

## **MODULAR: THE SOLUTION TO BRITAIN'S HOUSING CRISIS?**

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ORIGINATED BY

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*Foreword by*



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In 2016, a government-commissioned review of the UK construction labour model carried out by consultant Mark Farmer warned that the industry needed to 'modernise or die', in particular changing the way in which buildings are constructed.

As recently as July 2018, the UK government has highlighted off-site manufacturing as a core component of a £420m construction sector deal. The deal is intended to transform construction productivity through the use of innovative technologies - building more homes, more quickly and with less disruption - in a so called 'bytes and mortar' revolution.

With over a million new homes needed in the next three to five years, modular construction has the potential to be of significant assistance, particularly given a worsening skills shortage across the UK construction industry, likely to be exacerbated by Brexit.

Modular construction, a Modern Method of Construction (MMC), is a term used for a variety of different modern building methods in which components of the building, or modules, are prefabricated away from the building site itself. Modular construction can enable a range of efficiencies and improvements through the employment of factory processes in construction jobs.

In this paper we set out recent developments in modular construction, with a particular focus on residential housing development, setting out the primary benefits of this mode of construction. However, there are obstacles that have prevented its widespread adoption to date, posing the question of whether modular construction could be the sole answer to our housing crisis or rather, should be just one part of a suite of measures.

As interest in modular building grows, we set out key learnings from modular techniques to date, balancing the benefits and drawbacks. We also look to future application potential, particularly with a view to supporting the urgent need for an effective solution to the housing crisis.

A handwritten signature in black ink that reads "Richard Steer". The signature is fluid and cursive.

Richard Steer, BSc (Hons), FRICS, Hon FRIBA, FCIQB, FAPM  
Chairman of Gleeds Worldwide

# Definition of Terms

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For the purposes of this piece, modular construction will be taken to mean any construction method whereby a significant amount of fabrication of elements takes place “off-site”. There are generally regarded as being four main types of modular construction.

These are:

- Volumetric construction – Completed homes (or individual flats) are shipped to site completely pre-assembled
- Pods – Individual rooms or parts of rooms are pre-assembled and slotted in to place, for example bathroom pods
- Panellised systems – Structural wall panels made typically of either timber or light-gauge steel are pre-fabricated off-site and then assembled in-situ
- Sub-assemblies and components – The use of larger prefabricated components including roof and floor cassettes, and prefabricated chimneys, porches and dormers

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**Modular buildings** may consist of multiple prefabricated parts, or modules. Modular construction differs from traditional modes of building in that its individual sections are produced at a facility ‘off-site’, then delivered to the intended point of use. The prefabricated sections are then assembled in-situ.

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# Chapter One

## *How widely is modular construction already used?*

The construction industry in the UK contributes roughly 7% of Gross Domestic Product at present, with output of £162bn in 2017. There are no reliable figures for the proportion of this that is off-site construction, with the CITB in 2017 stating it was “less than 10%” of total output. Similarly, reliable data on modular uptake in the housebuilding sector specifically is scarce. The most recent estimate by the National House Building Council (NHBC) suggested that one in six homes in the UK are being built using either timber or steel-frame technologies, though this figure hides a big regional disparity, with eight in ten homes in Scotland using timber frame, but less than one in ten in England. While the NHBC doesn't have similar figures for other modular technologies, a survey of housebuilders it conducted suggests very low uptake for more sophisticated technologies, such as full volumetric construction or pods. While around 40% of housebuilders claim to have used panelised technologies, fewer than 10% have any experience with volumetric or pod systems.

For many, these figures are disappointing. Ken Shuttleworth, one of the designers behind the iconic Gherkin in London and founder of renowned architectural practice Make, says that house builders in particular must catch up with other sectors:

*“House builders remain a way behind the office market, for example, where modular has been happening for years. We're still seeing people building houses like they did in Roman times.”*

Despite this, and thanks to advances in technology allowing for improved flexibility on floor plans, sizes, multi-storey configurations and enhanced energy performance, modular is increasingly challenging traditional methods of construction. New manufacturing centres such as Laing O'Rourke's Explore Industrial Park, Swan Housing Association's facility in Basildon, and Legal & General's modular factory near Leeds are all examples of UK companies demonstrating a real commitment to a future in modular.

### **History of modular**

Modular building is not a new phenomenon. Indeed, the first record of such a build appears in the South Australian Record as long ago as 1837 and since then the technique has been used to construct everything from homes and hospitals, to fast food restaurants and hotels across the globe. Modular building was perhaps best known as a form of construction employed after World War Two known as 'prefabs', since when its popularity has ebbed and flowed.

Prefabricated houses were a major part of the delivery plan to address the United Kingdom's post-Second World War housing shortage, with more than 600,000 built in ten years. They were an initiative of war-time Prime Minister Winston Churchill in March 1944, legally outlined in the Housing (Temporary Accommodation) Act 1944.

In the 1960s, prefabricated houses were used again to swell supply. However, following the Ronan Point collapse in 1968, blamed on a prefabricated system, and a 1980s World In Action documentary exposing quality problems with housebuilder Barratts' timber frame homes, prefabrication developed negative associations and its use waned. The word brought to mind the idea of temporary, poorly built homes for which buyers struggle to obtain a mortgage, and the term fell completely out of use, ultimately rebranded as modern methods of construction or modular build.

There was, however, a major push for modular construction at the start of this century following the publication of the Rethinking Construction report authored by Sir John Egan in 1998. It called for the introduction of factory “production line” techniques in to the construction industry with the aim of improving stagnant productivity of the sector. By 2005, the National Audit Office had concluded that modern methods of construction (MMC) were a way of building homes more rapidly and efficiently, while a similar report published by the Barker 33 cross-industry group the following year claimed that such methods “...involved superior products and processes, all of which served to improve business efficiency, output quality, sustainability and delivery timelines.”

Many modular construction initiatives were abandoned with the onset of the credit crunch and subsequent collapse in house-building volumes. Only in recent years has interest in modular building begun to grow again.

### **Recent developments**

In 2016 the government-commissioned review of the UK construction labour model, carried out by consultant Mark Farmer, warned that the construction industry needed to ‘modernise or die’, in particular meaning it must change the way in which buildings are constructed.

This conclusion was reached following a particular focus on what is happening to construction skills. Farmer found an urgent need for the industry to reduce demand for on-site labour, which is one of the potential benefits of modular construction. Farmer estimated that over the next ten years there could be as much as a 25% decline in the existing UK construction workforce (this was without factoring in the potential loss of the 8% of UK construction workers who hail from the European Union).

The labour shortage is already having an impact on the construction industry, as observed by Make's Shuttleworth, who supports Mark Farmer's view. Shuttleworth says: “We cannot get the skills on site anymore to build houses. Youngsters don't want to go into construction because they don't want to work out in a muddy field but they are happy to work in a factory and make things, so the more we can do off-site the better.”

As recently as July 2018, the government has again highlighted off-site manufacturing as a core component of a £420m construction sector deal. The deal is intended to transform construction productivity through the use of innovative technologies – building more homes, more quickly and with less disruption – in a so-called ‘bytes and mortar’ revolution.

Echoing the deal's sentiments, The House of Lords' Science and Technology Committee published its own report in June, entitled ‘Off-site manufacture for construction: Building for change’ which said that off-site manufacture can help to increase productivity in the construction sector while reducing labour demands, improving the quality and efficiency of buildings, and reducing the environmental impacts associated with traditional construction.

The Committee's chairman, Lord Patel said: “The construction sector's business models are no longer appropriate and are not supporting the UK's urgent need for new homes and infrastructure. The sector needs to build more trust and create partnerships so that companies can work together to improve the uptake of off-site manufacture”.

The Committee heard evidence that if the Government is to achieve its aim of building 300,000 houses a year by 2020, such methods would in fact be the only way to meet this target, and that traditional construction methods simply do not have the capacity to build homes in such numbers.

Nevertheless, support from the industry for an increase in modular construction is certainly not universal. An EcoBuild survey published in March this year found that almost half of its two thousand respondents (49%) were still unable to identify what the term ‘modular home’ actually refers to. It also highlighted the lingering lack of confidence in this type of building, with a fifth of respondents stating that prefabricated housing is poor quality, and one in six labelling it as old fashioned. These sentiments were echoed in May by research conducted by YouGov on behalf of Home Group, one of the UK's largest providers of homes for sale and affordable rent. It reported that 52% of those surveyed would be unlikely to live in a modular home (although almost 90% failed to correctly identify a modern modular product) and 41% believe they are less durable than conventionally built homes.

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*“The real ticking ‘time bomb’ is that of the industry's workforce size and demographic. Based purely on existing workforce age and current levels of new entrant attraction, we could see a 20-25% decline in the available labour force within a decade. This scenario has never been faced by UK construction before.”*

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### **Mark Farmer**

Author of The Farmer Review of the UK Construction Labour Model

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# Chapter Two

## Advantages and disadvantages of modular

### Advantages

Despite its somewhat negative image among British home buyers, MMC continues to be touted as a viable solution to the housing crisis by numerous industry experts and governing bodies. The arguments for a shift are plentiful. The most obvious benefit is in construction time. While timeframes are of course dependent on the individual project, most estimates suggest that off-site homes can be produced in roughly half the time of those built using traditional construction methods. This is because modular construction allows construction of the home to happen simultaneously with the preparation of the site, such as the laying of foundations and installation of utilities.

Significant improvements are also in part achieved due to better programming and quality control, meaning more components can be designed and manufactured elsewhere. A simplification of site operations, reduced dependence on weather and the reduction of defects also contribute to a more compressed build schedule. Modules can be delivered to site pre-fitted, further reducing the building programme and accelerating the process overall. Lord Patel, chairman of the Science and Technology Committee said that “[The Committee] heard evidence that off-site manufacture could increase productivity in the sector by up to 70%.”

Rosie Toogood, chief executive of Legal & General’s modular division is confident that modular holds the key to increasing productivity and meeting the Government’s ambitious house building targets. She has been quoted as saying: *“Modular construction is set to revolutionise the house building sector, bringing new materials along with methods and processes used in industries such as car-making to raise productivity and help to address the UK’s chronic shortfall of new homes.”*

While this report is predominantly concentrating on housing, such benefits can be replicated across all sectors and we are seeing an increase in initiatives encouraging higher rates of adoption across the board. Hospitals and medical centres, for example, are in desperate need of additional space and upgrades. In response, the NHS SBS Modular Building Framework was launched in a bid to deliver faster, greener and cheaper building solutions, while reducing disruption.

*“Modular construction is set to revolutionise the house building sector, bringing new materials along with methods and processes used in industries such as car-making to raise productivity and help to address the UK’s chronic shortfall of new homes.”*

#### Rosie Toogood

Chief executive at Legal & General Modular

The potential benefit for commercial housing developers is that by expediting a build you are of course able to begin actively making money sooner through rent or sales, though (as detailed below) this is not always the case.

However, both private and public sector bodies can benefit where cost savings can be achieved during the build phase by reducing the time spent on site, though again cost issues can cut both ways. Independent research by KPMG found that despite elevated initial costs associated with one off off-site construction projects, financial net savings of around 7% were possible thanks to the considerably shorter construction period.

*“This framework offers...improved predictability of costs due to controlled factory production costs, as well as a faster speed of build, as much of the work is completed in the factory. The value engineering used by our suppliers can also help save costs, including reduced preliminary and carpentry costs.”*

#### Tony Woods

Technical manager at LHC

In a market where the supply of labour is constricted and often unpredictable, modular build can also make budgeting more predictable. For example, public sector procurement specialist LHC launched a £1bn off-site framework earlier this year, claiming to offer easy access to off-site manufactured, modular building systems for use in non-residential buildings. LHC’s Technical Manager, Tony Woods is reported as saying the framework offers *“...improved predictability of costs due to controlled factory production costs, as well as a faster speed of build, as much of the work is completed in the factory. The value engineering used by our suppliers can also help save costs, including reduced preliminary and carpentry costs.”*

For example, Stephen Taylor of the HSE Construction Engineering Specialist Team also says that a reduced number of workers on-site results in savings of up to 50% in the heating and lighting of temporary site accommodation.

This nods to another big benefit of modular, already referred to, which is the fact it reduces the need for skilled tradespeople on site, something which Mark Farmer concluded would prove vital to giving the construction industry the capacity to meet the government’s stated desire for 300,000 homes a year.

Proponents of modular construction also maintain that fabricating in factory conditions, sometimes with automated processes, allows them to deliver products with more consistently high quality than can be gained from traditional masonry construction. Hence, modular construction is a natural fit for those looking for more sustainable designs and improved environmental impact too, as sustainable features and low carbon technologies all require high build standards. In terms of their ability to adhere to traditional building codes and standards, modular builds are fabricated to at least meet but often exceed building regulations for thermal efficiency, radically reducing energy costs.

Complying with specific sustainability standards – such as BREEAM, AECB or Passivhaus – may also see further reductions in energy consumption and longer-term running costs.

*“The construction sector’s business models are no longer appropriate and are not supporting the UK’s urgent need for new homes and infrastructure. The sector needs to build more trust and create partnerships so that companies can work together to improve the uptake of off-site manufacture.”*

#### Lord Patel

Chairman of the Lord’s Committee for Science and Technology

#### Benefits: Modern Methods of Construction

- Construction phase can be complete in roughly half the time of a traditional build
- Improved quality control thanks to more rigorous factory processes
- Less reliance on skilled workforce on site
- Reduced waste
- Better safety profile for those who are on site thanks to cleaner environment
- Potential cost savings resulting from a considerably faster build programme
- Increased productivity sector-wide
- Enhanced energy efficiency

# Chapter Two

## Disadvantages

Why then has modular construction not seen take-up in the UK to the same extent as other nations such as the Netherlands, Sweden or Japan where these methods are commonplace?

Probably the biggest reasons have been commercial. The business model of most private sale housebuilders in the UK make it desirable to build homes at the same rate as they can sell them, which for standard edge of town sites is between one to two homes a week, easily within the capacity of traditional construction. Hence, the ability to build faster (with MMC) doesn't ultimately enable the housebuilder to make its return any quicker. So, while developers of homes for rent get a big financial boost from the principle benefit of MMC – its speed of construction – the fact the majority of homes are built for sale means this speed isn't valued by most housebuilding firms.

This wouldn't be a problem if modular was generally cheaper than traditional build, however until recently modular was perceived by housebuilders as a premium product. Recent increases in the cost of traditional construction mean this has changed, making modular financially competitive with traditional build in some areas, particularly high demand parts of London and the South-East.

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*"What you're getting with off-site is not superior, it's imported and it's costing British jobs."*

### Mike Leonard

Chief executive of the Building Alliance

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In addition, although cost savings can be achieved thanks to a reduced build programme, there are other hidden costs associated with MMC, such as the way in which materials need to be transported.

Mike Leonard, chief executive of the Building Alliance, is quoted as saying that components are often imported which not only leads to an increase in costs, but also means that the increase in air miles somewhat flies in the face of the sustainability argument. In contrast, Leonard argues that 80% of materials for traditionally built homes are sourced domestically and therefore by importing these modules from overseas, this kind of building negatively affects employment and trade in the UK.

A negative image is undeniably another barrier to the adoption of modular housing in the UK. Studies such as those cited earlier in this document show that many people simply cannot separate the post-war, difficult to finance, 'non-standard' bungalows from today's technologically advanced constructions, rendering modular housing developments somewhat undesirable real estate. Today, mortgage lenders generally expect a design life for the structure of at least 60 years and, despite being unrecognisable next to yesterday's prefabs, the durability of brand new systems is difficult to demonstrate. This has necessitated the existence of accreditation initiatives such as the Buildoffsite Property Assurance Scheme (BOPAS) in order to provide lenders with the confidence that a non-traditional build is fit for purpose.

Aside from that, while modular is commonly presented as being a relatively easy, cheap and quick option, traditional construction has a big benefit in the flexibility to develop and adapt a design as work progresses on-site. By reducing the on-site build programme, you rely on more preparation having been completed pre-contract and the specifics must be finalised far earlier than is necessary on a traditional build. The design phase itself is also more complex and, once a design has been approved, it becomes incredibly difficult and more expensive to make changes down the line should problems arise. While changes can be accommodated in some circumstances, often the impact on cost and programme can be prohibitive.

To achieve maximum benefit from off-site production, the manufacturer must be involved from the outset, and key decisions which may otherwise have been made at a later stage must be made early in the procurement process. Legal and General Homes, which expects to build between a total of 10,000 to 15,000 homes per year, is reported as having invested £50m to create their factory in North Yorkshire that is now two years behind schedule in delivering on that investment.

We have already alluded to the significant reduction in time spent on-site by the adoption of MMC, however such time savings may be misleading. The lead-in times required for the production of prototypes and the manufacture of the relevant modular units can be considerable, particularly if those units are bespoke. This increased timeline for the design and manufacturing phase of works can ultimately cancel out or at least significantly impact upon any time savings which may be achieved once on-site.

If more components are to be built in Britain to combat this, start-up costs will inevitably be a major stumbling block, given that modular construction requires considerable upfront investment for the development of a factory. Capital costs are high and this was reported as the primary concern in a study undertaken by the NHBC Foundation into the industry's views on MMC, followed by concerns around a lack of suppliers capable of meeting the requirements of volumetric building. Ken Shuttleworth echoes their concerns, saying: *"The big problem is whether you get enough throughput to justify the incredible investment of it all to go ahead and build a factory. It's a gamble. Unless you have the guaranteed sales you are gambling tens of millions of pounds. That's what I think puts some of the major contractors off doing it."*

A number of the top tier house builders still don't know quite how they should be approaching MMC so are reluctant to develop their own offerings, while those companies that are leading the way haven't had a smooth ride. Laing O'Rourke has reportedly spent a massive £150m on its Explore facility in Worksop. Chairman of the business, Ray O'Rourke is a strident believer that his investment is well-placed and is committed to transitioning from 'trades to technicians' in a bid to improve productivity. Problems with the factory processes have been behind two major write-downs in company accounts in recent years. O'Rourke has acknowledged the risk, and has been quoted as saying: *"It's a huge investment. Like any, you have to make sure you have the demand side. If you haven't got the demand side you won't be able to fund the capex required to make the decision."*

The Government, as we have reported, continues to push modular construction and digital solutions like BIM, but is yet to formally mandate on its adoption so a coherent plan on how to encourage more building off-site does not yet exist.

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*"The big problem is whether you get enough throughput to justify the incredible investment of it all to go ahead and build a factory. It's a gamble. Unless you have the guaranteed sales you are gambling tens of millions of pounds. That's what I think puts some of the major contractors off doing it."*

### Ken Shuttleworth

Founder of Make architectural practice

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#### Drawbacks: Modern Methods of Construction

- Speed of construction not valued by volume housebuilders
- Historically higher cost of modular compared to traditional build
- High capital expenditure requirement to develop new facilities
- Considerably longer design phase than that of a traditional build
- Lack of flexibility once design is approved, meaning changes are costly and time-consuming to introduce
- Public perception remains negative
- Logistical complexities relating to transportation of large units and lack of UK-based supply chain
- Foreign ownership of key modular building systems, vs home-grown traditional build industry

# Chapter Three

## *The application of modular techniques for high-rise construction*

With the advent of improved manufacturing techniques, the natural extension of harnessing modular construction is the adoption of modular high-rise units. Early privately operated developments were designed almost exclusively as blocks of residential accommodation and were low rise, low maintenance, built harnessing traditional load-bearing construction and constructed to very tight budgets.

In recent years, there has been a significant shift in the market. The reduced availability of land in many urban locations and a subsequent rise in costs, materials and transportation alongside fears about loss of green land has increased the desire for higher density, high-rise developments using alternative methods of construction. With developers wanting a smaller footprint, quicker build time, and stronger yields it is the market that is driving modular high-rise construction and the likes of Ken Shuttleworth are embracing it wholeheartedly; *“Some architects worry about all these types of development looking the same but I don’t think that’s the case at all. You can still design bespoke buildings, just using modular systems. It’s a great idea!”*

**The key benefits** are easy to see and tally for the most part with those identified on smaller scale developments:

- On-site programme savings due to less on-site build time. Hence, the construction programme is less likely to be affected by site constraints, weather and labour issues

- More predictable costs. With fixed price modular units de-risking possible price rises
- Factory production of units, including finishes and fitting out, can be progressed in advance and/or concurrently with the substructure build, saving time. Faster and more predictable delivery equates to earlier occupation and revenue earning opportunities
- Quality is enhanced by factory produced units and inspections are easier, and often better than, checks carried out on-site. This can also lead to improved building performance and a better BREEAM rating
- With units leaving the factory fully snagged and commissioned there is a reduction in on-site snagging and commissioning
- The whole process is made safer. With less on site building, site hazards are reduced to a minimum

Currently, the largest modular residential structure in Europe is being constructed in the UK - a residential tower in Croydon. It is very much a one off, with two towers extending to 38 and 44 storeys high which, once built, will likely be the tallest modular towers of their type anywhere in the world. It follows on from a newly completed 28 storey, 558-bed student accommodation complex in the heart of Wembley which was produced using the same methods in just 12 months.

The company, Vision Modular Systems, designs, manufactures, and commissions the modular pieces in its 170,000sq ft facility in Bedford that are subsequently fitted together on-site. These volumetric units are produced in a factory controlled environment, akin to the motor industry, and installed fully-fitted with everything from bathrooms through to floor finishes, and even some white goods. It can create up to 45 of the modular units a week, ready to ship to site.

David Coley, director of due diligence at Gleeds who is advising the funders on the Croydon project is an expert in modular construction. He undoubtedly sees this as being a key component of the future of the construction process, when it comes to creating volume high rise accommodation quickly and efficiently.

*“We are at the leading edge of this revolutionary form of construction”,* said Coley. *“You can save 40-50% of the time on site during the production period by producing the modular units in the factory at the same time as those on site are digging the foundations and undertaking enabling works. Once they are finished it is a case of shipping to site and bolting them together.”*

There are challenge areas however with this form of construction and those who fear the spread of what they call *“Lego Land high-rise”* claim that these are being minimised in the rush to build and save time.

### **Possible drawbacks include:**

- Volumetric, large scale production of units is not best suited to bespoke design and not everyone applauds the ‘cookie cutter’ approach
- Such methods only become cost efficient where there is a mass production requirement with repeat designs
- In order to benefit from programme savings design needs to be frozen at an early stage in the development cycle
- Inclement weather can affect the performance of cranes which are relied upon to assemble the units. Their ability to operate is at the mercy of the wind
- Production of units can be affected by availability of suitable production lines
- Due to the considerable up-front investment required there has been substantive delays in getting manufacturing facilities up and running
- The delivery of modular units still needs to dovetail with existing traditional construction techniques so if the units are completed but the site is not ready for them there is a storage issue for volumetric units of such a size
- Units are still transported via road and, in some cases where extra-wide loads are required, this can create its own issues in terms of cost
- The design provides less flexibility in terms of future design changes/ variations. The advantage of singularity of the design means that once produced they cannot be altered

- Issues around project team changes during the process are a key consideration. Once a bespoke system has been created, reverting to a traditional build programme carries considerable cost

### **Conclusion**

It is undoubtedly true that off-site construction seemingly presents a viable alternative to more traditional forms of construction, offering potential savings in terms of financial outlay (when producing identical modules in large volumes), and significant time savings on-site. It also offers the hope of meeting stated needs for housing without compromising on the quality of build. Yet the combination of the historical, undesirable image of prefabrication, and the perceived risks associated with investing in this method of construction need to be addressed by those endeavouring to innovate within the industry if it is going to be adopted universally as the answer to our housing crises.

In the UK, we are in the very early stages of the production process and there is much potential to innovate modular construction techniques. In the Netherlands they are already experimenting with 3-D printing for the construction of two storey residential units, with the printer producing the modular parts on site, working alongside the traditional workforce who are digging trenches and installing groundworks.

This technique is very much a work in progress and would suit some sites more than others.

### **Future recommendations**

- The government must make consideration of modular methods of construction a requirement for receipt of public funding, in order to generate a consistent pipeline of work. This pipeline would provide house builders with clear justification for committing to investments in UK-based factories which will create jobs and reduce expenditure associated with logistics
- The government could invest more in housing types, such as private and affordable rented homes, that are most commercially suited to modular construction
- More must be done to ensure clients understand the savings they could achieve over the lifecycle of their projects, so that modular construction becomes a standard requirement and not an unknown quantity
- As new innovations like 3-D printing of materials becomes available, the industry must discard its risk averse attitude to new technology and harness, manage and adopt in the way other sectors have done to their benefit

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# Summary of sources

All quotations and data referenced throughout this document:

**KMPG Smart Manufacturing; how off-site manufacturing can transform our industry - Published April 2016**  
<https://assets.kpmg.com/content/dam/kpmg/pdf/2016/04/SmartConstructionReport.pdf>

**Building magazine online; ‘Sustainability: modular construction’ by Dimitris Tsompanidis - Published 20<sup>th</sup> June 2018**  
<https://www.building.co.uk/data/sustainability-modular-construction/5094177.article>

**Local Authority Building & Maintenance online; ‘Research reveals the public’s lack of understanding of modular housing’ - Published 2<sup>nd</sup> March 2018**  
<http://labmonline.co.uk/news/research-reveals-publics-lack-understanding-modular-housing/>

**The Guardian online; ‘Can prefab homes solve UK’s housing crisis?’ by Joey Gardiner - Published 26<sup>th</sup> January 2017**  
<https://www.theguardian.com/sustainable-business/2017/jan/26/prefab-homes-uk-housing-crisis-modular-offsite-construction-manchester-liverpool-energy-efficiency>

**The Guardian online; ‘Legal & General aims to offer 3,000 affordable homes a year’ by Angela Monaghan - Published 27<sup>th</sup> April 2018**  
<https://www.theguardian.com/business/2018/apr/27/legal-general-affordable-homes>

**Construction News online; ‘Twisted perceptions of modular homes must be tackled’ by Brian Ham - Published 1<sup>st</sup> May 2018**  
<https://www.constructionnews.co.uk/analysis/expert-opinion/twisted-perceptions-of-modular-homes-must-be-tackled/10030564.article>

**Construction News online; ‘Tier one extinction: Is modular really a threat?’ by Lucy Alderson - Published 6<sup>th</sup> February 2018**  
<https://www.constructionnews.co.uk/best-practice/technology/tier-one-extinction-is-modular-really-a-threat/10027337.article>

**Evening Standard Homes & Property online; ‘Living in the future: pre-fabricated homes tipped to be the solution to London’s housing shortage – assembled on site in just six days’ by Lee Mallett Published 14<sup>th</sup> February 2018**  
<https://www.homesandproperty.co.uk/property-news/buying/new-homes/inside-the-prefab-homes-tipped-to-be-the-solution-to-london-s-homes-shortage-assembled-on-site-in-a117701.html>

**The Construction Index; L&G Modular unveils its prefab prototype - Published 10<sup>th</sup> July 2017**  
<https://www.theconstructionindex.co.uk/news/view/lg-modular-unveils-its-prefab-prototype>

**CRL content hub; The pros and cons of MMC Published - 8<sup>th</sup> February 2018**  
<https://c-r-l.com/content-hub/article/advantages-disadvantages-mmc/>

**Built Environment Networking website; ‘Modular homes – the future of the British construction industry?’ by Nathan Spencer Published 20<sup>th</sup> April 2018**  
<https://www.built-environment-networking.com/modular-homes-future-construction/>

**Ecobuild.co.uk, subsequently accessed via Offsitemagazine.co.uk - March/April 2018 digital issue**  
<https://www.ecobuild.co.uk/press-releases/why-british-people-struggle-to-understand-a-key-solution-to-the-housing-crisis>

**Money Week online; ‘Prefab houses off the production line’ by Merryn Somerset Webb Published 16<sup>th</sup> April 2018**  
<https://moneyweek.com/prefab-houses-off-the-production-line/>

**Planning & Building Control Today online; ‘The future is bright; the future is offsite construction’ by Lisa Carnwell Published on 21<sup>st</sup> December 2016**  
<https://www.pbctoday.co.uk/news/planning-construction-news/future-offsite-construction/29398/>

**Architects’ Journal online; ‘More architects needed for modular housing push’ by Greg Pitcher - Published on 4<sup>th</sup> January 2018**  
<https://www.architectsjournal.co.uk/news/more-architects-needed-for-modular-housing-push/10026663.article>

**Building magazine online; ‘Construction methods; Modular’ by Alex Hyams, Ed McCann and Hugh Ferguson - Published on 23<sup>rd</sup> July 2018**  
<https://www.building.co.uk/data/construction-methods-modular/5094760.article>

**Inside Housing online; ‘Lenders need assurance over modular homes’ by Nick Johnstone - Published on 26<sup>th</sup> April 2017**  
<https://www.insidehousing.co.uk/news/news/lenders-need-assurance-over-modular-homes-cml-says-50460>

**Strutt & Parker Knowledge and Research online; ‘Can modular homes solve the UK’s housing crisis?’ - Published Q1 2018**  
<https://www.struttandparker.com/knowledge-and-research/can-modular-homes-solve-the-uks-housing-crisis>

**Construction News online; Ray O’Rourke interview: ‘I see a change in our industry’ by Tom Fitzpatrick - Published on 2<sup>nd</sup> March 2017**  
<https://www.constructionnews.co.uk/analysis/interviews/ray-orourke-i-see-a-change-in-our-industry/10017827.article>

**Offsite Hub news; Ray O’Rourke interview: ‘I don’t think I’m difficult. Some people do’ - Cross-published from Construction News on 2<sup>nd</sup> March 2017**  
<https://www.offsitehub.co.uk/industry-news/news/ray-orourke-i-dont-think-im-difficult-some-people-do/>

**The Times online; ‘Ray the builder’s pre-fab plan to rebuild empire’ by John Collingridge - Published 13<sup>th</sup> May 2018**  
<https://www.thetimes.co.uk/article/ray-the-builders-pre-fab-plan-to-rebuild-empire-7svff0qgg>

**NHBC Foundation; ‘Homes through the decades – The making of modern housing’ - Published March 2015**  
<http://www.nhbc.co.uk/cms/publish/consumer/NewsandComment/HomesThroughTheDecades.pdf>

**Build Offsite website; ‘Modern methods of construction – views from the industry’ Primary research from the NHBC Foundation - Published June 2016**  
<https://www.buildoffsite.com/content/uploads/2016/07/NF70-MMC-WEB.pdf>

**House of Lords Science and Technology Select Committee Second Report of Session 2017-2019; ‘Off-site manufacture for construction: Building for change’ - Published 19<sup>th</sup> July 2018**  
<https://publications.parliament.uk/pa/ld201719/ldselect/ldsctech/169/169.pdf>

**Buildoffsite Property Assurance Scheme website**  
<https://www.bopas.org/>

**‘Modernise or Die’; The Farmer Review of the UK Construction Labour Model - Published October 2016 accessed via**  
<http://www.constructionleadershipcouncil.co.uk/wp-content/uploads/2016/10/Farmer-Review.pdf>

**‘LHC launches new £1bn modular buildings framework’ press release accessed via**  
<https://www.lhc.gov.uk/news/new-modular-framework/>

**OffSite Hub news: ‘For construction at pace, modular is the future’ - Published 18<sup>th</sup> June 2018 accessed via**  
<https://www.offsitehub.co.uk/industry-news/news/for-construction-at-pace-the-future-is-modular/>

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