking at how data and new and emerging technology can help the GCP achieve their target outcomes around things like reducing congestion and improving air quality.

### 3.2.2 Insights from Cambridge

Data collection for the Cambridge case study is still ongoing. Preliminary results indicate that Cambridge has considerable momentum towards implementing data driven solutions in their transportation system, e.g. by using additional camera systems. However, the number of governmental and delivery bodies may present a challenge for the area. Additionally, challenges relating to data cleaning and formatting have been cited as barriers to better digital collaboration. Further work will investigate the barriers Cambridge faces to using digital tools in planning, with a focus on the potentials for an increased use of BIM.

## 3.3 Scotland: geography as a driver for digitalisation

### 3.3.1 Scottish context

Scotland has a planning system that is distinct from that of England. Further research is underway evaluate the ways in which the difference between these two systems impacts on digitalisation and BIM uptake in planning. Preliminary results indicate that the planning bodies in Scotland have taken a centralized approach to delivering digitalisation, perhaps highlighting the benefits of taking a more regional, spatial planning approach, which England does not do.

Scotland is more sparsely populated: rural Scotland accounts for 98% of the land mass of Scotland and 17% of the population are resident there (Scottish Government, 2018).

### 3.3.2 Insights from Scotland

Results from Scotland highlight the important role that geography can play in shaping planning processes. The UK's largest local authority is Highland, which accounts for

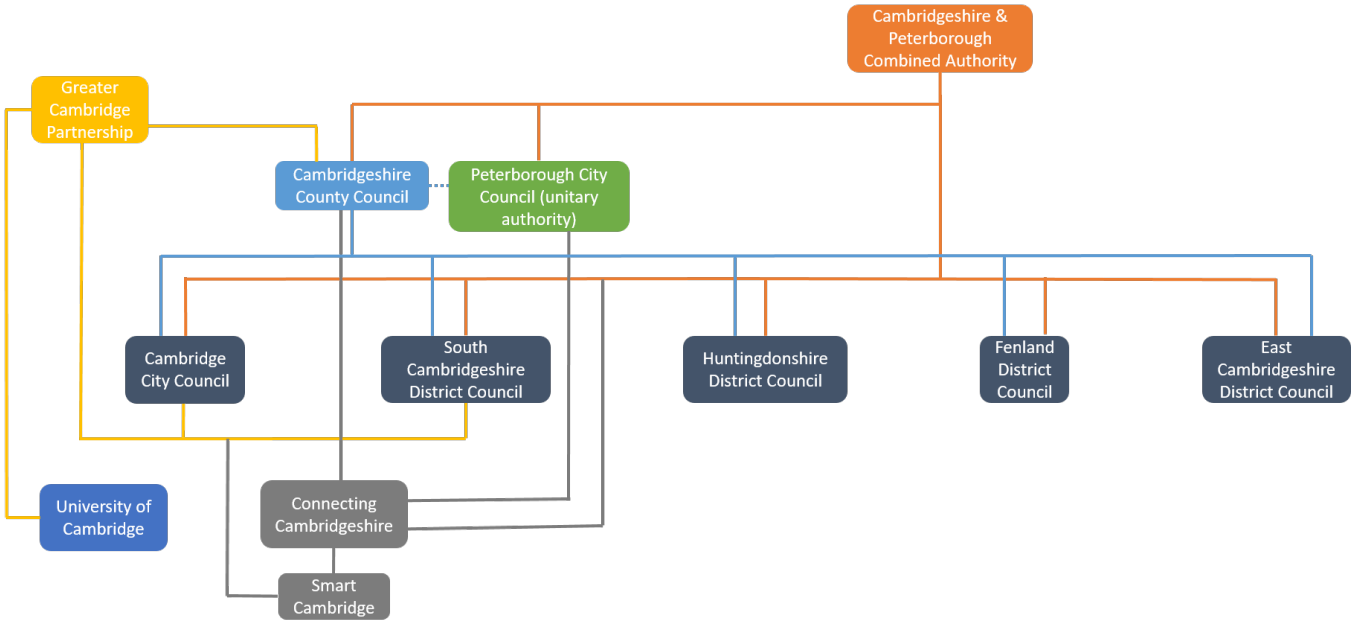


*Figure 1. Governance structure for the Cambridge area*

11.4% of the land area in Great Britain. In charge of such a large geographic region, Highland planners needed a better more efficient way to collaborate and manage data over such great distances. This led them to undergo a digitalisation process. For instance, the Council manages a virtual team of planners and field officers. Preliminary results indicate that digitalisation in the Highland Council area was driven not only by the geographic necessity, but also by an agile leadership and governance structures. In the Scottish context, the lack of machine-readable planning documentation has been highlighted as a barrier to using BIM in the planning system. This note has been repeated by various other individuals involved in the built environment and planning.

# 4 Policy measures to support the use of data-driven planning tools

Analysis of the barriers uncovered through the course of this research, and conversations with stakeholders across the built environment point towards several areas for policy making to support the use of data-driven planning tools. As barriers are often interrelated, so too are the policy solutions.

Resource barriers, in particular staffing and financial shortages as well as skills development are among the most crucial barriers to tackle when truly wanting to hive the opportunities for a more inclusive, efficient and better urban development. These include dedicated personal resources for digitalisation, education of the wider staff and the creation of guidance documents and standards. The later must encompass guidance frameworks for compliance with the numerous regulations, statutes and code of practices as well as guidances on interfaces between information modelling and planning. Digitalisation of long-established processes in all of the UKs local authorities will be an incremental process, based on the experience of pilot cases. These may include the testing of the embedding of BIM models and current e-planning systems. Further, without a clarification of the legal setting, local governments will be avoidant of spaces of uncertainty. There is an urgent need to address the questions of data privacy on a broader scale.

All in all, in order for local governments to in future truly be able to build on information modelling and integrate new tools with current (e-planning) systems, policy actions in the four categories, will be needed. A balance between organizational, legal, resource and technical measures and driven by political leadership is key.

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