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Customer experience in the housebuilding industry: the post-occupancy evaluation of MMC-delivered homes in the social housing sector

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Contents

1. Introduction	1
2. Post-Occupancy Evaluation and customer-centred housing	4
3. Customer surveys as a traditional measurement of POE across housing associations.....	6
4. Benefits of effective POE and gaps in the customer experience feedback loop	8
5. What new data could be collected from residents?.....	13
6. Recommendations.....	17
7. References	19

1. Introduction

Customer experience in housebuilding has become increasingly important in recent years. It is recognised that it has the potential to contribute to improving design and construction quality and, in turn, may help to increase the supply of better-quality homes in a market where housing shortages and poor construction quality has become the norm, and in the context of the current housing crisis (Burgess et al. 2020, MHCLG 2020a). Understanding the experiences of the end-users of a home can provide insights into the usability and functionality of homes built with the use of modern methods of construction (MMC). Furthermore, this understanding could inform the development of emergent MMC technologies in housebuilding. This report explores the post-occupancy evaluation (POE) mechanisms used by housing associations delivering homes with MMC in England and the role that customer feedback plays in those mechanisms.

By examining existing customer engagement and post-occupancy evaluation practices used in MMC-based housebuilding in the social housing sector, this research explores whether and to what extent the learning from end-users and completed projects has been employed. The research explores the feedback loop from the residents of occupied homes that were built with MMC through to the housebuilding supply chain and examines the barriers to effective POE that would otherwise inform the design and construction of future homes. The study focuses on the case of housing associations which, as the main providers of affordable housing in England, have the greatest interest in and motivation to work with customer experience as it can ensure long-lasting performance and better-perceived quality of the homes that comprise their housing stock.

The report highlights the potential benefits that effective customer experience research and systematic learning from previous projects can bring to housebuilding, given their potential to lead to better building performance and quality of housing, and to generate social and environmental value through meeting the needs of end-users, society and the environment.

The study is driven by an existing knowledge gap in the construction sector that largely overlooks the perspectives of occupants of the buildings delivered with the use of innovative technologies (Oti-Sarpong et al. 2021).

The project has been developed in collaboration with the Building Better Group, an alliance of housing associations and local authorities backed by the National Housing Federation.

The Building Better Group aggregates demand in the procurement of sustainable offsite-build homes of high quality (NHF, 2020).

This research forms part of the Centre for Digital Built Britain's (CDBB) work at the University of Cambridge within the Construction Innovation Hub which brings together world-class expertise from the Manufacturing Technology Centre (MTC), BRE and CDBB to transform the UK construction sector. The Construction Innovation Hub is funded by UK Research and Innovation through the Industrial Strategy Fund.

1.1. Methodology

This report relies on the analysis of qualitative data collected from 15 interviews with representatives of housing associations using MMC, manufacturers supplying high-category MMC products (volumetric, modular, panellised systems, timber and steel frames, roof and floor solutions), industry experts, and architects working with MMC solutions. The participants all held decision-making roles in these groups, and included development directors, heads of performance and design teams, planning and technical directors, and leaders on MMC.

The questions were structured around their experiences with MMC and POE; the current organisation of the feedback loop in their organisation; forms of engagement currently used with customers; the skills required; and practical issues with performing design and construction changes to the housing product.

1.2. The social housing sector and the increasing use of MMC

Housing associations are the primary affordable housing providers in England and act not only as housebuilders but also as long-term asset managers of built homes. Compared to other housebuilders, they have the greatest interest in improving their housing product in order to prevent complaints, reduce the work needed to rectify defects, and reduce maintenance needs and operating costs in the longer term.

Increased use of Modern Methods of Construction (MMC) is expected to improve efficiency in the construction industry and the build quality of homes, and could also bring environmental and aesthetic benefits (MHCLG 2019, NHBC 2018, 2019). The term MMC refers to a broad range of manufacturing techniques that are alternatives to traditional construction methods and comprise 'forms of offsite manufacture for construction, including modular and panellised systems, and timber or steel framed homes' (House of Commons 2019, p.14). The MMC framework comprises seven categories, where the first three

categories of MMC have the highest pre-manufactured value: 1- 3D primary structural systems; 2 - 2D primary structural systems; 3 - non-systemised structural components (MHCLG 2019). The adoption of MMC is incentivised across the industry, especially of high categories of MMC with high pre-manufactured value. According to the Affordable Homes Programme, new affordable homes built using MMC through the programme funding also need to meet the requirement of a pre-manufactured value of 55% or more (MHCLG & Homes England 2020). Hence, the report takes into consideration particularly the use of high categories of MMC (Categories 1-3) when it refers to MMC-based housebuilding.

Delivery of social housing in England will increasingly be tied to the use of MMC. In particular, the recipients of public subsidy for affordable homes are expected to increase their use of high-category MMC in their delivery of homes. The Affordable Homes Programme for 2021-26, which will receive investment of £11.5 billion, is expected to deliver up to 180,000 affordable homes by 2028-29 (HM Treasury 2021). The Affordable Homes Programme prescribes that strategic partnership grants are conditional on a commitment to delivering at least 25% of homes through MMC (MHCLG & Homes England 2020). As social housing providers, housing associations are already focused on residents and their needs, but recent Government initiatives encourage social housing providers to do even more in this respect. The most recent Social Housing White Paper (MHCLG 2020b, p.2) aims to encourage communities to have a greater say in their housing design, and to bring forward the voices of residents of social housing to ensure they 'are safe, are listened to, live in good quality homes, and have access to redress when things go wrong'.

2. Post-Occupancy Evaluation and customer-centred housing

The residential experience of new build homes in the UK housebuilding industry is assessed predominantly by means of customer satisfaction measured in the process of post-occupancy evaluation (POE). POE was first introduced in the US and is used to appraise the performance of buildings after they have been handed over and are occupied (Durosaiye et al. 2019).

The post-occupancy agenda is well established in academic research (e.g., Preiser 2001, Bordass 2003, Becker 2018, Hay et al. 2018, Leaman et al. 2010, Macmillan 2004) and various methods are used to evaluate the quality and performance of occupied buildings, both quantitatively and qualitatively. The key indicator that POE typically measures is customer satisfaction, which can be defined as a feeling of pleasure or disappointment resulting from a comparison of the perceived performance of a product or service with customer expectations (Kotler 1996). Similarly, Parasuraman et al. (1985) argue that service quality and customer satisfaction are determined by 'the discrepancy between expectations and perceptions' (p. 43). The drivers of customer satisfaction lie in 'tangible evidence' relating to the actual performance of a service or a product.

Post Occupancy Evaluation (POE) as an approach is designed to examine the performance of a building through user satisfaction, by defining the ways to 'improve building design, performance and fitness for purpose through the systematic evaluation of the buildings in use, from the perspective of the people who use them' (Turpin-Brooks and Viccars 2006, p.178). POE can demonstrate the actual use of spaces by occupants, the perceived quality of housing or of occupants' subjective thermal comfort, which do not necessarily correlate with technical indicators of building performance (Durosaiye et al. 2019).

It is established that, despite the well-researched benefits of POE, the culture of evaluating the performance of a building after it has been built and occupied by users for a while has not been successfully embedded into the design and procurement process (Durosaiye et al. 2019). Among the key challenges hampering customer-focused housing, studies highlight the issues around communication and cooperation within the housebuilding company, and between the company and its customers (Ozaki 2003). Good information flows between customers, housebuilders and design teams allow for the inclusion of customer requirements and preferences into the design and construction of the house in the most suitable way. However, active communication with end-users has not been a key priority for housebuilders nor their design, construction and decision-making teams (Bordass 2003; Palmer et al. 2016). Some research also argues that omitting the collation of customer

feedback can lead to misalignment between actual customer needs and architects' and engineering and construction professionals' perception of customer needs (Agee et al. 2021). Furthermore, Ozaki (2003) showed that, even when customer feedback around the motivations to not buy a house was repeatedly collected in some housebuilding companies, it did not reach the head office or design teams because there was no formal channel of communication between the marketing and front-end sales divisions. Developing improved communication and a loop of learning, not only between the customers and the housebuilder but also within the housebuilding company and with contractors, is considered essential to enable effective POE.

There have been attempts to generate a shift in the system of housing provision towards considering customers' interests in a better way. In particular, it is argued that housebuilding companies that think of themselves as manufacturing firms gradually have to change their thinking and view themselves as service organisations and act accordingly (Ozaki, 2013). POE is commonly referred to as a customer-focused approach or human-centred housing design (Agee et al., 2021; Eggen 2016; Orihuela and Orihuela, 2014). While the traditional approach to housebuilding employs a linear design and delivery model, contemporary challenges call for a new iterative, human-centred approach that must be employed in order to maximise both human well-being and the operational performance of produced buildings (Agee et al. 2021).

Traditionally, POE has been used to establish user satisfaction alongside certain pre-set technical criteria that a new build is expected to meet. In particular, POE has proven effective in exploring cause-effect relationships between the technical features of a building and user experiences and needs (Kim et al. 2013). However, over time, a wider understanding of POE came into use, consisting of two parts: (1) the process of evaluating building performance and quality in design and construction; and (2) the loop of learning from previous projects, disseminating accumulated knowledge and improving future processes and practices (Designing Buildings 2016, Hay et al. 2018).

3. Customer surveys as a traditional measurement of POE across housing associations

In presenting the findings, it is first worth exploring how POE is currently implemented by the housing associations interviewed and what it is being used for. The housing associations interviewed were at the beginning of their journey using MMC, and their approach to collecting customer feedback had therefore been established for collecting customer feedback on traditionally built homes. It typically included two stages:

- Move-in surveys

This information is collected from residents within the first 4-8 weeks of moving into a home. This is typically a short survey dedicated to aftercare and the identification of defects.

- Home satisfaction forms for new residents

A wider, follow on survey is sent out to residents at around 9-12 months after their move-in date. Questions asked evaluate how residents find living in their home, estimate if the running costs of the home are in line with their expectations and rate their views on service charges.

As confirmed by the interview participants, these two stages of surveys represent a standard practice for POE among social housing providers and by housebuilders in the industry more generally. No further systematic feedback on residential experience or housing design and quality is collected in the subsequent years of occupancy.

In terms of the level of detail collected in POE surveys, interviewees reported that the limited number of questions asked inevitably led to a paucity of data. Typical questions focused primarily on customer satisfaction, the perceived comfort of home, its energy efficiency and customer experiences of interactions with the sales and aftercare divisions of the company. Some interviewees indicated that having relatively few questions in their customer surveys is a result of having insufficient resources for collecting and analysing more detailed feedback. A consensus among those interviewed was that using customer surveys as an approach to POE serves the purpose of portraying a good general picture of customer satisfaction, but it is limited in terms of understanding the experience of residents, given that the level of detail collected is largely narrowed down to customer satisfaction metrics.

While surveys work as a valid tool for collecting customer information, they have shortcomings in terms of measuring the lived experience of end-customers and of

identifying opportunities for improvement of customer experience through gaining insights into the drivers of a good experience. According to analysis by McKinsey (2021, 3), survey-based systems of interaction with customers are outdated and have four main flaws, meaning that they are unable to meet the demands of today's companies: (1) they provide a limited view of what customers experience and value (and are usually limited in the representativeness of the sample among all customers); (2) they are backward-looking while customers increasingly expect rapid resolution of their concerns (which existing systems do not typically have mechanisms for); (3) they are ambiguous with limited applicability of findings as surveys do not expose the deeper causes of customer perceptions and feelings behind specific metrics; (4) they are unfocused with no direct connection between survey-based scores and business outcomes.

On occasions, more episodic feedback targeting specific issues is collected from residents. For these purposes, a smaller sample of residents is approached to carry out touchpoints¹, focus groups or specific customer surveys. For example, one housing association mentioned reaching out to customers about the house layout, whether an open-plan kitchen or closed-plan kitchen works best for residents.

At the time of the study, few of the housing associations interviewed had trialled customer experience research with residents of homes built using MMC.

Interviewees described a number of reasons that were limiting the expansion of customer experience research:

- the limited resources available in the social housing sector for customer engagement and further analysis and integration of collected data;
- difficulties in engaging residents in such initiatives; and
- lack of clarity as to the value and benefits of the data collected on end-user experiences.

¹ In terms of Customer Experience, touchpoints are occasions where an organisation is in direct contact with its customers. Touchpoints are viewed as interactions within the customer journey that identify key moments that can build or erode customer trust.

4. Benefits of effective POE and gaps in the customer experience feedback loop

The construction industry is known for its reliance on quantitative evidence in making decisions about customer experience (Parn et al. 2015) but despite being an important research tool, current surveys do not offer sufficient insights. POE and customer feedback has the potential to generate much larger benefits than the currently collected POE of two-step surveys, which are primarily used as a basis for confirming customer satisfaction levels. Housebuilders, like many other companies, continue to rely on survey-based measurements that for a long time formed the foundation of customer experience work across the industry. It requires effort by larger customer engagement teams, or market insight organisations, which dedicate much of their workload to managing questionnaires and boosting response rates in order to generate quantitative metrics that can be subsequently used in business decisions.

Changing the way companies evaluate and shape customer experiences represents a fundamental shift in customer-experience analytics of many forward-looking companies. Fast-paced and competition-driven industries developing in the digitalising world employ user experience research and agile project approaches as an integral part of their production cycles to form a more complete understanding of customer preferences and behaviours. They iteratively test design prototypes and adjust them in the next cycle, allowing them to tailor design solutions in order to ensure that the end product is most suited to meet user needs (Gothelf and Seiden 2016). This approach offers multiple benefits: connecting more closely with customers can help identify customer experience issues and opportunities in real-time, anticipate behaviours and prevent possible problems (McKinsey 2021). The basic principles of human-centred design include the central and participative role of a user in 'an iterative design process, as well as the identification of user-specific factors to guide and assess the design' (Eggen et al. 2016, p.2).

The many benefits that companies adopting a customer experience (CX) approach can realise include (McKinsey 2021; Statista 2022; Qualtrics 2022):

- Improve the living experience of residents, satisfaction and quality of life;
- Increase customer loyalty and interest from new customers;
- Gain a better and more timely understanding of issues with current designs and quality;
- Optimise time and cost of development, and increase effectiveness;

- Expand user engagement, build community and motivate users to interact;
- Generate a knowledge base for long-term validation of innovations.

As McKinsey predicts (2021, 2), 'the CX programs of the future will be holistic, predictive, precise, and clearly tied to business outcomes'. Those companies that have begun building the capabilities and skills and are evolving their organisational structure to integrate CX will gain substantial advantages and those who uphold traditional survey-based systems will fall behind in the years to come (ibid).

The CX approach includes both close work with customers and their experience, and the integration of these insights across the business in cross-functional teams. In housebuilding, post-occupancy evaluation includes two stages: the evaluation of building performance and design and construction quality; and the learning loop of accumulated knowledge from users of previous projects into the improvement of future development processes (Hay et al. 2018).

Many of the above-mentioned benefits are suitable for the context of housebuilding organisations. For example, customer loyalty improved through effective POE has the potential of boosting credibility and tackling the public mistrust of MMC-based housebuilding, something which is much needed at the early stages of its adoption. The improved living experience of residents and quality of life that can be achieved through working closely with customer feedback exemplifies the explicit objectives of housing associations. Moreover, identifying the key issues with current housing design and quality that residents encounter can have a crucial impact on satisfaction and residential experience, and make it possible to optimise resources and increase effectiveness, reducing the need for extensive after-care support, and reducing repairs and maintenance costs. Finally, building better knowledge about end-users' experiences of living in homes delivered by housing associations creates a much-needed industry database that can inform the development of new technological solutions in construction and thus be used to inform business decisions.

A number of interviewees expressed an interest in expanding the work with customers beyond move-in and home satisfaction surveys. Particularly, they conveyed a need for a more developed system for the feedback loop from residents, with a move towards the inclusion of customer feedback into design, and a need to revisit and revise the customer journey, not only thinking about customers moving into new properties but customers moving into existing properties. Most believed that these and other changes on the expansion of customer work would require a transition in terms of how the business works, and there were numerous barriers to implementation.

4.1. Barriers to effective POE

While effective POE can bring many benefits to the MMC journey in the social housebuilding sector, a number of barriers hamper customer experience research and stand in the way of it becoming a standard for the industry.

Traditional approach to customer feedback

One of the key barriers to effective POE in MMC-build homes is that processes for the collection of customer feedback are adapted from those designed for traditionally built homes and already established by housing associations. This traditional 'two-step customer surveys after move-in' approach is standard practice across the industry. However, it can be rather limiting and less beneficial for the early stages of MMC adoption. Collecting customer feedback in the first year after completion might address customer satisfaction goals for traditional housebuilding but for housing associations striving to pioneer MMC-build homes, longer-term engagement with residential experience is needed. Being not only developers but also asset holders, housing associations have goals of ensuring the long-term customer satisfaction of residents, not only for the first-time residents of new-built homes but also of tenants moving into these properties in subsequent years. Regular feedback collected over the long term has the potential to add significant value to housing associations.

In addition, one of the biggest challenges of enabling effective customer research is that it is typically associated with marketing, not technology (McKinsey 2021). MMC housebuilding relies on emerging technologies and their performance and usability have not yet been tested in the long run. Systematic collection of user data could support and ensure the longevity of housing quality of MMC-build homes and could also help create a 'golden thread' of accumulated asset data (Burgess et al., 2020), which has the potential to change the negative public perception of prefabricated homes and to provide the evidence base needed by other actors, such as insurers.

Limited data collected from residents

The traditional approach to POE has proven effective in portraying a good general picture of customer satisfaction but is more limited in terms of understanding the experience of residents. Interviews found that questions in customer surveys focused primarily on customer satisfaction levels, the perceived comfort of the home, its energy efficiency and customer experiences of interactions with sales and aftercare divisions of the company, with one or two questions per point of interest. The forms rarely asked detailed questions about residents' interaction with or experience of the housing design or quality of construction nor did they ask for suggestions for improvement. In order to gain insights that design and

development teams and manufacturers can act upon, questions need to be more nuanced and target particular issues rather than generalities.

Weak feedback loop mechanisms

The loop for transmitting resident feedback to design and development teams is poorly developed in the traditional housebuilding sector. Interviewees noted that feedback is often passed on informally rather than through a centralised system of feedback integration across the supply chain. Given that customer feedback is mainly collected to measure satisfaction, it is surprising that little or no mechanisms exist to feed information from residents to the design and development teams, and customer feedback is not tied to changes in the design and construction quality of the housing product. Interviews found that there is a lack of coordination between the customer side of organisations and the development and innovation divisions with minimal CX exchange between them. In order for POE to develop a 'lesson learnt' approach with design and construction changes in the housing product derived from information collected from occupants of previously completed projects, customer research would need to be driven by innovation and design teams, with the support of customer engagement teams, rather than by the customer engagement teams themselves, allowing cross-divisional teams to work with customer feedback.

Features of the MMC housebuilding supply chain

Building a feedback loop from customers is not easy for traditionally built homes, but it becomes more challenging with the involvement of an MMC housebuilding supply chain given the involvement of a new major stakeholder - the MMC manufacturer. This leads to even greater separation between the development of MMC technology and deployment of homes and after-care. Likewise, the integration of customer feedback becomes increasingly complex given the gaps between the MMC manufacturer, their client (i.e., the housing association) and the end-customer (residents), with minimal mechanisms for feeding information across the MMC supply chain. The Employer's Requirements² regulate the ability to influence the specifications of the product, but interviews revealed limitations in how housing associations can influence the design and quality of MMC-build homes.

In addition, the nature of the MMC production cycle has limitations in terms of product adaptability. With the production offsite, MMC manufacturers require scale to deliver their products and designs are fixed early in the process and, in order to make a design or construction change to MMC-build homes, there needs to be a feasible pipeline of demand. This effectively constrains and limits the product range available to housing associations who

² The expression 'Employer's Requirements' (ERs) refers to the document(s) produced by the client to set out its requirements in relation to the design and construction of the project (including the initial design, drawings, performance specifications, etc.).

individually may struggle to demonstrate that demand. As a consequence, effective POE which can influence the product is difficult to integrate into the MMC supply chain and aggregated demand across a number of housing associations might be needed.

Structural industry factors

The current processes around customer feedback, with a focus on measuring customer satisfaction and detecting defects, reflect the existing priorities and goals of the housebuilding industry, which are to deliver more homes more quickly and to manage costs of repairs and maintenance. The housebuilding industry is supply-driven, which means that there is an industry focus on short-term gains enabling the faster delivery of homes, in preference to addressing key performance indicators around long-term customer satisfaction and the impact of improved housing quality and design on residential experience.

The housing market in the UK is not conditioned by this factor as some demand-driven industries are and there is little motivation for housebuilders to build better homes, only to build more homes. As such, the government has committed to investing £11.5 billion through the Affordable Homes Programme to deliver up to 180,000 new homes by 2028-29 (HM Treasury 2021). These structural factors lead to a paucity of data collected from end customers, a lack of resources and skills to learn from customer experience, and a lack of trust and collaboration in collecting and sharing knowledge on POE, and issues around embedding post-occupancy evaluation in the design and the procurement processes.

Despite the government's ambitions to improve housing quality (MHCLG 2020a; Building Better, Building Beautiful Commission, 2020) and to encourage communities to have a greater say in housing design (MHCLG 2020b), the industry remains challenged by its structure and by the need to respond to the ongoing housing crisis faced by the UK. Although housing associations have greater motivation to deliver on these priorities, their resources are limited, and effective POE systems require the cooperation of many industry actors.

5. What new data could be collected from residents?

This section explores the information that housing associations and manufacturers interviewed in the study would be interested in collecting from residents of their MMC-built housing stock.

Housing quality

Supplemental to the simple questions asked in existing customer surveys (“How would you rate your satisfaction of the quality of your new home?”, “Have you reported any repairs?”), housing associations are interested in collecting more data on housing quality and designs, and they would like to do more to engage with customers in the design process. The current feedback forms rarely include questions about housing design (if they do, they mostly relate to layouts and kitchens) or construction quality (e.g., materials used, airtightness, the robustness of finish, day lighting), nor do they ask for suggestions for improvement. There was a clear interest in collecting residents’ opinions about design-based questions, at a level of detail and understanding that designers, architects, manufacturers can usefully employ in their work. Such incorporation of user feedback into the design process can lead to improved housing quality, reducing the need for repairs and snagging, and the cost of maintenance.

MMC-related questions about housing quality are also something that both housing associations and manufacturers would like to have end-customers’ input on. For example, feedback on the available designs of specific MMC-built home types could help to identify those that are more popular, and for what reasons, and could help housebuilders make decisions about iterating those (or a particular feature of them) in preference to others.

Building performance

Housing associations and MMC manufacturers are primarily interested in the energy performance of the building, namely the optimisation of heating and energy efficiency, whether the heating pumps and solutions installed in the home work for the residents, etc. It was suggested that such performance indicators can be better collected through the use of sensor technologies in homes. In addition to technical data, questions about the perception of the home energy performance could be asked to ascertain whether residents consider their heating bills to be good value for money. Collecting post-occupancy data on energy performance can thus demonstrate the social and environmental value of MMC and be used to inform decisions about sustainable responsible procurement as well as to close the performance gap.

MMC-technology providers seek to test their technologies and look to receive feedback on a number of issues, including the offsite completeness of their systems and how they could help increase the pre-manufactured value. They are interested in testing airtightness and finding the right balance between airtightness and airflow of the building in order to ensure a balanced and comfortable performance, and this requires them to work with contractors, architects, designers and residents. Exploring solutions for the de-carbonisation of construction is another priority research area being explored by MMC manufacturers and this could benefit from customer feedback and post-occupancy evaluation.

Living comfort and space functionality

As social landlords, housing associations are continually motivated to ensure that their product meets the needs of their residents and provides them with the best possible living experience. Housing associations are therefore primarily concerned with collecting more data on residents' comfort of living in the home, its functionality and use of space, and the adequacy of the home's specifications when measured against their needs and aspirations. One interviewee expressed this as follows: if tenants are provided with a three-bedroom family home, does it function well for them as a family home and is it adequate for their needs? More general exploration around lived experience was also welcomed: what do residents particularly like about living in their home, what don't they like about their home and what could be done differently? There were also requests for qualitative feedback about communal spaces and their functionality.

MMC manufacturers have a strong interest in user feedback on the achieved comfort for end users, and they note that this can be evaluated mainly through post-occupancy performance measuring of the building itself. Although they currently struggle to obtain this data without the support of their housing association clients, they are keen to obtain greater understanding of occupants' feelings and experiences from living in their offsite-build homes. Particular areas of interest are comfort, health and wellbeing within the living environment.

Raising awareness and residents' knowledge around MMC

One of the questions that housing associations delivering MMC-build homes are currently facing is whether there is a need to 'educate' users on MMC. Raising residents' awareness and knowledge about MMC has the potential to overcoming existing stereotypes around the poor quality of prefabricated homes, but this question has practical implications as well. MMC manufacturers would be particularly interested in using the post-occupancy contact to explore issues around user behaviour and misuse in MMC-build homes.

There is a view that it is not MMC that needs to be explained but rather the operational use of the building (e.g., district heating systems operate differently to a heating system in a

traditional home; windows might function in a particular way, etc.). This requires engagement with customers through supportive resources (booklets, videos, etc.) and thought-through home welcome packages, and manufacturers again need the support of housing associations in order to obtain this feedback. The differences in operational use between MMC-built and traditionally built homes also have consequences for the environment. Residents can impact the energy performance of a building by their behaviour and, given this perspective, providing education for residents might be important as their 'green practices' in their previous home might need to change significantly when moving into a new MMC-built home.

Testing and adapting new methods to work with end-user experience

The participants interviewed suggested that a variety of methods might be needed to collect the required data and insights from residents of MMC-built homes. Some could be generated with the use of digital technologies: smart meters, for example, are used to measure real-time energy performance. Smart homes, smartphone apps, virtual reality, immersive technology, IoT and predictive analytics could all help diversify and expand end-user data. Technologies are actively used to monitor user experience in industrial design: smart sensors are used to connect digital twins in the built environment, IoT automation has already become an essential part of controlling domestic appliances, and this market is only going to grow (Pinsent Masons 2021). What form the use of technologies might take in the housebuilding industry is yet to be explored, but embedding technologies in homes has already begun, with home energy management systems, real-time remote monitoring of air quality, and smart assistive technology used to support vulnerable and ageing residents. Connected homes have the potential to become a substantive element of a Smart City and could generate considerable quantities of user data. Furthermore, sensor technology can feed information on the performance of particular construction units through smart-building tools, which may in turn provide insights to MMC manufacturers. In the future, smart homes will drive efficiency in use and anticipate the needs of their occupants by learning about their experiences and behaviour (ibid).

It was also mentioned that decision-making in housebuilding needs to be more data-driven and based on customer research; bringing MMC and digital technology together will benefit the end-user, the manufacturer and the client (housing association). Most interviewees agreed that more customer data input is currently needed in the industry in order to move towards customer-centred housing. With an expansion of customer research methods towards digital technology-enabled feedback, consideration should be given to the implications of the collection and use of data, and to residents' views in this regard. In particular, housebuilders should consider the data privacy and data ethics issues that emerge from collecting technology-enabled data (Ehwi et al. 2022).

Study participants identified a need for more robust systems and processes around user feedback to be linked into subsequent cycles of construction. Particularly, a clear system on how to collect customer feedback would be beneficial - not just for general, routinely collected feedback but possibly a roadmap for episodic customer enquiries which could provide valuable input into design and build changes grounded in resident views and experiences. Echoing this, participants were interested in gaining a greater understanding of how to engage with customers more effectively to collect their feedback. Building evidence that can drive relatively quick, tangible business benefits to housebuilders (e.g., higher built quality and reduced repairs) should be a primary focus of customer research in order to gain support across the industry by proving the efficiency and applicability of CX in housebuilding.

6. Recommendations

- POE and existing customer feedback require housebuilders to make a shift in terms of primary goals from the collection of customer satisfaction metrics towards gaining a better understanding of end-customer experience and focusing on developing a feedback loop from residents to inform design and construction decisions in the next construction cycles. Feeding post-occupancy data into home design and construction will bolster the twin aims of increasing resident satisfaction and improving building performance.
- To begin the transition to effective POE, work with end-customer experience needs to be driven by cross-functional teams involving customer-facing departments, design teams, development division and aftercare services, and, most importantly for MMC-based housebuilding, should involve MMC manufacturers. Evidence about the lived experience of residents will include quantitative and qualitative information and should be collected through a variety of user research methods in line with meeting business needs.
- Given the commitment of housing associations, as asset holders, to ensuring long-term resident satisfaction and the enduring quality of housing, longer-term systematic customer research is needed. This would also help generate an accumulated knowledge base on completed MMC-built homes for the industry, help to tackle residents' mistrust of prefabricated homes.
- Partnerships between housing associations pioneering MMC and other housebuilders (especially among affordable housing providers), MMC manufacturers and research organisations could support the transition towards customer-centred housing and development and share learning about deploying MMC-built homes. Collaboration initiatives across industry stakeholders and the MMC supply chain such as the Building Better group (NHF 2020) should be promoted in order to pursue transparency and data-sharing practices that can in turn help to understand end-customer needs and lived experiences.
- In order to generate the type of feedback and level of detail that can be used to inform decisions around the next construction cycle, questions asked of residents require comprehensive revision. Customer research should be designed to answer questions posed by innovation, design and development teams, and MMC manufacturers, and generate more information around residential comfort and the functionality and adequacy of space when compared to household needs and

preferences, as well as on the impact of homes on health and wellbeing. The data generated could also be used to demonstrate the social and environmental value of MMC-built homes. Effective POE and customer research can substantially enhance the use of MMC in housebuilding. Systematic evidence collection of its impact on residents' lived experience can play a vital role in demystifying MMC, building trust in the industry and wider society, and generating the demand needed for greater MMC uptake.

- There is a significant potential for digital technologies and data-driven solutions in expanding customer research in the housebuilding industry, and housing associations pioneering MMC could benefit the most from this in the future. Increased use of digital technology-enabled feedback could help design and build greater residential experiences. It should be acknowledged that homes of the future will be highly connected technologically, regardless of tenure type or household composition and, in light of this, homes built using MMC today need to be future-proof, with technology already embedded. Smart home solutions can help to better address users' needs remotely but they also provide useful social and environmental performance data.
- The expansion of customer research in housebuilding also needs to be accompanied by work on understanding user views around data collection and use, ethics, privacy issues and acceptability of different technological systems into their everyday living and, generally, gaining a better understanding about interaction of residents with their (future) smart homes.

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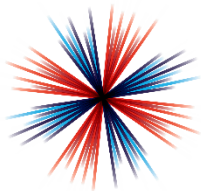
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