JANUARY 2025

Modern Methods of Construction (MMC):

an answer to the housing crisis?

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Cite as:

Wallace, A. et al., (2025) **Modern Methods of Construction (MMC): an answer to the housing crisis?**

Acknowledgements

The report draws on the ‘Prefabs Sprouting: modern methods of construction and the English housing crisis’, a 30-month research project funded by the Economic and Social Research Council (ES/V015923/2).

We are grateful to our expert steering group, especially Dr Kate Simpson, Nottingham Trent University, and to all project participants for their time and insights. The research team is responsible for this report and for any conclusions drawn from the collected data.

Edit and design: Research Retold (2025)

Research Retold

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Summary and key messages

Between March 2022 and July 2024, the research team investigated the Modern Methods of Construction (MMC) sector in England. This report details our findings. Key points:

- There is a housing crisis, a building crisis and a construction skills crisis in the UK. MMC has been framed by industry lobbyists and some politicians as a **solution to each of these interlocking crises.**

- MMC housebuilding involves some degree of prefabrication or **premanufacture of housing components in factory settings and is claimed to offer better designed, less carbon / labour intensive homes** delivered at a faster pace than the on-site masonry methods used by legacy housebuilders. Some critics dispute binary distinctions between 'modern' and 'traditional' methods, however.

- Seven categories of MMC have been defined by the UK government. **Category one denotes 'volumetric' construction**, involving the production of whole modules. **Category two denotes the manufacture of frame or flat panels for basic wall**, floor or roof structures.

- We found **95 category one and category two MMC manufacturers** with factories based in England operating today (see **interactive map**). Timber-based category two is the dominant manufacturing profile and the majority of MMC firms are small or medium-sized enterprises (SMEs).

- After an initial period of hype, investment and expectation, **several high-profile MMC category one manufacturers have gone out of business, creating uncertainty** and negativity around the sector.

- The study identified **215 housing schemes in England**, completed or in progress, where MMC firms are explicitly named as delivery contractors (see **interactive map**). **Ninety-four of these are being delivered for private developers, 70 for social housing providers, 41 for local authorities** and **10 for non-profit providers**. We estimate that **134 of the 215 schemes** we identified have been completed to date equating to **8,096 homes built using MMC**.

- **Critical factors in the viability of MMC firms and the effective delivery of housing schemes, according to our findings, include:** securing a stable pipeline of housing demand, optimising alignment between production and installation process, expending sufficient up-front R&D investment, achieving a critical balance between standardisation and customisation of product, and investing in project management expertise.

- There are **wide variations in the quality of MMC homes**, according to residents. We found many residents are happy with their home and found little evidence of stigma or anxiety about living in an MMC home. However, residents in some schemes expressed **significant concerns over the finish of their homes, reinforced by poor aftercare services**, especially around snagging lists. This created reputational damage in some cases.

- There are **wide variations in the thermal performance of MMC homes**, with some residents reporting difficulties in regulating internal temperatures.

- There remain **significant gaps in available independent evidence regarding the quality and outcomes of MMC housebuilding**, not least around residents' post-occupancy experience.

- There remain **significant gaps in evidence around jobs and conditions within MMC factories** and how to address skills gaps in the advanced manufacturing sector more generally.

- Existing regulatory frameworks for residential construction **do not take sufficient account of the specificities of 'modular' housebuilding**, not least around the testing and certification of MMC products, or around fire performance.

- If the MMC sector is to help address the catastrophic social rental housing crisis in England, **government needs to bring forward a wide-ranging strategic framework** taking account of the specific financing, land availability and regulatory demands that come with building via MMC.

- The MMC sector **is not a 'magic bullet' for solving a housing crisis** which has developed from long-term systemic dysfunction. Operating within this dysfunction, start-up MMC firms have had little margin for error, brutally exposing, in some cases, strategic and operational mistakes. Without wider systemic reform, MMC firms could become part of the dominant housebuilding model, merely helping to bring supply chain efficiency to an unacceptable status quo.

Part 1: Background and context

Introduction

Modern methods of construction (MMC) is a collective term for building methods which contain an element of off-site, factory-based manufacture. This contrasts with what we refer to in this report as traditional construction methods which typically take place on site and rely on 'wet trades' such as bricklaying, rendering and plastering. We make this distinction aware that it is considered a crude binary by some. In the UK residential construction space, MMC can be situated as a descendant of the housing prefabrication methods of the post-war period. The key difference being that MMC involves greater use of automation, robotics and digital technology.

Over the last decade, MMC has surfaced in assorted UK parliamentary debates and government papers, as politicians have begun to grapple with interlocking agendas around construction productivity, industrial strategy and the housing crisis (e.g. Farmer, 2016; DCLG, 2017; HLBEC, 2022; 2024). MMC is typically framed as a solution to these issues, cited as being a faster, higher quality and more sustainable way of building homes. In 2019, a working group for the Ministry of Housing, Communities and Local Government developed a seven-part MMC categorisation (MHCLG, 2019). Category one denotes 'volumetric' construction, involving the production of whole modules in controlled factory settings that can be brought to site for final installation. Category two denotes the manufacture of frame or flat panels for basic wall, floor or roof structures that are assembled on site.

Publicly available data on the scale of MMC housebuilding across the UK is limited although Savills estimated in 2020 that between 6–10% of new homes in the UK had been built using some form of MMC. Disaggregating this figure for England is difficult. Category two timber frame construction is dominant in Scotland but limited in England and Wales (CMA, 2024). There was significant MMC company formation in England in the pre-pandemic period and several large traditional housebuilders have acquired or invested in MMC facilities in recent years (CMA, 2024).

It is estimated that, to date, over £1 billion of private capital investment has flowed into the emerging MMC sector, mostly before the Covid-19 pandemic. This undergirded high-profile category one ventures like Legal and General Modular, established in 2016 with a 550,000 square feet factory near Leeds, West Yorkshire. The UK government supported other category one MMC firms such as Top Hat, Ilke Homes and House by Urban Splash via £100 million of investment from Homes England. These large, category one firms received considerable media attention, whilst a wider eco-system of manufacturers comprised of start-ups and long-established small or medium-sized enterprises (SMEs), became defined through the prism of MMC.

Since this period, lobby groups and consultancies have continued to effectively market and represent MMC as a coherent sector within the wider construction industry. There is now established momentum around the potential and diversity of the MMC sector. With this has come increasing demands for data regarding the activity and performance of the sector which have been more difficult to satisfy. For example, there are conflicting claims about the cost of building an MMC home versus traditional construction (HLBEC, 2024).

Other striking knowledge gaps exist regarding how residents experience built MMC homes, and how workers experience conditions in MMC factories. These might reflect longstanding tendencies to marginalise social questions and outcomes in technically focused construction research and development (R&D) (Payne & Serin, 2023; Rafa & Khalid, 2024).

In recent years, the MMC sector has experienced a succession of high-profile exits and insolvencies, particularly in the category one market, including Homes England-backed firms Ilke Homes and House by Urban Splash. In some cases, this has meant housing schemes which started as MMC, have stalled or had to be built out traditionally. The House of Lords Built Environment Committee (HLBEC) initiated an inquiry into the category one sector in late 2023 titled 'Modern Methods of Construction: what's gone wrong?' The committee concluded that Homes England's MMC investments were "undirected and nonstrategic". They also exposed a number of areas where public data is unavailable and deemed that government decision making around MMC lacked adequate methodologies. The committee also reported that category one MMC firms encounter problems securing stable demand for their products, in part linked with resistance to MMC from local planning authorities and "undue risk aversion" from warranty and insurance providers.

The Labour government has yet to make any concrete commitments to residential MMC. It is not yet clear if or how the sector is, specifically, expected to support the delivery of the 1.5 million homes the government has pledged to build over the next parliament. Policy frameworks including the 'Timber in Construction Roadmap', the 'Future Homes Standard' and a refreshed 'National Planning Policy Framework' could reshape demand for MMC products in England by introducing changes to building regulations and creating new development opportunities. The government's response to the Grenfell Inquiry Phase Two Report is likely to also have specific ramifications for regulations surrounding MMC.

Given these ongoing and urgent questions around housing delivery and planning reform in England, the dearth of independent evidence around the operations and impact of MMC housebuilding is glaring. The government has not instituted robust reporting or evaluation mechanisms, whilst commercial firms and lobbyists make claims that are not independently examined. Further, the dominant framework around MMC is one which foregrounds questions of 'uptake' (e.g., Pan & Goodier, 2012; Payne & Serin, 2023), encouraging limited research orientations. In this report, we address some of these gaps by providing a picture of the MMC sector in England, its condition to date and how it intersects with a housing system routinely described as being in 'crisis'. The report is built around four key themes:


understanding the MMC landscape in England


unpacking MMC claims and critiques


investigating the delivery of MMC homes and projects


documenting MMC resident perspectives

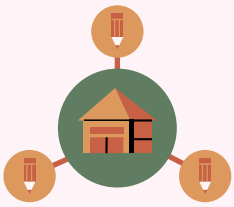
The UK housing crisis has left **17.5 million adults** living in overcrowded, unstable or unaffordable housing (Shelter, 2021) whilst **1.29 million in England alone** languish on local authority housing waiting lists (DLUHC, 2024). There is a consensus that at least 90,000 social rental homes (where rents are typically pegged at 50% of local market rate) need to be built in England (Bramley, 2018; HCLGC, 2020) each year to address this chronic shortage, to say nothing of the endemic affordability and quality problems in the private sector. The current housebuilding system simply does not deliver the homes most people need or want. This report is animated by a simple question: what happens when we bring MMC into dialogue with these dynamics?

Aims and methodology

This report is based on data collected during a 30-month study funded by the UK Economic and Social Research Council.

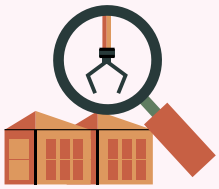
The research design was formulated during 2018–2020, a period of notable growth for the MMC housing sector in England. The parameters of the study were determined by the fact that housing policy is a devolved matter in the UK, and we did not have the capacity to investigate and compare variations in MMC activity across the four nations. A sole focus on England enabled us to examine MMC within the specific contours of a single housing system. We focused only on the presence and activity of manufacturers operating under MMC categories one and two.

The aim of the study was to examine how the emergence of MMC was reshaping the delivery of homes in England. The objectives were:



To advance novel understandings and mappings of the MMC housing sector in England by integrating concepts and methods from housing studies, geography, architecture, civil engineering and project management, not least to open up the sector for cross-national comparative investigation.

To integrate industry and policymaker perspectives to investigate and establish how systems of housing delivery are changing in England, if at all, in response to the emergence of MMC.



To critically evaluate the extent to which new MMC homes and developments are improving housing supply and quality (i.e., delivering better safety standards, greater carbon efficiency, more affordability, more accessibility, higher space standards and well-located new developments).

To build our analysis, we engaged with policy fields, delivery systems, individual housing development projects and resident experiences to produce new knowledge that offered: **descriptive sensitivity of an emerging sector, insights into housing delivery dynamics, and understandings of resident experience**.

To meet our objectives, we developed four distinct workstreams drawing on the interdisciplinary expertise in our research team (Figure 1). The first two workstreams focused on capturing 'national', 'industry' or 'systems' geographies and perspectives using key stakeholder interviews alongside a programme of mapping and ethnographic work. Here, we searched online websites, industry media, Companies House and industry portals to collect background data on all category one and two manufacturers headquartered in England. This included the location of factories, annual turnover, build system and notable housing developments started before or completed by April 2024. An MMC housing developments database was further filled out by searching online client platforms and monitoring sector media. This database captured, for each development, the dominant tenure, number of units, any main contractor involvement and client type. During the compilation of these databases, we made strategic decisions to visit a sub-sample of MMC factories and sites to observe them first hand. We also attended a number of construction and MMC industry events including UK Construction Week, Modular Matters and the Offsite Expo to gain first-hand experience of live debates in the sector.

Figure 1: Project workstreams and data breakdown

Workstream 1 (WS1):	Workstream 2 (WS2):	Workstream 3 (WS3):	Workstream 4 (WS4):
How has the emergence of MMC impacted the mainstream and alternative housing systems in England? To what extent can we detect positive transformations?	What kinds of firms, homes, jobs and developments are underpinned by MMC in England today? To what extent are housing-related inequalities being addressed by these?	How are homes and developments built via MMC performing? What are the implications for the future of housebuilding in England?	How are residential housing projects built via modern methods of construction governed? What are the implications for project delivery?
Dataset:	**Dataset:**	**Dataset:**	**Dataset:**
45 x qualitative interviews with: • government policymakers • local authority housing and planning directors • housing associations' strategy and delivery leads • housing NGOs • building safety experts • warranty providers • procurement specialists	**27** x qualitative interviews with: • MMC manufacturers • MMC consultants and experts • academics Ethnographic observations from: • MMC factory and site visits • industry events Databases and maps of: • MMC factories • MMC developments	**40** x qualitative interviews with residents living in 8 different MMC housing developments Survey data from **80** residents living in 10 different MMC housing developments	**18** x qualitative interviews with MMC project delivery stakeholders

Workstreams three and four drilled down into case studies of MMC housing developments in varying stages of project completion. In these cases, we attempted to survey and interview residents who had lived in their homes for at least six months as well as interview the development teams and clients involved in delivering each project. Interviews lasted between 60 and 90 minutes, whilst resident surveys comprising of 38 questions were completed online.

The 18 interviews conducted in WS4 were drawn from four case studies. In case studies 1 and 2, we were also able to survey and interview some residents on their post-occupancy experience to build a cogent understanding of MMC housing delivery from factory floor through to everyday housing performance. We consider these cases 'complete' (Figure 2).

Figure 2: Completed case studies

Case	Planned no of units	Tenure	MMC category	Build material	Progress	WS4 interviews	Survey responses	WS3 interviews
1	121	private sale	1	timber	on schedule	9	22	9
2	10	social rental	2	steel	completed	3	1	4

In the other two cases where we secured WS4 interviews, we were unable to access residents due, in case 4, to project breakdown caused by insolvency of the MMC contractor (see below) and, in case 3, to non-responses from residents in a small pilot project (Figure 3).

Figure 3: Incomplete cases with WS4 but no WS3 interviews

Case	Planned no of units	Tenure	MMC category	Build material	Progress	WS4 interviews	Survey responses	WS3 interviews
3	2	social rental	2	timber	completed	4	0	0
4	131	mixed	1	steel	stalled	2	0	0

Given the collapse of case 4, we decided to extend our sample to try to collect data from residents living in housing developments built by the same MMC manufacturer before it ceased production. However, these yielded only a handful of survey responses and only one interview (Figure 4).

Figure 4: Booster sample after case study 4 collapse

Case	Planned no of units	Tenure	MMC category	Build material	Progress	WS4 interviews	Survey responses	WS3 interviews
5	7	social rental	1	steel	completed	0	1	1
6	10	social rental	1	steel	completed	0	2	0
7	2	social rental	1	steel	completed	0	1	0
8	22	social rental	1	steel	completed	0	1	0

In light of challenges with collecting data at this manufacturer's sites, in order to fill our sample of household surveys and interviews, we decided to target residents living in homes manufactured by other contractors (one of which had also gone into administration) (Figure 5).

Figure 5: Booster sample with other manufacturers

Case	Planned no of units	Tenure	MMC category	Build material	Progress	WS4 interviews	Survey responses	WS3 interviews
9	94	private sale	1	timber	completed	0	11	8
10	142	mixed	2	timber	completed	0	7	0
11	72	private sale	1	timber	completed	0	7	7
12	70	private sale	1	timber	stalled	0	13	4
13	43	private sale	1	timber	stalled	0	13	6
14	30	private sale	1	timber	completed	0	1	1

Part 2: The MMC housebuilding landscape in England

Introduction

Whilst MMC has received significant attention in policy circles and industry media, it has not been adequately mapped as a sector in England.

Here we attempt to fill in some of those gaps. Note that here the term 'sector' describes an imperfect analytical category for what is a diverse ecology of MMC firms, methodologies and perspectives. We do not provide an exhaustive account, just one which moves us closer to understanding the key tectonics of the MMC housing landscape in England.

To do this, we compiled databases via desktop research which triangulated contractor and client website information, industry media articles and online resources such as **NHBC Accepted Systems**.

Also in this part, we draw on interviews with key stakeholders working either in the MMC sector as consultants, engineers or CEOs, or in the broader housing system working in policy, building safety or in social housing. We use these interviews to discuss two things.

Firstly, we examine the claims and counter-claims circulating MMC as it has emerged as an alternative to traditional modes of housebuilding.

Secondly, we explore some of the operational realities for MMC firms. We discuss what our participants told us, for example, about factory-based business models and skills and training issues, and we link these with the challenges of accessing land and finding clients willing to work with MMC contractors. We find a sector trying out a variety of different approaches and innovations as it grapples with start-up challenges, narrow margins for error and an incumbent housing market resistant to change. We begin, though, with a descriptive overview of the sector.

Who are the MMC firms and what are they delivering?

Over the course of our research, we found 104 MMC category one and two firms with factories located in England active in the residential housebuilding market. By the time of writing, 9 of these – all category one firms incorporated in the last decade – were no longer trading. Of the remaining 95, we estimate that only 25 were incorporated before the year 2000 giving a sense of the sector's relative immaturity. We broke down the 95 by MMC category and key assembly material (Figure 6).

Figure 6: Categorising MMC firms active in England's housebuilding market

MMC Category	Number of manufacturers
category one timber	4
category two timber	44
category one steel	24
category two steel	18
category two concrete	4
unknown	1

Whilst timber frame housebuilding is less prominent in England compared with Scotland, we can see that it is a significant player in the English MMC sector. It is notable that large traditional developers like Persimmon, Taylor Wimpey and Barratt Developments have all recently purchased timber frame factories.

That said, from our research we conclude that most extant category two timber firms are small businesses (less than £10.2 million annual turnover). If MMC firms are currently generating large revenues, they are not using timber. Rather, they are using steel and pre-cast concrete to deliver large, condominium-style buildings such as the 50-storey College Road development in Croydon, south London – the largest volumetric tower in Europe.

The geography of MMC factories and details of those firms is captured **here** in our interactive map. Liquidated firms or those that have ceased production during the project timescale are included to give a sense of the MMC production geography over recent years. We can see from the map that the larger MMC firms tend to have factories located in the Midlands or North of England, with Vision Modular in Bedford and Rollalong near Bournemouth being notable exceptions. We collected turnover data to try to capture the scale of MMC businesses over a three-year period. This was taken from Companies House and should be treated as indicative. Where MMC firms are subsidiaries of larger firms (such as Intrastack), or where large parent firms have MMC factories but have not incorporated a separate modular business arm (such as Taylor Wimpey or Vistry), turnover data is unclear or unavailable. Turnover for some firms will also reflect the multi-dimensional nature of their business beyond residential housebuilding which we were unable to disaggregate (e.g., Premier Modular).

With these caveats in place, using the UK government company reporting thresholds applicable pre-October 2024, we estimate that 64 of the 95 MMC manufacturers active in September 2024 classify as small businesses (i.e., with a turnover of less than £10.2 million per year), 23 classify as medium-sized business (with a turnover between £10.2 and £36 million) and eight classify as large businesses (turnover exceeding £36 million). As with the traditional construction sector, SMEs are the norm.

Our map also illustrates distances between a single manufacturer's factory and their housing schemes. We only mapped such distances for the 11 MMC firms visibly involved in at least five housing schemes during the study period.

This included three firms no longer trading (e.g., Homes, House by Urban Splash and Legal & General Modular Homes). We recognise this might be an under-estimation given some firms are involved in supply chains that are not publicly visible. Nevertheless, we can see how Homes England-backed Ilke Homes was supplying modules from their factory in Knaresborough, North Yorkshire to schemes across England. We can also observe how London and its suburbs is a lucrative build-to-rent market for category one firms specialising in high-rise residential. In addition, we can note how regionally-concentrated some SME firms are, for example LoCal Homes in the West Midlands.

In terms of what kinds of residential housing schemes our 104 documented MMC firms are supplying, they are present across both private and social sectors and involved in a wide range of housing schemes, including social housing estates, private brownfield developments and large apartment blocks. Firms building modular 'pod'-style units also sell to NGOs and local authorities looking for homeless 'move on' accommodation, whilst a handful of designers and fabricators espouse 'open source', 'wiki' style visions of community-based manufacturing, underpinning some experimental self-build housing schemes.

During the study period, we recorded 215 schemes completed or in progress across England where our 104 firms were explicitly named and visible as main delivery contractors. Precise numbers are difficult to establish, but we estimate this equates to 19,636 homes started, completed or planned to be built using MMC contractors.

Of the **215** schemes:

94 were for **private developer** clients (13,269 homes),

70 for **housing associations** (4,729 homes),

41 for **local authorities** (1,418 homes), and

10 for **NGOs** (220 homes).

Available information about the progress of individual projects is patchy, but at the time of writing, we estimate around 134 of these schemes had been completed, or 8,096 homes (41% of total units planned). Another 57 schemes were recorded as 'ongoing', equating to 7,038 homes (36% of total units planned). We estimate that 19 of our recorded schemes have 'stalled' due to contractor insolvency, equating to 4,289 homes (22% of total units planned). Some of these stalled schemes are being completed traditionally; the status of the remaining five schemes is unknown.

We captured these schemes **here** in our interactive mapping of MMC housing developments in England. Again, we have included schemes contracted to MMC firms that ceased production during the project timescale. Any schemes we think were paused, re-planned or built out traditionally, we have labelled as 'stalled'. Looking across the 214 schemes, there is a relatively even spread of developments across the country with clusters in London, the West Midlands and the M62 corridor from Liverpool to Leeds.

Whilst our map concentrates on explicitly MMC delivery, there is evidence that the residential construction supply chain is hybridising across traditional and MMC contractors, with notable acquisitions and investments including Persimmon purchasing an equity stake in Top Hat in 2023 and Taylor Wimpey's purchase of a timber frame manufacturing facility, also in 2023. This introduces a potential degree of supply chain complexity which was beyond the capacity of our mapping.

MMC claims and critiques

Pre-manufacture is not a new feature of the UK housebuilding landscape, but it has long struggled to challenge traditional masonry methods in England (Lovell and Smith, 2010).

That said, industry and policy activity over the 2010s, described in Part 1 of this report led to a new and diverse generation of firms emerging under the banner of MMC, indicating fresh impetus and some market penetration. With this nascent breakthrough came bombastic claims from industry lobbyists and high-profile firms about the capacity of MMC to help address skills and housing shortages – a message which some politicians were eager to amplify. This hyping of new technology or modes of production is typical of techno-scientific 'innovation' (Konrad et al, 2016). It is also to be expected, in this case, given the extent of hegemonic 'lock-in' enjoyed by traditional masonry methods in the UK (Lovell and Smith, 2010). MMC firms had to find ways of disrupting the status quo. As an example, this stakeholder reflected on the typical crisis and technology reference points used to legitimise and justify a turn towards MMC:

> *"So basically, the problems we have in housing are enduring...and intelligent people go, 'what are we going to do?' And we go, 'what about this industrialised offsite manufacturing? Shouldn't this be part of the solution as it is in other sectors', and we have another go... the technology we have now versus where we were in the 60s and 70s, the BIM, the CAD CAM, the robotics, we are genuinely in a different place in terms of the technology. We're also part of a global crisis for housing... but also therefore a big commercial opportunity for the robotics manufacturers, and the equipment manufacturer... They're getting huge orders from around the world because everybody's looking at the same challenges of labour shortages and housing quality issues and going how do we address them?"*
>
> – MMC sector stakeholder

The reference to “having another go” in this quote reflects how turning housebuilding into a manufacturing process has been a rhetorical solution to housing crises since at least the 1940s. This history brings baggage to MMC, not least the link with contested legacies of post-war ‘prefab’ construction (Iuorio et al, 2019). Indeed, mistrust over prefabricated build quality and longevity is said to endure in the risk averse attitudes of planning authorities, warranty providers and consumers (HLBEC, 2024).

These conditions make for a continuing discursive struggle over the quality and viability of MMC and the modernisation of English housebuilding culture, heightening the stakes for the sector and making firms sensitive around the intellectual property (IP) of their build systems. Arguably, this culture of sensitivity has also made it more difficult to collect data from which independent judgements on MMC delivery and performance can be made (HLBEC, 2024).

Unsurprisingly, a sequence of exits and liquidations during 2022–24 in the category one market created negative industry headlines and a sense that the sector is embattled. In response, MMC advocates note that the traditional construction sector has been experiencing similar struggles caused by, for example, rising material costs.

A double standard was thought to be emerging, one being used to protect the status quo:

> *“There’s a lot of scepticism I think in the construction industry about modular (sic), particularly in construction journalism… You only have to look through and realise they will report every loss that our members make, and they will report every scheme that goes slightly wrong or is delayed. They won’t do the same for Persimmon (traditional housebuilder), but they will do for us and there is that scepticism about whether this will work and I think part of it comes from fear in some sectors that we are competing.”*
>
> – MMC sector stakeholder

We found scepticism about MMC did indeed go beyond construction journalism. Some of this was based on harsh operational realities.

For example, local authority officers and social housing providers such as housing associations told us how recent category one insolvencies had undermined confidence in MMC contractors’ capacity to deliver housing schemes.

We found no satisfactory data on the proportion of social housing schemes that were both started and completed to clients’ satisfaction by MMC contractors, but we can assume many will have been delivered to time and budget.

However, we also know some housing associations have been left with costly, unfinished MMC projects. In one extreme case where some units were delivered before the MMC contractor collapsed, the client told us:

> *So we have had to have twenty-four-hour security on the site because of obviously how significant that asset is, one hundred and twenty-six two, three and four bed houses…So we've got the rental income that we were losing, the sales receipts we are losing, we are having to pay out for security on the site. We are having to pay things like standing charges on all those utilities… the council are still asking for contributions to Council Tax, that sort of thing, that does add up."*
>
> – social housing client

These examples are well known in the sector, and, given the limited financial headroom of housing associations, it was not a huge surprise to hear one client representative tell us that stepping away from MMC was now a 'no-brainer' for their organisation.

Such examples, whether representative or not, are grist to the mill of MMC sceptics. Some construction experts, with long experience observing and working in the industry, are unhappy with how MMC is defined by its lobbyists as 'modern' against the allegedly antediluvian techniques of masonry. They appear to object to this on two main grounds.

Firstly, they think the hyping of MMC deflects from systemic problems inflicted by policymakers and reproduced by the construction industry.

As one participant characterised it, MMC is a ***"a solution in search of a crisis"***.

Secondly, they feel a 'modern versus traditional' binary, allied with the 'modernise or die' rhetoric of the 2016 Farmer Review, impugns the knowledge and capacity of the construction sector.

For example, this category two MMC manufacturer told us:

> *When are you [MMC lobbyists] going to stop saying 'modernise or die', when all these companies that are trying to modernise just keep dying and…in the background you've got companies like us who quietly innovate, move things forward, new systems, a little bit more advanced, put a bit more premanufactured value in it, we're still going."*
>
> – MMC sector stakeholder

Fire safety

These critical lines on ‘modern methods’ can overlap with concerns about the systems and materials being brought to market by MMC manufacturers.

A number of building safety experts and fire engineers continue to express anxiety that the rush to herald and support MMC could lead to delivery corners being cut and critical questions being marginalised or silenced (e.g., the 2023 **Morrell and Day review** and the 2024 **manifesto** of the Fire Safety Association). Given the Phase Two Grenfell Tower Fire Inquiry Report confirmed that the construction sector is ineffectively regulated to a fatal degree, they ask how a shift towards ‘green’ construction methods (e.g., through the increased use of timber frame) complexify the built environment? This uncertainty demands, experts insist, wide-ranging reforms to create adequate systems of protection (e.g., better resourced, more data-driven and transparent testing and certification regimes and building control structures). Taken together, we were told, these factors make it more difficult to know how a fire will behave in an MMC building and how to establish lines of accountability:

> *You know a traditional building… we can sort of model it and say, right if a fire started over here this is what would happen, this is how much smoke’s generated, this is where it would go, and we could see that. But once a building becomes more and more complex…can you genuinely understand all of the individual parts that they’ve put together to bring you that outcome. Very, very difficult… part A needs to work with part B which works with part C and now that whole system becomes a modular constructed device, which any one of those things start to fail in some way, everything starts to fail.”*
>
> – fire engineer

Given the current lack of knowledge around fire performance in MMC buildings and homes, this is not just a matter of better product testing, certification and oversight, but one of knowledge exchange and training so that officers and engineers are better equipped to manage MMC buildings if a fire should happen.

The MMC factory

Jobs and skills

Whilst the MMC sector as a whole is embroiled in these discursive struggles and regulatory questions, individual manufacturers are in the knotty business of operations and delivery.

With the sector hailed as a ‘disruptor’ which can radically improve construction productivity and culture, their investments, processes and relationships become a matter of increased scrutiny.

For example, imagery of automated factory processes is typical in MMC contractor websites, industry reports and media coverage signifying an industry which prizes precision and efficiency. The factory also looms large in positive rhetoric around MMC, with advocates claiming that factories offer safer, more hospitable working environments than the 'muddy field' of the construction site (Farmer, 2016). In interviews and at industry events we heard myriad claims about factories being places where people under-represented in construction – women, people of colour, disabled people – might be attracted to work (e.g., HLSTC, 2019, p. 22), glossing MMC with an 'inclusive' sheen.

The fragmented nature of construction, with multiple sub-contractors working on site, is another issue that a shift to the 'whole system' approach of factory-focused pre-manufacture can allegedly help address (HLSTC, 2019, p. 22). However, it has been recognised that MMC introduces a new skills and knowledge profile to housebuilding, not least around automated processes and digital technology, requiring significant investment in training packages suitable for advanced manufacturing (e.g., HLBEC, 2022).

There are clearly challenges with traditional construction sites, exacerbated by a skills drain in the sector, with an estimated 225,000 workers needed by 2027 (Construction Leadership Council, 2023), not least the extent of accidents and deaths on site (HSE, 2024) and **mental health problems** generally.

However, when it comes to gauging the extent to which a shift to factory-based housebuilding is helping to address these issues, data about the profile and conditions of the MMC workforce is simply not available (HLBEC, 2022, p. 72).

It would seem intuitive that an indoor factory environment would be less dangerous and more hospitable than an outdoor construction site, but we do not know how pay and job security or satisfaction compare. Nor should we disregard issues with timber dust, noise and overheating that can come with indoor manufacturing. Indeed, MMC-manufactured homes still require installation and connection on site so do not dispense with traditional site environments or challenges altogether.

Whilst automation is assumed to be a motor of the MMC sector, potentially creating new highly skilled jobs, not all manufacturers have embraced advanced robotics. One MMC expert noted that the sector in England has seen widely varying levels of investment to date:

> *I mean *** are cagey about the level of investment but it certainly exceeds £30 million over five years. This whole notion of you can build an MMC factory on a shoestring, well let's not call it a factory. You can build in a shed on a shoestring. You cannot setup an MMC process line on a shoestring. You are tens of millions and five years of investment before you see a single penny back on return. So pretty much everybody else, and it's not meant to be derogatory, is building in a shed."*
>
> – MMC sector stakeholder

On workforce diversity, currently we simply do not know the extent to which the demographics of MMC factories differ from those of traditional sites. On skill mix, it is certainly true that factory production requires a different blend of expertise than traditional construction trades. Some of this is credentialed design and engineering knowledge injecting, in theory, more holistic and efficient understanding of manufacturing processes:

> *"[MMC] is much more about process, it is much more about being structured and organised in how you work and how you think, and you know, that is very much at odds with a lot of what happens on a traditional construction site, which is pretty random. It's pretty much reactive, you're dealing with issues and actually a lot of the time you're rectifying mistakes. So, it leads you to a different mindset. So I think there is a real subtle interesting thing about the mindset and the behaviour that sits behind how you can have an effective MMC career and how you maximise that ability to harness continue improvement and the efficiencies, a lot of that thinking that we see in manufacturing that is very, you know, it is basic bread and butter stuff to someone working at Jaguar Landrover or Airbus around tack time and the whole efficiency thing, you just, that is foreign language to many construction people."*
>
> – MMC sector stakeholder

However, it is also true that the factory floor requires direct assembly line and machine operations. The MMC manufacturers we interviewed were pragmatic and had some of their labour force directly employed and others sub-contracted. Manufacturers also had diverse DIY training structures in place. Some talked proudly about apprenticeship schemes and continual professional development (CPD) opportunities, including for those with backgrounds in the skilled trades. Others boasted that they preferred workers without a construction background in order that an assembly line mindset could be instilled through their rapid, in-house training programmes. Whatever the approach, we heard that DIY training is often firm-specific and not transferable between MMC factories, creating barriers to labour market mobility.

Factory – site tensions

The reality of adopting MMC is that it changes the relationship between design, manufacture and the installation of products.

Whilst this is a complex and multilinear process, it was often interpreted through the binary relationship of factory and site by our respondents. For example, we heard recurring frustration from MMC firms when they talked about the difficulty of moving and installing their precision-manufactured factory modules, frames or panels on site. Sometimes this was just a question of exposure to the unpredictability of the weather and site conditions. At other times sub-contracted install teams (comprised of joiners, electricians, plumbers and so on) were blamed for lacking a finessed understanding of MMC components or for not being fully equipped to deal with hybridised modes of construction where established knowledge needs to be applied and refined when working with pre-manufactured elements.

One firm we interviewed wanted to address this issue by directly employing their own install teams:

> *It's keeping control of the work on site and also getting the feedback from, one of the big things for us and massive things for, a massive challenge for construction, is it's very hard to get feedback on what's worked and what's not worked on site. So, for a sub-contractor who gets paid for a certain amount of work and if there's extra work they can charge more, it's in their interest not to flag up the problems and do that extra work on every plot and get paid for it again and again and again. Whereas for us we want to find out if there is an issue, fix it once in the factory and fix it forever and therefore you haven't got to do it again.*
>
> *It's also, the amount of work that's left to do on site is actually quite small, and often you don't need an electrician or a joiner or a plasterer for a whole day to do an activity on a house... So the ability to have multi skilled or multi-trades people that can work on multiple activities in an efficient way is something that typically tradespeople or sub-contractors aren't geared up for and aren't set up for and as a result of that you end...up paying for a day when they could have done it in a couple of hours, so, and there's a few reasons around efficiency, quality of feedback and also in some areas it's really hard to get hold of sub contactors and yes, and often they are, it's different to what they are used to doing and seeing so there's a learning curve, and if you are building in different parts of the country and you have got new sub-contractors, they have got to start that learning curve on every site, whereas if it's your own team and they move with our sites they know exactly what they are doing from day one, they have done it 100 times from the last site, they can do it instantly and correctly and if there's an issue they can feed it back straight away. So that's the rationale, cost, quality and speed."*
>
> – MMC manufacturer

The importance of feedback on site is crucial if we reflect on how vital it is for a MMC manufacturer to ensure excellence in their design and production processes. There is little margin for error, with mistakes upstream potentially translating into problems on site with ramifications for the confidence of consumers and clients:

> *I think you find with MMC which is…if you don't get the design correctly scrutinised in the factory, and you don't get that pre-leave the factory quality processes correct, with pressure testing and everything, you can completely derail all the advantages of having MMC within a construction programme. What that's done is, it's probably for us, set us back a little bit on us adopting MMC."*
>
> – social housing client stakeholder

The shift to in-house direct employment is not straightforward, however. According to one MMC sector lobbyist we spoke to, around 90% of the category one MMC labour force lives within ten miles of their factory. However, if we consider the social value calculations that are part of housebuilding contract procurement then this creates a tension around the political and economic geographies of planning:

> *So from a social value perspective…all of a sudden you're doing stuff 200 miles away in a factory, there is this tension as to where the jobs are created, what kind of jobs are created, how future proofed those jobs are, what working conditions they represent and there is a real mix there around the fact that again if MMC is done well you can create better working conditions, you can create probably different employment models that are more around payroll, direct employment rather than casual labour. And less health and safety risk you know, much more about multi skilling, rather than being siloed in trade boundaries. But you've got to accept that the geographic distribution of where the employment happens is very different, so it's not all at the location of the site. So from a planning perspective in particular… that promotes things like local labour creation, local skills creation, it doesn't always work well for that, so there is a tension there that needs a bigger picture perspective on where the [social] value is being created…"*
>
> – MMC sector stakeholder

Pipeline of demand

In any case, the large factory model adhered to by most MMC category one manufacturers has proven to be unstable for job creation.

The wave of exits and insolvencies has seen hundreds of job losses and resulted in a moratorium on the entire business model. The consensus is that large factories demand consistent throughput to service the huge capital expenditure outlay of factory set up, cover overheads and, ultimately reduce the unit cost of the MMC product. The consistency of demand has just not materialised in England to date. This appears to come down to a scarcity of developable and available land. Some of our participants criticised an unwieldy and risk averse planning system for not releasing land for MMC schemes in a timely and enabling fashion. Others blame government for not underwriting and derisking MMC housing schemes through appropriate financing or insurance.

As the CEO of category one manufacturer Top Hat told the House of Lords MMC inquiry in 2023:

> *We've had no support. We are trying to change an industry with private money."*
>
> – CEO of category one manufacturer

It is true to say that, unlike other parts of the public sector such as health and education, no central ministry has organised demand for MMC housebuilding at scale and that the scope of Homes England is limited.

A senior policymaker told us in response:

> *Homes England isn't here to be a safety net…to help businesses through those empty factory periods. And, if the customers aren't there, you know, it's not for government to pick up the tab and to carry the costs of the factory being empty during that period of time."*
>
> – senior policymaker

If the question of pipeline is ultimately a matter of finding land for MMC products, one client stakeholder used this useful analogy:

> *If you are opening a car factory, you know where the cars are going to go, they're going to go on the road and people's driveways. If you've got a mobile phone factory your phones are going to go in people's hands and their pockets. If you are opening a house factory, you need to know where those houses are going to go. The houses are going to go on land that your client needs to buy, or you need to buy as a manufacturer, so you've got somewhere to put them. RPs [registered providers] are going out and trying to buy land, the same land that Plcs are trying to buy and the Plcs have got much deeper pockets than RPs. So, getting our hands on sites is tricky.*
>
> – client stakeholder

This raises the spectre of the volume housebuilders who dominate the open land market in England and with whom MMC firms must ultimately compete. The fact is that 'consistency of demand' runs counter to decades of housing market and policy orthodoxy which has created cyclical and volatile market conditions, underpinned by a careful choreography of land scarcity. The upshot is that developers have few incentives to improve build quality or innovate their supply chain unless government intervenes:

> *Housebuilders don't really make money on the construction process. So, if you're selling an average house for £250,000 and it costs you £180,000 to build it, if somebody comes along and says I can completely change the way you do things and I'll save you another £10,000, they don't care. They don't really care. They're still going to make £70.000 or £80,000 on that plot because they've converted that land into a dwelling that somebody wants to buy. So the housebuilders aren't really that motivated into refining the construction process and throwing out everything that they know, and there are huge risks with doing that as well."*
>
> – housing industry stakeholder

One model adopted by some category one manufacturers in light of such uncertainty has been to implement a 'land led' approach to development. This enables them to work in partnership with, for example, a registered provider to buy and bring forward land for development giving them some control over the pipeline. Similarly, 'vertical integration' is another model of derisking. This occurs where a category one firm can offer an entire 'turnkey' solution to an investor or landowner by taking ownership of all or most aspects of development and manufacturing. Both approaches demand planning and/or project management expertise. Notably, one stakeholder told us that category one firms doing 'turnkey' solutions are beginning to only offer these, for example, to housing associations building out large sites (50 units or more), thereby removing themselves from smaller site development. These approaches contrast with other firms, often category two, which focus on selling manufactured products into the supply chain of traditional main contractors:

> *The other part of the MMC market that is often forgotten about…is recognising the role of hybrid MMC solutions. So this is not modular homes or flats arriving on the back of a lorry…the target market there is…general contractors who are deciding to do less labour-intensive work on site, because they are struggling to get labour…so it's less about that 'turnkey' offering, because you are selling your products into a main contractor and sub-contractor… We are seeing more and more contractors make decisions to move to high levels of what we call pre-manufactured value, the percentage of the job that is pre-manufactured is going up."*
>
> – MMC manufacturer

Category two products have certainly emerged latterly as perhaps the most effective way for MMC to influence and reshape the housing construction sector. There is an ongoing project led by consultancy firm Akerlof to develop a 'kit of parts' toolkit for MHCLG. This is exploring how to build in better 'interoperability' to the construction process. In theory, this would derisk MMC by ensuring that another contractor working to standardised design and build specifications could complete any unfinished work.

Production struggles

Category two manufacturers are theoretically better placed to work with a 'kit of parts' agenda because they are less in hock to the whole build systems IP developed by category one firms.

Such systems have also struggled, it would seem, to manage trade-offs between the replicability required to maximise factory efficiencies and product variance.

There appears to be two key reasons for this tension.

Firstly, the planning system was blamed for imposing different aesthetic demands on MMC housing manufacturers in line with regional design vernacular.

Secondly, some manufacturers found themselves offering different housing layouts and so managing exponential variation on the factory floor:

> *So at ******** there was 1,624 variations of layout. Yes, this was one of the problems that caused ******* to go into administration… because they never made a standard box. Every time one came down the line it was totally different. So, I think they were more trying to suit the customer needs instead of looking at the business itself…'oh, I want an upstairs living with a full kitchen', or 'I want a downstairs with an en-suite', instead of saying, we do seven variations, but you can have options added in."*
>
> – MMC manufacturer

The travails of some of the volumetric contractors in the single-family housing market contrasts with some profitable category one firms which, for example, supply relatively standardised modules for high-rise residential and purpose-built student accommodation schemes – both growth areas in many English cities. If category one has a future, some have suggested, it is in this private sector space where pacy and repeatable production is highly valued by investors.

Conclusion

The MMC sector in England has delivered a number of schemes and homes over recent years.

Most of these have been for private developers, although dozens of social housing developments have also been delivered. In social housing schemes, and in line with government incentives, shared ownership and 'affordable' (80% of local market rent) rental tenures tend to dominate over social rent (around 50% of local market rent). Most MMC manufacturers are category two and use timber, while the bigger players fabricate using concrete and steel. MMC production is spread around the country, even though the bigger factories tend to be located in the North and Midlands.

It is understandable that severe skills and housing shortages have incentivised a turn towards factory-based production models in England. There are good reasons, in theory, why such models should supersede, or at least offer an alternative to traditional, on-site construction.

These reasons include:

- better working conditions
- fewer accidents
- higher quality products
- greater capacity for innovation

However, there is evidence that the added 'value' of factory-based production is uneven in England to date. MMC factory jobs can be low or unskilled, with limited training opportunities. Indeed, in some cases production line operatives with little to no construction experience are being actively sought. We also found firms with admirable records of employment, training and apprenticeship schemes. There is an urgent need for better quality, independently verified data on the MMC factory workforce.

The need to deliver homes quickly to sustain factory throughput is an ongoing pressure for some category one contractors and this has led directly to insolvency. Issues of product variance, planning uncertainty and fragmentations between clients and contractors and between design and manufacturing remain constraints on the sector. However, there are moves to address these, with a strategic industry pivot towards supporting category two contractors' underway. This is thought to better enable shifts towards platformisation and interoperability.

The large-scale factory model remains precarious for firms who have not diversified their output, homed in on specific markets or invested shrewdly in R&D. Even where firms have achieved these milestones, the issue of land supply remains a big problem for the MMC sector, shrinking opportunities to prove itself.

Part 3: MMC housing project delivery

Introduction

Since the 2017 housing white paper, government – via Homes England – has supported the MMC sector by investing in individual firms and by stimulating demand through the Affordable Homes Programme.

However, there is little research evidence exploring how these incentives and investments have manifested in residential housing projects in England. In this part, we consider two relevant factors in project delivery: governance arrangements and stakeholder engagement. Three of the four cases we studied for this workstream were delivered during the period of the research. The small-scale case studies 2 and 3 were wholly completed, albeit case study 2 was delayed by several months. Case study 1 was a larger, phased scheme, which was also experiencing some delays. Case study 4 was started then stalled due to contractor insolvency. In all cases, we interviewed representatives from the relevant MMC manufacturer and a varying number of client stakeholders.

Governance

A number of MMC manufacturers have either halted production or gone into administration since our project started in 2022.

Whilst the reasons for these are diverse, they further raise the question of how residential housing projects using MMC were/are being organised and governed. The UK construction sector has long been considered 'adversarial' whilst projects are understood to be fragmented between client, designer and contractor (e.g., HLSTC, 2019, p. 25). Our findings suggest that the involvement of MMC contractors or techniques does not make a material difference to this tendency.

We observed project governance arrangements dominated by an agency approach and formal compliance mechanisms leading to short-term decision making with a focus on control and cost rather than long-term benefits. In part, we can attribute this to MMC firms failing to invest sufficiently in MMC-specific delivery expertise and relying on individuals from traditional construction backgrounds. MMC is characterised by product repeatability and manufacturing processes utilising high degrees of prefabrication. This requires extensive operations management knowledge and skills. This is in stark contrast to traditional construction which requires project management knowledge aligned with a focus on the delivery of unique products assembled on site. When a residential housing project utilises MMC, it places additional pressures on delivery governance structures to manage the relationship between factory floor and site assembly. We found variable and ad hoc arrangements here, with a degree of 'muddling through' by MMC contractors.

Approaches to inter-organisational collaboration have seemingly remained the same regarding short-term decision making and opportunistic behaviour. A change in construction method does not, from our evidence, necessarily improve collaboration styles if behaviour is not also changed. Governance arrangements can facilitate more collaborative engagements aligned with a stewardship approach. However, this is independent from construction methods and requires a cultural shift in the sector, which needs to be led by client organisations. Decisions based on client organisations' and MMC manufacturers' governance principles, in particular, accountability, responsibility and fairness impacted on case MMC project initiations and delivery. The implementation of corporate governance decisions based on accountability, responsibility and fairness in line with traditional construction masked structural failures within the MMC sector (i.e., access to reliable data, confusion over assurance and warranties).

The reasons for these challenges are not purely on the project level. We need to take a multi-level governance perspective to analyse the failures in the sector. Project governance arrangements do not exist in isolation; they are informed by the client organisation's corporate governance as well as metagovernance arrangements. Meta-governance constitutes the "governance of governance" (Torfing, 2016, p. 525) which manages and directs the organisations operating in the sector by drawing boundaries for their self-governance. We found that central as well as local government acted to a greater or lesser extent as metagovernors for the expansion of the MMC sector in the UK. Client organisations and MMC manufacturers received direct (e.g., Affordable Homes Programme, Levelling Up Home Building Fund) and indirect (e.g., skills and capability building) financial support from government which shaped their actions and decision making. However, problems with uncertain pipelines; knowledge shortfalls; and a lack of common understanding on MMC design, construction and performance between sector stakeholders persisted. This led to challenges to the expansion of the MMC sector in the UK. These governance issues in the realm of metagovernance have been found to be a cause for megaproject failure, and the findings of this study indicate that this is also relevant to residential projects in the MMC sector.

However, there was one notable exception in our study where the MMC contractor was also the project client, providing a 'turnkey' development solution. In this case, project governance arrangements were almost absent. The dominant approach here was characterised by stewardship indicating a longer-term orientation in actions and decisions. These were supported by informal compliance mechanisms relying heavily on trust and mindset. The overall set up of the organisation is based on low hierarchy, with central decision making and operating on a startup mindset. This has led to a lack of formal governance arrangements with little control mechanisms in place creating challenges in the interaction with other organisations involved in the project. However, the MMC contractor/developer in this case worked towards minimising the need for inter-organisational collaboration by reducing the outsourcing of activities.

This requires continued upskilling and expansion of expertise within the organisation itself which was achieved mostly through recruitment of individuals who have no or little prior experience in traditional construction. In theory, this supports the overall point made earlier that it is not the construction method, but rather the behaviour and approach individuals bring to the project that transform inter-organisational collaboration. However, in this case we also found that a lack of project governance negatively impacted on some residents who complained about unclear lines of accountability around snagging issues. We also spoke with directly employed operatives who criticised failures in firm project management structures which led directly to substandard build practices.

Stakeholder engagement

Levels of stakeholder confidence in MMC, and stakeholder knowledge (on construction, maintenance and performance) of MMC, have been barriers to the take-up of MMC in the UK (HCLGC, 2019).

However, concerns have been voiced by Homes England regarding the impact on the delivery of "much-needed" homes in regard to the capacity, capabilities and experiences of public and private sector housing delivery partners to "influence and convene stakeholders" (Homes England, 2023, p. 32), raising the question how the MMC sector, in particular, is engaging with stakeholders to deliver the government's housing delivery targets. To improve take-up, it is, therefore, important to understand the engagement strategies contractors and developers adopt, the reasons for their choice and the impact of these strategies. Our findings indicate that stakeholder engagement, whilst regarded as an essential factor supporting successful project delivery in major projects, is not prioritised in residential development projects utilising MMC. Our MMC case projects demonstrated an awareness of their stakeholders, however little actual engagement took place. This is particularly notable for two stakeholder groups: the end users and the planning authorities.

End users in residential developments are the residents, who might be either tenants or homeowners. Three of our case projects were supplying rental units to local authority or registered provider clients. The definitive stakeholder, characterised by high power, high legitimacy and high urgency, in each case was the client organisation, and hence, the clients were viewed by MMC firms as the most important stakeholders. Engagement with end users was coordinated through the client organisation, who allocated homes once project handover had been agreed. No requirements analysis with actual or potential end users took place and requirements were exclusively defined by the client or even the MMC manufacturer. Engagement between end users and MMC contractors was focused post-handover, during the 12–24 month snagging periods which constitutes reactive rather than proactive engagement. Hence, end users (social housing tenants in this case) whilst possessing legitimacy, were believed to not possess the power and urgency to influence project decisions and have a say in their homes. They were therefore considered as discretionary stakeholders, who are often viewed as beneficiaries in receipt of philanthropy as they have neither power nor urgent claims. This view of end users is concerning due to the impact homes have on the lives of these individuals. Interestingly, in the fourth case, where the end users were private buyers, the same approach was chosen. There was no engagement with the end users prior to the sales process taking place and they had no choice in terms of fit out or finishing touches for their homes. One reason for this might be that the focus on standardisation in the context of MMC methods does not support customisation needs or variations in the houses that are constructed. This varies across the sector. It is notable that in another case where we interviewed residents but not project stakeholders, residents reported being offered some choice of fittings and layout, creating levels of product variance that the relevant factory struggled to manage.

Planning authorities might be expected to be considered dominant stakeholders, i.e., stakeholders with high power and high legitimacy, who receive much of the client's and/or project manager's attention. In the context of MMC residential developments, which introduce new or complex built environments, it might be expected that clients and project managers try to engage with those dominant stakeholders who have the power to approve or reject their planning application. However, in our case studies we found that planning authorities were only engaged with as and when necessary. Indeed, in one case, the evolving MMC project appeared to contravene outline planning permission with a blind eye turned by the authority in question as it strove to deliver new homes in the context of endemic shortages. That said, this is perhaps unsurprising given the intense frustration MMC contractors and industry stakeholders expressed regarding under-resourced and unwieldy planning structures.

Conclusion

Our findings suggest that the adoption of MMC brings challenges to project delivery which have, so far, been insufficiently considered by researchers and industry.

In terms of governance, the argument that a change of construction method will not necessarily alter the interaction between parties needs reinforcing. As new production and delivery complexities are introduced through the adoption of MMC, a shift towards stakeholder and stewardship governance approaches seems required. It is clear from our cases that as MMC contractors mature, they need to establish greater clarity regarding their roles and strengths whilst being more vigilant about working within robust project management arrangements. Such a shift, if aligned with enhanced capacity and expertise around MMC-specific housing delivery, is likely to also encourage more collaborative and confident stakeholder engagement with end users and planning authorities as well as improve relationships with clients. Tensions between the drive for factory efficiencies and standardisation and the customisation and aftercare needs of end users will remain challenging without this additional expertise. Housing projects vary significantly by scale, with end-user needs and the design context placing significant pressures on MMC contractors to understand different market landscapes whilst calibrating their production and delivery capacities accordingly.

Part 4: Resident experiences – living in an MMC home

Introduction

Whilst MMC has received significant attention in policy circles and industry media, it has not been adequately mapped as a sector in England.

We have already noted that, currently, resident perspectives on MMC housebuilding are a neglected part of the research landscape. Indeed, post-occupancy evaluation is an inconsistent feature of all residential construction (RIBA, 2020). To understand some of the lived realities of MMC housing schemes, we surveyed and interviewed residents living in a range of built and 'in progress' MMC housing developments across England. Part 1 of the report provided a breakdown of our cases (Figure 7).

Figure 7: Sample of cases where surveys and resident interviews took place

Case	Planned no of units	Tenure	MMC category	Build material
1	121	private sale	1	timber
2	10	social rental	2	steel
5	7	social rental	1	steel
6	10	social rental	1	steel
7	4	social rental	1	steel
8	22	social rental	1	steel
9	94	private sale	1	timber
10	142	mixed	2	timber
11	72	private sale	1	timber
12	70	private sale	1	timber
13	43	private sale	1	timber
14	30	private sale	1	timber

Our resident survey included questions derived from post-occupancy evaluation (POE) methodology designed to generate feedback on building performance as well as more social scientific questions which explored feelings of home, dwelling and community.

Resident sample

We surveyed approximately 500 residents living in 16 different MMC housing schemes across England and received 84 completed responses from residents living in 12 schemes.

Private MMC housing schemes typically consist of more homes than social MMC housing schemes and the sample skewed in this direction, with 66% of surveyed residents living in private rented and mortgaged homes (Figure 8).

Figure 8: Tenure mix of survey respondents

In terms of responses, our survey sample was dominated by young-ish professionals living in large homes relative to household size.

- Most respondents were between 25–44 years old and were typically couples with no children or one child.
- All but three respondents lived in two-bedroom (24 respondents), three-bedroom (24 respondents) or four-bedroom (33 respondents) homes.
- 32 respondents had been living in their MMC home for 1–2 years and 28 living in their home for 2–5 years.
- Only 12 respondents had lived there for more than 5 years.
- Of the 40 households we recruited for follow-up interviews, only five lived in social rental homes.

Attitudes to MMC

Given anxieties in the sector about consumer confidence in MMC, we asked our interview participants how conscious they were of the MMC construction methodology before they moved in and their feelings about it.

Across our sample, most residents had some awareness that their home was built using MMC and were neutral on this point, rarely saying that it had deterred or motivated them either way. The vast majority were simply happy to be living in what they felt was an upgraded home or to be on the property ladder. Social renters mentioned they were intrigued by the possibility of lower energy bills whilst private buyers noted that MMC had often been used as a selling point in marketing suites:

> *I guess there was a push at the sales event on it being sort of ecofriendly... compared to your typical, traditional construction... I remember them making it really clear that the houses were being built off site and then they'd come to site for sort of- To be put together in two halves and obviously all of the services would be put into the house. Yes, so I guess from the sales event you did get the impression that it was something a little bit different and not something that happened on every new build site."*
>
> – resident, case study 9 – private, category 1, timber

A majority of households in our survey reported that an "environmentally sustainable" home was "very important" to them and stated this was a factor in them renting or buying their MMC home. If they expressed prior awareness of MMC, residents often cited the Grand Designs television show, as well as some professional knowledge and personal research. A minority understood MMC to represent a modernised iteration of 'prefab' homes.

Where residents had bought homes from high-profile developers, this generated trust in MMC as an exciting, innovative approach to housebuilding. Any initial concerns residents had about securing mortgages or insurance on MMC homes were typically assuaged early in sales processes, sometimes by MMC-savvy brokers suggested by marketing teams.

Delays

We know, at least for category one firms, that MMC factories need guaranteed demand over a set period to maximise efficiencies.

In one case, we found this filtering through to sales teams applying pressure on homebuyers to secure mortgages and lay down deposits for homes yet to be built. MMC firms, however, appeared to struggle to deliver homes to these agreed timescales.

Almost all of our interview respondents experienced delays moving into their MMC homes, some as long as 24 months. This was a point of intense frustration and created significant personal, financial and health challenges for residents.

One social tenant told us:

> *Bearing in mind I'd been packed up three times in my old property, to then unpack because there's things that I needed. So every time they were saying, 'You might be moving in', I was packing and then having to unpack… I've got physical mobility needs, and I've got problems and illnesses, so it wasn't something that was easy to keep doing."*
>
> – resident, case study 2 – social, category 2, steel

Another private owner recounted her experience, including the stress of securing a mortgage:

> *I needed to do Airbnb because they were saying the house will be soon, soon, soon. And that wasn't the case. I was paying more for Airbnb, and I felt like I just stuck in that system they created… I needed to remortgage because they give you only for six months and obviously because they were postponing so much every time the deal was expired…and at the time the markets was going really worse, worse and worse and the rates were going up and I have no other choice. If I didn't remortgage, didn't take the worst deal, then I wouldn't have been able to buy the house… The whole (MMC) concept looks very beautiful. It was like affordable houses delivered in the short term and very friendly for environment, but…it was completely opposite to what they delivered…it was almost took them like they were actually building from the scratch, basically the brick houses, it took them that long and I think they didn't have very well organised, the inside system, how to deliver and the management I think was changing as well."*
>
> – resident, case study 9 – private, category 1, timber

Others had to rent additional properties while they waited for their homes to be ready. One respondent told us they spent over £10,000 on rent and storage fees. For those with family support, they could move back in with parents and one young couple told us they used the time to save money and secure a cheaper mortgage. Where there were delays, there was often an apparent failure by sales teams to communicate with residents adequately and our respondents complained about a lack of accountability and of buck-passing among contractors and developers.

In more than one case, MMC delays were publicised by local media outlets. In some of the case studies being built out in phases, where MMC contractors had gone out of business, residents were left living in half-built schemes and with stalled regeneration projects where planned amenities like shops and community centres had not materialised.

Points of satisfaction

Survey respondents expressed satisfactory feelings about different design and structural aspects of their home.

There were some complaints about storage and power sockets, but respondents typically thought their homes were spacious, liveable and relatively well designed. Overall, buyers thought their homes were robust and felt positive about living in a home built using MMC, for example:

> *The house is built really well. I can't hear my neighbours at all... The actual fundamental build-up of the house is really, really good, and I think it's a really good move for the future as well, using renewable materials and extra insulation, all this stuff. I think it's the sort of thing that we should be doing."*
>
> – resident, case study 9 – private, category 1, timber

Whilst social renters did not tend to mention external aesthetics, private owners often mentioned how visually striking their homes were, eliciting feelings of pride and reassurance about sell-on value:

> *The houses are absolutely beautiful, and you know the number of times you see people stopping, stopping I'm not joking, to take pictures... people park their cars outside the houses on the side and stuff just to take pictures and videos... People come and touch the walls because it's so... different, and it's kind of, it's just really, really nice. I mean, when it's leafy as well, when it's spring, well it's just very, very nice. You know, and we've had sometimes letters being pushed through the letterbox, whatever, because agencies want to sell around here, you know..."*
>
> – resident, case study 11 – private, category 1, timber

Only a minority of private households were considering moving on in the short term and where overall dissatisfaction was expressed, this was usually linked more with questions of finish and installation. In all of our private MMC case studies, the contractors involved were praised for their vision and architectural design but were also widely criticised by our respondents for their poor communication, aftercare and repair processes. This sentiment was typical:

> *I think they've let themselves down on their quality. I do love the house, and I would buy another modular house, just not from ***, I'd buy it from a different company."*
>
> – resident, case study 12 – private, category 1, timber

Housing performance

On the question of how the buildings performed, we found mixed results.

Our survey showed relatively positive results on thermal comfort, air quality, energy use, noise and light. However, when interviewed residents reported wide variations in their capacity to warm and cool their homes and specific mechanical problems with heat pumps, ventilation systems and sprinklers. Relatively high ceilings and open plan layouts were frequently mentioned as challenges when trying to warm homes. A participant in one private estate (case study 13 – category 1, timber) noted that the houses were so cold that "you can see your breath in the kitchen". This led to them, and their housemates, spending more time in their bedrooms, which had a negative impact on their mental health. A key selling point of these houses was their environmental impact and insulation, yet multiple interviewees stated that the houses did not meet their expectations in this regard. Some felt that part of the issue was that the houses had ineffective electric heaters. Others stated that their insulation was substandard. Rather than consistency across the estate, residents had discussed with each other the variance in their energy bills for neighbouring homes. One interviewee noted that when they saw "the new houses going up" in phase two of the scheme, they noticed variation in the amount of time subcontractors spent "spraying the insulation" (resident, case study 11 – private, category 1, timber).

Cooling homes during hot periods was also a recurring problem for residents in case study 9 (private, category 1, timber) with one resident stating that it "is easily the worst thing about the houses". Multiple residents shared how they, and their neighbours, have purchased aircon units, as well as doing "quite dramatic stuff" to manage the temperature, such as sleeping in other rooms, or staying in a hotel "for a couple of nights [...] because it was so unbearable [...] even with the fan on". Some indicated that the aircon is used frequently, affecting the bills and the environmental impact of the house. Another issue with installing aircon was deciding where to put it: "I don't know where I'd put it because what's the most important room, I don't know.". Some of the interviewees noted that the houses becoming too hot was likely caused by the big windows, which they also often highly valued, due to the way in which they allowed for "bright", "natural" light. To help mitigate this, one resident installed solar filters, which has made it "a bit better", and another put up "proper reflective curtains". Others suggested that opening the windows on both sides helped by creating a through draught. However, some interviewees stated that there had been issues with some of the windows blowing open too far in the wind and becoming damaged, creating substantial repair costs.

Cooling problems also emerged in two other private estates where "unbearable" heat interfered with their ability to work from home in the summer. In one (case study 1 – private, category 1, timber), the homes had been sold by the developer as being up to Passivhaus standards, but residents were convinced this was not accurate. One respondent told us about the variations in air temperature in his three floored home:

> *...we were here throughout winter, I'm quite warm anyway so I don't really get that cold in a house. My fiancée found some parts freezing, so the bottom floor is more than comfortable for me. I like sleeping in a cold room. She struggled a little bit with how cold it is downstairs and there was quite a difference in temperature between floors, which isn't what a passive house is supposed to have. It's meant to be regulated throughout so that's not functioning very well."*
>
> – resident, case study 1

We were also told about issues with damp, condensation and mould in some homes across our case studies.

One social renter was using several appliances such as dehumidifiers, heaters and a window vacuum to maintain acceptable conditions, another example of a MMC resident bearing the costs of poor building performance.

Accessibility and adaptation

For our respondents living in social housing, accessibility emerged as an important factor.

Some appreciated the level of accessibility of the houses. However, there were issues for some tenants with specific needs, who needed their homes adapted, including the installation of grab rails or hoist mechanisms, after construction was completed.

For example:

> *Because this property is a metal, steel inside, and basically is not made from brick... There's nothing to put the grab rails on the wall with, because it's hollow. It wouldn't be able to take the weight... They're supposed to be designing some metal frames to be putting up to be able to get the grab rails in, but I've still got no further with that, and I've still got no grab rail. I've already had an accident."*
>
> – resident, case study 2 – social, category 2, steel

Both this respondent and another suggested that adaptations should have been made earlier in the process:

> *I just feel like they could have been better, and in future, again this is a council thing and feedback to say, well if you know that someone with a disability is moving in, talk to them about what adaptations they need so that the adaptations can be done whilst the build is being done."*
>
> – resident, case study 2 – social, category 2, steel

A significant accessibility issue highlighted by owners in one private case (case study 11 – category 1, timber) was related to the height of the houses meaning the "steps are steeper than what you find in a typical house". The steep steps can be difficult for people with limited mobility, and one respondent noted that "when our parents visit they find it hard".

Other interviewees stated that the height of the house meant there were areas that were out of reach for them, such as the hooks on the backs of doors and shelves in bathrooms. One participant stated: "I'm five foot six and a half and I can just reach the bottom shelf of those cabinets, so they're absolutely useless."

In terms of modifying their homes, tenants were not entirely sure what was possible and were nervous about doing anything.

For example, one reported being "too scared" to put up shelves, despite being usually confident with DIY. Although tenants had been provided with a handbook about the properties, they did not feel that this provided particularly useful information on modifications. All also suggested that the handbook was overly technical and lengthy and not easy to understand. There was significant variation among private residents regarding modifications depending on housing design and layout.

Residents were given manuals when they moved in, but these often ran into hundreds of pages and typically did not include design drawings. This created uncertainty about how to adapt their homes. Residents either did not bother making changes, learned by trial and error or, in some cases, shared information on neighbourhood social media groups about wall thicknesses and service cabling for those wanting to hang pictures or put up shelves.

One resident mentioned that professionals attending the houses on their estate (case study 12 – private, category 1, timber) were often "nervous because nothing is done in the way that they're used to". This meant that professionals take longer to complete the work, which could have cost implications. It was making modifications on their house that led one resident to start questioning the quality of their home because they "found things that were a little sloppy" such as power cables not "routed where they should be" and the quality of the wires which "could have been a little better".

In a different case with a different MMC build system, one resident had an entirely different experience:

> *...the one thing that I will give them is all the wiring and the plumbing was routed in a really, really clever way. So, it's dead obvious where all the pipes are, so you don't need a stud finder or anything...putting stuff like shelves and coatracks and stuff like that has been super easy."*
>
> – resident, case study 9 – private, category 1, timber

Snags and aftercare

Snagging is an accepted fact of new build housing and whether, globally, MMC homes have more snagging problems than traditionally built homes is a question beyond the remit of our study.

However, there were extensive issues flagged by residents during our interviews, some of which we can link with the specificities of MMC. We also found instances where residents were "rushed" into homes which were poorly finished after delays of months, even years.

In the lead up, I think it was the day we moved in we were literally handed over to someone I'd never met, heard of and she brought us to the front door. I remember her saying about seven times: 'I do apologise.' We were pretty much straight faced looking around at things like, we've just bought a house. This should be really exciting and all we're doing is wiping things… the whole thing was filthy. It was dusty. There was unfinished stuff. You could see bits that just clearly no one had looked at it because you'd look at it and go, we can't sell this house now. But they must have felt some time pressure to deliver because they'd been so late. I really wish they'd taken three days and taken some care of this because that would have been a great time. But yes, it was around then, walking into one of the rooms and the floor just went [noise] and we were like: 'Is that normal?' and they went: 'Oh yes.' It's like, no, it's not. Hold on, no, it's not. We came up here and I was like: 'The floor is pointing the wrong way.' They were like: 'What do you mean?' I said: 'Look, it's not even 90 degrees."

– resident, case study 1 – private, category 1, timber

Overall, we surmise that in too many cases, the satisfaction of residents and tenants was subservient to a construction method which had yet to iron out significant wrinkles in production and install processes. This created delays and significant snags and defects conjoined with some very poor and fragmented support, aftercare and repair systems:

*It's like an onion. The more layers you go the more weird stuff there is. And yes, every single aspect of the house seems to be done by a different person, and the flats seem to be another different person, and it's a whole complicated web of housing development. I was chatting to one of the ground crew, and he said he was originally employed by *** to put the houses in. He's now employed by ***, and I don't know if that's a new job or his role just moved over as the houses got handed over. I don't really know. But I think *** put everything in, and then this company *** did most of the groundwork, and then after that I don't really know. We just see lots of different vans on the estate."*

– (resident, case study 9 – private, category 1, timber)

In one of the social housing schemes (case study 2 – category 2, steel), delays in delivering the homes caused concern for the local authority client.

This client told us they would consider more MMC schemes in the future but only if the project was governed and managed differently bringing in specific project management expertise:

> *I do think ***** would be better supplying the products…they supply a good property, but I don't think they have that other side."*
>
> – resident, case study 2

Because of these problems, particularly the delays, the local authority were left without the effective MMC development showcase they had been hoping for. We found a similar sentiment expressed by planners at another large local authority. They, too, had been looking for a flagship scheme to 'prove' the MMC concept, and whilst the scheme has won industry awards, it is well known locally to have experienced significant delivery problems and has attracted negative attention in local media and housing circles.

Conclusion

We recognise that our sample of MMC housing residents is limited, and that research of this nature might disproportionately attract those with negative experiences to share.

That said, we found that, overall, respondents were largely happy with their MMC home. Private home buyers mostly insisted that they had no regrets about "going MMC" and mentioned many positive aspects of their homes, including layout, design and size. That some MMC developers have built family homes in urban brownfield sites has proven popular for those who value city life but want to avoid apartments (and suburbia) and have the financial resources to buy rather than rent in the city. There was some evidence of gentrification effects, however, with some tensions flaring between MMC enclaves and surrounding neighbourhoods.

That said, residents also reported a poor-quality finish in many homes, widespread snagging problems and ad hoc and weak aftercare support from developers and contractors. In terms of social housing, there remain questions about the extent to which MMC contractors can deliver the accessible and bespoke homes that are suitable for residents with complex needs.

Overall, the homes in our sample are reported to be performing in uneven ways, even within the same scheme. In some homes, heat pumps and ventilation systems work well, in others there have been serious problems. The height of ceilings, size of windows and open plan layouts were all cited as factors in creating unbearable heat in summer whilst electric heaters struggle to warm homes in winter. Residents of these MMC homes have had to invest hundreds, if not thousands of pounds in devices and strategies to resolve such problems.

Where there has been contractor insolvency, residents who have already moved into developments and committed to the MMC vision, have been left living in half-built schemes and with a sense of anxiety about stalled promises around place-making and project durability.

Epilogue – questions and dialogues

Housing, in the English context, is a crucible of social and economic injustice for too many households.

We know why this has happened: public policy and free market orthodoxies have combined, in the name of perpetual asset inflation and corporate bottom line, to ensure there are chronic shortages of safe, good-quality and affordable homes.

We also know now that housing is a matter of **ecological justice**; new build homes must simply be built and inhabited **differently**.

The question is: **how might these challenges be overcome?**

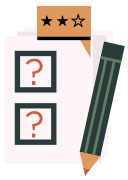
In this context, MMC offers a seductive solution. Lobbyists for the sector proclaim it can build faster and more efficiently. The failures of the current system and the moribund nature of traditional construction mean MMC can be positioned as an exciting 'disruptor'. This creates momentum for an industry-friendly research framework which asks: what are the barriers to enabling MMC to build the homes we need? In our view, this is not sufficient and more searching critical questions need to be asked about what has been built to date, using MMC, and what the future of MMC should look like.

On the first point, our findings are mixed. The MMC sector that we found was in its relative infancy. It was disproportionately populated with start-ups and pilot schemes. Firms were beset with hype and pressure whilst trying to figure out new build methodologies and delivery frameworks in a housing system not geared up for its specific requirements. Unsurprisingly, the outcomes were not always up to scratch and homes were of variable quality. Some people are living happily in sound MMC homes.

Others are not, their expectations raised then disappointed. We can link this unpredictability to a range of interlinking factors: imperfect and struggling factories, flawed business models, uneven skills and expertise, irregular government oversight and a volume housebuilding industry which protects its business model and bottom line at all costs. Where MMC has apparently thrived – delivering build-to-rent, high-rise residential homes on behalf of real estate investors – is not necessarily a cause for optimism in housing justice terms.

On the second point, there are some obvious interventions required by government before policymakers can even consider supporting the MMC sector in the context of the 1.5 million housing target.

We would highlight the following points for urgent industry, policy and research dialogue:



Built MMC homes

What types of evidence is it viable and appropriate to gather to evaluate their quality and performance to date?

Homes England

To what extent are its Affordable Homes Programme (AHP) investment strategies and reporting mechanisms fit for purpose?

MMC products

What independent and public testing and inspection structures do we need to certify and enforce safe MMC residential environments?

MMC building regulations

Do we need MMC-specific construction standards? How can we address MMC-specific risks around fire safety and ensure that they are understood and mitigated? What needs to change? What MMC-specific skills and resources would a new construction regulator need?

MMC building control

What kind of authority do we need to effectively regulate and improve MMC housebuilding? Is there sufficient MMC-specific expertise in the building control industry?

The MMC labour market

What are conditions like for factory workforces? What is the MMC job creation landscape? What are the skills gaps? How might these be reviewed and addressed within the remit of, for example, Skills England?

We would stress, however, that even if these points were to be addressed, further government intervention is required to harness the MMC sector, if we bear in mind the dysfunction of the dominant housing system and the scale of the social rental housing crisis in England.

This next step would involve policymakers engaging with and actioning the following questions:

- **Net zero**
  What regulations and enforcements are necessary to ensure MMC housebuilding is contributing to government targets?

- **Land and financing**
  How can these be released by government so that housebuilders are incentivised to use MMC to specifically build social rental housing, e.g., through the New Towns programme?

- **Circular and community-focused build methodologies**
  What kind of programmes could be introduced to better support these alternative approaches?

- **Community self-build schemes**
  How might growth in community-based MMC self-build schemes be incentivised?

- **The rights of social housing tenants**
  As MMC is scaled up in the social sector, what steps could be taken to redress power imbalances between landlords and tenants?

Unless these points are **addressed**, and **concrete steps are taken** to **effectively regulate** the sector to harness its potential for social and alternative housebuilding models, then MMC will likely remain a 'neutral' technology solution. At that point, MMC firms will either be invited in as sticking plasters on market failure or have their build systems absorbed / jettisoned by volume builders negotiating economic cycles. This suggests that, as well as enlarging and guaranteeing a role for MMC in more socialised housebuilding agendas, we cannot escape the fact that the dominant housing system needs radical attention. It remains to be seen whether policymakers have the capacity or inclination to recognise this fact and embark on the necessary reorientation of our collective and planetary relationships.

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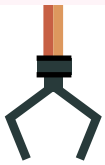

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