

EXPLORING A PLATFORM APPROACH TO IMPROVE THE UPTAKE OF OFFSITE CONSTRUCTION IN HOUSEBUILDING: EVIDENCE FROM THE UNITED KINGDOM

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ABSTRACT

The purpose of this research is to create guidance and direction for industry especially developers and / or housebuilders who can directly influence the decision-making process to create buildings and land developments that are considered more valuable. The UK has a massive housing shortage and with the added pressure of climate change and a very fragmented construction industry the need to look at smarter building methods is critical. The benefits of offsite construction are well documented but still thought of as expensive and high risk, therefore other solutions such as platforms could lower the barrier of entry and increase uptake. This study aims to investigate the current understanding of platform construction and the challenges that are contributing to its slow uptake. Qualitative research method was used and only construction professionals who have experience in offsite construction were interviewed to ensure the richest information. The study found that cost and supply are the core issues limiting uptake of product platforms. Through the continuation of government and industry collaboration, both supply and demand can be aggregated to solve these issues. However, the bar for improving knowledge and understanding across industry needs to be raised and points of recommendation are provided.

KEYWORDS

Offsite construction, product platforms, manufactured construction, standardisation, collaboration

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INTRODUCTION

To date, the UK construction industry has been built on inefficient processes and often described as a broken business model with issues relating to construction costs, supply, labour availability, productivity, and fragmentation in the market (Egan, 1998; Farmer, 2016). Many countries are facing a housing shortage and the UK is no different with projections of the number of households in England rising from 23.2 million in 2018 to 26.9 million in 2043 (House of Commons, 2021), which means the sector desperately needs to create more high quality and sustainable housing. With the construction industry contributing to 39% of global carbon emissions (WBCSD, 2021) it means the sector must also change the way it designs and builds to mitigate the acceleration of global warming. Looking at smarter ways to build, through manufactured construction, will not only help both the UK's housing shortage but also help decarbonise the sector.

Offsite construction has a critical role to play in moving the industry forward, however, to date the uptake of offsite manufacturing approaches remains low within UK housebuilding (MGCLG, 2019; Marte Gomez et. al., 2021). Offsite construction techniques where entire modules are constructed in a factory need extremely high capital costs for investment and funding. For one, there is a huge investment for the factory setup alone, plus with factory production there are very high upfront costs for production and delivery to site (Goulding and Rahimian, 2019; Barbour ABU, 2020; Tuesta et. al., 2022). As per, House of Lords, 2018, this means a lot of working capital is tied up, especially if the manufacturer is not paid until work is delivered to site, and that can be very challenging in terms of cash flow for the manufacturer to stay afloat. In fact, that can be the difference between an offsite manufacturer being successful or not as the case maybe. Platform construction, as per Mosca et. al., 2020; CIH, 2022, comprise of standardised interoperable components and assemblies which can be used at scale as well as standardising processes and programmes which ultimately will reduce project cost, delivery time and carbon emissions. A platform approach also creates a lower barrier of entry around investment and risk that come with offsite modular construction (Barbour ABI, 2020).

In an interview conducted by Bryden Wood, a manufacturing design and engineering practice, it highlighted there is a mindset shift is needed to really progress the uptake of manufactured construction by making better choices early in the process. This means that smaller housebuilders and developers have a pivotal role to play to ensure a better delivery of housing stock (Bryden Wood, 2021). This research tests the viability of manufactured construction, such as offsite and platform approaches, amongst UK housebuilders and developers by encouraging “manufacturing thinking” right at the very start of a project to drive design, client and supply chain engagement (Goulding and Rahimian, 2019; Tuesta et. al., 2022). To improve uptake of offsite construction and increase the housing supply in the UK this study seeks to achieve these two objectives:

13. Investigate the current level of knowledge amongst UK developers and / or builders, concerning platform construction;
14. Identify the challenges that prevent UK developers and / or builders from adopting such building methods thus contributing to the slow uptake of offsite construction.

LITERATURE REVIEW

OFFSITE AND PLATFORM CONSTRUCTION

Offsite construction typically has become to be known as an approach to a project whereby a proportion of construction activities are carried out under factory conditions and then later transported to the site usually in the form of complete modules (Goulding and Rahimian, 2019; CITA, 2022). It has been recommended as part of the solution to solving some of the

inefficiencies in the construction sector for decades now from the UK’s government report Rethinking Construction (Egan, 1998) to the government’s review of the construction labour model in Mark Farmer’s Modernise or Die report (Farmer, 2016). Subsequently this has evolved thinking and best practices by taking the learnings from other manufacturing industries, like automotive, and applying them to the delivery of buildings. The construction sector is now using terms such as ‘standardisation’, ‘lean manufacturing’, ‘pre-assembly’, ‘economies of scale’ which has given rise to various categorisations of offsite construction designed to help improve understanding and confidence in the use of smarter building techniques (MHCLG, 2019).

Figure 1 was developed for a report for Construction Research & Innovation Strategy Panel (CRISP) and focuses on the term ‘pre-assembly’ by subdividing into four categories based on increasing amounts of pre-assembly (Gibb and Isack, 2003). More recently, in Figure 2, construction was further defined by incorporating innovative construction techniques known as the Modern Methods of Construction (MMC) Definition Framework (MHCLG, 2019). This divided the innovative construction techniques or MMC into seven categories by encompassing a range of offsite manufacturing and onsite techniques and measuring how much pre-manufacture is used on a construction project. Measuring pre-manufacture or Pre-manufactured Value (PMV %) enables organisations to adapt design, supply chain and construction choices to aggregate and standardise demand (Pan and et. al., 2008; MHCLG, 2019).

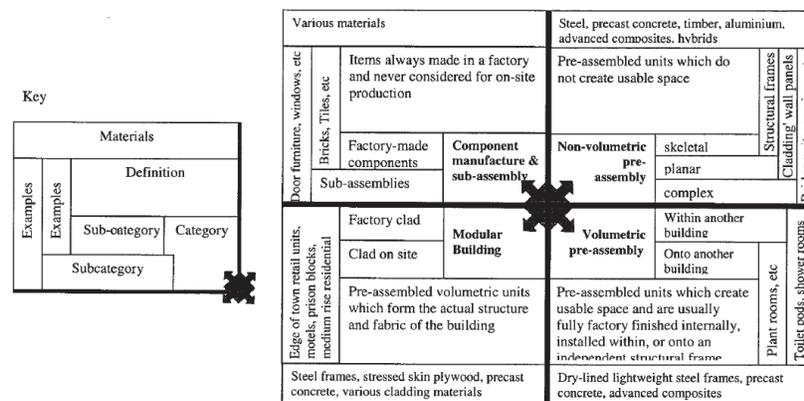


Figure 1: Four categories of pre-assembly, definitions, subcategories, examples and main materials (Gibb and Isack, 2003)

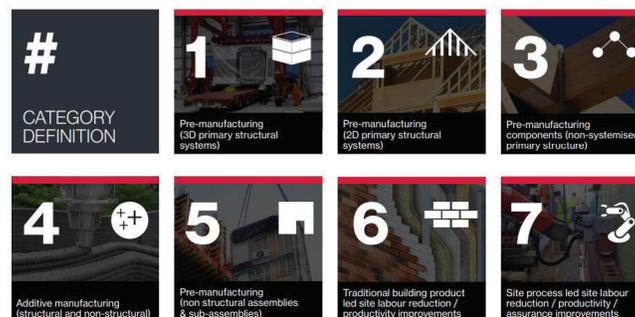


Figure 2: The MMC Definition Framework: Categorisation (MHCLG, 2019)

Platform construction, however looks at the project holistically by identifying commonalities and creating components that offer a higher level of standardisation and repetition (Barbour ABI, 2020; CIH, 2022). This negates the need for a large costly factory because platforms can leverage on existing processes through value engineering and continual improvements (Bryden Wood, 2021c; Bryden Wood, 2018; Barbour ABI, 2020). As per Mosca et. al., 2019, there are many kinds of product platforms but they all have three characteristics. Firstly, a group of fundamental components, such as a car's chassis, that don't vary too much. Second, a group of auxiliary parts which may be paired with the chassis to produce lots of repetition of the same vehicle. And lastly, a reliable interface that enables the components to connect (Mosca et. al., 2020; CIH, 2022). So whichever framework is used to categorise offsite manufacture, whether it be Figure 1 or Figure 2 or another, they illustrate examples of pre-assembly or pre-manufacture in construction, which really aligns to the thinking of a product platform approach by providing a stable core which is configured and combined with complementary components (via defined interfaces) to suit a particular project (CIH, 2022).

MANUFACTURED CONSTRUCTION PRINCIPLES

In understanding offsite and platform construction techniques and securing the benefits of these manufacturing led processes in housebuilding, there is a real need to recognise the importance that “manufacturing thinking” is different to “construction thinking”. As per Bryden Wood, 2021c; Bryden Wood, 2018; Goulding and Rahimian, 2019; Tuesta et. al., 2022, a key manufacturing principle is to strip out anything that is non-value adding and work out what is the leanest possible way to deliver it to the end user. Design for Manufacturing & Assembly (DfMA) describes the process of manufacturing and assembling a product and the need to design a product towards the process (Bryden Wood, 2021).

One of the major problems in the construction industry is that far too often people do a traditional design process and then shoehorn DfMA into a project such as modular or panelised. This compromises the design by making it fit the system and thus designing an inefficient system. This is where architectural and consultancy practices specialising in offsite construction would be able to add significant value in the process by being system-agnostic and designing the best solution for that project also advocating the role of the MMC Adviser at RIBA Stage 0 (Modularize, 2021; RIBA 2021). In manufacturing there is a different set of constraints to traditional construction such as manufacture and assembly (and dis-assembly), transport, safety, cost, environment etc. which all need to be carefully planned and considered right at the very start of a project (Modularize, 2021; Laovisutthichai et. al., 2022; CITA, 2022).

According to Zhang and et. al., 2009, DfMA is more familiar in offsite construction such as building fully completed volumetric and modular buildings where there is controlled environments and optimised processes. Platform construction, takes components and assemblies that can be put together in lots of different ways to make lots of different products and has been termed a ‘kit of parts’ (Bryden Wood, 2021c; Bryden Wood, 2018).

Identifying commonalities to work from a common kit of parts and applying manufacturing techniques and processes can really drive productivity, innovation and cost efficiencies (Zhang and et. al., 2009; Barbour ABI, 2020). As mentioned, product platforms are used extensively in the automotive industry where there is a lot of customisation but use the same components and standard manufacturing processes, for example BMW and VW use the same chassis on a lot of their models and it's the engine, the wheels, the trim etc. that make the car different even though technically it is the same model allowing a degree of customisation (Bryden Wood, 2021).

PLATFORM CONSTRUCTION DRIVERS AND ENABLERS

The UK's government for procuring construction has changed significantly and has seen them championing MMC and committing to migrating from traditional construction techniques to

smarter building methods. The creation of the Product Platform Rulebook was created to support the implementation of the government's strategies outlined in the Construction Playbook [December, 2020] to improve the uptake of MMC and increase adoption of platform approaches also described in TIP (Transforming Infrastructure Performance): Roadmap 2030 [September 2021] which builds on the Industrial Strategy of 2017 about delivering greater value in buildings (HM Gov, 2017; HM Gov, 2020; IPA, 2021; CIH, 2022). The Rulebook, therefore, not only sets out 'The Rules' that should be followed to develop a successful product platform but also details a common framework of approaches that can be used to implement a platform approach to delivery (CIH, 2022; Bryden Wood, 2021c).

The Platform programme therefore incorporates an end-to-end solution by re-evaluating the whole construction process, not just by considering the kit of parts approach and associated manufacturing processes but the knowledge, people and relationships required to deliver a project from inception to completion and beyond. It therefore focuses on 1) utilising manufacturing approaches to improve efficiencies by shifting focus to quality, performance and whole-life value; and 2) changing behaviours of clients and supply chain by enabling all-encompassing outcomes. This is really important as the industry moves towards a focus on performance outcomes and building a net zero carbon future (CN, 2021; Bryden Wood, 2021b).

RESEARCH METHOD

In order to look at a project more holistically so it can drive improvements by focusing on outcome-based specifications it needs to be pushed by industry. This puts emphasis on the housebuilding community to ensure a better delivery of housing stock by making decisions earlier on in the process (Bryden Wood, 2021). However, because the understanding of platforms is a relatively new subject, a qualitative approach was used for this research to allow a more thorough discovery into this subject area (Naoum, 2013; Fellows and Liu, 2015). To date the current information available on platform construction is based on offsite manufacturing philosophies and lean manufacturing practices to improve efficiency and eliminate waste (Laovisutthichai et. al., 2022; Goulding and Rahimian, 2019; Tuesta et. al., 2022). At scale these methodologies have successfully been adopted in other industries such as automotive but have not yet translated to the construction industry.

This means the numerical data is not readily obtainable for manufactured housing because it has not yet "stood the test of time" compared to traditional methods of construction. A lot of the information to date, therefore, remains idealistic and even though there has been some great work between government and industry showing the potential of manufactured and platform construction, it doesn't show the scale it needs to become mainstream (CIH, 2022; Bryden Wood, 2021c). This new concept of platform construction means a purposive sampling technique was best suited for this research allowing people with the most knowledge to participate in order to ensure the richest information was obtained (Braun and Clarke, 2013). Because of the newness of 'platform construction' more recognised terms such as 'volumetric', 'modular', 'panelised' etc. were used to identify those that have used manufacturing techniques in their building practices. This was essential to ascertain if a platform approach could be adopted more widely to build more quality houses faster.

Structured interview questions allow more accurate answers to be obtained compared to unstructured ones, as well as helping the interviewer to remain impartial (Naoum, 2013). For this research a semi-structured approach was taken by using both open and closed questions to 1) help prevent predeterminism but 2) allow respondents to give their views and opinions where necessary (Naoum, 2013). During data analysis common language was identified, in the form of themes and sub-themes, to rationalise the results. Thematic analysis is an approach that determines a level of prevalence by using code-frequency counts to identify common patterns

in the data (Braun and Clarke, 2006; Braun and Clarke, 2013). Therefore, a middle-ground was achieved through the inclusion and exclusion of code-frequency counts.

RESULTS AND DISCUSSION

RESPONDENTS BACKGROUND

Although some additional dialogue with industry experts was undertaken to allow a deeper examination of this subject area, the focus of this research methodology is the UK housebuilding community. Therefore, twenty developers and / or housebuilders and key personnel were identified and contacted based on their knowledge and experience in this field of study, with ten confirming their participation. Before any data collection was undertaken respondents were asked to confirm their business category e.g., builder, developer or developer-builder and the type of housing projects they are involved in e.g., build-to-sell, detached, low-rise, affordable etc. etc and confirm their understanding of platform construction.

RESPONDENTS UNDERSTANDING OF PLATFORM CONSTRUCTION

The research showed that most of the respondents, 90% in fact, had heard of the term platform construction shown in Table 1. But to evaluate the true understanding amongst respondents they were also asked to describe platform construction which as in seen in Table 2 comprises of three initial codes. What this shows was most respondents mentioned the Use of a manufactured construction process to create efficiencies in the build by standardising components like they do in the car industry; using the same components & standard manufacturing processes to build, offering different finishes & ways to assemble to create variation, in the words of one respondent, “Constructing buildings in a manufacturing way – not just efficiencies in the design & build of the product but also in the process.”

Table 1: Data analysis of respondents re. What is platform construction?

S. No	Description	Frequency	Percentage
1	Yes	9	90%
2	No	1	10%
Grand Total		10	100%

Table 2: Detailed data analysis of respondents re. Understanding about platform construction

Themes	Initial Codes	Frequency	Quotes from Transcripts
Understanding about platform construction	Building with a manufacturing mindset	1	Building with a manufacturing mindset by limiting choice to leverage greater economies of scale.
	Standardising	2	The ability to standardise the main asset like a chassis of a car and then a continuous reuse of manufactured components to produce variations in the supply chain. For example, VW Beetle and VW Golf are the same chassis! Kit of parts approach creating standardised components, with standardised processes to create efficiencies whilst having customisation.

Use of 5 manufactured construction process	Using manufactured construction processes to create efficiencies in the build by standardising components like they do in the car industry. Using the same components & standard manufacturing processes to build, offering different finishes & ways to assemble to create variation - car industry!! Constructing under the limitations of manufacturing techniques to produce very efficient buildings. Using a manufacturing environment to create a fixed set of parts that can be put together in different ways to create variety & throughput. Constructing buildings in a manufacturing way - not just efficiencies in the design & build of the product but also in the process.
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During the launch of the new DfMA Overlay to the RIBA Plan of Work, one of the major challenges that has contributed to the slow uptake of MMC and DfMA is a fundamental lack of understanding within the construction industry about manufacturing processes (RIBA, 2021; SCSS, 2021). Because there are currently so many variations and interpretations around terminology, whether it be modular, offsite or platforms, it makes it a very confusing and complicated landscape to work in (RIBA, 2021). Most of the respondents interviewed used these terms interchangeably to mean the same thing including modular, DfMA, MMC, offsite, prefabrication. Certainly, some respondent's understanding was more comprehensive than others, but most could relate platforms to manufacturing processes such as the automotive industry and understood the need to standardise to create efficiencies in the construction process.

But this confusion around terminology therefore limits the respondents understanding about how to get the best out of manufactured construction. As per Modularize, 2021; SCSS, 2021, it was discussed that offsite architects that work across all MMC systems can identify the best solution for that project, therefore not limiting the design to a particular system. This coupled with the role of the MMC Adviser to be assembled as part of the project team at RIBA Stage 0 will ensure that offsite is not an afterthought, so all the benefits of MMC can be consumed and it does not impinge on design choices and customisation (RIBA, 2021). Although standardisation creates less design and layout choice compared to traditional, there are still lots of opportunity to create customisation by offering a variety of sizes, materials and finishes to suit different tastes, styles, and types. As per Mosca et. al., 2020, platforms need a holistic approach to be successfully adopted therefore moving the conversation away from cost and focusing on performance outcomes.

THE CHALLENGES SLOWING MMC UPTAKE AS PER THE RESPONDENTS

To identify the challenges that prevent UK developers and / or builders from adopting manufacturing techniques, respondents were asked to give their key reasons for the slow uptake of MMC allowing four initial codes to be formed as highlighted in Table 3.

Table 3: Detailed data analysis of respondents re. Key reasons for the slow uptake of MMC

Themes	Initial Codes	Frequency	Quotes from Transcripts
Key reasons for the slow uptake of offsite construction	Cost related issues	6	No cost benefits. For most projects we undertake it's not cost-effective compared to traditional. We are a developer / builder that sell our houses, so cost is a major driver. Ultimately we can talk about other value drivers such as innovation and sustainability but if you can't make the project viable it becomes irrelevant. The build size cost is too high for offsite, of course if you can build in volume and benefit from economies of scale it is cost comparable. But most brown field sites don't offer the opportunity to build 100 homes at a time. We've looked at modular several times on larger projects & still unable to get the numbers to stack up in terms of viability.
	Other	1	Planning is inadequate – lots of challenges here but main issue is that current planning policy does not consider zero carbon. MMC houses surpass building regulations but there is no recognition of that in current planning policies – you still only need to meet building regs.
	Lack of Understanding	2	Lack of understanding in how to deliver MMC therefore no cost benefits. Too late post-planning
	Supply Chain Issues	5	No cost certainty from supply chain. Not enough supply-chain availability and no interoperability. Not enough supply chain capability on the market. Manufacturers not interested in small projects – need volume. We build high-end luxury homes – at the moment there isn't enough design flexibility in the current supply-chain without incurring huge cost.

Cost was definitely a bone of contention throughout the interviews, in the words of one respondent “Ultimately, we can talk about other value drivers such as innovation and sustainability but if you can't make the project viable it becomes irrelevant”. A lot of this can be attributed to the lack of understanding in the level of detail required at the early design stages of a project as discussed in the above section (Modularize, 2021; CITA, 2022). In manufacturing there are a different set of constraints to be considered right at the very start of a project compared to traditional construction and it is knowing these intricacies that will give housebuilders and developers the edge to maximise project value and deliver a viable and cost-effective solution (Modularize, 2021; CITA,2022). Also, it brings into focus about not looking at a project in isolation and designing bespoke every time like traditional construction. Of course, a platform approach makes sense when delivered at large scale but even for small housebuilders there's no reason why some elements and processes cannot be standardised and used across multiple sites to reduce costs (Bryden Wood, 2021a; (CIH, 2022).

An interesting finding in the research contributing to the slow uptake is the planning inadequacy with one respondent making the point “Planning is inadequate – lots of challenges here but main issue is that current planning policy does not consider zero carbon. MMC houses surpass building regulations but there is no recognition of that in current planning policies – you still only need to meet building regs.” If industry were able to get to a point where it was evaluating on other aspects such as social, economic, or environmental outcomes, it could then start to bridge the gap between on-site, offsite and everything in between. This might even remove the confusing industry terminologies and rather than differentiating between offsite and traditional, it could be referred to as just ‘construction’. The use of materials are the same whether you build on-site or offsite, it’s just the location that changes to whether it is built in a factory or on-site. As per CITA, 2022; Daniel et. al., 2020, most house designs surpass building regulations as standard in terms of airtightness and thermal performance, but if there is no recognition of this in current planning policy these extra costs a ‘green’ developer incurs naturally make offsite construction more expensive compared to traditional.

One of the other recognised challenges amongst the respondents was the insufficient supply-chain with one respondent saying there is “Not enough supply-chain availability and no interoperability”. The result of this is the developers and / or builders interviewed felt the current supply-chain is monopolising the marketplace making a manufacturing option unviable in terms of price competitiveness (compared to traditional). And because every manufacturer is doing something slightly different, there is no interoperability, so each time a project must be redesigned as per the manufacturers system (Modularize, 2021; Bryden Wood, 2021a). As mentioned, where platform construction starts to be viable is delivering on large scale to drive the benefits of applying the standardisation of process and approach (CIH, 2022). But if there was interoperability and willingness to collaborate in the industry, it would allow manufacturers to come together and deliver a much larger programme (Daniel et. al., 2020). For example, by having different manufacturers using common elements, and potentially being able to procure together, not only is it a much more exciting environment in terms of materials, appearances, and styles, it becomes a much stronger commercial case for them to be involved. But as one respondent went onto describe so much of this is chicken and egg because for the supply chain to work together and invest, they need to have confidence in demand. That’s the problem to date that so many of the platform projects highlight the opportunity but not the scale (Bryden Wood, 2021a; Bryden Wood, 2021b; Bryden Wood, 2021c; CIH, 2022).

CONCLUSIONS AND RECOMMENDATIONS

The aim of this study is to improve adoption of offsite construction, by investigating if a product platform approach can lower the barrier of entry and scale housing production in the UK. The study found that lack of knowledge of the platform approach, lack of supply chain capability and cost are among the barriers to the adoption of the platform approach. The study also found that the current planning policy that do not fully incorporate NetZero carbon limit the level of adoption of the MMC by house builders. For sure, there are a lot of challenges to overcome, but it is this joined up approach with government and industry working together that will move the industry away from procuring on just cost. This enable higher quality and sustainable houses to be built faster. As seen the Platform Rulebook has been instrumental in setting out key processes and approaches to enable the market to develop product platforms and learn how to deliver platform projects at scale.

Although the industry may not be quite there yet, as this research was conducted, the elements are coming together, and this makes the industry a very exciting place to be right now. As the industry moves away from cost to performance outcomes it will start to create an equal playing field for construction. Digitalisation of course will support this transformation and expanding interoperability to technology will allow the design process to be sped up to facilitate

true digital design and operation. However, it cannot be stressed enough the industry needs to collaborate to innovate and make the industry less complex and more efficient to work in. Those three words from the Construction Playbook ‘harmonising’, ‘digitising’ and ‘rationalising’ demand will enable standardised and repeatable components and interfaces to be designed and drive the adoption of offsite manufacturing technologies.

RECOMMENDATIONS FOR INDUSTRY

This study helps anyone working in the UK residential sector by improving industry knowledge and understanding. It is joining up the design, client, and supply chain relationships to work in collaboration, that will assist UK developers and / or housebuilders in making manufactured and platform construction their first choice. The main points of recommendation are:-

Manufactured construction is not an afterthought, it is a conscience business decision that is made at the start of a project with buy-in from all the project stakeholders;

Understand that a manufacturing approach has a different set of constraints to traditional construction and therefore cannot be procured in the same way;

Look at the project more holistically and move away from cost by focusing on performance outcomes and building a net zero carbon future;

Standardising, components, assemblies and processes, as much as possible and taking the concepts and learnings across multiple projects will reduce costs in the long run as well as strengthening supply and demand;

To unlock the true benefits of DfMA engage early with a MMC Adviser / Specialist Offsite Architect (ideally RIBA Stage 0).

This study is limited to ten interviews which may not adequately present the state of the art of application of the Platform approach in the UK. Future study should conduct an industry wide survey to present a more broader picture of the issue. Case study approach should also be used .

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