

POLICY SERIES

AN INDUSTRIAL STRATEGY FOR TOMORROW

TACKLING THE HOUSING CRISIS THROUGH DIGITAL TECHNOLOGIES AND OFFSITE MANUFACTURING

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Introduction

For the newly elected government in the UK, like many of its counterparts elsewhere, industrial strategy has become the most important institutional vehicle through which it seeks to achieve some of its core goals. These include promoting economic growth, tackling falling productivity growth, designing research and innovation policies that will enhance the strengths of the UK economy, and ensuring that its leading sectors are globally competitive.

Its declared commitment to 'levelling up' the performance and opportunities of poorer regions with wealthier and more productive ones is also connected to its industrial strategy. This shift in UK government thinking mirrors developments elsewhere, as a range of international organisations and various western governments have recently proclaimed their commitment to 'place-based' economic development strategies.

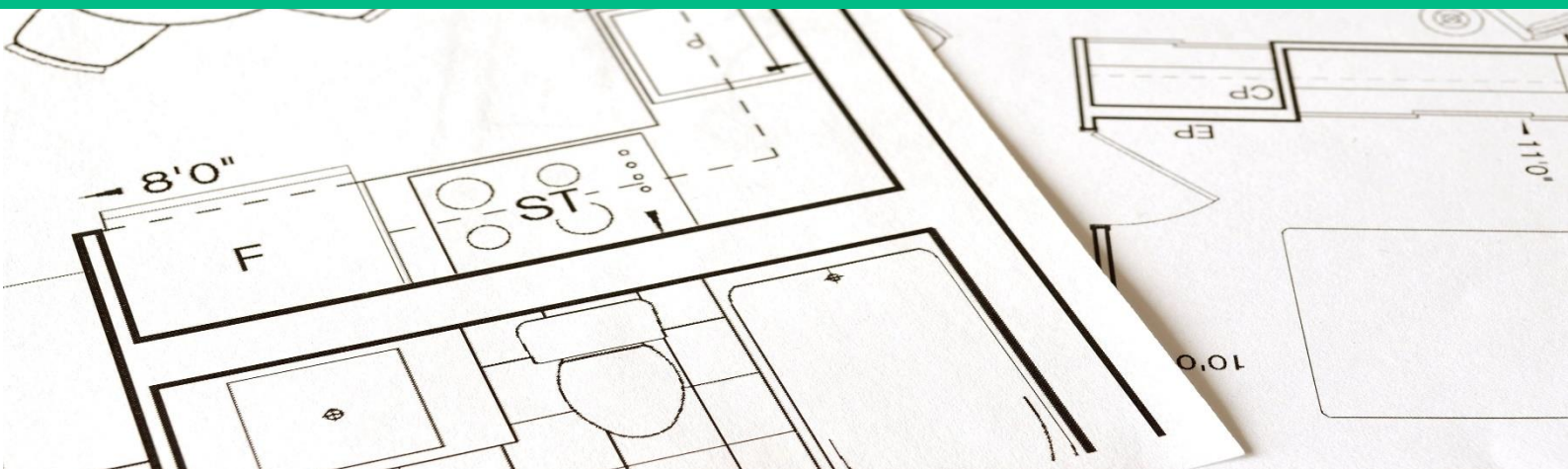
Some experts in this area argue that there exists a template or model that the UK could import from other leading economies. At the Bennett Institute, however, we take a different tack. We have been working with some of the leading researchers at Cambridge, and engaging key decision-makers in government, to interrogate more deeply some of the dilemmas and challenges facing those tasked with designing and evaluating the industrial strategy, and the local strategies which government has encouraged some of its metro-mayoral authorities and Local Enterprise Partnerships in England to develop. Our belief

is that these will only succeed if they understand and address today's social and economic needs from place to place, and align with the key dynamics shaping the economy emerging in the coming decades.

Each of the papers in this series offers an in-depth examination of some of the fundamental issues – concerning data, measurement, definition, research policy and strategic ambition – which will determine how well governments across the UK fare in this area. Some of these draw upon evidence from other countries, and some offer arguments and proposals that are germane internationally, as well as applying to the UK.

Our aim in publishing these is to enrich and stimulate thinking and debate about some of the core precepts and goals of industrial strategies. The massive societal impact of the coronavirus pandemic, and the stark geographical divides which it has illuminated, make it all the important that we devise an industrial strategy which can help restore economic growth in the coming years, and generate tangible benefits for all.

Michael Kenny and Diane Coyle
Co-Directors of the Bennett Institute for Public Policy





TACKLING THE HOUSING CRISIS THROUGH DIGITAL TECHNOLOGIES AND OFFSITE MANUFACTURING

Key advice

- The UK house building industry consistently fails to deliver enough new homes to meet need and there is consensus that we have a housing crisis. The Industrial Strategy emphasises the need for a shift from conventional housebuilding methods towards more innovative approaches if the crisis is to be tackled.
- Digital technologies, e.g. Building Information Modelling (BIM) and offsite manufacturing (OSM) should be part of the package of measures to tackle the housing crisis. Combined, these innovative approaches to construction should provide benefits across the design, construction, management and maintenance of housing in the UK.
- We need to understand and address the key organisational, regulatory, individual and industry related constraints holding back the uptake of these innovations in the housing sector. The reasons identified for this low adoption are related to costs, funding availability, lack of evidence to support investment decisions, a lack of regulation, the fragmented nature of the housing sector and its supply chain models, a lack of innovation champions, and consumer mistrust for 'prefab'.

OVERVIEW

It is well known that the UK is grappling with a housing shortage. Insufficient numbers of new homes are built each year and the UK continually fails to meet the demand for new and, in particular, affordable housing. The insufficient supply of new housing to meet the needs of the UK population contributes to worsening housing affordability, growth of the insecure private rented sector, a decline in home ownership, increasing waiting times for social housing, and exacerbates homelessness. There is strong consensus that we need to build far more new homes than we have delivered over the past two decades. A preference for conventional construction methods contributes to the inability of the housing sector to meet the supply need of 300,000 units per annum (DCLG, 2017). Challenges facing the construction industry – including low productivity, fragmented supplier networks, lack of collaboration, labour shortages, an ageing workforce, and failure to embrace new technologies – further exacerbate the housing crisis (Burgess, Jones & Muir, 2018).

The recent Industrial Strategy (HM Government, 2018) emphasises the need for a shift from conventional housebuilding towards more innovative approaches if the crisis is to be tackled. The call for innovation in the housing sector is linked to the government's vision to transform construction into "a sector

that can build new homes in weeks – and even days – rather than months; that can deliver new buildings at a third of the cost; that can provide affordable, energy efficient homes" (p.3). To this end, the Industrial Strategy (IS) places digital technologies, e.g. Building Information Modelling (BIM) and modern methods of construction (MMCs) - specifically offsite manufacturing (OSM) - at the centre of solutions to tackle the housing crisis. Combined, these innovative approaches to construction should provide benefits across the design, construction, management and maintenance of housing in the UK. However, despite the promotion of these technical solutions, their uptake in the housing sector remains low.

This paper discusses the supply shortage, poor quality and maintenance issues related to the UK housing crisis, and illustrates how OSM and BIM hold the potential to tackle the crisis. It identifies the key organisational, regulatory, individual and industry related constraints holding back the uptake of these innovations in the housing sector. The paper highlights areas for policy attention and makes several recommendations to drive innovation in house building to ensure that the aspirations of the IS are met. In line with the broader transformation agenda envisioned in the IS, mandating the use of OSM and digital technologies for housing development remains a viable policy initiative to create the needed 'push' towards significant

change in the house building sector. Stakeholders in the housing industry need to use exemplary housing projects to create more awareness about the benefits of using innovative technologies in order to potentially reduce scepticism among developers and home buyers and boost investment confidence among lenders. Identifying and backing innovation champions in the housing sector would support their efforts at achieving sector-

wide transformation through the use of OSM and digital technologies. Organisations in the housing sector intending to embark on their innovation journey should endeavour to develop transition strategies that include employee upskilling and provide clear assurances about job security.

The UK housing crisis

The UK has a historical under-supply of housing and there is a need to increase house building rates (Burgess et al., 2018). The Government's aspiration is for the housing market to deliver 1.5 million homes by 2022 and 300,000 homes per year on average by the mid-2020s. Current home-building rates are just half of the 300,000 required annually and as such are insufficient to meet the accumulated need (HM Government, 2018). The supply shortage contributes to making housing less affordable, sustaining the rise of the relatively insecure private rented sector (PRS) and decline of home ownership, and increasing waiting times for social housing.

The quality of housing, linked to how homes are designed and built, is another aspect of the crisis. The conventional design process is usually fragmented, with different professionals (e.g. architects, structural and electrical engineers) providing input at different stages. Designs are consequently problematic, with clashes remaining undetected until construction begins. The construction of the majority of dwellings follows 'traditional' techniques that involve the assembly of several components (e.g. bricks, windows and door sets, etc.) in an open-air environment by multiple trades and subtrades (MHCLG, 2019). The involvement of several subcontractors in the construction process often leads to increased reworking due to on-site rectification of design problems and poor inter-trade coordination, and thus contributes to overall poor quality.

With the UK having some of the oldest housing stock in Europe, adequate maintenance is important to ensure that existing housing is safe to live in and of a decent standard. Poor maintenance of housing in the UK contributes to around 15 million people living in poor housing, accounting for about 70% of health service costs (DCLG, 2017). The Grenfell fire

tragedy in 2017 claimed over 70 lives and was followed by the Independent Review of Building Regulations and Fire Safety, led by Dame Judith Hackitt. Its purpose was to make recommendations that will ensure a sufficiently robust regulatory system for the future. To help tackle the poor management and maintenance of housing, the report highlighted the need for a 'golden thread' of detailed data and information for built assets (2018). For new build housing, BIM offers an opportunity to create, store and share data and information to ensure their effective management and maintenance in the future.

One of the consequences of the coronavirus (Covid-19) outbreak in the UK is that the negative impacts of the housing supply shortage and of poor quality and sub-standard housing maintenance have been compounded and magnified, making the need to turn to innovative ways to tackle the crisis more pressing than ever. People who have to live in overcrowded housing conditions are at risk of quickly contracting the illness if a person in their household is infected, in addition to the mental strain of enduring lockdown in poorly built, badly maintained homes. With Covid-19 impacting economic activities, people who have lost their sources of income will face increasing hardship in renting any form of decent housing in an expensive and unregulated PRS. Government directives to tackle the spread, including prolonged weeks of lockdown, have meant that non-critical construction sites, including those for housing development, have been put on hold. Already, under normal circumstances, supply is only half of what is needed to meet the housing shortage (DCLG, 2017). If reliance on conventional construction techniques for housing continues once the Covid-19 pandemic is over, the supply gap can only worsen – alongside the negative impacts of poorly built and badly maintained housing.

Tackling the crisis through digital technology and offsite manufacturing

In recent years, the housing supply shortage, along with concerns about quality, poor management and maintenance, have led to a resurgence of interest in the possibility that the application of digital technologies and off-site manufacturing (OSM) might offer solutions (cf. NHBC, 2016; 2019; HM Government, 2018).

OSM is a manufacturing-based approach involving the production of components of buildings (e.g. foundations, roof cassettes, walls, floors, kitchen and bathroom units), or whole (modular) units of a dwelling, in a factory for installation in their final positions on a site (cf. Goodier and Gibb, 2007). This high-precision, factory-based approach for construction is well-positioned to be used to provide increased numbers of new-build housing units that are of high quality and at a fast rate.

Digital technologies (e.g. BIM, geographic information systems (GIS) and 3D printing) are becoming more widely used in construction. BIM, a computer-based object modelling technology, in particular, is widely used in the UK (HM Government, 2018). By employing digital technologies in housing construction projects, design problems can be detected and eliminated in the virtual environment, preventing time-consuming, costly reworking on site. This technology provides a rich source of comprehensive, 'as built' data and information about building components and installations, and this can be integrated into central management systems to support maintenance related decision-making for assets (Abandah et al., 2017).

The combined use of BIM and OSM holds significant potential for tackling the housing crisis. With housing representing 53% of all repair and maintenance work by value (ONS, 2019), and the NHBC paying £85m annually to rectify defects in new build homes (NHBC, 2019), significant value could be realised through increased uptake of digital technologies and OSM. The ability of BIM to ensure quality design, eliminate defects through object modelling and analysis, and provide a data source for each component in a building will help to tackle the problems of poor quality in housing, and will provide the data and information needed to enable better maintenance and management. Using BIM designs in the manufacture of housing components or whole modular units will help to produce better quality housing at faster rates, increasing supply and potentially making new homes cheaper to produce. The factory-based nature of OSM will also lead to higher precision in construction, again eliminating time-consuming and costly reworking on site.

Constraints on the uptake of OSM and digital technologies in the housing sector

Despite the potential benefits that the housing sector stands to gain from the adoption of OSM and digital technologies, our research shows that there is limited adoption of such innovations as a result of a number of industry constraints. These are not technical in nature, but rather are a series of social, economic and cultural issues that hinder the uptake of BIM and OSM in the sector. Unless such non-technical constraints are addressed, the aspirations contained within the Industrial Strategy for digital innovation to help solve the UK's housing crisis are unlikely to be realised.

High upfront costs and the cost of borrowing are two major commercial and financial constraints to organisations in the uptake of BIM and OSM in the housing sector. These issues remain because of the lack of robust evidence to support investment decisions. The high cost of investment required to adopt OSM and digital technologies is a major barrier to

their uptake in the housing sector. Off-site housing production needs large up-front investment (e.g. establishing a factory) and this often deters housing developers who are primarily interested in continuously reducing costs and increasing profit. With traditional methods suiting their commercial interests, there is no incentive to incur costs by shifting towards innovative but initially costly approaches. Organisations in the housing sector wanting to use OSM and digital technologies often find that the necessary finance is too expensive and can be difficult to access, meaning that the cost of borrowing to fund investment in innovations is deemed too high. Lenders are also less willing to provide finance for developers and contractors who want to use these innovative approaches as, unlike the 'tried and tested' conventional approaches currently used in the housing sector, they are deemed to be high risk. The scepticism is not limited to lenders only. Across the sector, it is sustained by the lack of robust evidence to quantify the benefits of the use of OSM and digital technologies, particularly short and long term cost savings, discouraging house builders from investing in their uptake. Without robust evidence, developers are not well-informed about the long term benefits of OSM and digital technologies that could accrue to them and to wider society. Furthermore, since developers do not always have a vested interest in the additional value of lifetime operating cost savings (e.g. energy efficiency savings) to be gained from using OSM and digital technologies in housing construction, there is no motivation to invest in their use. In particular, where housing is sold on the housing market, there is no incentive to bear the upfront cost of investment, as future benefits will follow the homeowner. Although some large developers and housing associations have made investments in the use of these innovations, there is not yet sufficient evidence to demonstrate clear commercial gains from OSM and digital technologies over the use of traditional approaches, given the significant boom in profits in the housing sector over the last decade.

Structural constraints to the widespread use of OSM and digital technologies in the sector relate to how the housebuilding industry traditionally functions, the nature of preferred business and supply chain models used in the sector and the lack of regulations to govern the use of these innovations. The house building industry operates on a location-based model with a fragmented, flexible supply chain that is able to accommodate late, on-site, design alterations. The low level of coordination and complex, highly localised supply chains pose a barrier to the implementation of BIM across the multiple supply chains found in housing construction. Furthermore, the use of OSM will require a significant paradigm shift towards more collaborative procurement routes, highly coordinated design processes and early-stage design finalisation. The Construction Leadership Council (2017, p.6) observes that for many housing developers, their existing business models are at odds with anything 'modern' or 'innovative', and 'housing completions are typically slowed to match the rates to maintain desired sales prices'. This model relies on a supply chain comprising multiple actors (developers, contractors, lenders, etc.) who are bound by various contracts that tend to

promote adversarial relationships, a lack of trust, and an aversion to risk (cf. Farmer, 2016). This supply chain model does not support the collective risk-taking and collaborative working needed to embrace innovation. Since the current industry model serves the commercial interests of developers, there is no incentive to build faster or at scale given that this would potentially lower prices and consequently profits. With developers continuing to make financial gains from the existing operating model of the industry, there is little motivation to shift towards innovations that will require changes to current ways of working.

At the organisational level, resistance to change among individuals and leaders, as well as the absence of strategic vision and innovation 'champions' in organisations, remains one of the most significant constraints to the uptake of OSM and digital technologies in the housing sector. The use of these innovations would require organisations to develop relevant new capabilities in order to support their deployment. Employees' resistance is linked to fears of job or status loss, and a lack of understanding about the new technologies. These fears reinforce organisational resistance to the adoption of OSM and digital technologies. Skills shortages, both for house builders and their numerous suppliers, are also barriers to the adoption of digital technologies. Employees may not have the required level of digital literacy to implement and use BIM systems, and the training process can be time-consuming and expensive.

The UK consumers' negative view of housing built using OSM, based on mistrust of 'prefab' housing acts as a demand side constraint inhibiting the wider use of OSM in the sector. This mistrust lingers from the Post-War housing boom, where the pressing need for the provision of housing promoted the use of prefabricated homes which later collapsed (causing death and injury) or were demolished (leading to homelessness and financial losses for families). A cultural preference for traditionally built 'bricks and mortar' homes still exists, reinforcing the belief that OSM-produced houses are somehow inferior. With the preference for conventionally built housing remaining high, developers have little motivation to introduce OSM.

Conclusion

The historical undersupply of new housing stock, low quality new-builds, and poor maintenance and management of the existing stock are all real problems that need to be tackled in order to solve the housing crisis in the UK. Offsite manufacturing and digital technologies have been identified as holding the potential to help tackle the problems underpinning the crisis. Combined, these innovations can ensure more rapid construction of higher quality housing and provide a 'golden thread' of information needed for effective management and maintenance of housing going forward. Notwithstanding these benefits, the uptake of these innovations in the housing sector is low. The reasons identified for this low adoption are related to costs, funding availability, lack of evidence to support investment decisions, a lack of regulation, the fragmented nature of the housing sector and supply chain models, a lack of innovation champions, and consumer mistrust for 'prefab' housing.

To achieve the housing related vision set out in the recent Industrial Strategy and adequately tackle the crisis, mandating the use of OSM and digital technologies for housing schemes of specific sizes remains a possible policy initiative to promote increased uptake of these innovations in the housing sector. Lessons learnt from the government's implementation of the 2016 BIM mandate for the construction industry could provide some guidance in rolling out a directive tailored specifically for the housing sector. At the sector level, increasing awareness of OSM and BIM from exemplary housing projects would help to provide an evidence base to demonstrate their immediate and long-term benefits. This could help to overcome stakeholder scepticism and encourage developers to invest in the use of such innovations. Developing an evidence base has the potential to boost confidence among lenders, encouraging them to finance housing projects that employ similar innovative approaches.

Innovation champions, including the cross-industry group BIM4Housing, need strong sector backing to boost their efforts to rally stakeholders in the industry and promote the benefits of OSM and BIM innovations. At an organisational level, the identification by strategic decision makers of individuals to champion their innovation journey through incremental adoption and use of OSM and digital technologies would bring similar benefits. In taking steps to adopt OSM and digital technologies, leaders of organisations in the housing sector should endeavour to roll out plans that will provide the opportunity for their employees to be upskilled. Organisations also need to highlight provision for the training and support necessary to align existing roles with new technologies, providing explicit assurances for employees that innovation will not lead to job losses.

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