MADE FOR LONDON: REALISING THE POTENTIAL OF MODERN METHODS OF CONSTRUCTION

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ACCOMMODATING GROWTH

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Foreword

Neil Martin, Managing Director, Construction, Europe, Lendlease

The shortage of housing of all tenures across London remains one of the biggest challenges facing our industry today. We are not delivering the targets set out by the London Plan, and local authorities are consistently failing to meet their own housing ambitions.

The construction industry must take some responsibility for this - our own methods have held us back. From the unrest of Brexit, to an ageing workforce, the causes of slow delivery aren't simple. We know there are also issues with build quality and costs, so what must we do to improve?

This report suggests that we look to Modern Methods of Construction (MMC) for the answers. MMC such as off-site manufacturing can reduce the time we spend on site, therefore significantly reducing build costs. Off-site manufacturing in a factory environment not only achieves the cost-savings and time efficiencies we need, but can also improve safety, reduce waste and minimise the stop-starts caused by external issues such as weather. In short it enables us to plan more meticulously and gives us more power over our schedule.

However, realistically, we are not yet in a place where MMC are fully incorporated into our plans or entirely trusted. There are still issues of buy-in from stakeholders, who – like us – have become used to the old methods, and while there is appetite for innovation, no single company is an undisputed expert in the field. These factors, unsurprisingly, do little to reassure funders or insurers, which is possibly why in 2015 little more than 10 per cent of new homes were constructed using modular techniques. As with all industries, the more niche something is, and the more sporadically it is done, the slower the growth and the costlier it is. Which means the potential cost-saving is not delivered.

The opportunities to improve our delivery are there, but we need to work together to make them a reality, and we'll have to bring all of our stakeholders with us to see a real transformation.

List of acronyms

- Buildoffsite Property Assurance Scheme **(BOPAS)**
- Construction Industry Training Board **(CITB)**
- Cross-Laminated Timber **(CLT)**
- Design for Manufacture and Assembly **(DfMA)**
- European Union **(EU)**
- Fine particulate matter **($PM_{2.5}$)**
- Greater London Authority **(GLA)**
- Large particulate matter **(PM_{10})**
- Mayor's Construction Academy **(MCA)**
- Ministry of Housing, Communities & Local Government **(MHCLG)**
- Modern Methods of Construction **(MMC)**
- National House Building Council **(NHBC)**
- Nitrogen Oxide **(NOx)**
- Nitrogen Dioxide **(NO_2)**
- The Pan-London Accommodation Collaborative Enterprise **(PLACE)**
- Science, technology, engineering and mathematics **(STEM)**

Summary

The Mayor of London's most pressing priority is to increase the availability of quality, affordable homes for Londoners. The causes of slow housing delivery are manifold, but construction methods are one of the stumbling blocks that have hindered housing delivery in London.

This research considers how innovations in housing construction and manufacturing could improve the speed, scale, and quality of housing delivery across the capital, taking into account London-specific challenges. It also outlines how the potential of Modern Methods of Construction (MMC) in the capital could be realised.

London faces huge challenges in improving the quality and quantity of homes for Londoners…

- Housebuilding has not kept up with housing targets set in successive London Plans.
- The current construction model is often criticised for its build quality, environmental impact, and cost.

…and these challenges are likely to be exacerbated by growing skills shortages in the future.

- The UK construction workforce is ageing, and in London the industry is particularly reliant on European workers.
- More workers are leaving than entering the profession, and take-up of apprenticeships is low.

MMC have the potential to enhance the speed, cost and quality of housing delivery…

- Off-site manufacture can achieve faster delivery on-site than traditional construction—in about two-thirds of the time.
- Improved efficiencies in the manufacturing process and reduced construction time can drive cost savings.

- Manufacture in a factory environment (in London or beyond) can mitigate the risk of poor weather hampering construction time, as well as providing tighter controls and oversight – meaning a more precise and more consistent build quality.

...but the MMC sector is still in its infancy.

- In 2013, seven per cent of the UK's construction output was from off-site construction.

- There are no specific figures for London, but MMC processes are being used by developers, housing associations, councils, and new entrants such as institutional investors.

- The wide range of approaches adopted partly results from site conditions defining the construction method, but also reflects the fact that the sector is still in an early phase of the industrial innovation cycle, with many manufacturers and technologies vying for market position.

A number of barriers are impeding the growth of the MMC sector.

- The novelty and variety of developments using MMC means that warranties, insurance, development finance and mortgages can be hard to secure.

- The MMC sector will require volume and continuity of demand in order to become more established and realise efficiencies, but both the wide variety of products and the relatively small number of clients is making it hard for manufacturers and developers to scale up.

- MMC is struggling to shake off negative public perceptions, and its use does not always sit easily with local planning policies.

If MMC is to be part of the solution to London's housing affordability crisis, a step change is required – to develop skills, improve supply chains, promote the potential of MMC, and ensure supportive policy and financing structures.

1—The **Mayor** should consider how to use devolved skills funding to help existing construction workers develop the skills needed to implement MMC, in the context of a growing commitment from City Hall to deliver MMC homes at scale across London.

2—To build capacity and realise economies of scale, **housing developers and construction companies** should commit to increasing adoption of MMC throughout their supply chains.

3—Faced with construction workforce challenges in London, **developers and industry bodies** should invest in upskilling workers for the transition to MMC.

4—**Councils and housing associations** (with support from the Mayor and government) should pool expertise and purchasing power to form an MMC buying club. This would allow them to build at scale across multiple London boroughs, thereby helping sustain levels of factory production.

5—**Housing providers and the Mayor** should set up an exhibition to bring the industry together and showcase examples of well-designed modular housing and high-quality placemaking.

6—The **Mayor** should use this exhibition as a platform to discuss what can be achieved through his proposed common design framework, and encourage its widespread use as an open source tool for residential developers and manufacturers.

7—The **Mayor and partners** should commission further research on customers' perception of MMC.

8—**Mortgage providers** should offer preferential loans for energy-efficient MMC homes.

9—**Councils** should include a general statement supporting MMC in local plan policy, and identify small sites for SME builders.

Introduction

The Mayor of London's most pressing priority is to increase the availability of quality, affordable homes for Londoners. The draft New London Plan released in December 2017 has set out an ambitious target of 65,000 homes built each year from 2019. This target reflects the need to keep up with London's projected population growth, but also the need to accelerate the present rate of housing delivery, with only six boroughs having met the homebuilding targets set by the previous London Plan.[1]

The causes of slow housing delivery are manifold, and the draft New London Plan has identified both where we build (i.e. the land, development and planning decisions which have been the subject of much research) and how we build (i.e. whether current development models and construction methods enable delivery at speed, quality and quantity) as being among the stumbling blocks that have hindered housing delivery in London.

This report looks at how we build, and specifically at construction methods. The UK's housebuilding sector has been very slow to innovate, compared both to other sectors and to other countries. We still build homes using labour-intensive methods of bricks and mortar, while construction elsewhere has been characterised by rapid change and radical innovation. But with consistent demand for traditionally built houses, volume housebuilders have had little incentive to do things differently.

All this may be set to change for a number of reasons. As London's housing crisis has intensified, homes are being built by new entrants to the market – including commercial developers, build-to-rent investors and local authority companies – who are less wedded to traditional methods and have tangible incentives to innovate. As targets have risen, more attention is being focused on the speed of construction and build-out rates. The industry also faces a capacity crunch, with a third of its London workforce from continental Europe and 12 per cent of the London workforce due to retire in the next five years. Finally, technology is advancing

rapidly, with a widening range of off-site modular and component-based techniques being piloted and adopted. Modern methods of construction (MMC) in housing are coming of age.

This report looks at the potential for innovation in London housebuilding, as well as the interaction between innovative construction approaches and different types of site. Our research considers how innovations in housing construction and manufacturing could improve the speed, scale, and quality of housing delivery across the capital, taking into account London-specific challenges. Building on 18 one-to-one interviews with key stakeholders in the industry – including developers, housing providers, architects, planners, construction consultants, academics, investors and other finance providers – it identifies the roadblocks to innovations being adopted on a wider scale. It also makes recommendations to London's boroughs, the Greater London Authority (GLA), central government, and industry.

Chapter 1 discusses the current challenges faced by London's housebuilding sector, including the slow delivery and poor quality of some homes, as well as workforce pressures. Chapter 2 outlines the size and scope of different technologies available, the advantages that their increased use could bring, and the increasingly supportive policy environment. Chapter 3 outlines the level of MMC use in London, looking more closely at challenges specific to the capital, whereas Chapter 4 identifies the barriers currently hindering the increased use of MMC. Finally, Chapter 5 summarises our findings and sets out recommendations for central government, the GLA, London boroughs and industry professionals.

1. Context: stepping up housing quantity and quality

This chapter examines the housing and construction challenges currently facing London – challenges that could be mitigated by the wholesale adoption of MMC by London's housebuilders. We also consider workforce factors that are likely to worsen the situation.

Housing challenges

Slow delivery

London needs to step up housebuilding. In order to meet the targets set by the Mayor's draft New London Plan, the capital needs to deliver at least 65,000 new homes a year across London from 2019.[2]

Disparity between housing need and housing supply is worsening the capital's affordability crisis. In the last two decades from 1997 to 2016 the number of jobs in London has grown by 40 per cent and the number of people by 25 per cent, but the number of homes has grown by only 15 per cent.[3] Most of the need is for housing that is affordable to Londoners on modest wages, and recent research estimates that 58 per cent of need is for homes costing less than £450 per square foot.[4] However, only 6,863 affordable homes were delivered in the year to end March 2018 (though starts rose sharply).[5]

Planning is also running ahead of construction. In 2014 permission was granted for nearly 55,000 homes in London, but in 2017 fewer than 30,000 homes had been built or were under construction – an attrition rate of 46 per cent.[6] The independent review for central government into the gap between planning permissions and construction (led by Sir Oliver Letwin) argues that the rate at which newly constructed homes are believed to be sellable into the local market without distributing the market price – known as the "absorption rate" – is fundamental to build-out rates.[7] In order to accelerate the slow rate of housebuilding on major sites in the capital, Sir Oliver's interim report recommended that developers on large sites build a mix of tenures – including more affordable homes and a wider range of home types and sizes – to enable faster absorption.[8]

Poor quality

Furthermore, many of the houses that are being built are of unsatisfactory quality. A recent customer satisfaction survey carried out by the Home Builders Federation (HBF) and the National House Building Council (NHBC) found that 93 per cent of homebuyers report snags or larger defects to their housebuilder after moving in – and of these, 35 per cent report 11 or more problems.[9] Recent news coverage has shined a light on the concerns of homeowners and has highlighted common complaints about workmanship, including issues with masonry, unfinished fittings and faults with utilities.[10] Many housebuilders blame workforce challenges for the increasingly poor quality of new house builds. A recent survey found that 58 per cent of all supplier and contractor respondents said skills shortages contributed to the poor quality of workmanship in the construction industry.[11]

Financial and environmental costs

The current construction model is costly. Despite a slowdown in London construction price inflation, the capital still ranks as the fifth most expensive place to build globally, with skills shortages identified as the principal driver of high costs.[12]

Traditional construction is also a significant—but often overlooked—contributor to poor air quality, with severe environmental and health impacts. The London Atmospheric Emissions Inventory has identified construction sites as responsible for approximately 7.5 per cent of nitrogen oxide (NOx) emissions, 8 per cent of large particle emissions (PM_{10}), and 14.5 per cent of emissions of fine particles ($PM_{2.5}$) – the vast majority of which originate from diesel vehicles and machinery[13]. Research by King's College London found that in 2010 there were the equivalent of 9,500 premature deaths across London associated with the two pollutants of most concern – $PM_{2.5}$ and nitrogen dioxide (NO_2).[14]

Workforce challenges

Converging workforce pressures mean that construction in the capital faces a growing skills shortage and lacks the capacity to increase housing supply as fast as is needed. Skills shortages resulting from an ageing workforce are being exacerbated by the lack of new workers entering the profession. Reduced migration resulting from Brexit would be a compounding factor.

Skilled workforce shortage

The construction industry is struggling to attract and retain the workers required to alleviate its skills shortage, and ultimately deliver the quality and quantity of houses that London requires.

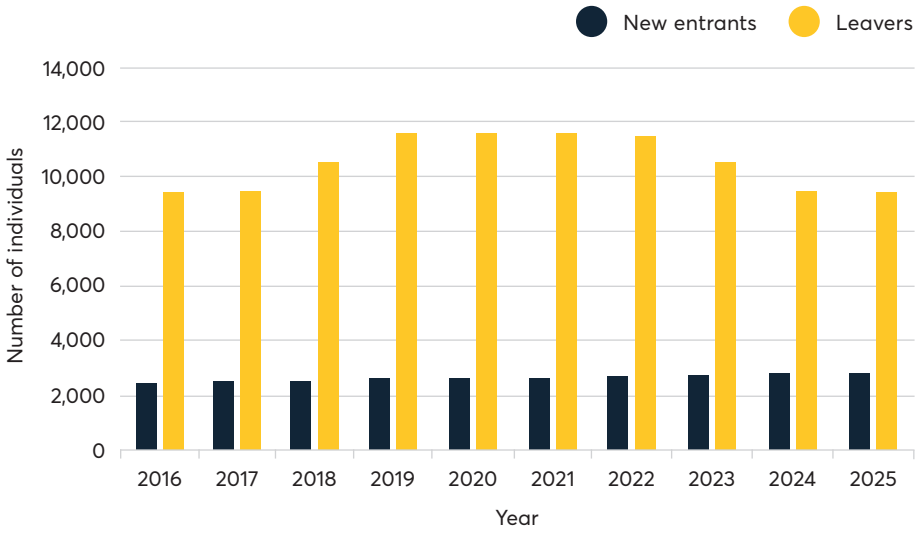
To meet London's housing demand, a capable and available workforce is needed. In many on-site occupations, demand outstrips levels of current employment. Recent findings by the GLA indicate that across the whole of Greater London, the construction occupations facing the greatest skills shortage are all on-site trades, namely plant mechanics, scaffolders and bricklayers. According to their calculations, demand in all three occupational areas in 2017 exceeded 300 per cent of 2015 employment levels.[15]

In its interim report, the Letwin Review found that most bricklayers in the construction industry are already employed on housebuilding projects, raising questions of how build-out rates can be increased using current construction methods. Furthermore, the tightening of the construction skills market – characterised by a growing skills shortage and increasing cost of contracting labour – is a key driver behind build-cost inflation in the capital.[16]

Retirement and departure

The strength of London's construction industry is being further weakened by an ageing workforce – 12 per cent of London's construction workers are due to retire in the next ten years.[17] In 2017 twice as many workers left the construction industry as joined it (see Figure 1), and this ratio is projected to worsen over the next few years.[18]

Figure 1: Housebuilding sector: New entrants and leavers



Source: The Farmer Review of the UK Construction Labour Model, 2016

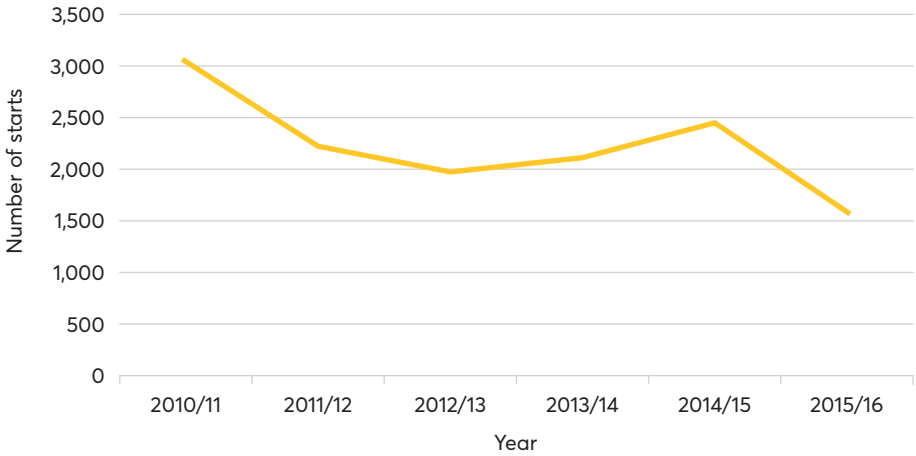
The skills shortage associated with the industry's ageing workforce is likely to be compounded by a reduction in the number of migrant workers in the capital, as the UK prepares its departure from the European Union (EU). This is a particularly acute challenge for London: EU nationals account for 33 per cent of the construction of buildings workforce, compared to only 10 per cent in the rest of the UK.[19] Of greater concern is that a disproportionate number of London's skilled on-site workers are from overseas, including 70 per cent of carpenters.[20]

Low take-up of construction apprenticeships

To meet these challenges, London's construction industry will require a pipeline of younger, skilled employees. Despite the introduction of the Apprenticeship Levy in April 2017, there are growing concerns that government initiatives are failing to encourage the scale of construction apprenticeship starts necessary to prevent a growing skills shortage. London is a consistently low-performing region in

England for apprenticeship starts in the construction sector[21] and has a wide gap in gender participation, particularly at levels of advanced skill, with no women taking a high-level apprenticeship in construction in the capital in 2015/16.[22] The number of apprenticeship starts in construction, planning and the built environment in the capital has declined by almost 50 per cent in the five years to 2016 (see Figure 2), even as need has intensified.[23]

Figure 2: Apprenticeship starts in construction, planning and the built environment in London, 2010/11 to 2015/16



Source: Department for Education and Education and Skills Funding Agency (July 2018). Apprenticeship Programme Starts by Geography, Age and Level

Recent research by the Construction Industry Training Board (CITB) found that 34 per cent of apprenticeship leavers surveyed cited low pay in the construction industry as a reason for choosing to leave the sector, in addition to 34 per cent feeling that career development would be too slow.[24]

Retrofitting existing homes via traditional construction will take up capacity

To make matters worse, London's housing stock is ageing, and in coming years its repair and upkeep will place yet more demand on the skills of the traditional construction

workforce. Fifty-five per cent of London's homes were built before World War Two.[25] The evidence base for the Mayor's Housing Strategy estimates the total cost of meeting the basic repair costs to be £6 billion, with £4.6 billion of this to be spent on homes built before the end of World War Two.[26] Older homes require more repair and maintenance than new build properties; repair and maintenance of properties in Greater London accounted for over a quarter of output in the construction industry in the year to mid-2018.[27]

London's need for a step change in housing delivery is at its highest for decades, but there are both systemic and workforce challenges to meet. Current construction models are often criticised for their environmental impact and build quality. They are not easily able to accelerate delivery in current market conditions, and in any case, a shortage of workers with the necessary skills is likely to limit any attempts to do so. The next chapter considers how modern methods of construction can help meet these challenges.

2. Building better: the role of Modern Methods of Construction

What are Modern Methods of Construction?

MMC is an umbrella term used to describe a number of different modern construction methods. Other terms used to describe MMC (or specific types of MMC) include:

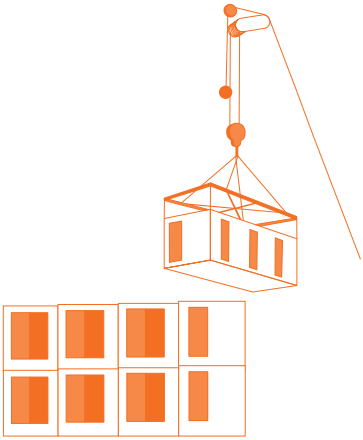
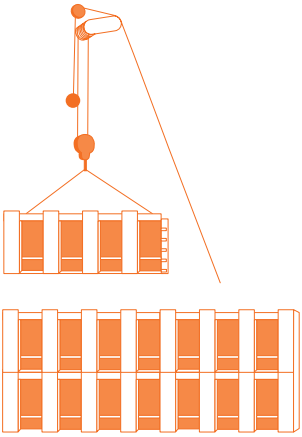
- Off-site construction
- Off-site manufacture
- Precision manufactured housing
- Modular construction
- Smart construction
- Prefabricated housing

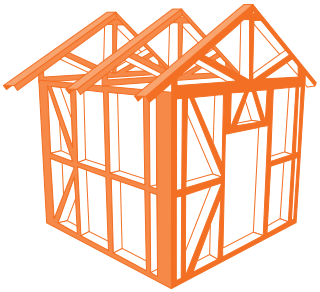
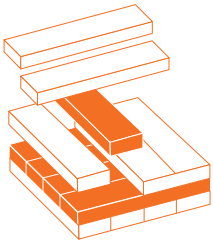
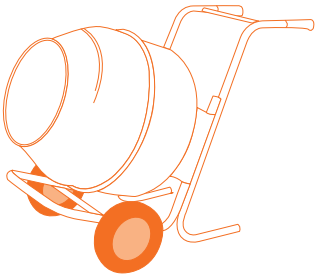
MMC involves the manufacture of housing from modular units or significantly scaled components, often using precision digital design for manufacturing techniques in off-site locations – in contrast with traditional construction where bricks, timber, raw concrete and structural elements are assembled on-site. MMC utilises many different technologies, the application of which varies according to site constraints and the requirements of the housebuilder, as well as access to resources and finance.[28]

While many traditional housebuilders use some elements of MMC (such as bathroom pods), this report will focus on developments that are fully manufactured off-site, rather than those with some sub-modular components.

The raw materials used in MMC are similar to those used in traditional construction, but MMC systems normally involve replacing the inner concrete block with a frame (either timber or steel) or with precast concrete. Cladding finishes tend to be completed on-site in a traditional manner.[29]

Types of MMC

Off-site manufactured:	
Volumetric	3D units constructed off-site, fully or partially fitted. Transported on to site and stacked onto each other on pre-prepared foundations. Most efficient when used for large numbers of identical units. 
Panellised systems	Panellised systems come through combining a number of different systems and material types, including: • **Closed systems:** Factory-fitted windows, doors, fixtures and fittings manufactured with external cladding. The entire assembly and sealing of closed panels is undertaken off-site. 

Off-site manufactured:	
Panellised systems	• **Open systems:** Skeleton frames of timber or lightweight steel. Open panel systems are manufactured in a factory environment and transported onto site. 
	Cross-laminated timber (CLT) • Off-site manufactured solid panels, engineered by laminating lengths of timber with adjacent layers. Each layer is laminated together with grain directions perpendicular to one another. 
	Precast concrete • Precast concrete is concrete that is cast off-site into panelised forms, to be transported onto site when required. 

Off-site manufactured:	
Hybrid	Volumetric units integrated with panellised systems
Pods	Pods are similar to volumetric systems – fully fitted 3D units constructed off-site, and most efficient when used for large numbers of identical components. Most commonly used for bathrooms or kitchens. Pods can be surrounded by a steel, concrete or timber frame.
On-site manufactured:	
	Innovative methods of construction are also used on-site. For instance, construction firm Mace has developed and used an on-site "jumping" factory in the construction of their 30-storey residential development in Stratford. The factory is built around the perimeter of the new building, which is constructed floor by floor. Once a storey is completed, the factory is "jumped" up to the next storey using a series of hydraulic jacks and steel brackets. (The third annual survey of UK housebuilding by Lloyds Bank revealed that 61 per cent of housebuilders were investing in site-based MMC.[30])

Design for Manufacturing and Assembly

The digitalisation of the design process can allow for significant savings in both time and cost, as well as greater precision. Design for Manufacture and Assembly (DfMA) approaches that are commonplace in the aircraft and car industries are increasingly being employed by those in the MMC sector to assist with designing for manufacture.[31] For instance, Laing O'Rourke's DfMA approach has been used by London's off-site construction sector to ensure ease and efficiency of housing assembly.

Potential advantages of MMC

Proponents of MMC approaches often hail their advantages compared to traditional construction, whether due to reduced timescales, improved energy efficiency or lower build costs.[32] This section looks at these arguments more closely.

Speed

Off-site manufacture can achieve faster delivery on-site than traditional construction, once planning permission has been obtained. Research by AECOM indicates that projects using exclusively MMC can be constructed on-site in less than half the time of traditional schemes.[33] Our interviewees estimated that an MMC project can be completed in two-thirds of the time when accounting for manufacturing, site preparation and assembly. Other sources estimate that construction time for volumetric MMC schemes is 50-60 per cent that of traditional methods, compared to 30-40 cent for hybrid construction, and 20-30 per cent for panelised construction.[34]

Although take-up is still limited, the speedier project completion afforded by MMC could make it a particularly attractive option for those seeking to minimise the time-cost of being on site and who are constrained by industry capacity to build out at pace. Examples might be housing associations, boroughs and local housing companies, build-to-rent investors and other developers building for the rental market. By contrast, private developers who are constrained by the "absorption rate" of their product may find this prospect less enticing, potentially slowing adoption.

Cost

Time is also money: the rapid nature of MMC project completion makes it particularly attractive to those in the build-to-rent sector – who can receive rental income faster – as well as developers who took out loans to fund the cost of land and construction in terms of interest.

Improved efficiencies in the manufacturing process and reduced construction time should therefore drive important cost savings. As well as costs being easier to predict, government has estimated the cost saving of MMC at 10 per cent.[35] Although the capital costs may not be less than on-site constructed projects, there may also be accumulated savings from earlier receipt of rent, as well as reduced waste and maintenance costs.

That said, the cost of MMC currently remains particularly high, owing to the limited number of manufacturers, the immaturity of the supply chain (discussed in Chapter 4), and the need to recoup initial research and design costs by many housebuilders. Although a government Housebuilding Fund has been established to help housebuilders secure loan finance, the high setup costs incurred during the research and design process can also act as a deterrent to manufacturers and SME housebuilders wishing to adopt MMC techniques (as discussed in Chapter 3).

Yet, with a growing skills shortage in the construction industry and higher than average labour costs in the capital – both of which are likely to increase the costs of traditional construction faster than MMC – the cost savings and certainties of MMC are likely to become even more appealing over time, particularly for the increasingly important build-to-rent sector in London.

Tight coordination, consideration and planning is required early in the project timeline to benefit from the cost and time savings that MMC can provide – though this also reduces the flexibility to respond to market changes, to which many traditional developers have become accustomed.

Reliability

At present, the MMC industry lacks quantified evidence to compare the improved quality benefits of MMC with traditional building methods in absolute terms.[36] Yet many industry proponents are quick to highlight the potential of design-led MMC to improve reliability. Unlike on-site projects, manufacture in a controlled factory environment can also mitigate the risk of poor weather adding to construction time, affording improved cost certainty and accuracy.

The tighter controls and oversight afforded by a factory environment in which production is standardised should also result in more precise and consistent build quality.

Sustainable use of materials and energy efficiency

Fewer manufacturing defects and less traffic on-site means that a move to MMC can help contribute to a more environmentally sustainable construction industry that is less disruptive for local communities.

MMC also generates less raw material waste than traditional forms of construction, owing to its precise and standardised engineering process. The extent of waste reduction varies depending on the type and scale of MMC used; some estimates suggest that volumetric MMC building systems can reduce waste to between 50 and 60 per cent of that incurred through traditional building methods.[37] Government figures have estimated the reduction in on-site construction waste to be five per cent when compared to traditional building methods.[38]

The transfer of manufacture to the factory setting can also result in the reduction – some estimates suggest up to 80 per cent – of traffic flows to and from the construction site, minimising the impact of local air and noise pollution and resulting in a safer environment for pedestrians and cyclists.[39]

Precision engineering and manufacturing can also result in homes that are more energy-efficient than buildings erected by traditional methods of construction, thereby passing on cost savings to residents with lower energy bills in the long term.

Job creation and inclusion

Increased take-up of MMC methods may also translate into improved health and safety standards in an industry that many consider to be unsafe. Nationally, 80,000 construction workers suffer work-related ill health each year. Though fully accident-proofing the construction industry is unlikely, MMC can contribute to this by moving manufacturing to a safer factory location, thereby reducing the time workers spend on site.

In addition, the skilled science, technology, engineering and mathematics (STEM) jobs offered by MMC – and a fixed working environment which offers the opportunity for split shifts – could help create a more inclusive workplace by encouraging more women into the

industry. Government data recently revealed that women currently make up only 11 per cent of employees in the construction industry and earn on average 22 per cent less than men.[40]

Policy support

GLA and boroughs

The Mayor's draft New London Plan and Housing Strategy have both expressed support for "precision manufactured housing" (the GLA's preferred term for housing built with MMC) in the capital. The Housing Strategy seeks to promote housing innovation, suggesting that improved construction skills training alongside a shift to MMC can help overcome the constraints of industry-wide skill shortages.[41] In a similar vein, the draft New London Plan backs the use of precision manufactured housing, at all scales, to both speed delivery and minimise waste.[42]

In March 2018, City Hall announced £50,000 of funding to contribute towards the creation of a common framework for delivering MMC homes at scale in London. The remaining costs of the £147,500 project are being met by Legal & General Modular Homes, L&Q housing association, Transport for London, and Greystar (a build-to-rent provider).[43]

The GLA and Londonboroughs are also exploring the potential of MMC to provide affordable temporary accommodation in the capital and maximise the use of available land. The Pan-London Accommodation Collaborative Enterprise (PLACE), backed by 18 London boroughs, London Councils and a GLA grant, is a special-purpose vehicle that plans to procure local-authority-owned MMC homes. The homes are intended to provide temporary accommodation on meanwhile or under-utilised sites.[44]

Central government

Central government has long supported the adoption of MMC in the UK housebuilding industry and in infrastructure project procurement. Most recently, the government showed its support for MMC in the

February 2017 Housing White Paper, which recognised the need for builders using MMC to access finance on the same basis as those building homes traditionally.[45] Correspondingly, the government established a Home Building Fund – a pot of £4.5bn – to help increase the number of new homes.[46] The Fund is intended to offer a flexible source of funding to housebuilders who would have otherwise been unable to secure loan finance to meet the costs of site preparation and housebuilding.[47]

Unlike other countries such as Japan, Germany and Sweden, the UK's MMC industry is still developing, which makes it challenging for housebuilders to derive benefits such as the improved speed of delivery, quantity and quality of new homes in London. The next chapter will look at the current take-up of MMC in London.

3.
Made for London: Modern Methods of Construction in an urban context

This chapter shows that innovative London schemes have started to emerge, but that there are also challenges to the widespread adoption of MMC – such as the lack of standardisation among approaches and, more specifically to London, tightly constrained sites.

Adoption of MMC

Modern methods of construction are only slowly gaining a foothold on UK sites, despite the need to build homes more quickly. Data on the extent of MMC adoption are hard to come by, though a government report suggested that approximately seven per cent of the UK's construction output in 2013 was off-site construction,[48] while figures from 2015 suggest that around 15,000 out of 143,000 homes built were constructed using modular techniques.[49]

As part of our research, we analysed a sample of 14 MMC schemes in London by client, method of construction and contractor. Some schemes have been completed, while others are still underway. As presented in Table 1, the MMC schemes within our sample encompassed a range of different clients, including build-to-rent developers, large and small private for-sale developers, housing associations, and councils. As noted in the previous chapter, some forms of housing have a closer affinity with modular construction techniques owing to their ability to benefit from the speed advantages of MMC, including student housing (where units must be completed before the start of the academic year) and build-to-rent (where a quicker completion of units means more rent for investors). Both types have constituted big growth areas for London in recent years. In addition, local housing companies such as Brick by Brick and BeFirst – which are growing in size as housing providers in the capital[50] – intend to build modular homes as part of their portfolio.

Most schemes analysed have adopted volumetric steel frame and timber approaches, but there is still a wide range of approaches, contractors and manufacturers available. This can be explained with reference to site typology, but also the fact that different clients are

experimenting with different MMC approaches in the capital.

Table 1: Sample of MMC schemes in London

Scheme	Client	Modern Method of Construction	Contractor/Manufacturer
1	Build-to-rent developer	Volumetric/steel frame	Elements Europe
2	Developer	Modular/steel frame	Not known
3	Developer	Volumetric/steel frame	Vision
4	Developer	Volumetric/steel frame	Vision
5	Housing association	Cross-laminated timber, Glulam	Henry Construction
6	Developer	Modular/steel frame	Caledonian Modular
7	Developer/Housing Association	Concrete panels	Laing O'Rourke
8	Developer	Cross-laminated timber	Lendlease Construction (Eurban timber engineer)
9	Council	Volumetric/timber	SIG
10	Developer	Jumping factory/ precast concrete	Mace
11	Housing association	Volumetric/steel frame	Wates
12	Developer	Cross-laminated timber	Ramboll (timber engineers)
13	Developer	Panels with integrated façade	Hurks, Netherlands
14	Developer	Volumetric/steel frame	Ilke Homes

Site typology and MMC

The capital's portfolio of sites is diverse. London has many large sites, which are expected to account for as much as 62 per cent of housing delivery in the next ten years; many are suitable for volumetric construction.

There are also smaller gap and infill sites, where kit-of-parts based approaches might be preferable.[51]

It is clear that different approaches work for different sites, and our interviewees emphasised that site typology and access define the build methodology. Site preparation to receive an MMC structure is often more complex than for traditional approaches, with the need to clear obstructions for the assembly of modules by cranes. Irregular and constrained central London sites present a challenge for the assembly of volumetric modules; similarly, restricted site access for the flat-bed trucks required to transport these onto the site can be an issue. However, there are some examples of successful MMC development on constrained sites. For instance, Pocket Living developed a 27-storey modular tower in Mappleton Crescent, Wandsworth on a constrained site (476 sq m, triangular in shape and bordered on one side by the River Wandle). Each flat was built and fitted off-site, then craned into place at a rate of one storey a day. Panelised homes, where the factory-produced structural components of a home are assembled closer to the construction site, could also answer some of these challenges.

Comparisons with New York indicate similar challenges, but also a similar growth arc for the use of precision manufacturing. Across the USA, take-up of MMC is also slow – currently, only two per cent of new single-family homes are constructed using MMC[52] – but unlike London, New York already boasts several high-density MMC housing developments. The city is home to one of the world's tallest modular buildings at 461 Dean Street in Brooklyn, completed in 2016 and standing at 32 storeys. Designed by Shop Architecture, 50 per cent of the building's 363 units are reserved for low-income residents and will be allocated through a housing lottery.

However, London is catching up: 44- and 38-storey modular towers in Croydon have recently been granted planning permission and will be built by a partnership comprising Greystar and Tide Construction. The towers, at 101 George Street, are planned to be assembled from modules manufactured in Bedford, and are expected

to be completed on-site over a period of 24 months. Also in Croydon, Pocket Living and Optivo housing association have teamed up with Elements Europe to build a 21-storey, 100 per cent affordable modular tower near East Croydon station.[53]

Where should we manufacture homes for London?

In contrast to traditional construction, MMC mostly takes place off-site before assembly, which opens up possibilities for where new homes could be manufactured.

Should we be building new factories in London? Having factories in the capital would help to reduce travel time and emissions, contribute to local employment and training, and could make use of some unused, meanwhile sites. On the other hand, establishing MMC factories outside London – where land is more readily available and cheaper – could also help to create jobs elsewhere in the UK.

In practice, most factories are located within four hours of London. As for the modular manufacturers mentioned in Table 1, Elements Europe's factory is located in Telford; Caledonian Modular's is in Newark; and Vision's is in Bedford. Berkeley Modular has set up its factory in Northfleet, Kent; NU Living's factory is in Basildon, while Legal and General Modular Homes' factory is located in Leeds.

However, there are on-site MMC examples in London, such as Mace's jumping factory in Stratford mentioned previously. In Docklands, The Silvertown Partnership (consisting of Chelsfield Properties, First Base and Macquarie Capital), working with AECOM, was granted planning permission by Newham Council to build 3,000 new homes using its own on-site factory, the first of its kind in the capital.

Driving forward housing innovation

The market for MMC in London is expanding and changing. London developers and housing associations, including Berkeley Homes, Lendlease, Swan Housing and Laing O'Rourke, are experimenting with a variety of approaches. And new entrants from outside the construction industry include pension funds as well as supply chain and manufacturing companies.

The variety of models adopted and the extent of experimentation reflect where housebuilding is

in the innovation cycle. In the terms popularised by Abernathy and Utterback, London's MMC sector is in the fluid phase of the industrial innovation cycle, with many different manufacturers and contractors as well as prevailing market and technological uncertainties.[54] Once the industry moves towards a transitional phase, we can expect increased rationalisation and a reduction of costs. By comparison, the Japanese MMC industry (see Case Study 1) has reached a specific phase, with heavy standardisation in product design.

Table 2: Phases of innovation and their impact on the market

	Fluid Phase	Transitional Phase	Specific Phase
Innovation	Product changes/ radical innovations	Major process changes, architectural innovations	Incremental innovations, improvements in quality
Product	Many different designs, customisation	Less differentiation due to mass production	Heavy standardisation in product designs
Competitors	Many small firms, no direct competition	Many, but declining after the emergence of a dominant design	Few, classic oligopoly
Organisation	Entrepreneurial, organic structure	More formal structure with task groups	Traditional hierarchical organisation
Threats	Old technology, new entrants	Imitators and successful product breakthroughs	New technologies and firms bringing disrupting innovations
Process	Flexible and inefficient	More rigid, changes occur in large steps	Efficient, capital intensive and rigid

Source: Abernathy and Utterback, 1978

A number of factors have been driving the innovation process in London. One factor has been the cost of the traditional contractor market, especially for SME developers. For housing associations, lower manufacture costs as MMC take-up increases represent

an important driver. Swan Housing has set up its own construction arm (NU Living) and a factory in Basildon, with the aim to achieve vertical integration for their business.

Councils such as Lewisham and Lambeth have been using modular schemes to meet the growing need for temporary accommodation, and vacant sites have offered the opportunity to experiment. More broadly, and as outlined in Chapter 2, 18 London boroughs are collaborating to build temporary modular housing to tackle homelessness through PLACE; and as councils are actively becoming housebuilders once again,[55] many have expressed interest in modular construction methods.

Large developers are also experimenting with modular prototypes and testing new approaches on some schemes, with the intention of being more resilient to construction workforce challenges and offering better quality products. More broadly, some developers see investment in modular as an "imperative" to maintain current levels of housing delivery.

Case Study 1: MMC in Japan

In Japan's urban environment, the housing market is such that few people see homes as long-term investments. The fast depreciation of house value (20-30 years) makes quickly constructed bespoke MMC housing appealing. According to estimates, 15 per cent of detached homes in Japan were built using MMC in 2016, compared to just 7 per cent in the early 1970s.[56]

Key manufacturers – including Sekisui House, TamaHome, Daiwa House and PanaHome – have driven the extensive cultural acceptance of MMC housing in Japan.

Whilst the context of many Japanese cities may seem a far cry from the UK's housebuilding sector, the demographic challenges that the two countries face are not so dissimilar. A lack of new entrants into the construction industry coupled with an ageing workforce has created an acute labour shortage, causing the Japanese construction industry to shrink by 26 per cent in the last two decades (from 4.6 million in 1997 to just 3.4 million in 2013).[57]

While the potential for MMC in London is clear, the range of technologies remains in the fluid stage, with many different approaches being trialled. While some standardisation is likely as innovation advances,

London's diverse and sometimes complex suite of sites and development opportunities is likely to continue to demand a range of approaches. In the next chapter, we discuss the barriers preventing a more widespread and consistent adoption of MMC.

4.
Hitting a brick wall: what is holding London back?

The two previous chapters outline the potential of MMC to deliver quality housing in London, with potential time and cost savings over traditional methods. While take-up appears to have grown in recent years, a number of barriers continue to impede the growth of the sector.

Finance, warranties and insurance

Our research suggests that availability of finance and mortgages for MMC developments is a considerable barrier to more widespread adoption in London, closely linked to the ability to provide warranties and insurance for these novel construction techniques.

Compared to traditional methods of construction, MMC requires considerable early capital expenditure. Access to the large amount of finance required excludes many SMEs – who lack access to sufficient capital or debt funding, and for whom cost represents a bigger proportion of turnover – from entering the market.

Housing development financers and mortgage lenders require an assurance that the MMC product will retain value over time. Warranties are an important way of assuring this; without such guarantees the vast majority of lenders are unwilling to take on the associated risk. The emerging and proprietary nature of much MMC technology can make it harder to issue warranties – owing to lack of track record and uncertainty of future supply – thus making it difficult for those involved in its use to secure the necessary finance.

Schemes are also far more diverse in approach than those undertaken by traditional methods. One project can incorporate a number of different MMC approaches, such as the use of both panellised systems and bathroom pods. This can be confusing for lenders and warrantors.

Research by the London Assembly suggests 80 per cent of MMC companies in London find it very difficult to secure funding from high street banks due to a lack of confidence on their part.[58] Anecdotal evidence from our own research paints a similar picture. Some interviewees suggested that a few larger lenders are engaged, but that their engagement does not compensate for the lack of

other lenders, who remain deterred by the diverse and innovative nature of the pipeline.

The lack of warranties and insurance compounds the difficulties that developers using MMC in the capital face. Insurance and lender scepticism were frequently cited as barriers to the growth of the MMC sector during our research. Some interviewees suggested that debt financers would be concerned if their portfolio grew to include more than 50 per cent MMC developments. The lack of resilience in the MMC sector – in particular, the inability of developers to withstand the potential insolvency of suppliers when compared with traditional methods – was also seen to fuel mortgage lender scepticism.

However, there is evidence to suggest that mortgage providers are steadily growing more supportive of MMC undertakings, and a better understanding of the nature of the products that precision manufacturing can afford. The Buildoffsite Property Assurance Scheme (BOPAS) offered by Lloyd's Register accredits manufacturers and constructors as well as approving construction methods that meet lender mortgage standards, representing a positive step towards greater confidence in MMC by the lending community. The National House Building Council (NHBC) offers clients a review process for MMC schemes to ensure adherence to a required level of performance, but are yet to introduce the equivalent buyer's warranty scheme that they provide for traditional builds.

In addition, the Ministry of Housing, Communities & Local Government (MHCLG) has established an assurance, insurance and finance working group, chaired by Mark Farmer. The group is intended to improve the perception of MMC within the construction and finance sectors, and to set out an approach to the management of risk. Outcomes of the working group will be published at the end of 2018.

Immature supply chain

Realising the economies of learning from innovation (and ultimately, economies of scale) that MMC could offer requires volume and continuity of demand.[59]

Interviewees suggested that the current modular market in London is seen as immature, and that supply chain inefficiencies inhibit the development of a scalable business model. In particular, supply chain infancy was perceived to inflate the costs of MMC. This is partly a result of the "fluid" state of innovation in the sector, as discussed in the previous chapter. While a wide variety of approaches are tested out, the sector is prevented from reaping the full benefits from MMC techniques at scale.

Some interviewees expressed concerns about the capacity of factories and the risks involved in establishing factories to serve the MMC sector. Precision manufacture factories have to work at a high capacity to break even, a challenging feat for many given the volatility of the housing market and lack of consistent pipeline of demand. Some interviewees also expressed concern that the pre-manufactured components used in bespoke MMC designs would be difficult to maintain and repair if a factory shuts down. To assure themselves of stability and scalability of supply, some developers are setting up their own factories, or buying out their suppliers, a decision which incurs significant costs and a new set of risks. Examples are Urban Splash following their acquisition of SIG, or Swan Housing through their NU Living construction arm.

In some cases a non-factory-based hybrid approach is adopted – using modern technologies to automate on-site construction approaches, such as the use of robotic bricklaying machinery. This partial use of advanced robotics on construction sites represents a transitional adaptation to modern methods in the construction industry. Whilst the use of such advanced robotics may help housebuilders cope with the growing shortage of construction labourers, they are not the required widespread rethinking of the construction industry called for by Mark Farmer's review of the UK construction industry, which argued for the need for wholesale but positive disruption.[60]

Industry culture

Research interviews suggested that a lack of collaborative partnerships and trust within the construction industry is hindering the development of housing innovation within the capital. In their current form, the fragmented and lengthy nature of supply chains makes collaboration within the construction sector hard to achieve.

Interviewees argued that closer integration between stakeholders involved in the development and implementation of MMC, including clients, industry, the government and GLA, would help advance take-up. To ensure resilience and deliver economies of scale in London's off-site manufacturing sector, interviewees expressed the need for manufacturers to build long-term relationships with developers, for developers to work together in specifying and purchasing modules or components, and for manufacturers and developers alike to clearly communicate the benefits of MMC to clients.

Planning system

Some interviewees also expressed frustration with the planning process, which they perceived as rigid and unaccommodating to MMC. This was particularly the case with projects of a smaller scale, and with specific aspects of MMC such as construction employment being off-site rather than local. Others suggested that more clarity from developers can help accelerate the planning process and alleviate setbacks. In other words, those wishing to undertake MMC need to be clear as to whether a development will incorporate MMC from the onset and undertake fewer alterations thereafter.

Planning policy in the UK starts with the presumption that new development should broadly fit with its context. In many parts of London, this can lead to the prevalence of brick buildings. More often than not, however, the appearance, design and quality of schemes are more important for local planning authorities than the construction method. Though many planning authorities do focus on local employment, this should not on its own be a material consideration for rejecting

an application. And planners should also note positives, such as the speed of construction, and the lesser impact of MMC on local residents during construction.

Lack of guidance and standardisation of design

Our research identified that a lack of standardisation of MMC design and method act as barriers to the take-up of MMC in the capital.

Interviewees suggested that a lack of design standardisation was to blame for the high costs that precision manufactures incur. For design costs to be reduced – and the benefits of scale reaped – information sharing between MMC housebuilders is required. Yet, our research found reluctance within the sector to do so, particularly – and understandably – when a company has invested significant capital into the research and design phase of their development.

Within the construction industry, there is also sometimes a sense that the use of MMC risks restricting architectural freedom, but our research found that this was not always the case. Architects that we interviewed said they favoured the greater control that MMC affords during the initial design process and the higher level of technical detail required from the onset. Others in the industry have expressed the benefits for architects involved in MMC schemes, suggesting that the need to make final design decisions at the beginning of the construction process offers architects more control over detail and an opportunity to reclaim build quality, rather than allowing the final form and quality of a building to be dictated as much by contractors as the architects.[61]

Some felt that the standardisation of MMC housing components could also enable greater customisation of home design by the homebuyer, allowing a similar degree of flexibility to that offered by kit-of-parts structures. Swan Housing already allows homebuyers to choose the layout, specification and external appearance of homes at their development site in Basildon using online configuration software.

The GLA is taking steps to address the lack of standardisation across MMC manufacturers and

residential developers. In the latest Housing Strategy, the Mayor pledged to invest £50,000 in a project to develop a standardisation tool and a common framework with the aim of increasing the delivery of off-site manufactured homes in the capital.[62]

Perceptions

MMC is struggling to shake off negative public perceptions surrounding its use. Following World War Two, housebuilders across London used extensive prefabrication to quickly replenish the stock of public housing. Prefabricated houses built in London during this period – such as the Excalibur Estate in Lewisham – were of a low density and often low-quality due to their planned temporary status.[63] Higher-density housing blocks built in London during the 1960s that incorporated techniques such as precast concrete panels were of the same low quality, with explosions such as that at Ronan Point shining a spotlight on the industry's poor safety record. Despite the passage of time and a change of terminology, many remain sceptical and believe that MMC creates unattractive, poor-quality and disposable housing.

Elsewhere in Europe, MMC has attained a reputable status in the construction industry. In Germany, MMC is now associated with high quality of construction and bespoke design (though often of low density and on large plots of land). This was not the case in the 1980s, but in recent decades the industry has regained its position through the development of quality standards and certification schemes, alongside consistent promotion of the merits of MMC. Sweden also struggled with quality concerns in early years, but has now adopted prefabricated timber elements across the industry (see Case Study 2).

The lack of public enthusiasm for precision manufactured housing is often cited as a barrier to its adoption. However, evidence from interviews and previous research shows that the issues may actually be the way that the supply chain operates in the UK, the lack of warranties for buyers, and problems around long-

term maintenance and costs. It may be that consumer perception is underdeveloped rather than openly hostile. Indeed, there are few differences between MMC-built homes and traditionally built homes, besides the potential difficulties in obtaining a mortgage as outlined above; and modular schemes are often advertised to potential occupants without mention of their modular nature.[64]

If MMC were to offer perceivable benefits to consumers (in terms of capital cost, running cost, appearance, maintenance, environmental credentials, and acoustics), there might be a stronger consumer demand for MMC-built homes, which would likely represent a turning point in impacting housebuilders' decision-making (see Case Study 2).

Case Study 2: MMC in Sweden

In Sweden, market adoption of MMC has been successful, with 84 per cent of detached homes incorporating pre-fabricated timber elements. The MMC sector in Sweden is home to a number of vertically integrated companies – such as Eksjöhus (saw mill, manufacturing and transportation) and Derome Timber (forest, sawmill, hardware and residential build) – some of whom can manufacture 20 housing units per week, both for sale within Sweden and export to external markets.

As in the UK, there was a post-war drive in Sweden to build homes using prefabricated methods. The Million Homes Programme sought to build one million new homes between 1965 and 1974, and turned the country's housing shortage into a surplus by 1970.[65] Swedish people perceived these homes as uniform and architecturally poor,[66] not unlike the UK's public perception of prefab homes; however, this did not prevent Sweden from adopting prefabrication at scale in the following decades.

Though there are lessons to be learnt from Sweden – such as the need for positive public opinion to drive reliable consumer demand – there are also great differences. The take-up of precision manufacturing in Sweden is encouraged by favourable environmental conditions, most notably an abundance of premium forest-grown timber. Harsh climatic challenges also help drive take-up, as the Scandinavian climate leaves a very short construction season (six-seven months on-site), making the time savings afforded by precision manufacturing all the more appealing.[67]

5.
Breaking through: realising the potential of Modern Methods of Construction in the capital

This report has outlined how the increased adoption of MMC could make a real difference to construction speed, cost and quality, as well as helping to address the acute workforce challenges within London's construction industry. We have demonstrated why innovation within the housing sector is necessary to maintain and increase London's current levels of housing delivery. But if MMC is to be a solution for the current difficulties faced by the industry, a step change is required, pushing MMC from the margins to the forefront of London's housebuilding sector.

Recommendations

Addressing the construction skills shortage

Converging workforce pressures mean that construction faces a growing skills shortage and lacks the required capacity to meet the necessary increase in housing supply.

The Mayor has demonstrated his commitment to improve skills in the sector through the Mayor's Construction Academy (MCA). This includes supporting the development of training provision for the construction of precision manufactured housing, as set out in the July 2018 Skills for Londoners Framework which sets out priorities for devolved Adult Education Budget and other skills funding streams.

Recommendation 1: The **Mayor** should consider how to use devolved skills funding to help existing construction workers develop the skills needed to implement MMC, in the context of a growing commitment from City Hall to deliver MMC homes at scale across London.

Future-proofing housebuilding

With a growing skills shortage in the construction industry and higher than average labour costs in the capital, both of which are likely to increase costs of traditional construction faster than MMC, the cost savings and certainties of MMC are likely to become even more appealing over time. MMC can also help contribute to a more environmentally sustainable

construction industry that is less disruptive for local communities.

Some developers are already experimenting with modular prototypes; however, only seven per cent of the UK's construction output in 2013 was off-site construction. To address this, the Farmer Review has proposed that the government should consider introducing a charge on business clients of the construction industry to further influence commissioning behaviour and to supplement funding for skills and innovation.

Recommendation 2: To build capacity and realise economies of scale, **housing developers and construction companies** should commit to increasing adoption of MMC throughout their supply chains.

Recommendation 3: Faced with construction workforce challenges in London, **developers and industry bodies** should invest in upskilling workers for the transition to MMC.

Establishing a buying club to pool demand for MMC

Reaping the benefits of MMC requires volume and continuity of demand, but the cost of MMC currently remains particularly high in London, owing to the limited number of manufacturers, the immaturity of the supply chain and the need to recoup the high setup costs incurred.

MMC can be appealing for new entrants to the housing market (such as councils and smaller developers) who are not constrained by existing supply chains. It can also appeal to existing actors (such as housing associations) attracted by the prospect of the lower manufacturing costs on suitable sites. Given that the time savings and cost benefits of MMC are realised through purchase at scale and standardisation of layouts and specification, joint collaboration between housebuilders through a MMC buying club would allow

resources to be combined to build at scale across London. This would be similar to the current PLACE vehicle backed by the GLA and London Councils, but at a greater scale and for permanent housing.

Recommendation 4: Councils and housing associations (with support from the Mayor and the government) should pool expertise and purchasing power to form an MMC buying club. This would allow them to build at scale across multiple London boroughs, thereby helping sustain levels of factory production.

Sharing and showcasing knowledge through a dedicated MMC exhibition

The lack of collaborative partnerships and trust within the construction industry is hindering the development of housing innovation within the capital. There is a need for manufacturers and developers to build mutual long-term relationships, and for them to clearly communicate the benefits of MMC.

Recommendation 5: Housing providers and the Mayor should set up an exhibition to bring the industry together and showcase examples of well-designed modular housing and high-quality placemaking to Londoners.

The Mayor has announced £50,000 towards the creation of a common design framework to address the current lack of standardisation and increase the delivery of off-site manufactured homes in the capital.

Recommendation 6: The **Mayor** should use this exhibition as a platform to discuss what can be achieved through his proposed common design framework, and encourage its widespread use as an open source tool for residential developers and manufacturers.

Understanding consumer perceptions of MMC

The lack of public enthusiasm for precision manufactured housing is often cited as a barrier to its adoption. However, it may be that consumer perception is underdeveloped rather than openly hostile. There are few differences between MMC-built homes and traditionally built homes; and modular schemes are often advertised to potential occupants without mention of their modular nature, which is not yet seen as a strength as it is in other countries.

Consumers could lead an important role in driving demand for MMC take-up in the capital, but we first need to better understand consumer perceptions of modular homes. Is the final product sufficiently attractive to consumers? Would spaces that adapt to consumers' needs be a unique selling point? The exhibition mentioned could also contribute to a better understanding of the public perception of MMC, as well as increased engagement with the public.

Recommendation 7: The **Mayor and partners** should commission further research on customers' perception of MMC.

Offering preferential mortgages for energy-efficient MMC homes

Our research suggests that a considerable barrier to MMC take-up is the lower availability of mortgages for MMC developments, which is closely linked to the ability to provide warranties and insurance for these novel construction techniques.

From June 2018, Welsh Help-to-Buy loans have been adjusted according to the energy rating of the home being purchased, meaning that those purchasing the most energy-efficient homes may be offered a larger loan as a consequence of their smaller anticipated energy bills. Barclays also announced that it will begin offering discounted interest rates for highly efficient homes. These initiatives should be extended to energy-efficient modular

homes, and could significantly help potential homebuyers in London to boost the demand for modular schemes.

Recommendation 8: Mortgage providers should offer preferential loans for energy-efficient MMC homes.

Ensuring clarity in the planning system

Currently there is a perception that planning may be hindering MMC schemes, especially with regard to planning policies on the employment of local people and the appearance of schemes. However, MMC also often entails reduced disruption to local communities. There is a role in the planning system to help establish MMC.

Recommendation 9: Councils should include a general statement in local plan policy to support MMC, and identify small sites for SME builders. Where an MMC scheme could override policy on local employment, planning policy should recognise the specific construction requirements of MMC.

London's housing crisis could be worsened by continued slow housing delivery and a growing skills crisis. To address this, London needs to make the most of innovations in construction techniques. Our research shows how modern methods of construction could make a real difference to construction speed, cost and quality. But realising this potential will require better collaboration within the construction sector, the development of standardised techniques and financing models, and a strong lead from both the GLA and national government.

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The Mayor of London's most pressing priority is to increase the availability of quality, affordable homes for Londoners. The causes of slow housing delivery are manifold, but construction methods are one of the stumbling blocks that have hindered housing delivery in London. Made for London examines how Modern Methods of Construction could improve the speed, scale, and quality of housing delivery across the capital, identifies the barriers and challenges currently hindering their increased take-up, and outlines how their potential could be realised in London.

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