

## Research

# Modular momentum: assessing the efficacy of modular construction in alleviating the UK housing crisis

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## Abstract

This manuscript critically evaluates the potential of modular construction as a viable remedy to the ongoing housing crisis in the UK. In light of the escalating construction costs and the long-standing lack of productivity gains in the residential construction sector, there is in fact an urgent need to explore innovative solutions to address the scarcity of affordable housing. The study delves then into the feasibility and effectiveness of modular construction in providing cost-efficient and sustainable housing alternatives, particularly for the working-class population. Through a comprehensive analysis of construction trends and methodologies, and stakeholder perspectives, this research aims to illuminate the advantages and limitations of modular construction compared to traditional building techniques. Drawing upon data sourced from construction professionals, and government records, the study assesses crucial factors such as construction timelines, financial implications, design adaptability, and overall efficacy in tackling the housing crisis. The findings of this study are poised to offer valuable insights into the potential role of modular construction in transforming housing solutions in the UK. By examining the intersection of housing demand, construction practices, and technological advancements, the manuscript seeks to inform decision-making processes in both public and private sectors. Ultimately, the objective is to identify strategies that can facilitate the widespread adoption of modular construction as a sustainable and scalable solution to the housing crisis, in line also with the principles of the circular economy, thereby enhancing access to safe, affordable, and high-quality housing for all segments of society.

**Keywords** Modular construction · UK housing crisis · Affordable housing construction · Sustainable solutions

## 1 Introduction

The United Kingdom is grappling with an unprecedented housing crisis characterized by soaring property prices, stagnant supply, and a widening affordability gap, presenting formidable challenges for policymakers and citizens [31]. The demand for housing has surged due to population growth, urbanization trends, and evolving socio-economic landscapes [8, 9, 12, 43–45]. Despite efforts to boost housing supply, the discord between demand and availability persists, pushing homeownership and home occupancy further out of reach for many.

The staggering rise in residential construction costs in the UK has reached unsustainable levels, creating barriers to homeownership and widening social disparities [29]. The average property price continues its meteoric ascent, driven largely by land values rather than construction costs, far outpacing income growth rates and perpetuating the unattainability of homeownership for many. The relentless surge in property prices, driven by escalating land values, has priced out a significant portion of the population—particularly young adults and low-income households—leading

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to precarious living arrangements and, in some cases, homelessness [1]. This affordability crisis is often attributed to a chronic shortage of housing supply, driven by planning constraints, regulatory red tape, and construction inefficiencies. However, some experts, like Mulheirn [41], question whether increasing supply alone can effectively address the issue. While enhanced construction technologies can help mitigate construction costs, they cannot address the rising land values contributing to this crisis. This discord between housing demand and supply is then exacerbated by systemic inefficiencies and market dynamics [40].

In response to the urgent need for affordable housing solutions, this manuscript sets out to explore the transformative potential of modular construction in addressing the UK's housing crisis [51]. Modular construction, characterized by off-site fabrication of building components in controlled factory settings, offers a departure from traditional construction methods. Modular construction, with its standardized production processes, optimized logistics, and expedited project delivery, holds potential to revolutionize housing design and construction [51]. Research by Young et al. [57] highlights that modular construction can significantly reduce construction time and costs compared to conventional methods. Additionally, studies by Kamali and Hewage [39] demonstrate that modular construction promotes sustainability by minimizing waste generation and resource consumption during the building process. Furthermore, research conducted by Musa et al. [42] indicates that this method enhances the quality and durability of housing units through rigorous factory-controlled manufacturing processes.

Modular construction presents a promising approach to addressing some aspects of the UK's complex housing crisis [51]. While it can potentially speed up construction and reduce costs, it is important to recognize that no single innovation can fully resolve the multifaceted challenges, and market forces ultimately determine housing prices. While leveraging innovative manufacturing techniques, this method offers the potential for faster, more cost-effective, and sustainable housing delivery. However, it's important to consider why, despite its promise, this technology has struggled to gain traction so far. Past efforts to industrialize housing construction, such as the 'system built' council housing estates of the 1960s, ended in failure, and more recent attempts to promote modular housing over the last 10–15 years have seen only modest success, with significant setbacks including the closure of modular build factories [4].

In the context of escalating housing demands and environmental concerns, the exploration of modular construction's alignment with the circular economy then becomes not just pertinent but imperative for fostering sustainable urban development. This study seeks to evaluate the efficacy of modular construction in addressing key challenges facing the UK housing market, including affordability constraints, supply shortages, and construction bottlenecks. In employing a mixed-methods research design, this manuscript combines the qualitative insights gathered from construction professionals through a structured questionnaire with secondary data obtained from government sources and reputable databases to analyse trends in housing prices and demand.

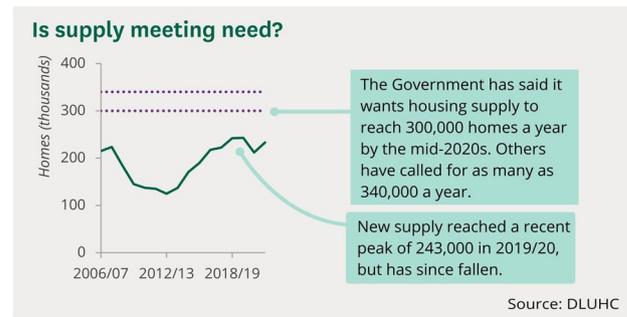
The implications of this research extend to policymakers, urban planners, developers, and construction professionals grappling with the complexities of the UK housing crisis [33]. By critically examining the potential of modular construction as a viable solution, this paper aims to make an original contribution to the literature by providing a balanced analysis of its advantages and limitations within the broader context of the UK housing crisis. It then aims to inform decision-making processes, foster innovation, and drive transformative change in the built environment sector. Moreover, by emphasizing affordability, sustainability, and inclusivity in housing provision, this research contributes to broader discussions on social equity and urban development.

## 2 Literature review

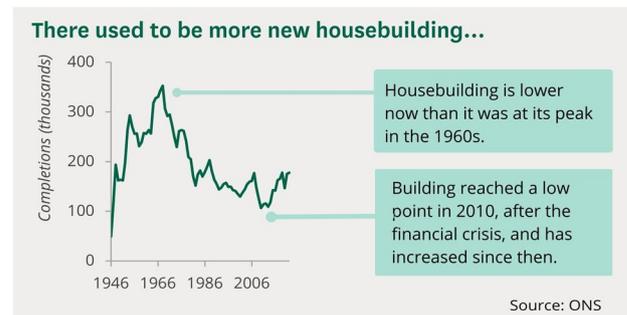
Exploring the intricate dynamics of housing market prices requires a multidimensional approach, encompassing economic, geographic, and policy perspectives. Theoretical frameworks in economics provide foundational insights into the mechanisms driving fluctuations in housing prices. Central to housing market price determination is the interplay between supply and demand. Glaeser et al. [28] highlight how imbalances between housing supply and demand influence price movements. When demand exceeds supply, prices often rise, while an oversupply can lead to price declines. However, this basic principle oversimplifies the complex dynamics of the housing market, where factors like land values, market speculation, and regulatory influences also play significant roles in shaping prices.

Geographic factors play another important role in shaping housing market prices. Malpezzi [40]; Adewale and Parisi [1] emphasizes the impact of location on housing values, with proximity to urban centres, amenities, and transportation hubs often correlating with higher prices. Accessibility to desirable locations drives demand, exerting upward pressure

**Fig. 1** Trends in housing production up to 2019—2020 and target goals for the future. Source: Wilson et al. [54]



**Fig. 2** History of property development. Source: Wilson et al. [54]



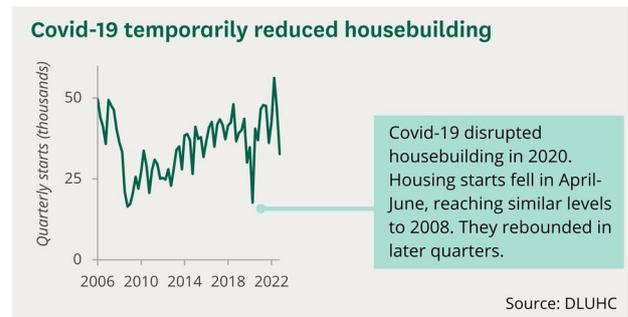
on prices in certain geographic areas. Understanding spatial variations in housing prices requires careful consideration of these geographic influences. Housing markets exhibit segmentation based on various factors, including property types and demographic characteristics. DiPasquale and Wheaton [18] suggest that different market segments may experience distinct price dynamics. Luxury housing markets, for example, may respond differently to market stimuli compared to affordable housing segments. Recognizing these segmentation realities is essential for analysing housing market prices comprehensively.

Urban economics theory then underscores the role of policy and urban planning in shaping housing market dynamics. Gyourko and Tracy [32] highlight the influence of zoning regulations, land use policies, and infrastructure investments on housing prices. Regulatory constraints and urban development patterns contribute to price differentials across neighbourhoods and regions. Evaluating the impact of policy interventions requires an understanding of these urban dynamics.

In this context, the insights provided by studies such as those by Donyavi, Flanagan, and Parisi [19], Donyavi et al. [20], and Donyavi, Parisi, and Flanagan [21] offer valuable perspectives on the operational challenges faced by Micro, Small, and Medium-sized Enterprises (MSMEs) in the construction sector. By understanding the complexities of materials procurement and optimizing resource allocation, MSMEs can enhance their efficiency and competitiveness, thereby contributing to the wider goal of addressing the housing crisis. Furthermore, the paradigm shift discussed by Donyavi, Parisi, and Flanagan [21] underscores the need for innovation and adaptation within the construction industry. As the manuscript explores the potential of modular construction to revolutionize housing delivery, it becomes imperative to consider how MSMEs can leverage emerging technologies and management strategies to capitalize on this momentum.

Shifting the focus on the United Kingdom, the housing crisis is not just a matter of inadequate supply; it represents a multifaceted challenge that demands innovative solutions to address the persistent gap between supply and demand. The demand for housing in the UK continues to grow steadily, driven by population growth, urbanization, and changing demographic trends [47]. Government research estimates an annual requirement of approximately 340,000 homes, with a significant portion needing to be affordable [50]. Despite various initiatives to increase housing supply, construction rates have consistently fallen short of meeting demand, exacerbated by factors such as the COVID-19 pandemic [47]. This persistent undersupply not only exacerbates affordability challenges but also underscores the urgent need for innovative and efficient housing solutions [24]. Historical trends in housing production (Figs. 1 and 2) reveal a chronic imbalance between demand and supply, highlighting the necessity of adopting novel approaches to effectively address the housing crisis. It is imperative that these solutions not only provide immediate relief but also contribute to long-term sustainability and resilience in the housing sector. Covid

**Fig. 3** Impact that Covid19 has had on the production of property. *Source: Wilson et al. [54]*



**Table 1** Comparative data on housing construction. *Sources: [2, 35, 17, 49]*

Metric	Traditional affordable housing	modular housing	Sources
£ per Square meter	£2,997.00	£2,307.46	[2, 35]
Typical construction time	6–12 months from start to finish	8–15 weeks of completion period	[17]
Energy efficiency	Standard	Up to 15% better	[49]

has had an impact on the property development and begun its increase, however now there is another decrease [54] (Fig. 3).

In this context, modular construction presents a promising technology with potential benefits in efficiency, sustainability, and scalability for addressing the UK’s housing needs [36]. By assembling building components in a controlled factory environment and transporting them to the construction site for assembly [52], modular construction can significantly reduce construction time and costs while minimizing environmental impact [3]. Modular construction presents various potential benefits such as time savings, enhanced safety, and reduced material waste [39]. Recent data from Hyams, A. [35] indicates that the average cost of traditional affordable housing in the UK has risen to approximately £2,997.00 per square meter, with projects frequently extending beyond 12 months [17]. In contrast, modular construction presents a transformative alternative by utilizing prefabricated components manufactured off-site and assembled on-site, with 8 to 15 weeks of completion period [17]. This approach can reduce overall project costs to approximately £2,307.46 per square meter [2] (Table 1).

While it aims to improve efficiency and productivity compared to traditional construction methods [52] and offers advantages in precision and quality control, it is crucial to critically assess these claims, as it is important to recognize that major efforts to promote modular construction over the past 10–15 years have yielded disappointing results, highlighting the need for a more nuanced approach. The method’s potential for minimizing on-site disruption and contributing to sustainability goals [30, 38] should be evaluated in the context of both its successes and limitations. Addressing the broader environmental and housing challenges requires a balanced examination of modular construction’s effectiveness and practical impact.

Exploring modular construction through the lens of the circular economy then sheds light on its capacity to tackle the UK’s housing challenges sustainably. As highlighted by Hossain et al. [34], integrating circular economy principles into construction can optimize resource utilization and minimize waste generation. Furthermore, insights from Gallego-Schmid, A. et al. [25] emphasize the transformative potential of circular strategies in mitigating environmental footprints while enhancing the resilience of the construction sector. There is also a strict link between this construction method and the Design and Build procurement method that integrates design and construction under a single contract, fostering collaboration and streamlining project delivery [26]. This method, as opposite to a sequential procurement approach favoured by the traditional construction and characterised by distinct phases of design and construction [48], is particularly compatible with modular construction, as it enables seamless coordination between design adjustments and construction processes. While this approach offers greater flexibility, allowing for design changes during the construction phase, it also presents challenges. Late-stage design changes can lead to additional expenses and project delays, disrupting the original timeline and budget [48]. Moreover, the design and build approach introduces complexities in contract management and risk allocation, requiring careful consideration to ensure successful project outcomes.

Despite its potential, modular construction in the UK has encountered challenges such as design flexibility and logistical constraints [51]. Standardized module dimensions and transportation limitations may restrict architectural creativity and customization [15], while coordination and logistical issues, particularly for large-scale projects, can complicate on-site assembly [6]. Although proponents highlight benefits like cost-effectiveness and reduced construction time, critics raise concerns about these limitations [14], including design constraints, transportation costs, and quality control issues [5]. Additionally, previous studies may have limitations related to sample size, methodology, or geographical scope, impacting the generalizability of their findings [56]. Understanding which of these factors has contributed to the relatively disappointing progress of modular construction in the UK's housebuilding industry since 2010 is crucial for informed decision-making and policy development.

The historical context of 'system built' council housing from the 1960s and 1970s provides valuable insights into the evolution of modular construction. The post-war push for system-built housing aimed to rapidly address housing shortages through prefabricated units. However, many of these projects are now regarded as failures due to issues with build quality, design inflexibility, and long-term durability, with significant maintenance problems and costly repairs. Modern modular construction, however, has evolved significantly from these early attempts. Advances in technology and materials have led to improved insulation, structural integrity, and design flexibility. Contemporary modular units now offer up to 15% better energy performance compared to traditional homes [49], and their quality control measures have reduced defect rates as well. Furthermore, the UK government has been proactive in supporting modular construction, with recent policy updates aimed at reducing regulatory barriers and promoting wider adoption through the Modular Housing Taskforce [11].

The J57 Mini City Skyscraper (Fig. 4) is a good example for its remarkable construction pace, with three floors erected each day. This project well exemplifies the efficiency and speed of modular building systems, showcasing their scalability and rapid deployment capabilities. Examining it provides valuable insights into the practical applications of modular construction methodologies [22] and their potential impact on contemporary construction practices. Central to its success is its extensive reliance on prefabrication techniques, with a staggering 95% of the structure fabricated off-site in controlled factory environments. This prefabrication-centric approach not only expedited construction timelines but also minimised disruptions to the urban landscape, thereby mitigating environmental impacts and enhancing overall sustainability [55].

The environmental benefits of modular construction are further accentuated by the project's reduced dependence on traditional building materials, notably, concrete. Architect Xian Min Zhang lauds the project for its significant reduction in concrete usage, equating to the elimination of 15,000 trucks' worth of material, thus demonstrating a firm commitment to resource efficiency and environmental stewardship [23]. Moreover, the swift completion of the *J57 Skyscraper*

**Fig. 4** J57 Mini City Skyscraper design. Photo: © BROAD Group via CTBUH [37]



underscores the economic advantages inherent in modular construction methodologies. By optimizing project timelines and minimizing labour costs associated with conventional construction methods, modular techniques offer compelling cost-saving opportunities for developers and investors, heralding a more financially sustainable approach to urban development [13]. The successful realization of the *J57 Mini City Skyscraper* underscores the transformative potential of modular construction in addressing contemporary urban challenges. By embracing innovative building methodologies such as prefabrication and modular assembly, projects of unprecedented scale and complexity can be executed with remarkable speed, efficiency, and sustainability, reshaping the future of urban development worldwide [27].

As cities worldwide grapple with the urgent need for affordable, resilient, and sustainable housing solutions, case studies like the *J57 Skyscraper* offer invaluable insights and inspiration for future development initiatives. By embracing modular construction principles and fostering collaborative innovation, the construction industry can chart a path towards a more equitable and resilient urban future, one skyscraper at a time [53]. The *J57 Mini City Skyscraper* project in Changsha, China, serves then as a beacon of hope and inspiration for addressing the UK's housing crisis through innovative construction methods. Its rapid completion, environmental consciousness, and cost-effectiveness showcase the potential for modular construction to revolutionize housing development strategies.

In adapting the lessons learned from the *J57 Mini City Skyscraper* to the UK, it is crucial to recognise the unique socio-economic and regulatory landscape. While the principles of rapid construction and sustainability are universal, nuances in local policies, market demands, and architectural preferences may require tailored approaches [10]. Drawing parallels to the UK, the lessons learned from the *J57 Mini City Skyscraper* case study offer significant applicability. The UK, facing its own housing crisis, can draw inspiration from the project's rapid construction pace, environmental considerations, and cost efficiencies. However, challenges such as design complexity and scalability must be addressed to fully harness the benefits of modular construction in the UK context [7]. Moreover, differences in regulatory frameworks, design preferences, and infrastructure may pose challenges to direct replication. For instance, although modular construction has made some inroads in the UK, significant challenges persist, such as adapting designs to diverse urban landscapes and scaling to meet varying demand. These issues require thorough evidence and detailed examination to accurately assess their impact on the effectiveness of modular construction in different contexts [46]. The theoretical analysis presented underscores the potential of modular construction as a solution to the UK's housing crisis. Drawing insights from the case study of the *J57 Mini City Skyscraper*, it becomes evident that modular construction offers a viable path towards rapid, sustainable, and cost-effective urban development. The advantages of modular construction—such as accelerated project timelines, reduced environmental impact, and cost savings—position it as a promising solution for the growing demand for affordable housing in urban areas. However, to understand why it has not yet achieved widespread adoption, it is essential to examine the barriers and challenges that have impeded its progress to date.

### 3 Methodology

This study employs a mixed-methods research design to comprehensively investigate the viability of modular construction as a solution to the UK housing crisis. It then encompasses both qualitative and quantitative approaches, allowing for a multifaceted exploration of the research questions [16].

The qualitative component of the research involves gathering insights from construction professionals through a structured questionnaire. The choice of construction professionals as respondents for the questionnaire was deliberate, aiming to gather diverse insights across the industry. By recruiting individuals for roles such as project managers, architects, engineers, and construction managers through a structured process involving targeted outreach, interviews, and selection criteria, the research ensures a comprehensive range of perspectives from across the industry. This approach is designed to capture diverse insights and experiences relevant to the study. Participants have been selected based on their expertise and involvement in projects utilizing modular construction methods, which ensures that the data collected is relevant and informed. However, it is important to note that their attitudes towards modular construction might not be entirely objective, particularly if the questions are designed to align with the paper's purpose of demonstrating rather than critically investigating the efficacy of modular methods. The questionnaire (Appendix 1) has been designed to elicit nuanced opinions and experiences regarding modular construction, focusing on key themes such as efficiency, affordability, and sustainability. The research approach is characterised by a purposive sampling strategy, targeting professionals with direct experience in construction and housing development projects. The qualitative data collection process will prioritise open-ended questions to allow participants to express their opinions freely and provide rich insights into their experiences. Qualitative data obtained from the questionnaire have then been subjected to thematic

analysis, wherein recurring themes and patterns will be identified and synthesized. Key themes related to the benefits, challenges, and perceptions of modular construction have been extracted from the responses. Ethical considerations are paramount throughout the research process, particularly concerning participant confidentiality, informed consent, and data privacy. Participants have been assured of anonymity and confidentiality, with data aggregation techniques employed to anonymize individual responses. Informed consent has been obtained from all participants, outlining the purpose of the study, voluntary nature of participation, and data handling procedures. Data storage and handling comply with relevant data protection regulations to ensure the security and integrity of research data.

In addition to qualitative data, this study as part of the literature review utilizes secondary data from government sources and reputable databases to analyse trends in construction costs and logistics.

## 4 Results and analysis

This paragraph embarks on a comprehensive journey into the realm of modular construction, wielding a mixed-methods approach to dissect its potential as a panacea for the UK housing crisis. Through a judicious blend of quantitative data analysis and qualitative insights gleaned from industry professionals, this study endeavours to unearth actionable insights to inform future housing policy and development initiatives. The qualitative data obtained through *Microsoft Forms* offers a snapshot of industry sentiment. The responses provide valuable insights that merit careful consideration in the broader context of the study.

To start with, as clear from Fig. 5, the responses to the question about how modular construction might impact the overall timeline reveal that opinions are relatively evenly split among the participants. Eleven people believe that modular construction can significantly reduce the timeline, another ten think it can minimize delays, and the remaining ten indicate that the impact might be variable depending on the project.

However, these perspectives must be considered alongside the significant regulatory hurdles that have consistently slowed the adoption of modular construction. Despite the potential for reduced timelines, the reality is that complex planning permissions and stringent building codes—often not adapted to modular methods—pose substantial barriers. These regulatory requirements demand extensive approvals, which can delay project initiation and execution, undermining the perceived time savings that modular construction might offer.

Moreover, design limitations and logistical challenges further complicate the process. Modular construction's reliance on standardized components can restrict architectural flexibility, making it difficult to adapt to diverse project needs. This limitation is particularly problematic in urban areas, where the transportation and assembly of modular units are often hindered by restricted access and high-density environments. These logistical hurdles can erode the timeline advantages that modular construction theoretically offers.

Market scepticism and high initial costs also contribute to the variability in impact on timelines. Concerns about the durability and long-term performance of modular buildings, compared to traditional methods, lead to hesitancy in adoption. Additionally, the substantial upfront investment required for modular construction—covering manufacturing facilities, technology, and training—can create financial barriers that slow down the process. Establishing a reliable supply chain for modular components is another challenge, with potential disruptions affecting both timelines and costs.

### 1. How might incorporating modular construction into a project impact the overall timeline?

[More Details](#)

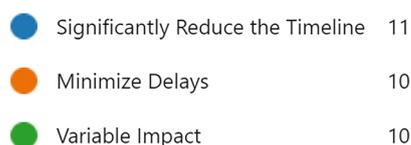


Fig. 5 Survey Response to question number 1. Source: Authors' elaboration, 2024

2. Can you offer a comparison of timelines between modular construction and traditional methods, maybe drawing from your own examples or experiences if you have any?

[More Details](#)

16  
Responses

Latest Responses

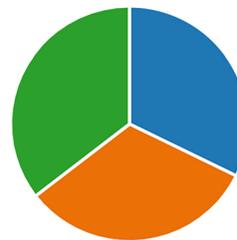
*"In the UK context it frequently yields shorter timelines than traditional meth..."*

**Fig. 6** Survey Response to question number 2. *Source:* Authors' elaboration, 2024

3. Based on your experience with projects of various sizes, how do you perceive the impact of modular construction on project costs?

[More Details](#)

<span style="color: blue;">●</span> Yes, Generally Lower Costs	10
<span style="color: orange;">●</span> Cost Savings Vary by Project	10
<span style="color: green;">●</span> Potential for Cost Savings, but N...	11



**Fig. 7** Survey response to question number 3. *Source:* Authors' elaboration, 2024

Cultural and institutional resistance within the construction industry further exacerbates these issues. Traditional construction practices are deeply ingrained, and shifting to modular methods requires overcoming significant resistance to change. This resistance, combined with the aforementioned regulatory, logistical, and financial barriers, explains why the adoption of modular construction remains slower than its potential benefits might suggest. Addressing these challenges is crucial to unlocking the full promise of modular construction in reducing project timelines and enhancing overall efficiency in the UK's housing sector.

When comparing timelines between modular construction and traditional methods then (Fig. 6), a spectrum of perspectives emerges, reflecting diverse experiences and observations. Some contributors emphasise the inherent efficiency of modular construction in expediting project timelines. They note that modular construction's concurrent onsite and offsite processes often lead to shorter overall durations compared to traditional methods, which may involve sequential steps. As one respondent puts it, "modular construction can significantly expedite projects through parallel assembly, potentially reducing completion times by up to 50%." Another adds, "it typically presents shorter timelines compared to traditional methods due to its streamlined assembly process and concurrent on-site work." On the other hand, some responses acknowledge the nuanced nature of project timelines, which can vary depending on factors such as project scope. One contributor highlights this variability, stating, "the time saved can vary." Similarly, others note that while modular construction has the potential to accelerate timelines, the extent of time savings may differ based on individual project requirements. Personal experiences further enrich the discussion, with anecdotes underscoring the accelerated timelines often associated with modular construction. For instance, one participant shares, "in my experience, it has often showcased accelerated timelines, with projects completed in months rather than years." Another adds, "drawing projects in the UK, modular construction has consistently showcased accelerated timelines in comparison to traditional methods, attributed to its efficient off-site fabrication and minimized on-site disruptions, leading to faster project completions." These insights collectively paint a nuanced picture of the comparison between modular construction and traditional methods, highlighting both the potential for time savings and the importance of considering project-specific factors.

Exploring the impact of modular construction on project costs (Fig. 7) unveils a range of perspectives stemming from diverse experiences. The responses to the question of whether modular construction tends to lower project costs reveal a nuanced understanding of the financial implications of this building method. The fact that respondents were almost

evenly split between "yes, generally lower costs," "cost savings vary by project," and "potential for cost savings, but not guaranteed" reflects the complexity of the economic dynamics at play.

Those who affirm that modular construction generally lowers costs likely see the benefits of off-site production, which can streamline labour, reduce waste, and minimize on-site delays. However, this optimism must be tempered by the reality of substantial regulatory hurdles that can erode these savings. Complex planning permissions, stringent building codes that do not always accommodate modular methods, and the need for extensive approvals can introduce significant delays and additional costs, thus diminishing the financial advantages of modular construction. These regulatory barriers often mean that the anticipated cost reductions are not as straightforward or as significant as proponents might suggest.

The respondents who believe that cost savings vary by project highlight an essential consideration: modular construction's financial benefits are not universal. They depend heavily on the specific circumstances of each project, including its size, location, and complexity. For example, while modular methods may reduce costs in more predictable, repetitive projects, they may be less effective in unique or highly customized builds. Furthermore, logistical challenges—particularly in urban environments—can complicate transportation and assembly, adding unexpected expenses that offset initial savings. These variable outcomes underscore the importance of careful project assessment before committing to modular construction as a cost-saving measure.

Finally, the group that views cost savings as potential but not guaranteed provides a critical perspective on the inherent uncertainties in modular construction. While there is potential for cost efficiency, it is not a given, particularly when factoring in the high initial investment required for modular infrastructure, such as manufacturing facilities, technology, and training. These upfront costs can be prohibitive and may not be recouped in the short term, particularly if projects face delays due to regulatory issues or supply chain disruptions. Additionally, market scepticism regarding the durability and quality of modular buildings can lead to resistance from clients and stakeholders, further complicating the financial equation.

Cultural and institutional resistance within the construction industry compounds these challenges. Traditional construction practices are deeply rooted, and the shift to modular methods is often met with scepticism and reluctance. This resistance can lead to a slower adoption rate, limiting the potential for widespread cost savings that modular construction might offer. Overcoming these barriers requires a concerted effort to address regulatory challenges, enhance industry collaboration, and invest in the necessary technology and training to support modular construction's growth.

While modular construction holds promise for reducing costs, then, the reality is far more complex. Regulatory hurdles, design limitations, logistical challenges, market scepticism, and institutional resistance all play significant roles in determining whether these cost savings can be realized in practice. To fully capitalize on the potential of modular construction, these barriers must be systematically addressed, requiring a multi-faceted approach that goes beyond the mere adoption of new building techniques.

When reflecting on the financial implications of adopting modular construction then (Fig. 8), insights gleaned from personal experiences shed light on the multifaceted nature of its impact on project costs. Several respondents highlight the cost-saving advantages associated with modular construction. For instance, one contributor points out, "its adoption contributed to decreasing costs by streamlining production processes, reducing labour expenses and minimizing material waste." Another adds, "it primarily decreases costs by reducing labour expenses and accelerating project timelines." These perspectives underscore the efficiency gains derived from modular techniques, particularly in terms of labour optimisation and streamlined material procurement. However, it is important to acknowledge the nuanced considerations that accompany these assertions. Some respondents caution against oversimplification, noting that the impact on costs can vary depending on factors such as project scale, design complexity, and local market

4. *Based on your personal experiences, could you explain how the adoption of modular construction either contributed to increasing or decreasing costs? Please provide details on any specific cost areas that were affected.*

[More Details](#)

15

Responses

Latest Responses

*"In the UK it usually cuts costs through streamlined labor, quicker project co..."*

**Fig. 8** Survey Response to question number 4. *Source:* Authors' elaboration, 2024

conditions. As one respondent articulates, "while it may decrease costs through faster construction timelines and reduced on-site labour, potential increases could arise from transportation expenses, customization requirements, and initial investment in modular infrastructure." Nevertheless, overarching themes emerge, emphasising the significant influence of modular construction on various cost areas. From accelerating project timelines to minimising waste and optimising labour efficiency, the adoption of modular techniques appears to offer substantial opportunities for cost reduction. This sentiment is echoed in responses highlighting the positive impact on expenditures related to construction labour, project management, and material utilisation. While acknowledging the potential for variability and contextual factors, then, the consensus among respondents suggests that modular construction often yields cost-saving benefits by enhancing efficiency across key aspects of construction projects.

As shown in Fig. 9, The responses to the question regarding the impact of modular construction on labour costs reveal a spectrum of perspectives, reflecting the varied and complex realities of the construction industry. The distribution of opinions—11 respondents citing a "Significant Reduction in Labor Costs," 7 noting a "Moderate Impact on Labor Costs," and 13 acknowledging a "Variable Impact Depending on Project"—underscores that the effect of modular construction on labour costs is not uniform across projects.

Those who believe that modular construction significantly reduces labour costs likely focus on the method's ability to streamline processes by shifting a substantial portion of work off-site. This off-site construction can reduce the need for on-site labour, lower the risk of delays due to weather or other on-site issues, and improve efficiency through the use of standardized, repetitive tasks that can be performed by a smaller, more specialized workforce. However, these potential labour savings are often complicated by regulatory hurdles, which can offset some of the advantages of modular construction. Complex planning permissions and stringent building codes that are not adapted to modular techniques can slow down projects and introduce additional labour costs related to compliance, inspections, and adjustments to meet regulatory standards.

Respondents who noted a moderate impact on labour costs likely recognize that while modular construction can indeed reduce the number of workers needed on-site, the overall cost savings may be mitigated by other factors. For instance, the initial setup of modular construction processes, including investment in specialized training for workers and the establishment of off-site manufacturing facilities, can require significant upfront costs. Moreover, the need for skilled labour to transport, assemble, and integrate modular units on-site still persists, particularly in complex urban environments where logistical challenges can drive up labour costs. These challenges are particularly pronounced in high-density areas where access is restricted, and the transportation of large modular units can be difficult and time-consuming.

The largest group of respondents, who reported a variable impact on labour costs depending on the project, highlight the importance of context in determining the effectiveness of modular construction. The variability in labour cost savings is influenced by factors such as the scale and complexity of the project, the geographical location, and the degree to which regulatory and logistical challenges are present. For example, in projects where design flexibility is limited, the benefits of modular construction might be reduced, leading to fewer savings on labour costs. Additionally, market scepticism regarding the quality and durability of modular buildings can result in higher labour costs due to increased inspections, quality assurance processes, and the need for additional customization to meet client demands.

Moreover, high initial costs associated with modular construction, such as investment in manufacturing facilities and training, can further diminish the expected labour savings. The establishment of a reliable supply chain for modular

##### 5. *What is your perspective on the impact of modular construction on labour costs in a project?*

[More Details](#)

- Significant Reduction in Labour ... 11
- Moderate Impact on Labour Co... 7
- Variable Impact Depending on P... 13

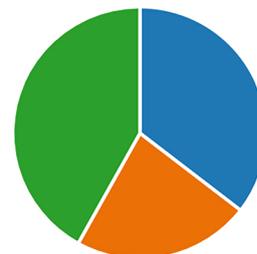


Fig. 9 Survey Response to question number 5. Source: Authors' elaboration, 2024

components is crucial, as disruptions in this chain can lead to delays that increase labour costs and complicate project timelines. The cultural and institutional resistance within the construction industry, where traditional methods are deeply entrenched, also plays a role in moderating the impact of modular construction on labour costs. Without widespread acceptance and adoption, the full potential of modular construction to reduce labour costs remains unrealized.

While modular construction offers the potential for significant labour cost reductions, then, the actual impact is highly dependent on a variety of factors, including regulatory challenges, project-specific characteristics, and the broader market context. To fully harness the potential of modular construction to lower labour costs, it is essential to address these barriers through targeted policy reforms, industry collaboration, and investment in the necessary infrastructure and training. Only by overcoming these challenges can the industry realize the full benefits of modular construction in terms of labour cost savings.

Delving then into the rationale behind perspectives on labour costs in modular construction (Fig. 10) reveals a diverse array of considerations, reflecting nuanced assessments of efficiency, skill demands, and other pertinent factors. Some contributors stress the importance of meticulous examination and project-specific analysis. As one respondent notes, "the potential cost savings depend on careful consideration of a lot of factors and project-specific circumstances." This sentiment underscores the need for a comprehensive understanding of the intricacies involved, suggesting that blanket assertions may oversimplify the complex landscape of labour costs in modular construction. Others highlight the potential for fluctuations in the workforce due to specific installation requirements. One contributor observes, "there might be an increase in the workforce due to specific tasks required during the installation days." This acknowledgment underscores the dynamic nature of labour demands within modular construction projects, where certain phases may necessitate additional manpower. However, there is a prevailing consensus that modular construction tends to minimise on-site labour requirements and demand less specialised skills. This perspective emphasises the efficiency gains derived from off-site fabrication and standardised assembly processes. As one respondent articulates, "this method minimises on-site labour requirements and demands less specialised skills." Such efficiency-driven considerations align with the overarching rationale of optimising outcomes by strategically balancing resource allocation and leveraging skillsets effectively. Moreover, contributors stress the importance of contextual factors and industry norms in shaping labour cost dynamics. As one respondent highlights, "it may vary depending on the specific context, as factors such as industry norms, organisational culture, and the unique challenges of a given situation could necessitate a nuanced approach towards efficiency, skill demands, and other considerations." This recognition underscores the need for adaptable strategies tailored to each unique context. In essence, while perspectives may vary, the overarching rationale hinges on a holistic evaluation encompassing efficiency, skill demands, and contextual variables. By carefully weighing these factors, stakeholders can navigate the complexities of labour costs in modular construction and strive for optimal outcomes tailored to specific project contexts.

When considering the impact of modular construction methods on the complexity of developing advanced design plans, a prevailing sentiment among respondents is affirmative, with 31 individuals asserting that indeed, the complexity does increase (Fig. 11). This collective agreement hints at the multifaceted challenges inherent in integrating modular techniques into the design process. Modular construction often requires meticulous planning and coordination to accommodate prefabricated components, standardised modules, and logistical considerations associated with off-site fabrication. As a result, design teams may face heightened complexity in ensuring seamless integration of modular elements within the overall architectural vision. Moreover, the need to adhere to specific modular construction standards and constraints can further compound the complexity of design planning. Ensuring compliance with modular assembly requirements, structural integrity, and transportation logistics adds layers of intricacy to the design process, necessitating close collaboration between architects, engineers, and modular construction specialists. However, it is

6. Kindly explain the rationale behind your perspective, taking into account factors like efficiency, skill demands, or any other pertinent considerations.

[More Details](#)

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Responses

Latest Responses

*"In the UK, my view balances efficiency, skill needs, and relevant factors, aimi..."*

Fig. 10 Survey Response to question number 6. Source: Authors' elaboration, 2024

7. Does the complexity of developing advanced design plans increase when utilizing modular construction methods?

[More Details](#)

<span style="color: blue;">●</span> Yes	31
<span style="color: orange;">●</span> No	0
<span style="color: green;">●</span> Maybe	0

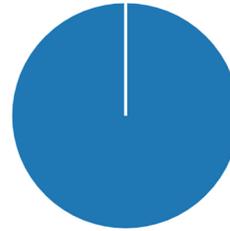


Fig. 11 Survey Response to question number 7. Source: Authors' elaboration, 2024

essential to recognise that while modular construction may introduce complexities, it also offers opportunities for innovation and efficiency. By leveraging parametric design tools, digital fabrication technologies, and modular design principles, designers can streamline the development of advanced design plans for modular projects. Furthermore, modular construction's potential to enhance construction speed and quality can outweigh the initial challenges posed by increased design complexity. In summary, while acknowledging the heightened complexity associated with developing advanced design plans for modular construction, it is crucial to view this challenge as an opportunity for creative problem-solving and collaboration. By embracing modular design principles and leveraging technological advancements, design teams can navigate complexities effectively and unlock the transformative potential of modular construction methods.

When considering the potential of modular construction for implementing intricate design concepts (Fig. 12), a spectrum of perspectives emerges from respondents' insights. Some contributors view modular construction as a promising avenue for innovative architectural endeavours. One respondent notes, "it offers a promising avenue for implementing intricate design concepts by leveraging its inherent efficiency and adaptability, allowing for greater creativity and precision." This perspective highlights the potential of modular techniques to facilitate the realisation of complex design visions through their adaptable framework and collaborative approach. However, others caution that complex designs pose challenges when employing modular construction methods. As one respondent observes, "complex designs pose challenges when employing this approach." These challenges may stem from the need to reconcile intricate design elements with modular assembly requirements and constraints, requiring careful consideration and planning from design teams. Despite these challenges, many respondents express optimism about the capacity of modular construction to efficiently realise complex design concepts. They view modular construction as a compelling avenue for seamlessly integrating intricate design elements, harnessing its adaptable nature and systematic methodologies to actualize cutting-edge architectural visions. One respondent aptly describes it as "a dynamic canvas for bringing intricate design visions to life, offering a fusion of efficiency and creativity." Moreover, within the UK context, respondents highlight modular construction as a transformative solution for addressing the demands of sustainable and affordable housing while meeting stringent regulations. They see it as poised to redefine the architectural landscape by efficiently executing complex design concepts and streamlining construction processes. While acknowledging the challenges, then, respondents overwhelmingly perceive modular construction as a progressively efficient approach for

8. On the other hand, do you perceive Modular Construction as a progressively efficient approach for implementing intricate design concepts? Please share your insights, particularly focusing on your experience with modular construction and its capacity for design.

[More Details](#)

17  
Responses

Latest Responses

"In the UK, it holds immense promise for efficiently bringing to life intricate d...

Fig. 12 Survey Response to question number 8. Source: Authors' elaboration, 2024

implementing intricate design concepts. They recognise its potential to revolutionize the architectural landscape, offering a dynamic canvas for creativity and innovation within the realm of construction.

When evaluating the efficiency of modular construction as a building method (Fig. 13), perspectives vary among respondents, yet a prevailing sentiment underscores its efficacy, particularly in the context of sustainability and streamlined processes. Several contributors highlight modular construction's capacity to enhance sustainability, emphasizing its ability to minimise waste and integrate sustainable materials and practices. As one respondent asserts, "undoubtedly, it stands as an efficient building method driven by its capacity to enhance sustainability." This viewpoint underscores the role of modular construction in fostering environmentally conscious building practices and reducing the industry's ecological footprint. Moreover, many respondents draw from personal experiences to affirm modular construction's efficiency in terms of project management and economics. They cite quicker project timelines, cost-effectiveness, and simplified project management as key advantages. One respondent succinctly summarizes, "based on my experience, a project employing modular construction tends to be quicker, more economical, and simpler to manage." These insights highlight the tangible benefits of modular construction in delivering efficient project outcomes. However, some respondents acknowledge that further advancements are necessary for the technology to progress, suggesting room for improvement in addressing certain challenges or limitations associated with modular construction methods. In the UK context, respondents emphasise modular construction's potential to address housing shortages and infrastructure demands while promoting efficiency and sustainability. They see it as a promising avenue for reshaping the construction landscape, offering a blend of efficiency, sustainability, and quality. One respondent noted, "in the UK, it emerges as a potent solution, synergising efficiency with sustainability, resilience with innovation, and project outcomes with a dynamic approach." In summary, while acknowledging the need for continued advancement, respondents overwhelmingly perceive modular construction as an efficient building method, particularly for its contributions to sustainability, streamlined processes, and project outcomes, both within the UK and globally.

## 5 Conclusions

The United Kingdom's housing crisis, characterized by soaring prices, a profound mismatch between supply and demand, and widening affordability gaps, remains one of the most pressing socio-economic challenges of our time. Despite the urgency, solutions have been elusive, prompting stakeholders to explore innovative strategies that could reshape the housing market and deliver sustainable outcomes for communities nationwide. Among these strategies, modular construction has emerged as a potentially transformative approach, promising to disrupt traditional building practices and offer a viable path toward alleviating the housing crisis. However, a deeper examination reveals that while modular construction holds significant promise, its practical implementation is fraught with challenges that may limit its impact if not carefully addressed.

Through qualitative analysis, this study provides a nuanced understanding of construction professionals' attitudes toward modular construction. A clear sense of optimism is evident, with many professionals highlighting its potential to accelerate project timelines, reduce costs, and enhance sustainability. Yet, this optimism is tempered by real concerns about the industry's readiness to fully embrace this methodology. While modular construction could indeed revolutionize the construction landscape, initial capital investments, coupled with perceived design inflexibilities, present significant barriers. These concerns point to a broader issue: the construction industry's conservative nature, which often resists radical shifts, especially when they involve substantial upfront costs and untested practices on a large scale.

9. *In your opinion, is modular construction an efficient method for building? Please offer succinct reasons for your perspective, taking into account factors such as sustainability, durability, and overall project outcomes.*

[More Details](#)

17  
Responses

Latest Responses

*"In the UK, it offers an efficient, sustainable solution to housing shortages an...*

Fig. 13 Survey Response to question number 9. Source: Authors' elaboration, 2024

The analysis also reveals that regulatory barriers pose a formidable challenge to the adoption of modular construction. Complex planning permissions and outdated building codes, which have not evolved to accommodate modular methods, introduce delays, and add layers of bureaucratic complexity. These regulatory hurdles not only slow the adoption of modular construction but also raise questions about the capacity of the current regulatory framework to support innovation in housing. The persistence of these barriers suggests a deeper systemic inertia within the regulatory bodies, which could stifle the very innovation needed to address the housing crisis. Thus, while modular construction offers a streamlined and efficient building process in theory, in practice, it often encounters a regulatory quagmire that diminishes its potential benefits.

Quantitative analysis further underscores the urgency of addressing the UK's housing affordability crisis. The study highlights the relentless upward trajectory of housing prices, driven by factors such as urbanization, population growth, and a constrained housing supply. Modular construction is posited as a solution that could scale efficiently to meet diverse housing demands. However, the practical challenges of implementing modular construction, particularly in urban areas, cannot be overlooked. The reliance on standardized components, while beneficial for efficiency, often clashes with the need for architectural flexibility, especially in diverse urban environments. Logistical challenges, such as transporting large modular units through congested urban areas, further complicate the process, undermining the theoretical advantages of modular construction.

Supplemental findings on modular construction highlight a critical paradox: while it is lauded for its time-saving and cost-reducing potential, the reality of its implementation reveals a more complex picture. Participants in the study acknowledged modular construction's capacity to reduce project timelines and costs. However, they also pointed to mixed outcomes concerning labour costs and the challenges of executing advanced design plans. The initial investments required to establish modular manufacturing facilities, coupled with the need for specialized training and technology, represent substantial financial barriers. Furthermore, establishing a reliable supply chain for modular components—an often-overlooked aspect—emerges as a critical challenge. Disruptions in this supply chain can have cascading effects, leading to cost overruns and project delays.

Market scepticism and cultural resistance within the construction industry add another layer of complexity. Despite the advantages of modular construction, there remains a deep-seated scepticism about the durability and long-term performance of modular buildings. This scepticism is not entirely unfounded, as the long-term viability of modular construction has yet to be proven on a wide scale in the UK. Moreover, the construction industry, traditionally conservative and risk-averse, exhibits significant resistance to change. The entrenchment of traditional building practices, combined with the challenges of retraining a workforce accustomed to conventional methods, means that the shift toward modular construction is likely to be slower and more contested than proponents might hope.

The lessons from the J57 Mini City Skyscraper, while instructive, underscore the need for a tailored approach when applying modular construction in the UK. The unique socio-economic and regulatory landscape of the UK presents challenges that require careful adaptation of the principles of modular construction. The rapid construction pace and sustainability achieved in the J57 project offer valuable insights, but direct replication in the UK context may be hindered by differences in regulatory frameworks, design preferences, and urban infrastructure. The UK's diverse urban landscapes and varying demand levels necessitate a more flexible approach to modular construction, one that can adapt to local conditions while still delivering on the promise of efficiency and sustainability.

In conclusion, while modular construction holds significant potential as a solution to the UK's housing crisis, its widespread adoption faces considerable challenges. Regulatory barriers, logistical constraints, design limitations, and market scepticism all contribute to a complex landscape that cannot be navigated with a one-size-fits-all approach. To unlock the full potential of modular construction, a concerted effort is required to address these challenges systematically. This involves not only policy reforms and regulatory adjustments but also a cultural shift within the construction industry, coupled with sustained investment in technology, infrastructure, and workforce development. Only by overcoming these multifaceted barriers can the UK fully realize the promise of modular construction as a transformative solution to its housing crisis.

## 5.1 Limitations of the study

In striving to illuminate the potential of modular construction in mitigating housing challenges, this study encounters several constraints that merit recognition. To start with, the study predominantly focuses on the UK housing crisis, potentially overlooking the complexities of housing issues in diverse global contexts. Future investigations should expand their purview to encompass a broader geographical range, ensuring the applicability of findings across varied settings.

The skewed composition of the sample toward specific professional backgrounds may introduce bias. To bolster the reliability of findings, future research endeavours should aim for larger, more diverse samples. Furthermore, the subjective nature of professional opinions captured in the questionnaire introduces variability and potential bias. Professionals specialising in modular construction may exhibit inherent positivity towards the method, therefore influencing their responses. Future studies should account for such biases to ensure the integrity of findings. Moreover, dependence solely on self-reported data from construction professionals carries the risk of response bias and subjective interpretations. Augmenting questionnaire data with alternative methods, such as interviews or observational studies, could offer a more comprehensive understanding of stakeholder perspectives.

The study's findings are contingent upon data collected within a specific timeframe, potentially disregarding long-term trends or market fluctuations. Continuous monitoring and periodic reassessment of housing dynamics are imperative to ensure the currency and accuracy of conclusions over time. The data collected on housing prices, while informative, suffers from potential inconsistencies, particularly in the earlier years. The lack of detailed information and transparency regarding data collection methods raises concerns about the reliability and accuracy of the dataset. Future research should prioritise robust data collection practices to bolster the credibility of findings. While this study provides valuable insights into the potential of modular construction, then, its findings must be interpreted with caution due to the aforementioned limitations. Acknowledging and addressing these constraints will be crucial in ensuring the validity and applicability of future research in this domain.

## 5.2 Recommendations for future studies

Building on the insights gained from this research, future studies in the field of modular construction and housing solutions should consider the following recommendations:

- Conduct longitudinal studies to track the evolution of modular construction practices and their impact on housing affordability and availability over time. Longitudinal data collection allows for the identification of trends, patterns, and emergent challenges in the adoption of modular construction methodologies.
- Expand comparative analyses to assess the performance of modular construction against alternative construction methods in terms of cost, time, sustainability, and quality. Comparative studies can offer valuable insights into the relative advantages and disadvantages of different approaches, informing evidence-based decision-making in the construction industry.
- Foster interdisciplinary collaborations between researchers, policymakers, industry professionals, and community stakeholders to address housing challenges from multiple perspectives. Interdisciplinary research frameworks enable holistic problem-solving approaches and facilitate the integration of diverse expertise and insights.
- Evaluate the effectiveness of existing policies and regulations in promoting the adoption of modular construction and addressing housing affordability issues. Policy evaluation studies can inform policy development and implementation strategies aimed at creating an enabling environment for sustainable and inclusive housing solutions.

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**Author contributions** LP played an instrumental role in conducting the primary research for this study, encompassing data collection, meticulous analysis, and thoughtful interpretation of findings. Her efforts ensured the comprehensive exploration of modular construction's efficacy in addressing the UK housing crisis. LP brought also invaluable expertise to the project, offering guidance and insights on the seamless integration of circular economy principles within the framework of modular construction practices. His contributions enriched the study's holistic approach to sustainability and resource optimisation. SD assumed a pivotal role in overseeing the final stages of the research process. With a keen eye for detail and a commitment to scholarly rigor, he meticulously reviewed the manuscript, provided critical feedback, and ensured adherence to high-quality standards. His supervision and guidance were integral to refining the manuscript for submission. Collectively, all authors engaged in robust discussions, shared insights, and collaborated closely throughout the research endeavour. Their combined efforts culminated in the production of a manuscript that reflects a comprehensive examination of modular construction's potential to address the UK housing crisis while embracing principles of sustainability.

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**Data availability** The data supporting the findings of this study are available within the manuscript. The qualitative data, comprising responses gathered from construction professionals through the structured questionnaire (provided in Appendix 1), have been thoroughly analyzed and integrated into the manuscript to offer insights into the benefits, challenges, and perceptions of modular construction. These qualitative

findings are presented alongside relevant discussion points to provide a comprehensive understanding of the research outcomes. Furthermore, the quantitative data utilized in this study, sourced from government databases and reputable sources, are referenced within the manuscript to analyze trends in housing prices, demand, and demographic factors. These datasets contribute to the contextualization of the housing crisis and the identification of patterns that inform potential solutions. While the aggregated results of the qualitative data are included in the manuscript, individual participant responses are not publicly available to maintain participant confidentiality and privacy. Ethical considerations regarding participant confidentiality, informed consent, and data privacy were carefully addressed throughout the research process. Measures such as anonymity assurances and data aggregation techniques were implemented to safeguard the identity of participants. For inquiries concerning access to specific datasets or further details regarding the data utilized in this study, interested parties are encouraged to contact the corresponding author. They will facilitate any requests for additional information or data access, ensuring transparency and accountability in the research process.

## Declarations

**Competing interests** The authors declare no competing interests.

## Appendix 1: Questionnaire

1. How might incorporating modular construction into a project impact the overall timeline?
2. Can you offer a comparison of timelines between modular construction and traditional methods, maybe drawing from your own examples or experiences if you have any?
3. Based on your experience with projects of various sizes, have you found that modular construction tends to lower project costs?
4. Based on your personal experiences, could you explain how the adoption of modular construction either contributed to increasing or decreasing costs? Please provide details on any specific cost areas that were affected.
5. What is your perspective on the impact of modular construction on labour costs in a project?
6. Kindly explain the rationale behind your perspective, taking into account factors like efficiency, skill demands, or any other pertinent considerations.
7. Does the complexity of developing advanced design plans increase when utilizing modular construction methods?
8. On the other hand, do you perceive Modular Construction as a progressively efficient approach for implementing intricate design concepts? Please share your insights, particularly focusing on your experience with modular construction and its capacity for design.
9. In your opinion, is modular construction an efficient method for building? Please offer succinct reasons for your perspective, taking into account factors such as sustainability, durability, and overall project outcomes.

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