

*Review of Building Regulations and Fire Safety*²⁵ (the Hackitt review), made a similar point: “Over the longer term, it is expected that the changes set out in [the report] will lead to the greater use of more standard and better quality-assured systems being constructed off-site and less elemental construction on-site”.²⁶

23. While evidence from Zurich Insurance²⁷ and the Concrete Centre²⁸ warned about the dangers of some materials used in off-site construction being less resilient to fire, water and physical damage, robust regulation and design considerations should be able to mitigate these risks.

Client experience

24. As well as enabling the manufacture of better-quality buildings and infrastructure, these processes provide direct benefits to the client. Better-quality components produced as part of a standardised design process reduce the time and cost for resolving snagging issues compared with traditional methods of construction. This means that clients have greater certainty over timescales and costs of a project.²⁹
25. CCG OSM Ltd told us that some clients might be reluctant to use off-site manufacture because “multiple aspects” of a project “need to be finalised at an earlier stage” by the client than they do in traditional construction.³⁰ Mark Enzer, Chief Technical Officer at Mott MacDonald, explained that “we have been used to being able to change things when we are on-site. There has been enough flexibility to redesign while we are building it. That ... goes away with design for manufacture and assembly”.³¹ Volumetric design can also limit the flexibility and adaptability of a building once it has been built.³²
26. However, the digital nature of off-site manufacture presents opportunities for clients. Low Carbon Journey told us that “Because OSM buildings are designed and constructed based on a digital model, the information relevant to the client can be handed over ... on completion. This information is critical to cost-effective long term operational management”.³³ Digitalisation allows a construction project to be viewed first as a digital model, at which point it is possible to resolve difficulties and flaws before the asset is manufactured and constructed in real life. It also enables the construction process to be carried out with greater precision and efficiency.

Labour patterns and the experience of construction workers

27. All witnesses who were asked about the construction workforce profile agreed that there is a current labour shortage which will only worsen in the coming

25 Ministry of Communities, Housing and Local Government (MCHLG), *Building a safer future: Independent review of building regulations and fire safety: final report (the Hackitt Review)*, Cm 9607, May 2018: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707785/Building_a_Safer_Future_-_web.pdf [accessed 14 June 2018]

26 *Ibid.*, p 92

27 Written evidence from Zurich Insurance (OMC0054)

28 Written evidence from Concrete Centre (OMC0061)

29 Written evidence from Loughborough University (OMC0032)

30 Written evidence from CCG OSM Ltd (OMC0009)

31 Q 19 (Mark Enzer)

32 Written evidence from ProCure22 (OMC0017)

33 Written evidence from Low Carbon Journey (OMC0005)

years. Jamie Ratcliff, Assistant Director of the Greater London Authority, explained why:

“The Farmer review³⁴ found that due to the age profile of the workforce, huge numbers are retiring and not being replaced and there was what he called a “burning platform”. That was before the referendum on leaving the European Union. ... There is a massive challenge with the uncertainty of what is going to happen when we leave the European Union, and what that means for our construction workforce.”³⁵

This is corroborated by the June 2018 official statistics on the migrant labour force within the construction industry³⁶, which show that:

- In London, 28% of construction workers are EU27 nationals and 7% are non-EU nationals; this compares to 13% who are EU27 nationals and 10% non-EU nationals in all other industries in London (excluding construction).
 - The construction workforce is ageing; there was a 13% increase in the numbers of workers aged 45 years and over in the construction industry between 1991 and 2011, but non-UK nationals are younger (18% aged 45 years and older) compared to UK nationals (47% aged 45 years and older).
28. This labour shortage, coupled with the fact that the UK already lags behind other countries in construction productivity (Mark Reynolds estimated the construction productivity gap as “15% to 25% less than [some other] countries”³⁷), means that the UK must urgently find solutions.
29. Mr Reynolds estimated that the use of off-site methods could improve productivity by “up to 50% ... and maybe higher”.³⁸ Additionally, off-site manufacture requires fewer workers because many of the manufacturing processes are digitalised and completed by machines. While new skills are required for off-site manufacture (which we turn to in chapter 4), moving to an off-site model for construction may help to ameliorate the worsening labour shortage.
30. Increased productivity has been seen in the projects that have been undertaken off-site so far. Laing O’Rourke told us about their “70:60:30” approach, which means that “70% of a project’s construction [is] conducted off site, leading to a 60% improvement in productivity, and a 30% improvement in delivery schedule”.³⁹
31. Off-site manufacture also creates “wider local economic growth away from London and the main congested conurbations”.⁴⁰ Heathrow Airport explained

34 Mark Farmer, *The Farmer Review of the UK Construction Labour Model: Modernise or Die* (October 2016): <http://www.constructionleadershipcouncil.co.uk/wp-content/uploads/2016/10/Farmer-Review.pdf> [accessed 14 June 2018]

35 Q 14 (Jamie Ratcliff)

36 Office for National Statistics (ONS), *Migrant labour force within the construction industry* (19 June 2018): <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/internationalmigration/articles/migrantlabourforcewithintheconstructionindustry/2018-06-19> [accessed 20 June 2018]

37 Q 24 (Mark Reynolds)

38 *Ibid.*

39 Written evidence from Laing O’Rourke (OMC0055)

40 Written evidence from Osborne Group Holdings Limited (OMC0023)

how they have “invited communities from across Britain to showcase how their area could help to build expansion” which will enable them to “spread the benefits and the legacy of this national piece of infrastructure across the country”.⁴¹

Health and safety

32. Off-site manufacture has the potential to improve working conditions for construction workers. Heathrow Airport told us that “An average of 2.2 million working days were lost to work-related injuries and ill health in the construction sector each year between 2013/4 and 2015/16” with a cost of “around £1.2 billion a year” to the sector.⁴²
33. Due to the controlled nature of the factory environment, benefits to health and safety include:
 - “Reduced likelihood of work-related ill health;
 - Efficiencies in process, which reduces exposure to hazards by process re-engineering;
 - Reduced [musculoskeletal disorders] both on and offsite
 - Reduced risk of injury and accidents;
 - Reduced risk of developing latent health conditions.”⁴³

Environmental factors and other externalities

34. We heard evidence that off-site manufacture has many environmental advantages over traditional methods of construction, both in the process of building the product and in the finished product.
35. Interserve, a multinational support services and construction company, listed some of the ways in which the process of manufacturing off-site leads to improved environmental outcomes, including:
 - “Waste reduction through using standard material sizes (designing around standard component sizes)
 - Reduced errors and damage leading to less production and waste
 - Reduced travel to site through fewer personnel movements and fewer material deliveries (though operatives do travel to the factory environment)
 - Greater standardisation leading to more energy efficient factories
 - Better control of material suppliers—including chain of custody etc.”⁴⁴

Materials wastage in the construction sector totals nearly 120 million tonnes of waste per year and accounts for almost a third of the UK total;⁴⁵ more off-site manufacture could significantly lower this figure.

41 Written evidence from Heathrow Airport ([OMC0035](#))

42 *Ibid.*

43 Written evidence from B&CE ([OMC0016](#))

44 Written evidence from Interserve ([OMC0019](#))

45 Written evidence from BEIS ([OMC0011](#))

36. This is borne out in studies which have shown that “precast concrete manufacturing in the UK has reduced carbon emissions by 26%, mains water consumption by 31%, and waste to landfill by 95% over the period 2008 to 2016”.⁴⁶
37. Moreover, the precision manufacturing of buildings and infrastructure can result in products that are more energy efficient. Currently, “Buildings account for an estimated 40% of UK energy consumption and 19% of UK greenhouse gas emissions”⁴⁷, but Rosie Toogood, Chief Executive of Legal & General Modular Homes, told us:
- “We believe the way in which we are designing and precision manufacturing these homes makes them more airtight and delivers homes of a higher quality and use of the fabric-first approach allows us to deliver homes which are more energy-efficient in the long term. That is driving up standards in the industry across the board. In terms of adopting new energy systems, the factory-manufactured environment allows us to look at innovations in the way in which energy is captured and stored to be able to take homes off grid and deliver new energy solutions.”⁴⁸
38. WPI Economics referred to the benefits off-site manufacture provides to the local community at the site of the asset:
- “By reducing time, headcount and the range of activities that need to be completed on site compared to traditional on-site methods, off-site construction leads to projects that are completed more quickly with less noise, less local air pollution and less traffic disruption, easing the concerns of local residents.”⁴⁹

Architectural ambition

39. Despite the benefits of off-site manufacture for construction, uptake is limited, at least in part because of perceptions about the aesthetics of these buildings. These may stem from some of the early problems and poor aesthetics associated with pre-fabricated housing in the post-war era.⁵⁰
40. Many of our witnesses argued that assumptions that pre-fabricated buildings must all look the same are misconceived. Buildoffsite explained:
- “The paradigm that offsite will stifle aesthetics is as untrue in construction as it is in the fashion industry: There will always be an appetite for iconic ‘haut couture’ buildings but that should not mean that there is not a high quality aesthetic on the high street for mass scale housing, schools and infrastructure.”⁵¹

46 Written evidence from the University of Cambridge (OMC0064). Statistics taken from British Precast, ‘Sustainability Matters 2017’: <https://www.britishprecast.org/Publications/Sustainability-Matters-2017.aspx> [accessed 20 June 2018]

47 Written evidence from BEIS (OMC0011)

48 Q 16 (Rosie Toogood)

49 Written evidence from WPI Economics (OMC0031)

50 Written evidence from Carl Henry Modular Ltd (OMC0012), Chartered Institute of Building (CIOB) (OMC0040), and Laing O’Rourke (OMC0055)

51 Written evidence from Buildoffsite (OMC0036)

41. Several witnesses likened the customisation which is available with off-site building to the options available for customising cars.⁵²
42. Swan Housing Association explained how they offer purchasers of their modular homes “up to 36,000 combinations of layouts and external and internal finishes ... The customer can design their own home, much as they would a new car, seeing the price of each option reflected in the cost of the home with each choice made”.⁵³
43. Off-site manufacture has enabled the construction of other types of innovative infrastructure and buildings over the last few years. Kier Construction Ltd highlighted the following projects:

“Crossrail Farringdon Station, Sainsbury Wellcome Centre, Kings Cross R7 (all delivered by Kier) or 1000 Museum (by Zaha Hadid) reaffirm that modern digital manufacturing methods can enable greater variation and complexity in components, without traditional increase in labour and costs. OSM has therefore become an enabler for complex geometries, and facilitated, not inhibited architectural ambition.”⁵⁴

Conclusions and recommendations

44. **There are clear and tangible benefits from off-site manufacture for construction which make a compelling case for its widespread use. These include:**
 - **Better quality buildings and infrastructure;**
 - **Enhanced client experience and faster delivery;**
 - **Fewer labourers and increased productivity;**
 - **Creating more regional jobs away from large conurbations;**
 - **Improved health and safety for workers;**
 - **Offering building safety advantages—making it easier to ensure buildings meet quality assurance standards;**
 - **Improved sustainability of buildings and infrastructure; and**
 - **Reduced disruption to the local community during construction.**

The Government has a ‘presumption in favour’ of off-site manufacture and has affirmed its commitment to investing in off-site in the Construction Sector Deal; we strongly support this direction of travel.

45. *In the light of the health and safety benefits arising from off-site manufacture for construction, the Health and Safety Executive should work to raise the profile of these techniques and to encourage wider uptake of them.*

52 For example, [Q 26](#) (Dick Elsy).

53 Written evidence from Swan Housing Association ([OMC0076](#))

54 Written evidence from Kier Construction Ltd ([OMC0024](#))

CHAPTER 3: INFRASTRUCTURE, BUILDING AND HOUSING

Infrastructure

Hospitals, schools and prisons

46. Off-site manufacture is suitable in many cases for construction of important social infrastructure such as hospitals, schools and prisons. If the benefits set out in Chapter 2 are realised, off-site manufacture could be used to build better quality, more user-friendly facilities leading to better outcomes for clients and users. In Boxes 1 and 2 we set out several case studies that we received in evidence.

Box 1: Dumfries and Galloway Royal Infirmary

The Dumfries and Galloway Royal Infirmary (DGRI) was constructed using off-site manufacture. This led to the following benefits:

Time—A 30-month construction programme for DGRI was six months shorter than traditional construction, resulting in reduced overheads and labour costs.

Value—an earlier completion date provided significant savings to DGRI's operating costs and rental cost on existing buildings.

Standardisation—use of repetitive components reduced the number of component types and interface details, making more effective use of resource and increasing output.

Improved health and safety—significantly reduced vehicle movement and crossover of trades on-site. Installation of external wall panels, structural frame and suspended floor planks manufactured off-site meant that no scaffold was required on DGRI, reducing the risk of falls from height.

There were, however, some drawbacks:

Remedial work was required to bathroom pods to replace wall linings damaged during construction or affected by water ingress. Temporary weather protection needed to be addressed and considered more thoroughly to reduce impact.

The intention on DGRI was for panels to be craned immediately from delivery to installed position; however this often was not practical, so additional storage on-site was required.

Source: Written evidence from Ryder Architecture (OMC0067)

Box 2: Other examples

Royal Victoria Building, Western General Hospital, Edinburgh

A 20-week reduction in programme length, where 55% of the project was manufactured off-site and was delivered with a team that was 25% smaller with zero accidents.

Reigate Primary School

The main building structure took five weeks to complete and the school was completed 14 weeks early by achieving the best combination between off-site and on-site assembly.

Witham Railway Station

A new booking hall structure was created within one week on-site, compared to the eight weeks required for traditional techniques. The station superstructure was completed within a three-week programme on-site to reduce impact on station users.

West Hill School, Surrey

A challenging sloping and highly restricted site at West Hill School was developed to link the original special needs school and an existing modular building with a new classroom block. The building was manufactured off-site and was ready for occupation on time and after less than eight months on-site. Both buildings either side of the new facility remained fully operational throughout. The project made extensive use of BIM and virtual reality, which facilitated early decision-making with stakeholders and helped to engineer an off-site solution which addressed the complexities of the site.

Source: Written evidence from Mott MacDonald (OMC0069), Osborne Group Holdings Ltd (OMC0023) and McAvoy Group (OMC0047)

Horizontal infrastructure

47. As well as being used for buildings, off-site manufacture provides significant benefits for horizontal infrastructure such as roads, railways and utilities. In Boxes 3 and 4 we set out case studies that show how the benefits of off-site manufacture were realised.

Box 3: Crossrail

Platforms at Tottenham Court Road and Liverpool Street stations were delivered for the Crossrail programme. Both stations had similar scope, but the 250-metre platforms were built using very different methods, the former relying on traditional in-situ construction; and the latter applying Design for Manufacture and Assembly solutions, where 460 precast concrete elements were manufactured in a controlled factory environment.

The off-site approach delivered an 11-week programme saving, with fewer people required to work underground and reduced occupational health risk. The Tottenham Court Road platform took 67,000 man hours to complete whereas the Liverpool Street platform took 27,000 man hours.

Fifty-seven skilled operatives were required to deliver the in-situ installation at Tottenham Court Road. At Liverpool Street there were seven people on-site (the skills of those seven people were not traditional concrete-laying skills. These were people who understood logistics, assembly and manufacturing-type techniques. They walked along large craneages that lifted big components in place and put them in place against the digital model) and 27 people in the factory.

Source: Written evidence from Laing O'Rourke (OMC0055) and Q 59 (Andrew Wolstenholme)

Box 4: Other examples

Davyhulme wastewater treatment works

A 10–20% reduction in raw materials was achieved by using off-site manufactured elements (for example, thinner, higher performing wall panels), while saving three months on project delivery.

Ordsall Chord

By adopting a fully digital approach to delivering the Ordsall Chord viaduct in Manchester, the project programme was reduced by 20% and costs by 15%, while eliminating site queries and associated costs and delays.

Source: Written evidence from Mott MacDonald ([OMC0069](#))

Housing

48. Housing has become an increasingly pressing issue in recent years. In the Autumn Budget 2017 the Chancellor announced a target of delivering 300,000 additional homes a year by the mid-2020s, with a series of financial incentives to help achieve this.
49. Witnesses told us that off-site manufacture would be the only way to meet this target, and that traditional construction does not have the capacity to build enough homes.⁵⁵ However, we were also told that off-site manufacture is currently most suited to mid- to high-rise buildings rather than individual small homes.⁵⁶ This is in part because there is more certainty in the pipeline of projects for these types of homes, often driven by housing associations⁵⁷ and build-to-rent, compared to individual homes.
50. Dr Chris Goodier and Professor Alistair Gibb from Loughborough University highlighted how off-site manufacture could reduce the flexibility of housebuilders to respond to changes in the housing market, both locally and nationally:

“The longer lead-times associated with offsite methods (i.e. the early design freeze and the offsite manufacturing stage) requires the housebuilder (usually) to commit to a production schedule significantly in advance of actual unit sales. When market conditions deteriorate (which they always will at some point, and which housebuilding firms are acutely aware of and sensitive to), or do not grow as anticipated, off-site housebuilders may find it difficult to reduce unit output and thus expenditure. The risk of committing to production early is a concern for housebuilders looking to adopt off-site—there is a risk that they will no longer have full control of production, and hence financial outlay, on site.”⁵⁸
51. We were also told about the concerns of mortgage lenders regarding lending for homes built using off-site manufacture. The Building Societies Association told us that the concern of lenders is “the accurate valuation of properties using MMC [modern methods of construction] and the existing provision of building warranties to ensure lenders and borrowers have cover

55 [Q 9](#)

56 [Q 10](#) (Jamie Ratcliff)

57 Written evidence from Swan Housing Association ([OMC0076](#)) and Accord Housing Association ([OMC0079](#))

58 Written evidence from Loughborough University ([OMC0032](#))

in the wake of something going wrong with a building”.⁵⁹ UK Finance told us:

“some types of non-traditional construction have a relatively poor track record compared to more traditional construction methods. This can lead to lenders, whether they are providing individual mortgages for home-ownership, or finance for newly built property in the social rented sector, to take a cautious approach to new methods of construction which do not have a proven track record.”⁶⁰

As a result, there have been calls for some form of industry accreditation or sign-off body for off-site manufactured housing.

52. ***We recommend that the Government explore options for the accreditation of housing built using off-site manufacture, to ensure that mortgages are available to those who wish to purchase them.***
53. To increase the use of off-site manufacture in the housing sector the Government could put pressure on housing associations, through conditional funding, to use off-site manufacture. Richard Harrington MP, Minister for Infrastructure and Construction at the Department for Business, Energy and Industrial Strategy (BEIS), told us that “while housing associations are independent in their legal standing, it is quite right that government should apply conditionality to the money that they spend. That is why I am seeing Homes England about it”.⁶¹ It was also suggested by Jane Richards, Director of Building Structures at WSP UK, that the Government could mandate that a certain proportion of housing be built using off-site manufacturing in large regeneration projects.⁶²
54. In the Construction Sector Deal the Government sets out that it will provide £15 billion of new financial support for housing over the next five years, taking total financial support to at least £44 billion to 2022/23. Furthermore, it will “ensure that ... funding for the Transforming Construction programme supports the development and commercialisation of technologies and digital building designs that can help deliver the government’s housing objectives”.⁶³ However, the Sector Deal gives no detail about how the additional funding for housing will be used to drive the uptake of off-site manufacture and other technologies, which are part of the three strategic areas of the Sector Deal (see paragraph 5).
55. ***The Government must set out what conditions it will attach to the extra financial support for housing to drive the uptake of off-site manufacture and other innovative technologies.***
56. ***We recommend that the Government, through Homes England, put pressure on housing associations and local authorities to stipulate the use of off-site manufacture, where appropriate, when procuring new housing developments. It should also consider mandating a proportion of off-site manufacture for large regeneration projects.***

59 Written evidence from the BSA (OMC0049)

60 Written evidence from UK Finance (OMC0051)

61 Q 77 (Richard Harrington MP)

62 Q 33 (Jane Richards)

63 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

57. In Boxes 5 and 6 we set out several housing case studies that we received in evidence.

Box 5: Kidwells housing estate

One housing group needed to replace 84 homes and add a further 120 apartments. The new homes for existing tenants had to be built without the tenants moving off-site during construction.

Minimising onsite disruption was important and several noise restrictions were imposed. An energy-efficient, convenient and cost-effective, off-site manufactured infill system was adopted for the concrete framed structures.

Source: Written evidence from Osborne Group Holdings Limited (OMC0023)

Box 6: Athletes Village for the 2014 Commonwealth Games

As part of the City Legacy Partnership, 237 units were delivered across the Athletes Village for the 2014 Commonwealth Games in Glasgow. These 237 units were fully completed in 292 days. Coupled with the speed of construction each unit was designed to allow flexibility of use. During the international sporting event the units were required to be utilised in ‘Games Mode’ sleeping up to 12 athletes and post-games the units were transformed to ‘Legacy Mode’ providing a mix of two, three and four-bedroom houses.

The design brief and environmental strategy set by the client was to achieve zero carbon and a 60% reduction on the standards required by the 2012 building regulations. Carbon dioxide emissions were reduced by approximately 30% reduction compared to a typical house. A further 30% reduction was driven by the use of renewable technologies such as Mechanical Ventilation with Heat Recovery and photovoltaics roof panels. This project was delivered ahead of programme within the budget set by the client.

Source: Written evidence from CCG OSM Ltd (OMC0009)

International Comparisons

58. Ann Bentley, Global Practice Director at Rider Levett Bucknall, told us that the commercial construction sector in the UK is “as advanced as anybody” globally on off-site manufacture. She went on to say the in the high-rise residential sector the UK is “quite advanced” but that in the low-rise residential sector the UK is “substantially behind Scandinavia, North America and Japan”.⁶⁴
59. David Hurcomb, Chief Executive of NG Bailey, explained that a disruptor in the construction sector, using off-site manufacture, is “most likely to come from overseas, and perhaps from China”.⁶⁵
60. **There is an opportunity for the UK to maintain its position at the forefront of off-site manufacture globally in the commercial and high-rise residential sectors. However, we are concerned that the UK lags significantly behind other countries in the low-rise residential sector. The Construction Leadership Council and the Government have an important role to play in encouraging the use of off-site manufacture in the low-rise residential sector. This can be done by the spreading of best practice and case studies by the CLC and by the Government providing incentives to house-builders.**

64 [Q 70](#) (Ann Bentley)

65 [Q 44](#) (David Hurcomb)

CHAPTER 4: SKILLS

Skills gap

61. As we have noted, there is a growing labour and skills shortage in the construction sector in the UK. This could be exacerbated by Brexit unless it is urgently addressed. While off-site manufacture could lessen the labour shortage (see paragraph 27), the different skills required for manufacturing must be developed.
62. This should be done alongside continuing investment in traditional building skills. There was concern from witnesses such as the Building Alliance that “Young people will be deterred from taking up vital trades such as bricklaying leading to long term skill shortages with no opportunity to recover”.⁶⁶ There will always be demand for buildings constructed through traditional methods of construction, so it is imperative that training for skills needed for off-site manufacture does not displace training schemes for skills such as bricklaying.

Skills required for off-site manufacture

63. We set out below the skills required for off-site manufacture to work effectively, but which our evidence showed are lacking in the UK labour market. It may be the case that part time training and education opportunities can help provide some of these skills.

Digital skills

64. Witnesses agreed that digital skills are essential when using a Design for Manufacture and Assembly approach. Ryder Architecture told us that “Knowledge and understanding of digital technologies used for offsite construction is still limited. A better understanding and use by design teams and contractor teams will provide better opportunities for quality and appearance”.⁶⁷
65. Low Carbon Journey agreed, and emphasised the improvement in skills needed for providers and clients:

“There is a real opportunity to link more closely with the digital design, modelling and 3D output to support the final quality of the delivered building. This involves an uplift in skills (and culture) throughout the construction chain, including clients, to realise the benefits”.⁶⁸
66. A secondary benefit of attracting a more diverse and digitally skilled workforce to the construction sector was articulated by NHBC (National House Building Council):

“Greater use in off-site construction by house builders will demand new digital skills for roles such as BIM technicians as well as changing the image of a construction worker to be a specialist working in a comfortable, controlled environment. Doing more to promote the awareness of such roles in schools and colleges, for example through

66 Written evidence from the Building Alliance ([OMC0033](#))

67 Written evidence from Ryder Architecture ([OMC0067](#))

68 Written evidence from Low Carbon Journey ([OMC0005](#))

closer partnerships with employers, could be an opportunity to attract younger, more diverse entrants into the industry.”⁶⁹

Jamie Ratcliff told us that the skills required for these new jobs are likely to appeal more to women than traditional construction jobs.⁷⁰

Site implementation skills

67. Although manufactured off-site, buildings and infrastructure must still be assembled on-site. The precision-designed approach of the factory can be negated if the components are installed badly.
68. Steve Radley, Director of Policy at the Construction Industry Training Board, said that off-site manufacture “creates new roles for on-site assembly and there is a lot more emphasis on precision, using things like BIM, logistics management communication”.⁷¹

Technical planning and collaborative skills

69. A wide range of further technical planning and collaborative skills are required for the whole-system approach associated with off-site manufacture. These are not required for traditional construction, which tends to be more fragmented.
70. Osborne Group Holdings Limited told us that “The technical personnel will need greater integration skills at a higher level in technical planning and development of the solutions”.⁷² Phil Wilbraham, Expansion Programme Director at Heathrow Airport, recommended an emphasis on “logistics and assembly rather than ... trades coming to site to finish things off”.⁷³
71. The Chartered Institute of Building explained the need for flexibility of skills among the off-site construction workforce:

“Managers will need to manage a greater number of variables and diverse teams, bringing together on- and off-site activities. Other hybrid roles may develop, such as an overlap between managerial and professional levels, or technical sales roles where commercial and technical skills overlap. Site managers will need to deepen their logistics competencies. This suggests that behavioural development is as important as skills development for education and training providers. There will be a need for leaders and managers to develop softer collaborative skills such as problem solving, team working and communication alongside their technical competencies.”⁷⁴

‘Gatekeeper’ skills

72. None of the above will have any effect unless clients are aware of and receptive to the idea of using off-site manufacturing for construction projects. Simon Rawlinson, Construction Industry Council, told us:

“There is a really important role in upskilling the gatekeepers, the people who have the first contact with the client, whether that is a lawyer or a

69 Written evidence from NHBC ([OMC0021](#))

70 [Q 14](#) (Jamie Ratcliff)

71 [Q 27](#) (Steve Radley)

72 Written evidence from Osborne Group Holdings Limited ([OMC0023](#))

73 [Q 3](#) (Phil Wilbraham)

74 Written evidence from the Chartered Institute of Building ([OMC0040](#))

consultant, who shapes their thinking at the early stages ... so when that client meets an inspirational contractor, for example, they are receptive to somebody coming up with an innovative idea that says, “We could do it this way”.⁷⁵

Procurement skills

73. Chapter 6 focuses on issues with the current procurement models and the biases they create against commissioning off-site construction projects. If procurement models change, the people who commission projects, such as civil servants, should be trained to understand the new balance between procurement and risk. Andrew Wolstenholme told us:

“We should also consider the skills of a civil servant who is presented with a procurement problem and a risk profile, and who needs to understand them. I am delighted to say that the Saïd Business School is providing some sort of skills opportunity for civil servants, not just to be good at delivering policy but at understanding how to manage portfolios of risk.”⁷⁶

This will be even more important if the recommendations we make in Chapter 6 are adopted.

Skills training

74. The Government has announced that, from 2020, new technical qualifications called ‘T levels’ will be introduced, with construction being one of the first. T levels aim to transform technical education in the UK and offer young people the opportunity to study a technical qualification at level 3, which is equivalent to A levels. Time is short for the construction sector to influence the content of the qualification so that the next generation are equipped with the skills needed for modern methods of construction.
75. Steve Radley emphasised that companies in the construction sector should be involved in developing the new qualification:

“it is up to employers to work closely with government and training providers to make sure that the right content is developed in training ... One of the key elements is ensuring that we have sufficient employers that are able to provide work placements for three months in those areas.”⁷⁷

He also told us that employers should “join together and ensure that they are training to common standards, having set out the skills that are needed.”⁷⁸

76. Mr Radley said that, to develop the skills needed for off-site manufacture, the construction T level should focus “on multiskilling so that, particularly in the first year of training, you get an understanding of a greater range of trades”.⁷⁹
77. Additionally, we heard that the Apprenticeship Levy, a mandatory scheme whereby larger companies pay for the training of their apprentices, needs

75 [Q 56](#) (Simon Rawlinson)

76 [Q 62](#) (Andrew Wolstenholme)

77 [Q 27](#) (Steve Radley)

78 [Q 29](#) (Steve Radley)

79 [Q 27](#) (Steve Radley)

reforming. MOBIE (Ministry of Building Innovation and Education), an educational charity, told us that “there is currently no approved standard suitable for OSM or innovative digital design training courses. This means that companies effectively have to pay twice in order to provide this training, as the lack of approved standard obstructs the ability to draw down from the levy”.⁸⁰

78. Andrew Wolstenholme said that under the Apprenticeship Levy “some organisations will be required to pay at least 1% toward apprentices. We are saying let us work out a better way of spending that 1%. That is no new money; it is smarter ways of directing that 1% towards the skills we need for the future”.⁸¹
79. The Government announced several initiatives in the construction Sector Deal, including working with the construction sector to “co-ordinate the development of new apprenticeship standards across the sector” and developing “a single industry platform and portal to support construction careers”.⁸²

Conclusions and recommendations

80. ***The Government must work with the construction sector to design new qualifications to close the current skills gap. This should be done primarily through the Construction Leadership Council as the industry lead body, but other industry bodies should be encouraged to engage in the process as well.***
81. ***The Government must ensure that young people entering the workplace are equipped with the digital skills needed for modern methods of construction, including off-site manufacture. It is important that this is reflected in post-school training provision, but also in the school curriculum so that the next generation have the basic skills necessary to undertake more specialist training.***
82. **Perceptions of the types of jobs available in the construction sector are based on the skills needed for on-site construction. We welcome the creation of the single industry platform and portal announced in the Construction Sector Deal to support construction careers and promote the new types of careers in construction to the next generation.**
83. **We support the Government’s plans to create new apprenticeship standards across the sector. *Alongside this, the Government, with the construction sector, must re-assess the wider operation of the Apprenticeship Levy in the construction sector and make the necessary changes to ensure the money is best spent to benefit the long-term viability of the sector.***

80 Written evidence from MOBIE (Ministry of Building Innovation and Education) ([OMC0073](#))

81 [Q 59](#) (Andrew Wolstenholme)

82 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

CHAPTER 5: SECTOR BARRIERS TO UPTAKE

84. As set out in Chapter 2, the evidence revealed a compelling case for the widespread use of off-site manufacture for construction. However, many witnesses told us that the current culture and structure of the construction sector is not conducive to extensive use of off-site manufacture, placing barriers in the way of wider uptake. In this chapter we consider these barriers and actions the sector could take to overcome them.

Sector fragmentation and lack of collaboration

85. Severfield plc explained that “the industry is fragmented and traditionally works in silos ... the culture and mindset of the industry has limited expertise and experience in collaboration”.⁸³ UK Research and Innovation made a similar point, telling us that surveys of the construction sector show “entrenched cultural practices” within the sector, including a “reluctance to break from their existing, established networks of contracting bodies”, hampering the spread of off-site manufacture.⁸⁴
86. The fragmentation of the industry makes it difficult for all parties—client, designer and contractors—to be involved from the beginning of a project. Ian Heptinstall told us that “fragmentation and misalignment within each [construction] project ... is the real issue”,⁸⁵ not fragmentation within the sector as a whole. Tony Meggs told us:

“The industry is quite disaggregated both vertically and horizontally in all sectors, quite frankly. From a government perspective, our historical approach, not universally but a lot of the time, has been to move as much risk as possible down the chain and away from government.”⁸⁶

87. We were told that there is a lack of trust, and therefore a lack of collaboration, between businesses within the sector. Arup told us:

“Widespread collaboration across the construction sector is essential to make a step change in wider adoption of off-site [but] ... fundamentally the industry isn’t overly trusting of each other ... collaboration will require a change of mind-set prompted by a big incentive.”⁸⁷

NG Bailey told us that “encouraging greater collaboration and a more balanced sharing of risk” would increase the use of off-site manufacture.⁸⁸

88. Andrew Morris, Partner at Rogers Stirk Harbour, said that disputes are often seen “as part and parcel” of working in the construction industry.⁸⁹ Suzannah Nichol, Chief Executive of Build UK, pointed out that companies in the sector “do not have ... deep relationships with their supply chain”.⁹⁰

83 Supplementary written evidence from Severfield plc ([OMC0084](#))

84 Written evidence from UKRI ([OMC0074](#))

85 Written evidence from Ian Heptinstall ([OMC0001](#))

86 [Q 68](#) (Tony Meggs)

87 Written evidence from Arup ([OMC0010](#)). See also [Q 9](#) (Jamie Ratcliff).

88 Supplementary written evidence from NG Bailey ([OMC0086](#))

89 [Q 32](#) (Andrew Morris)

90 [Q 51](#) (Suzannah Nichol)

Solutions to fragmentation

89. We heard evidence about three different ways to address the fragmentation of the construction sector: increased collaboration, the use of systems integrators to integrate horizontally, and vertical integration.

Collaboration

90. The Construction Leadership Council (CLC), co-chaired by Andrew Wolstenholme OBE and Richard Harrington MP, brings together the sector and Government. One of its key roles is to “push on-site construction to off-site construction”.⁹¹ It aims to do this by encouraging collaboration within the sector. Andrew Wolstenholme told us:

“The start point from the CLC was to put forward the thesis that unless the sector came together around a compelling and simple agenda that could attract the attention of a very diverse sector and industry against one set of initiatives, we would, like many others previously, fail to get critical change across the different parts of the sector.”⁹²

91. The Infrastructure Client Group (ICG) is a forum for major infrastructure clients to work collaboratively to understand best practice. The ICG has recently launched Project 13 (see Box 7),⁹³ a “new model for construction”.⁹⁴ Martin Chown, representing the ICG, explained: “Project 13 is a change to how we can go to market and procure on a more collaborative basis, right from the start of the need for construction. It seeks ... to come up with better models to drive that collaboration within the supply chain”.⁹⁵

Systems integrators

92. ICG’s Project 13 promotes an enterprise structure (see figure 1) which uses systems integrators to bring together clients, suppliers and advisors. Mark Enzer explained to the Committee that “at the heart of [greater integration] is the role of the integrator ... whose job it is to pull it all together”.⁹⁶ He also explained that Project 13 could transform the industry into something that is more integrated “not necessarily ... by one organisation being ... integrated but by many organisations coming together in an enterprise to be more integrated”.⁹⁷

Vertical integration

93. The University of Brighton told us that “vertical and horizontal integration enabled through systemic thinking remain a key factor” in achieving the changes needed in the construction sector. This cannot be “accomplished successfully unless the UK Government takes a more proactive role in this regard”.⁹⁸
94. There has been some movement towards greater vertical integration. Jamie Johnston told us that “we are seeing some clients starting to address vertical

91 [Q 71](#) (Richard Harrington MP)

92 [Q 58](#) (Andrew Wolstenholme)

93 Infrastructure Client Group, ‘What is Project 13’: <http://www.p13.org.uk/> [accessed 10 July 2018]

94 [Q 65](#) (Martin Chown)

95 *Ibid.*

96 [Q 18](#) (Mark Enzer)

97 *Ibid.*

98 Written evidence from the University of Brighton ([OMC0028](#))

integration”⁹⁹ and Rosie Toogood confirmed that Legal and General Modular Homes are adopting this method.¹⁰⁰

Box 7: Infrastructure Client Group Project 13

Project 13 is an industry-led initiative to improve the way high-performing infrastructure is delivered and managed. Project 13 seeks to establish a new approach within the construction sector—based on an enterprise, not on traditional transactional arrangements (see Figure 1).

The most significant changes in an enterprise structure as opposed to a transactional structure are:

- the owner is central and leads the enterprise, defining long-term value.
- suppliers and advisors have direct relationships with the owner.
- an Integrator actively engages and integrates all tiers of the market.
- the key suppliers, owner, advisor and integrator work as one team to optimise value.

The main differences between an enterprise model and a traditional construction programme model are:

- Reward in the enterprise is based on value added to the overall outcomes, not service provided.
- There is greater understanding of cost drivers and risk across all organisations in the enterprise, with commercial incentives for collaboration to jointly mitigate risk, not transfer it.
- Establishing a high-performing enterprise requires fundamentally different leadership, governance, behaviours and skills to succeed. This will be underpinned by organisations with increasingly diverse skills and backgrounds.

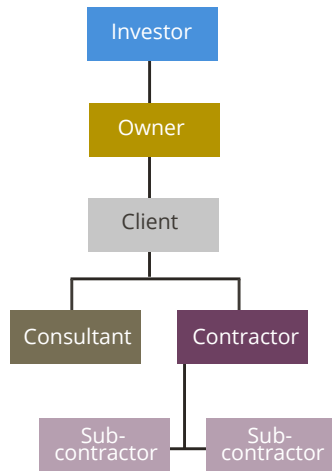
Source: Institution of Civil Engineers, *P13 Blueprint* (May 2018): <http://www.p13.org.uk/wp-content/uploads/2018/06/P13-Blueprint-Web.pdf> [accessed 10 July 2018]

99 [Q 32](#) (Jamie Johnston)

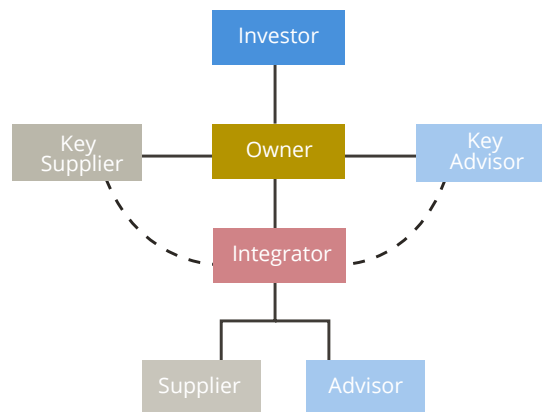
100 [Q 9](#) (Rosie Toogood)

Figure 1: Traditional structures in the construction sector (left) and those proposed by Project 13 (right)

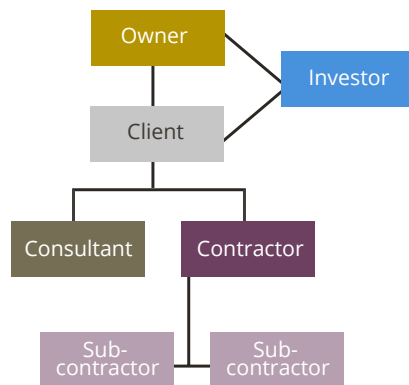
Transactional Structure (Private)



Project 13 Enterprise Structure



Transactional Structure (Public Sector)



Source: Institution of Civil Engineers, P13 Blueprint (May 2018) p 6: <http://www.p13.org.uk/wp-content/uploads/2018/06/P13-Blueprint-Web.pdf> [accessed 10 July 2018]

95. **The construction sector needs to build trust and partnerships so that companies can work together to improve the uptake of off-site manufacture. We welcome initiatives such as the Construction Leadership Council and the Infrastructure Client Group's Project 13 but more needs to be done by other industry groups to facilitate collaboration within the sector.**
96. *The Construction Leadership Council should provide overarching, active and focussed leadership for the sector. They should gather and disseminate data including case histories, sign-post to resources and spread best practice around the sector.*

Business models in the construction sector

97. We heard that business and procurement models used in the construction sector, including the structure of contracts, assignment of risk and cash flow, are designed for traditional construction and are a barrier to the use of off-site manufacture. Professor Jennifer Whyte, Director of the Centre for

Systems Engineering and Innovation at Imperial College London, told us, “you cannot change technologies of production without changing business and procurement models”.¹⁰¹ Suzannah Nichol said that “the current way we buy and deliver construction is not sustainable and the business models are not fit for purpose”.¹⁰²

98. In the Construction Sector Deal the Government stated “the current business model of the construction sector is not sustainable. Construction customers and businesses across the supply chain are focused on the costs and risks of individual projects, and do not collaborate effectively”.¹⁰³
99. Laing O’Rourke told us that current business models are often based on lowest cost rather than value for money and that the sector “does not have the processes or systems required to successfully manage the complex supply and production relationships involved in delivery of one-off projects; resulting in waste, low productivity, poor quality design and construction”.¹⁰⁴
100. Several witnesses told us that off-site manufacture needs to be considered from the start of the design process. Mark Enzer said: “It is very important to design the end-to-end delivery process around off-site manufacture rather than just bolting it on as an afterthought”.¹⁰⁵ He thought that this was the only way to ensure that the benefits of off-site were realised, including productivity gains. However, the British Standards Institute told us that it can be challenging for architects to get involved at an early stage¹⁰⁶; this could be addressed by having a set of design standards that suit off-site manufacture.
101. Arup explained that in the construction sector processes happen “sequentially and in isolation, designers design, engineers engineer and as a result the industry delivers bespoke products and the process is inefficient”.¹⁰⁷ This contrasts with a manufactured approach: “Manufactured products are designed holistically and include suppliers in the design process. The design is often heavily influenced by parts that are available”.¹⁰⁸ The McAvoy Group described this as the “Design for manufacture ethos”; it “requires earlier decision making” and minimises “the risk of projects running late and over budget”.¹⁰⁹ Mark Farmer said that the current sequential model of designing, then procuring through a competitive process, then tendering to an ad-hoc supply chain is “not the best way of advancing off-site”.¹¹⁰
102. The Ministry of Justice told us that “the traditional role of Tier 1 construction companies will need to be challenged and re-defined”. This may include “new forms of contract that make it easier for the companies to fully collaborate” and new processes that “will need to be embraced by construction professionals, such as planners and quantity surveyors”.¹¹¹

101 [Q 3](#) (Prof Jennifer Whyte)

102 [Q 52](#) (Suzannah Nichol)

103 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

104 Supplementary written evidence from Laing O’Rourke ([OMC0085](#))

105 [Q 18](#) (Mark Enzer). See also [Q 2](#) (Phil Wilbraham).

106 Written evidence from the BSI ([OMC0022](#))

107 Written evidence from Arup ([OMC0010](#))

108 *Ibid.*

109 Written evidence from McAvoy Group ([OMC0047](#))

110 [Q 25](#) (Mark Farmer)

111 Written evidence from the Ministry of Justice ([OMC0081](#))

103. The Construction Sector Deal sets out three areas where action will be taken to change business models in the construction sector:
- Improving and standardising approaches to design and procurement of construction projects;
 - Fairer and more sustainable approaches to contractual and payment practices; and
 - Benchmarking the performance of assets so clients and contractors have access to more data to deliver better assets.¹¹²
104. **Designers, contractors and suppliers must all have early involvement in a project for off-site manufacture to be successful. This requires a change in business models in the sector and amongst clients, both private and public sector, as well as far greater collaboration. There is a need for a client’s professional team or advisers to adopt a different approach, as outlined by the Infrastructure Client Group’s Project 13 (see Figure 1), to enable off-site manufacture. We welcome moves in the construction Sector Deal to address business models in the sector and make them more effective.**

Financing and cash flow

105. The way contractors in the construction sector organise cash flow will have to change if off-site construction is to be more widely used. Contractors are usually paid by their clients each month based on a certificate of the work done.¹¹³ In certain circumstances a contractor might be paid before materials are paid for. In the case of a housing site, the houses can be easily financed as they can be easily secured and sold. Off-site construction may require the financing of a factory and the work in progress of that factory and contractors will probably only be paid when the modules produced are erected on site. Suzannah Nichol made this point, explaining that off-site manufacture required high up-front investment.¹¹⁴ Dr Mark Bew explained:

“There is a very different cash flow profile to opening a factory, buying materials, buying labour and having stock sitting in a yard. [Contractors’] balance sheets are geared to not doing that ... They need to change and there needs to be a different model.”¹¹⁵

106. The Construction Sector Deal states that “modernising the [construction] sector will require significant additional investment ... To do this, the sector will work with the government and the financial services sector to identify what sources of funding are available, and how these can be used”¹¹⁶

107. **At present the upfront finance required to set up off-site manufacture appears greater than the finance required for conventional construction. We welcome the commitment in the Sector Deal to**

112 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

113 [Q 35](#) (Andrew Morris)

114 [Q 52](#) (Suzannah Nichol)

115 [Q 19](#) (Dr Mark Bew)

116 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

identify sources of funding available to the sector. *Should this review highlight gaps in the availability of funding, we recommend that the Government work with the construction sector and the financial services sector to develop sources of funding to fill those gaps.*

Risk

108. The way risk is handled in the construction sector could be a barrier to off-site manufacture. The evidence we received was that risk is often shifted from clients to tier 1 contractors who then move that risk on to their supply chain.¹¹⁷ Jamie Johnston, Director at Bryden Wood, told us that off-site manufacture is more successful when a client says, “I’ll absolve you [the tier 1 contractor] of some of that risk and I’ll take a much more active role in developing the brief and understanding the vision and the supply chain”.¹¹⁸
109. Andrew Morris explained that, when clients assume some of the risk by taking out project insurance so that individual consultants on the project do not have to, it “draws you together, because you are then focused on the task at hand”.¹¹⁹
110. The Ministry of Justice made a similar point. It told us that modern methods of construction (which include off-site manufacture) currently require high levels of innovation. This relies on “everyone being able to work in a fully collaborative environment where risk is shared amongst the most appropriate parties”. They explained that traditional routes of risk management create a cautious risk appetite amongst contractors and the easiest route to a collaborative environment is through “project insurance with the client holding a larger central risk pot and passing less risk onto the supply chain”.¹²⁰
111. Osborne Group Holdings Ltd told us that “traditional standard forms of contract do not protect the main contractor where a large proportion of the contract sum is placed with a single service provider (as is the case for off-site)”.¹²¹ This can create a risk because, if that single provider cannot deliver (for example, if they go out of business), it may not be possible to procure an alternative.
112. Martin Chown told us that new procurement models developed through the ICG’s Project 13 (see Box 7) will take account of changes to cash flow and risk “because [the new model] has to be based on payment and profit for performance and outcomes”¹²² and that in Project 13 “we advocate risk sharing as opposed to risk transfer”.¹²³
113. **We will follow with interest the success or otherwise of the new models developed through the Infrastructure Client Group’s Project 13. *If they are successful in tackling some of the issues we have raised around risk and cash flow, the Construction Leadership Council should promote these models across the sector.***

117 [Q 33](#) (Jamie Johnston)

118 *Ibid.*

119 [Q 34](#) (Andrew Morris)

120 Written evidence from the Ministry of Justice ([OMC0081](#))

121 Written evidence from Osborne Group Holdings Ltd ([OMC0023](#))

122 [Q 65](#) (Martin Chown)

123 [Q 68](#) (Martin Chown)

Client knowledge and leadership

114. Accord Housing Association told us that “the lack of understanding of clients in terms of the products and the process” of off-site manufacture is a potential barrier to its use.¹²⁴ Mark Enzer told us that “there needs to be leadership in client organisations to commit to what is quite a big change”;¹²⁵ this also applies to designers and other consultants.
115. Changes to client behaviour through initiatives like Project 13 from the ICG are starting to happen but more could be done in this area, including by Government. We discuss this in paragraphs 151–152.

A pipeline of projects at scale

116. Mark Farmer observed that the construction sector suffers from being highly cyclical.¹²⁶ The cyclical nature of investment in the industry matching economic cycles has proved damaging to the construction industry in the past. Dr Diana Montgomery, Chief Executive of the Construction Products Association (CPA), explained why this is a barrier to greater use of off-site manufacture:

“Any manufacturing requires capital investment to get your plant off the ground and it needs a sensible payback. If you are looking at a pipeline that looks less than six months out ... without that longer-term vision, it is really problematic to write a business case and get investment.”¹²⁷

117. To have the confidence to invest in the capital needed to set up a manufacturing facility, a company needs a consistent pipeline of projects that they will have a high chance of supplying. Laing O’Rourke pointed this out: “for offsite methods to become the norm and transform the way in which the built environment is delivered, industry needs confidence and visibility of pipeline, at a regional and national level”.¹²⁸
118. Kier Construction Ltd told us that existing market vulnerabilities “are amplified by a sensitivity to fluctuations in pipeline, with a lack of long-term planning, confidence and predictable demand a business and sector challenge”.¹²⁹
119. Laing O’Rourke recommend longer term relationships within the sector as a solution: “having contracts structured to enable multiple sequential delivery over a period of time enables visibility of continuity of resource and the ability to invest in and benefit from progressive learning and innovation”.¹³⁰ Martin Chown explained how Project 13 hopes to address the lack of a reliable pipeline:

“The clients around the table of Project 13 come up with models in which suppliers can work on many projects, both large and smaller, and can go from one project to another building on that success. We feel that

124 Written evidence from Accord Housing Association ([OMC0079](#)). See also written evidence from the Ministry of Justice ([OMC0081](#)).

125 [Q 18](#) (Mark Enzer)

126 [Q 28](#) (Mark Farmer)

127 [Q 51](#) (Dr Diana Montgomery)

128 Written evidence from Laing O’Rourke ([OMC0055](#)). See also written evidence from Elliot Group Ltd ([OMC0027](#)) and BEIS ([OMC0011](#)).

129 Written evidence from Kier Construction Ltd ([OMC0024](#))

130 Written evidence from Laing O’Rourke ([OMC0055](#))

that enables innovation and productivity and a knowledge to be built in from one project to another.”¹³¹

120. **Many of the barriers to the greater uptake of off-site manufacture for construction facing the construction sector, such as a lack of collaboration and attitudes to risk, are cultural and can only be dealt with by the sector. *The sector must look at ways to reduce the barriers and this should be led by the Construction Leadership Council.***

131 [Q 64](#) (Martin Chown)

CHAPTER 6: GOVERNMENT ACTIONS TO OVERCOME BARRIERS

121. The Government, and the wider public sector, is the biggest client of the construction sector. The evidence showed that the Government has an important role in encouraging and facilitating the uptake of off-site manufacture. Andrew Wolstenholme explained off-site manufacture “will not happen across the whole of the sector unless the public sector, which by a country mile is the largest construction client, understands the part it has to play”.¹³² In Box 8 we summarise some of the levers available to Government to encourage off-site manufacture and in this chapter we discuss in more detail the actions the Government is taking and what further steps it needs to take.

Box 8: Levers available to Government

Mandating: The Government can mandate the use of certain techniques or technologies in construction projects, for example the requirement that Building Information Modelling (BIM) level 2 is used.

Procurement Frameworks: Frameworks for procurement such as those drawn up by the Crown Commercial Service can be designed in such a way to make it easier, or encourage, public sector clients to use off-site manufacture. There is also a role for the Infrastructure and Projects Authority (IPA) in drawing up procurement frameworks for government.

Funding conditions: The Government can put conditions on funding provided for construction projects. For example, funding provided by Homes England to Housing Associations could require a certain proportion of houses to be built using off-site manufacture.

Sharing knowledge and expertise: The Government can share knowledge and expertise about off-site manufacture with other public-sector clients.

Regulation: The Government or other regulators (such as those for utilities) could use regulatory requirements to encourage a move towards off-site manufacture.

Research funding: The Government can provide research funding for new technologies, such as those used in off-site manufacture.

Construction Sector Deal

122. The Government announced the Construction Sector Deal in November 2017 as part of its Industrial Strategy white paper.¹³³ The Sector Deal was published on 5 July 2018.¹³⁴ Andrew Wolstenholme explained that it “is the catalyst that is going to unlock much of the intent and the opportunity” of off-site manufacturing.¹³⁵ Mark Reynolds, Chief Executive of Mace,

132 [Q 59](#) (Andrew Wolstenholme)

133 Department for Business, Energy and Industrial Strategy, *Industrial Strategy: building a Britain fit for the future*, Cm 9528, 27 November 2017: <https://www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future> [accessed 11 June 2018]

134 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

135 [Q 57](#) (Andrew Wolstenholme)

explained that the “Sector Deal is really important to the construction and infrastructure industry”.¹³⁶

123. *The Construction Sector Deal is an important step forward for off-site manufacture and the wider construction sector. It is important that the Government and the Construction Leadership Council work together with the sector to make sure the Sector Deal is a success. The CLC must draw up a detailed implementation plan containing a timetable, objectives and metrics as soon as possible and hold those responsible for delivering the Sector Deal to account. This is particularly important considering the sector’s problems with collaborating and working together in the past.*

Digital agenda

124. Digital technology is an important enabler of off-site manufacture. Mott MacDonald explained:

“Digital and process maturity is required to help unlock the broader benefits of off-site manufacture. A main strand of this is end-to-end digital delivery, without which off-site manufacture is often more challenging due to slower, less reliable information and fragmentation of the project team.”¹³⁷

125. The focus of digital technology in construction is on building information modelling (BIM). BIM uses 3D models of a building or other built asset and a common data environment to access and share information across the supply chain. It can help the entire supply chain to work from a single source of information, reducing the risk of error. Mark Enzer told us that it is “difficult to imagine an efficient approach to off-site manufacture that does not use information modelling ... information ends up being the golden thread that joins up the overall delivery process”.¹³⁸ Dr Robert Hairstans told us that BIM “moves construction towards increased levels of digitisation and creates a platform for improved levels of project and supply chain communication horizontally and vertically thus facilitating collaboration”.¹³⁹

126. The Government’s 2011 Construction Strategy defined four levels of BIM:

- Level 0: Projects will use only 2D computer-aided design (CAD) drafting. There is little collaboration. Any data that are exchanged are typically done so via paper or print.
- Level 1: Projects will use a mixture of 2D and 3D CAD drafting. They will use a common data environment for the electronic sharing of data. This will often be managed by the main contractor and may be shared among team members. Projects may also use some standard data structures and formats.
- Level 2: Projects will use intelligent, data-rich objects in a managed 3D BIM environment. All parties working on a project are able to combine their BIM and design data to collaborate and share information through the use of a common data environment (CDE). The CDE enables users

136 Q 28 (Mark Reynolds)

137 Written evidence from Mott MacDonald (OMC0069)

138 Q 20 (Mark Enzer)

139 Written evidence from Dr Robert Hairstans (OMC0078)

to carry out checks against data validation strategies to make sure they are on target.

- Level 3: Projects at this level are fully collaborative. They use a single, shared project view for data integration, which all parties can access and modify as allowed through process and security controls.¹⁴⁰

127. Since April 2016 the Government has mandated that BIM level 2 must be used for all public procured construction projects as set out in its *Government Construction Strategy 2016–2020*.¹⁴¹ The mandate has driven change in the sector. Dr Mark Bew told us that “we are not seeing any other nation doing massively better than us [at using data] at the moment”.¹⁴²

128. NBS, part of the knowledge management business of the Royal Institute of British Architects, carries out an annual survey of BIM adoption and usage in the construction industry. In its 2017 report, *NBS National BIM Report 2017*,¹⁴³ it found that BIM awareness is near-universal and 62% of construction companies were using BIM on some projects.

129. However, 51% of respondents thought that the Government was failing to enforce its BIM mandate and 37% were not clear what they needed to do to comply with the mandate. The survey also found that a majority described themselves as confident that they had the required skills and knowledge to use BIM (a proportion that has steadily increased in recent years).¹⁴⁴

130. ***We recommend that the Government provides companies who want to bid for Government contracts with the information they need to comply with the BIM mandate. It is important that the Government enforces the mandate, as it is a significant enabler for off-site manufacture.***

Presumption in favour of off-site manufacture

131. Any changes the Government and other public-sector organisations make to procurement processes for construction projects are likely to affect how the construction sector works. Andrew Wolstenholme argued that the “market responds by the client asking some pretty bold questions” so public-sector clients should “put down some very strong indicators about the percentage of manufacture they would like off-site”.¹⁴⁵ Professor Jeremy Watson said, however, that even if the Government procures against certain requirements, there is little evidence that the private sector will follow.¹⁴⁶

132. In the November 2017 Budget the Chancellor announced a “presumption in favour” of off-site construction by 2019 across suitable capital programmes, where it represents best value for money. The presumption in favour will

140 Innovate UK and Infrastructure and Projects Authority, *Creating a Digital Built Britain: what you need to know* (2 August 2017): <https://www.gov.uk/guidance/creating-a-digital-built-britain-what-you-need-to-know> [accessed 21 June 2018]

141 Infrastructure and Projects Authority, *Government Construction Strategy 2016–2020* (March 2016): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/510354/Government_Construction_Strategy_2016–20.pdf [accessed 20 June 2018]

142 Q 22 (Dr Mark Bew)

143 NBS, *NBS National BIM Report 2017* (12 May 2017): <https://www.thenbs.com/knowledge/nbs-national-bim-report-2017> [accessed 20 June 2018]

144 *Ibid.*

145 Q 59 (Andrew Wolstenholme)

146 Q 4 (Prof Jeremy Watson)

apply to five Government departments: the Department for Transport, the Department of Health and Social Care, the Department for Education, the Ministry of Justice and the Ministry of Defence.¹⁴⁷

133. Tony Meggs explained that the presumption in favour means that the five departments will work together, with the Infrastructure and Projects Authority, through a working group. All projects should have “at least one option that includes the substantial use of off-site manufacture” during the option development stage. Mr Meggs went on to say that how that requirement works in practice is “yet to be seen”, but that the presumption would lead to “aggregation of demand across those departments” and that “it sends a signal to industry that we are serious” about off-site manufacture.¹⁴⁸

134. The Minister told us:

“I thought that the presumption in favour did not actually mean very much, but it is a pledge that, from next year, for every built asset that these five departments contract there is a presumption in favour of it being made in a factory rather than on the building site in the traditional way. That does not bind them absolutely, because some buildings just would not be suitable for it, but it is possible for many.”¹⁴⁹

135. *We recommend that the Government develop and publish a series of Key Performance Indicators against which the success of the “presumption in favour” can be assessed. Furthermore, where the presumption in favour is set aside and a project goes ahead that does not use off-site manufacture, the Government should publish a statement explaining why it has not been used and justifying that decision.*

Ensuring a pipeline of projects

136. In Chapter 5 we discussed how the lack of a consistent pipeline was a barrier to wider use of off-site manufacture. Andrew Wolstenholme told us that “the Government have to understand the value of a consistent pipeline”.¹⁵⁰ However, the CPA told us that the “track record of the National Infrastructure and Construction Pipeline to date has seen significant delays in funding for a number of projects” and that this does not provide the industry with the confidence to invest in off-site manufacture.¹⁵¹

137. David Hurcomb argued that the lack of a clear Government pipeline meant that innovation and learning in the construction sector is lost:

“Where you have seen innovation in this industry, it is through large government programmes ... because the supply chain gets good at doing stuff and you start to see that benefit. The problem is that as these programmes come to an end, some of that innovation gets lost.”¹⁵²

147 HM Treasury, *Autumn Budget 2017* (22 November 2017): <https://www.gov.uk/government/publications/autumn-budget-2017-documents/autumn-budget-2017> [accessed 14 June 2018]

148 [Q 66](#) (Tony Meggs)

149 [Q 74](#) (Richard Harrington MP)

150 [Q 60](#) (Andrew Wolstenholme)

151 Written evidence from the CPA ([OMC0050](#))

152 [Q 49](#) (David Hurcomb)

He thought that the Government needs to trust the industry more and provide frameworks that give longer-term certainty to allow for investment.¹⁵³

138. The CPA told us that “take-up of offsite will only occur en masse with consistent, coherent Government policy given that the public-sector accounts for one-quarter of total construction output”.¹⁵⁴ Constructing Excellence said that the Government’s ‘presumption in favour’ is “a very welcome intervention” to help achieve a pipeline of repeatable projects.¹⁵⁵
139. Some progress has been made by the Government on a consistent pipeline. For example, the Department of Transport has designated ring-fenced funds for Highways England over a six-year period from 2015 to 2021.¹⁵⁶ The Government has also committed to “take forward the public-sector investment set out in the National Infrastructure and Construction Pipeline” in the Construction Sector Deal.¹⁵⁷
140. ***We recommend that the Government, using the levers we set out in Box 8, provides a steady pipeline of projects for the construction sector so that companies can plan and make the capital investments necessary for off-site manufacture. We welcome the Government’s commitment to the National Infrastructure and Construction Pipeline in the Construction Sector Deal. It is important that the Government adheres to the pipeline to provide certainty to the sector. The ‘presumption in favour’, if properly executed, will also help to do this.***

Procuring for value

141. Witnesses described how changes to public procurement criteria could help to increase the use of off-site manufacture. Of benefit would be procuring for value rather than lowest cost. This means considering the whole life cost of an asset—including improved safety and environmental performance of buildings and infrastructure—rather than just the initial capital cost. This may mean a larger initial cost but should lead to higher quality assets that cost less to run and maintain. Consequently, the lifetime cost should be less.
142. Procurement processes could also take account of externalities that do not directly affect the cost of an asset but which could provide environmental and societal benefits. Externalities include the health and safety of the construction workforce and the final users of the building or infrastructure, reduction of noise pollution and dust caused by working on a construction site, minimisation of waste, and the environmental performance and energy use of the building or infrastructure. Trowers and Hamblins LLP promoted this approach, and recommended that public procurement should “emphasise the social value benefits which can be derived from modular projects, such as addressing skill shortages and environmental and sustainability targets”.¹⁵⁸

153 *Ibid.*

154 Written evidence from the CPA (OMC0050)

155 Written evidence from Constructing Excellence (OMC0046)

156 Highways England, *Highways England designated funds* (14 June 2017): <https://www.gov.uk/guidance/highways-england-designated-funds> [accessed 20 June 2018]

157 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

158 Written evidence from Trowers and Hamblins LLP (OMC0053)

143. Tony Meggs told us that in the past there has been “a track record in the industry of working with government to procure for the lowest cost rather than for best value”.¹⁵⁹ Mott MacDonald wrote that “procurement needs to move from a traditional, transactional, risk-averse approach to recognise that value (not price) is all important”.¹⁶⁰ A similar point was made by Mace, who welcomed the balanced scorecard approach announced in the Industrial Strategy, telling us “A scorecard that tracks elements such as spend with [small and medium-sized enterprises], payment practices, productivity and use of [modern methods of construction]” can be used to drive the right behaviour and practices that will promote productivity improvements.¹⁶¹
144. BEIS thought that the way Government procures construction projects “can influence the speed of emergence and adoption of new technologies, and encourage more economically and environmentally sustainable practices”.¹⁶²
145. BEIS told us that the Government has encouraged a more strategic approach to procurement through Crown Commercial Service’s balanced scorecard:
- “This is a procurement approach which balances cost against wider social, environmental and economic themes using a set of Key Themes and can also be used to encourage better working practices. It should be applied to all construction, infrastructure and capital investment procurement with a value over £10 million”.¹⁶³
146. Ann Bentley agreed that the Crown Commercial Service has a “big part to play” because “a lot of public procurement ... is done through that service”. She considered that the many historical frameworks used from procurement are not being combined into larger national frameworks. “Each framework would then probably have a lot of suppliers on it, because it is not trying to get rid of competition; it is trying ... to aggregate the market”. Once a supplier was on a framework; “you might not know exactly which schools or hospitals you are going to build, but you will know that, as you are on the framework, you are in with a good shot of getting a percentage of that work” and would therefore be able to invest in manufacturing facilities.¹⁶⁴
147. The Minister told us that externalities were “precisely what Government can stipulate in procurement contracts, and ... Government has to stipulate these things if it is to achieve ... targets to do with the environment”.¹⁶⁵
148. The Construction Sector Deal commits the sector to “develop an industry wide definition of value which takes into account more than capital cost” and the Government to “embed [a] ‘procure for value’ approach in public procurement”.¹⁶⁶
149. **The use of national frameworks for procurement that include different suppliers should help maintain a visible and reliable pipeline. It should also ensure that there is no loss of learning between projects**

159 Q 65 (Tony Meggs)

160 Written evidence from Mott MacDonald (OMC0069)

161 Written evidence from Mace (OMC0025). See also Q 59 (Andrew Wolstenholme).

162 Written evidence from BEIS (OMC0011)

163 *Ibid.*

164 Q 67 (Ann Bentley)

165 Q 74 (Richard Harrington MP)

166 Department for Business, Energy and Industrial Strategy, *Construction Sector Deal* (5 July 2018): <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal> [accessed 5 July 2018]

and that knowledge can easily be transferred from one project to the next, unlike the current system where learning is often lost as each project is re-tendered. Having different suppliers signed up to the frameworks will enable these benefits while also ensuring that there is still competition between suppliers.

150. *We welcome the commitment to develop a definition of value and for steps the Government has taken so far to embed procuring for value in the public sector. However, more needs to be done. The Government must consider what further action it can take to embed procurement for value in the public sector and the consideration of externalities, including environmental performance, reduction of waste and health and safety in all procurement processes.*

Sharing knowledge and best practice

151. While the public sector is the biggest client of the construction sector, procurement is done by many different bodies, including Government departments, local authorities and NHS trusts. Simon Rawlinson told us that this presents a challenge because the ability of the Department of Health and Social Care, for example, to influence NHS trusts “is a little limited”.¹⁶⁷
152. *We recommend that the Government shares intelligent client best practice in relation to off-site manufacture between departments and with other public-sector clients, such as NHS trusts and local authorities.*

Standards

153. Tim Carey, National Product Director at Willmott Dixon, explained that a lack of harmonisation of design standards, particularly for affordable housing, is a barrier to greater use of off-site manufacture.¹⁶⁸ Cogent Consulting explained that “with more standardisation there is a higher likelihood of a production process being repeatable and therefore automated, with automation comes investment in machinery which increases efficiency levels and provides cost reductions”.¹⁶⁹
154. The British Standards Institute told us that “standardisation has a clear role to play in driving market development” in off-site manufacture.¹⁷⁰ Rosie Toogood made the comparison to other industries where standardisation “is seen as an enabler”.¹⁷¹
155. *The Government should promote the adoption of recognised standards for off-site manufactured components within the industry by working with bodies such as the British Standards Institute and the Building Research Establishment.*

Research and development

156. The construction sector typically spends little on research and development (R&D). Cogent Consulting told us that it has the lowest spending on R&D of

167 [Q 56](#) (Simon Rawlinson)

168 [Q 10](#) (Tim Carey)

169 Written evidence from Cogent Consulting ([OMC0030](#))

170 Written evidence from BSI ([OMC0022](#))

171 [Q 15](#) (Rosie Toogood)

any sector in the UK, “currently estimated to be running at 0.1% of output”.¹⁷² The McAvoy Group argued that “R&D should be recognised as an inherent and critical part of offsite to maximise the potential of the sector and its positive impact on the wider construction industry”.¹⁷³ Interserve stated that “the evidence is not well recorded” for the benefits of off-site manufacture and “a focus on detailed performance data for buildings” is needed.¹⁷⁴

157. One of the aims of the Construction Sector Deal is to increase spending on R&D in the sector. Alongside the initial Sector Deal announcement the Government announced a £170 million investment in the ‘Transforming Construction’ programme, as part of the Industrial Strategy Challenge Fund.¹⁷⁵ Fergus Harradence, Deputy Director of Construction at the Department for Business, Energy and Industrial Strategy, set out what this money would be spent on, including £70 million on a core innovation hub: “a centre that will take forward the development and commercialisation of digital and off-site manufacturing technologies” that will “work in a similar way to a catapult centre”. Around £30 million will be invested in an active building centre, which will “develop technologies that will enable buildings to be energy self-sufficient or ideally energy positive”. The remainder, about £70 million, will be “awarded by various competitions and will support R&D projects”.¹⁷⁶
158. Mr Harradence went on to say that Innovate UK estimates that the Government investment will “leverage around £250 million of matched funding from the industry through its contribution to funding R&D projects”.¹⁷⁷
159. Wider use of R&D tax credits by the sector could help to increase spending on R&D. Mark Reynolds told us that “HMRC should be working with industry on the R&D tax credits and demonstrating the benefits”.¹⁷⁸
160. Kier Construction Ltd said that research on off-site manufacture has typically been into technology and economic solutions. They considered that consideration of “psychological, behavioural and cultural factors is potentially the greatest opportunity for review”.¹⁷⁹
161. *Her Majesty’s Revenue and Customs should work with the sector to foster greater understanding of how R&D tax credits work, what the benefits are and how to meet the criteria to receive them.*
162. *We recommend that a portion of Government funding for research and development in the construction sector should focus on detailed performance data for the lifetime of buildings and infrastructure. Not only will this provide an important evidence base for improving future designs, it will also enable a comparison for whole-life cost*

172 Written evidence from the Chartered Institute of Building ([OMC0040](#))

173 Written evidence from McAvoy Group ([OMC0047](#))

174 Written evidence from Interserve ([OMC0019](#))

175 ‘Government and industry cement deal to give UK construction the edge’, *Department for Business, Energy and Industrial Strategy*, (29 November 2017): <https://www.gov.uk/government/news/government-and-industry-cement-deal-to-give-uk-construction-the-edge> [accessed 11 June 2018]

176 [Q 73](#) (Fergus Harradence)

177 *Ibid.*

178 [Q 28](#) (Mark Reynolds)

179 Written evidence from Kier Construction Ltd ([OMC0024](#))

can be made between manufactured and traditionally built buildings and infrastructure.

163. **The role of the Government and the wider public sector is pivotal in a move to greater use of off-site manufacture. We have set out actions that we think the Government should take including implementation of the Sector Deal, committed execution of the ‘presumption in favour’ of off-site manufacture and a greater move to procuring for value rather than cost.**

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The case for off-site manufacture for construction

1. There are clear and tangible benefits from off-site manufacture for construction which make a compelling case for its widespread use. These include:
 - Better quality buildings and infrastructure;
 - Enhanced client experience and faster delivery;
 - Fewer labourers and increased productivity;
 - Creating more regional jobs away from large conurbations;
 - Improved health and safety for workers;
 - Offering building safety advantages—making it easier to ensure buildings meet quality assurance standards;
 - Improved sustainability of buildings and infrastructure; and
 - Reduced disruption to the local community during construction.

The Government has a ‘presumption in favour’ of off-site manufacture and has affirmed its commitment to investing in off-site in the Construction Sector Deal; we strongly support this direction of travel. (Paragraph 44)

2. *In the light of the health and safety benefits arising from off-site manufacture for construction, the Health and Safety Executive should work to raise the profile of these techniques and to encourage wider uptake of them.* (Paragraph 45)

Infrastructure, building and housing

3. *We recommend that the Government explore options for the accreditation of housing built using off-site manufacture, to ensure that mortgages are available to those who wish to purchase them.* (Paragraph 52)
4. *The Government must set out what conditions it will attach to the extra financial support for housing to drive the uptake of off-site manufacture and other innovative technologies.* (Paragraph 55)
5. *We recommend that the Government, through Homes England, put pressure on housing associations and local authorities to stipulate the use of off-site manufacture, where appropriate, when procuring new housing developments. It should also consider mandating a proportion of off-site manufacture for large regeneration projects.* (Paragraph 56)
6. There is an opportunity for the UK to maintain its position at the forefront of off-site manufacture globally in the commercial and high-rise residential sectors. However, we are concerned that the UK lags significantly behind other countries in the low-rise residential sector. The Construction Leadership Council and the Government have an important role to play in encouraging the use of off-site manufacture in the low-rise residential sector. This can be done by the spreading of best practice and case studies by the CLC and by the Government providing incentives to house-builders. (Paragraph 60)

Skills

7. *The Government must work with the construction sector to design new qualifications to close the current skills gap. This should be done primarily through the Construction Leadership Council as the industry lead body, but other industry bodies should be encouraged to engage in the process as well. (Paragraph 80)*
8. *The Government must ensure that young people entering the workplace are equipped with the digital skills needed for modern methods of construction, including off-site manufacture. It is important that this is reflected in post-school training provision, but also in the school curriculum so that the next generation have the basic skills necessary to undertake more specialist training. (Paragraph 81)*
9. Perceptions of the types of jobs available in the construction sector are based on the skills needed for on-site construction. We welcome the creation of the single industry platform and portal announced in the Construction Sector Deal to support construction careers and promote the new types of careers in construction to the next generation. (Paragraph 82)
10. We support the Government's plans to create new apprenticeship standards across the sector. (Paragraph 83)
11. *Alongside this, the Government, with the construction sector, must re-assess the wider operation of the Apprenticeship Levy in the construction sector and make the necessary changes to ensure the money is best spent to benefit the long-term viability of the sector. (Paragraph 83)*

Sector barriers to uptake

12. The construction sector needs to build trust and partnerships so that companies can work together to improve the uptake of off-site manufacture. We welcome initiatives such as the Construction Leadership Council and the Infrastructure Client Group's Project 13 but more needs to be done by other industry groups to facilitate collaboration within the sector. (Paragraph 95)
13. *The Construction Leadership Council should provide overarching, active and focussed leadership for the sector. They should gather and disseminate data including case histories, sign-post to resources and spread best practice around the sector. (Paragraph 96)*
14. Designers, contractors and suppliers must all have early involvement in a project for off-site manufacture to be successful. This requires a change in business models in the sector and amongst clients, both private and public sector, as well as far greater collaboration. There is a need for a client's professional team or advisers to adopt a different approach, as outlined by the Infrastructure Client Group's Project 13 (see Figure 1), to enable off-site manufacture. We welcome moves in the construction Sector Deal to address business models in the sector and make them more effective. (Paragraph 104)
15. At present the upfront finance required to set up off-site manufacture appears greater than the finance required for conventional construction. We welcome the commitment in the Sector Deal to identify sources of funding available to the sector. (Paragraph 107)
16. *Should this review highlight gaps in the availability of funding, we recommend that the Government work with the construction sector and the financial services sector to develop sources of funding to fill those gaps. (Paragraph 107)*

17. We will follow with interest the success or otherwise of the new models developed through the Infrastructure Client Group's Project 13. (Paragraph 113)
18. *If they are successful in tackling some of the issues we have raised around risk and cash flow, the Construction Leadership Council should promote these models across the sector.* (Paragraph 113)
19. Many of the barriers to the greater uptake of off-site manufacture for construction facing the construction sector, such as a lack of collaboration and attitudes to risk, are cultural and can only be dealt with by the sector. (Paragraph 120)
20. *The sector must look at ways to reduce the barriers and this should be led by the Construction Leadership Council.* (Paragraph 120)

Government actions to overcome barriers

21. *The Construction Sector Deal is an important step forward for off-site manufacture and the wider construction sector. It is important that the Government and the Construction Leadership Council work together with the sector to make sure the Sector Deal is a success. The CLC must draw up a detailed implementation plan containing a timetable, objectives and metrics as soon as possible and hold those responsible for delivering the Sector Deal to account. This is particularly important considering the sector's problems with collaborating and working together in the past.* (Paragraph 123)
22. *We recommend that the Government provides companies who want to bid for Government contracts with the information they need to comply with the BIM mandate. It is important that the Government enforces the mandate, as it is a significant enabler for off-site manufacture.* (Paragraph 130)
23. *We recommend that the Government develop and publish a series of Key Performance Indicators against which the success of the "presumption in favour" can be assessed. Furthermore, where the presumption in favour is set aside and a project goes ahead that does not use off-site manufacture, the Government should publish a statement explaining why it has not been used and justifying that decision.* (Paragraph 135)
24. *We recommend that the Government, using the levers we set out in Box 8, provides a steady pipeline of projects for the construction sector so that companies can plan and make the capital investments necessary for off-site manufacture. We welcome the Government's commitment to the National Infrastructure and Construction Pipeline in the Construction Sector Deal. It is important that the Government adheres to the pipeline to provide certainty to the sector. The 'presumption in favour', if properly executed, will also help to do this.* (Paragraph 140)
25. The use of national frameworks for procurement that include different suppliers should help maintain a visible and reliable pipeline. It should also ensure that there is no loss of learning between projects and that knowledge can easily be transferred from one project to the next, unlike the current system where learning is often lost as each project is re-tendered. Having different suppliers signed up to the frameworks will enable these benefits while also ensuring that there is still competition between suppliers. (Paragraph 149)
26. *We welcome the commitment to develop a definition of value and for steps the Government has taken so far to embed procuring for value in the public sector.*

However, more needs to be done. The Government must consider what further action it can take to embed procurement for value in the public sector and the consideration of externalities, including environmental performance, reduction of waste and health and safety in all procurement processes. (Paragraph 150)

27. *We recommend that the Government shares intelligent client best practice in relation to off-site manufacture between departments and with other public-sector clients, such as NHS trusts and local authorities. (Paragraph 152)*
28. *The Government should promote the adoption of recognised standards for off-site manufactured components within the industry by working with bodies such as the British Standards Institute and the Building Research Establishment. (Paragraph 155)*
29. *Her Majesty's Revenue and Customs should work with the sector to foster greater understanding of how R&D tax credits work, what the benefits are and how to meet the criteria to receive them. (Paragraph 161)*
30. *We recommend that a portion of Government funding for research and development in the construction sector should focus on detailed performance data for the lifetime of buildings and infrastructure. Not only will this provide an important evidence base for improving future designs, it will also enable a comparison for whole-life cost can be made between manufactured and traditionally built buildings and infrastructure. (Paragraph 162)*
31. *The role of the Government and the wider public sector is pivotal in a move to greater use of off-site manufacture. We have set out actions that we think the Government should take including implementation of the Sector Deal, committed execution of the 'presumption in favour' of off-site manufacture and a greater move to procuring for value rather than cost. (Paragraph 163)*

APPENDIX 1: LIST OF MEMBERS AND DECLARATIONS OF INTEREST

Members

Lord Borwick
Lord Fox
Lord Griffiths of Fforestlach
Lord Hunt of Chesterton
Lord Kakkar
Lord Mair
Lord Maxton
Baroness Morgan of Huyton
Baroness Neville-Jones
Lord Oxburgh*
Lord Patel (Chairman)
Lord Renfrew of Kaimsthorn
Lord Vallance of Tummel
Baroness Young of Old Scone

* Lord Oxburgh did not take part in this inquiry

Declarations of interest

Lord Borwick
Property developer, mainly of housing sites

Lord Fox
No relevant interests declared

Lord Griffiths of Fforestfach
Mentoring one person on the Laing O'Rourke's Senior Development Executive Programme

Lord Hunt of Chesterton
Fellow, Royal Society
Hon. Fellow, Institution of Civil Engineers
Director, Cambridge Environmental Research Consultants (CERC) Ltd
Fellow of Trinity College, Cambridge

Lord Kakkar
No relevant interests declared

Lord Mair
Consultant to Laing O'Rourke Group—Advising them on geotechnical aspects of underground construction projects (principally tunnelling and deep excavations)
Emeritus Professor of Civil Engineering and Director of Research, University of Cambridge. Laing O'Rourke collaborate with, and provide funding to, the Engineering Department at Cambridge
Chair, Science Advisory Council, Department of Transport
President, Institution of Civil Engineers

Lord Maxton
No relevant interests declared

Baroness Morgan of Huyton
Vice-Chair of Council, King's College, University of London
Non-executive Director, Countryside Properties PLC

Baroness Neville-Jones
No relevant interests declared

Lord Patel

No relevant interests declared

Lord Renfrew of Kaimsthorn

Fellow, British Academy

Hon. Fellow, Royal Society of Edinburgh

Lord Vallance of Tummel

Chairman, Edinburgh Business School

Baroness Young of Old Scone

Chancellor for Cranfield University 2010–present day

Chairman, Woodland Trust

Hon. Fellow, Royal Society of Edinburgh

A full list of Members' interests can be found in the Register of Lords Interests:
<http://www.parliament.uk/mps-lords-and-offices/standards-and-interests/register-of-lords-interests/>

Specialist Adviser

Mike Putnam

Non-Executive Director, Network Rail, January 2018 to date

Non-Executive Director, Southern Water Utility Company, October 2017 to date

Supervisory Board Director, ARCADIS, April 2018 to date

Non-Executive Directorships, Skanska, 2010–17

Member of Government's Construction Leadership Council (Construction 2025 Strategy), 2013–January 2018

Chair of Government's Green Construction Board, 2012–November 2017

Member of ACE (Association of Consulting Engineers) Advisory Board, 2012 to March 2018

Member of CBI Construction Council, 2009–17

President and CEO, Skanska UK Plc, October 2009–May 2017

APPENDIX 2: LIST OF WITNESSES

Evidence is published online at www.parliament.uk/off-site-manufacture-construction/ and available for inspection at the Parliamentary Archives (020 7219 3074).

Evidence received by the Committee is listed below in chronological order of oral evidence session and in alphabetical order. Those witnesses marked with ** gave both oral evidence and written evidence. Those marked with * gave oral evidence and did not submit any written evidence. All other witnesses submitted written evidence only.

Oral evidence in chronological order

- | | | |
|----|--|--------------------------|
| ** | Professor Jeremy Watson CBE, Vice-Dean of Engineering Sciences and Professor of Engineering Systems, University College London | QQ 1–8 |
| ** | Phil Wilbraham, Expansion Programme Director, Heathrow Airport | |
| ** | Professor Jennifer Whyte, Director of the Centre for Systems Engineering and Innovation, Imperial College London | |
| ** | Rosie Toogood, CEO, Legal and General Modular Homes | QQ 9–16 |
| * | Jamie Ratcliff, Assistant Director (Housing), Greater London Authority | |
| * | Tim Carey, National Product Director, Willmott Dixon | |
| * | Dr Mark Bew MBE, Chairman, PCSG Ltd, former Chair of the Industry-Government BIM Task Group between 2012–16, and Strategic Adviser, Centre for Digital Built Britain | QQ 17–23 |
| ** | Mark Enzer, Chief Technical Officer, Mott MacDonald | |
| * | Mark Farmer, CEO, Cast | QQ 24–29 |
| * | Steve Radley, Director of Policy, Construction Industry Training Board (CITB) | |
| ** | Mark Reynolds, Chief Executive, Mace | |
| ** | Dick Elsy, CEO, High Value Manufacturing Catapult | |
| * | Andrew Morris, Partner, Rogers Stirk Harbour and Partners | QQ 30–40 |
| ** | Jane Richards, Director, Building structures, WSP UK | |
| * | Jaimie Johnston, Director, Bryden Wood | |
| ** | Dr Sarah Williamson, Technical Director, Laing O’Rourke | QQ 41–49 |

- ** Martin Kelly, Strategic Business Development
Director, Severfield
- ** David Hurcomb, Chief Executive, NG Bailey
- * Suzannah Nichol MBE, Chief Executive, Build UK [QQ 50–56](#)
- * Simon Rawlinson, Construction Industry Council
(CIC)
- ** Dr Diana Montgomery, Chief Executive, Construction
Products Association
- * Andrew Wolstenholme OBE, Co-Chair, Construction
Leadership Council, Former CEO of Crossrail [QQ 57–63](#)
- * Tony Meggs, Chief Executive, Infrastructure and
Projects Authority (IPA) [QQ 64–70](#)
- * Ann Bentley, Global Practice Director, Rider Levett
Bucknall
- * Martin Chown, Infrastructure Client Group
- ** Richard Harrington MP, Minister for Infrastructure
and Construction, Department for Business, Energy
and Industrial Strategy (BEIS) [QQ 71–77](#)
- ** Fergus Harradence, Deputy Director, Construction,
Department for Business, Energy and Industrial
Strategy (BEIS)

Alphabetical list of all witnesses

- Accord Housing Association [OMC0079](#)
- Addleshaw Goddard LLP [OMC0065](#)
- Arup [OMC0010](#)
- B&CE [OMC0016](#)
- BEAMA Ltd [OMC0052](#)
- BLP Insurance [OMC0072](#)
- Blue Lion Consultants Ltd [OMC0068](#)
- * Bryden Wood ([QQ 30–40](#))
- BSI (British Standards Institution) [OMC0022](#)
- * Build UK ([QQ 50–56](#))
- Buildeco Offsite Architecture [OMC0029](#)
- Building Alliance [OMC0033](#)
- Building Societies Association (BSA) [OMC0049](#)
- Buildoffsite [OMC0036](#)
- Caledonian Modular Limited [OMC0037](#)
- Carl Henry Property Limited [OMC0012](#)
- * Cast ([QQ 24–29](#))

	CCG OSM Ltd	OMC0009
	The Chartered Institute of Building (CIOB)	OMC0040
	Civil Engineering Contractors Association (CECA)	OMC0044
	Cogent Consulting	OMC0030
	The Concrete Centre	OMC0061
	Constructing Excellence	OMC0046
*	Construction Industry Council (CIC) (QQ 50–56)	
*	Construction Industry Training Board (CITB) (QQ 24–29)	
*	Construction Leadership Council (QQ 57–63)	
**	Construction Products Association (QQ 50–56)	OMC0050
**	Department of Business Energy and Industrial Strategy (BEIS) (QQ 71–77)	OMC0011
	DIRTT Environmental Solutions	OMC0043
	Education and Skills Funding Agency (ESFA)	OMC0088
	Elliott Group Ltd	OMC0027
	Mr Simon Fawcett	OMC0058
	Paul Fear	OMC0002
	First Home Vision	OMC0056
*	Greater London Authority (QQ 9–16)	
	Dr Robert Hairstans	OMC0078
	Hatch Homes Accelerator	OMC0087
**	Heathrow Airport (QQ 1–8)	OMC0035
	Ian Heptinstall	OMC0001
**	High Value Manufacturing (HVM) Catapult (QQ 24–29)	OMC0077
	Peter Huf	OMC0083
	IET (The Institution of Engineering and Technology)	OMC0071
	ilke Homes	OMC0066
*	Infrastructure and Projects Authority (IPA) (QQ 64–70)	
*	Infrastructure Client Group (QQ 64–70)	
	Interserve	OMC0019
	IPInitiative	OMC0020
	Kier Construction Ltd	OMC0024
	Kingspan	OMC0004
**	Laing O’Rourke (QQ 41–49)	OMC0055 OMC0085

	Lean Thinking Ltd	OMC0026
**	Legal and General Modular Homes (QQ 9–16)	OMC0062
	Loughborough University	OMC0032
	Low Carbon Construction	OMC0038
	Low Carbon Journey	OMC0005
**	Mace (QQ 24–29)	OMC0025
	The McAvoy Group	OMC0047
	Ministry of Justice	OMC0081
	MOBIE (Ministry of Building Innovation and Education)	OMC0073
**	Mott MacDonald (QQ 17–23)	OMC0069
**	NG Bailey (QQ 41–49)	OMC0086
	NHBC	OMC0021
	Offsite Solutions	OMC0039
	Osborne Group Holdings Limited	OMC0023
*	PCSG (Professional Construction Strategies Group) Ltd (QQ 17–23)	
	Place Venture Management Limited	OMC0003
	ProCure22	OMC0017
	Ramboll UK	OMC0057
*	Rider Levett Bucknall (QQ 64–70)	
*	Rogers Stirk Harbour and Partners (QQ 30–40)	
	Rolls Royce	OMC0082
	Royal Academy of Engineering	OMC0075
	Ryder Architecture	OMC0067
**	Severfield (QQ 41–49)	OMC0084
	Space Projects (UK) Ltd	OMC0048
	SPECIFIC Innovation and Knowledge Centre	OMC0045
	Stride Treglown	OMC0015
	Structural Timber Association	OMC0059
	Swan Housing Association	OMC0076
	Tidal Lagoon Power (TLP)	OMC0018
	Totally Modular Ltd	OMC0007
	Trowers and Hamlins	OMC0053
	UK Finance	OMC0051
	UK Research and Innovation	OMC0074
	University of Brighton	OMC0028

	University of Cambridge	<u>OMC0064</u>
	University of the West of England	<u>OMC0041</u>
	Urban Splash	<u>OMC0042</u>
**	Professor Jeremy Watson (<u>QQ 1-8</u>)	<u>OMC0008</u>
**	Professor Jennifer Whyte (<u>QQ 1-8</u>)	<u>OMC0080</u>
*	Willmott Dixon (<u>QQ 9-16</u>)	
	WPI Economics	<u>OMC0031</u>
**	WSP (<u>QQ 30-40</u>)	<u>OMC0014</u>
	Zurich Insurance	<u>OMC0054</u>

APPENDIX 3: CALL FOR EVIDENCE

The House of Lords Science and Technology Select Committee, under the Chairmanship of Lord Patel, is conducting an inquiry into *Off-site manufacture for construction*. The Committee invites interested individuals and organisations to submit evidence to this inquiry. The deadline for receiving written submissions is Thursday 26 April.

Background

The UK Construction industry was worth nearly £100 billion to the UK economy in 2016. The sector contributes 6.1% to UK GDP. The construction industry is also vital to solving some of the pressing problems facing the UK, such as a lack of affordable housing and ageing infrastructure that needs replacing or increasing in capacity. However, the construction industry suffers from poor productivity and has not experienced the improvements in productivity seen in other sectors. New technologies, including off-site manufacture, could help to improve the productivity of the construction industry.

Off-site manufacture for construction describes a range of construction activities that involve bringing together construction processes, components, elements or modules in a factory before installation into their final location. While it is not a new idea the level of technology now available means it is much more viable as a modern method of construction.

The Government announced the Construction Sector Deal in November 2017 as part of its Industrial Strategy white paper. This included £170 million of investment from the Government in the Transforming Construction programme. The construction industry committed to match that funding with a £250 million investment. The programme will “bring together the construction, manufacturing, energy and digital sectors in a new hub to commercialise technologies capable of building assets which are both cost effective and energy efficient.”¹⁸⁰

Scope

The Committee’s inquiry will consider the potential benefits of off-site manufacture for construction and any drawbacks or obstacles to its wider use. It will also consider how off-site manufacture might contribute to improving productivity within the construction industry and how it will fit in with the Construction Sector Deal announced by the Government. It will examine how Government policy, particularly around public procurement, might need to change to encourage economically and environmentally sustainable practises in the construction industry, which could facilitate off-site manufacture.

Questions

In answering the questions below please provide practical examples where possible. If relevant, please state how you define off-site manufacture in your response.

Perceived advantages of offsite manufacture for construction

1. What are the opportunities offered by offsite manufacture for construction? What are the likely drawbacks? What factors are likely to influence clients, architects, design engineers, contractors and the supply chain in deciding whether to choose offsite manufacture?

¹⁸⁰ <https://www.gov.uk/government/news/government-and-industry-cement-deal-to-give-uk-construction-the-edge>

2. It is often claimed that offsite manufacture can lead to:
 - lower costs, faster delivery and increased quality;
 - increased productivity;
 - improved health and safety;
 - greater provision of new, affordable housing.

What is the evidence for this?

Potential barriers to wider use of offsite manufacture

3. What are the drawbacks to offsite manufacture for construction?
4. What re-skilling of the construction workforce is required to facilitate a change to more off-site manufacture for construction?
5. Can the benefits of standardisation and factory manufacture be realised without hampering architectural ambition? If so, how?
6. What R&D is needed, and by whom, to realise fully the potential benefits of off-site manufacture

Government actions

7. (If published) does the construction Sector Deal correctly identify the issues faced by the construction industry and the actions that the Government and other stakeholders need to take to address them? What should it contain/ what is missing?
8. What changes could be made to public procurement processes to encourage more economically and environmentally sustainable practises in the construction industry and facilitate off-site manufacture?

29 March 2018

APPENDIX 4: SEMINAR HELD AT THE HOUSE OF LORDS ON 6 FEBRUARY 2018

Members of the Committee present were Lord Patel (Chairman), Lord Borwick, Lord Fox, Lord Griffiths of Fforestfach, Lord Hunt of Chesterton, Lord Mair, Lord Maxton, Baroness Morgan of Huyton, Baroness Neville-Jones, Lord Oxburgh and Baroness Young of Old Scone.

Presentations were heard from:

- Paul Westbury CBE, Group Technical Director of Laing O'Rourke; and
- Professor Keith Ridgway CBE, Advanced Manufacturing Research Centre, University of Sheffield.

APPENDIX 5: SEMINAR HELD AT THE HOUSE OF LORDS ON 17 APRIL 2018

Members of the Committee present were Lord Patel (Chairman), Lord Borwick, Lord Griffiths of Fforestfach, Lord Hunt of Chesterton, Lord Kakkar, Lord Mair, Lord Maxton, Baroness Morgan of Huyton and Lord Renfrew of Kaimsthorn.

Presentations were heard from:

- Professor Peter Hansford, Professor of Construction and Infrastructure Policy, UCL; and
- Mr Jaimie Johnston, Head of Global Systems, Bryden Wood Architects.

APPENDIX 6: COMMITTEE VISIT TO LAING O’ROURKE EXPLORE INDUSTRIAL PARK (EIP), WORKSOP ON 22 MAY 2018

Members of the Committee present were Lord Hunt of Chesterton, Lord Mair, Baroness Neville-Jones, Lord Renfrew of Kaimsthorn, Lord Vallance of Tummel and Baroness Young of Old Scone.

The Committee visited the Laing O’Rourke EIP factory in Worksop where they heard presentations on off-site manufacturing for construction and had tours of the factory and prototype ‘precision manufactured’ apartments. Members met with Chris Millard, Head of Engineering Excellence, Paul Westbury, Technical Director, Alan Clucas, Director of Explore Manufacturing, and Chris Bailey, Business Unit Leader for concrete products.

APPENDIX 7: ABBREVIATIONS, ACRONYMS AND TECHNICAL TERMS

BEIS	Department for Business, Energy and Industrial Strategy
BIM	Building Information Modelling
CAD	Computer-aided design
CDE	Common data environment
CLC	Construction Leadership Council
CPA	Construction Products Association
DfMA	Design for Manufacture and Assembly
DGRI	Dumfries and Galloway Royal Infirmary
HMRC	HM Revenue and Customs
ICG	Infrastructure Client Group
IPA	Infrastructure and Projects Authority
MCHLG	Ministry of Communities, Housing and Local Government
MMC	Modern methods of construction
MOBIE	Ministry of Building Innovation and Education
NHBC	National House Building Council
ONS	Office for National Statistics
OSM	Off-site manufacture for construction
R&D	Research and development
Tier 1 Contractor	Designers and constructors that have a direct contract with the ultimate client