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MODULAR CONSTRUCTION FOR SOCIAL HOUSING: A FEASIBILITY STUDY

RESEARCH PROPOSAL; RESEARCH PROJECT DESIGN. ACBA5024

This study explores the feasibility of modular construction for social housing in Pembrokeshire, Wales. It examines cost savings, time efficiency, and challenges like logistics and regulations. Using interviews and project data analysis, the research aims to provide actionable insights for policymakers and housing associations.

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1. ABSTRACT

There has been an increase in interest in modular construction to address the deficits in social housing supply in an efficient and economical manner. The primary focus of this research proposal is to determine the viability of implementing modular construction methods on social housing projects based in Pembrokeshire, Wales. This study will consider the potential advantages, which include lowered construction time and expenses, as well as the obstacles, such as logistical complications and quality assurance concerns. A convergent parallel approach (Edmonds & Kennedy, 2017) will be used, where qualitative interviews will be conducted with construction industry members, including those who work within housing associations and local councils, together with a quantitative evaluation of cost and time data from completed modular projects. This study responds to the significant gap identified in the literature by investigating the use of modular techniques in rural Wales. Findings comprise a thorough assessment of the practicality of utilizing modular construction, and possible conclusions to assist local authorities and housing associations in policy and decision-making.

2. INTRODUCTION

BACKGROUND OF THE STUDY

The demographic changes and issues surrounding housing affordability have forced an increase in the need for social housing in Pembrokeshire, which has significantly increased over the last few years (Priority 1 - Increase the Supply of Affordable Housing to Meet Local Needs, 2024). Traditional methods of construction are often unable to meet this demand due to their slow construction process, resulting in high costs and extended timelines. Modular construction could be a potential solution because it lowers the costs and time needed to assemble the structure on-site.

Modular construction broadly has two categories: volumetric modular construction and penalized modular construction. This involves constructing the entire structure of the building in a factory. It is then transported to the site and assembled. This method allows for rapid assembly and provides excellent quality control. However, it faces challenges such as accessibility and the high costs of transportation. Volumetric construction is where panels are made off-site; for example, walls, floors, and roofs are brought to the site for assembly. This method of construction provides greater design flexibility. Though it requires more skilled labour on-site, this method is both easier and cheaper to transport.

In my opinion, off-site modular construction could meet the social housing demands in Pembrokeshire in a timely manner while providing consistent quality control. Unlike traditional construction, where delays due to weather, labour shortages, and material availability are common, volumetric modular construction allows for site preparation and module fabrication in parallel, streamlining the process. However, implementing this method in Pembrokeshire does face some challenges, including logistical issues such as transporting large modules on narrow, single-lane roads and planning regulations that may not yet be fully adapted to modern modular techniques. Despite these obstacles, the efficiency and scalability of volumetric construction make it a compelling solution for social housing shortages. Therefore, this study will assess its feasibility in Pembrokeshire by analysing cost implications, regulatory barriers, and both stakeholder and local residents' perceptions to determine whether its benefits outweigh the challenges.

3. RESEARCH QUESTION

- **Proposed primary question:** How feasible is modular construction for addressing social housing shortages in Pembrokeshire, Wales?

4. AIMS / OBJECTIVES OF THE STUDY

OBJECTIVE 1: TO EVALUATE THE COST AND TIME EFFICIENCY OF MODULAR CONSTRUCTION FOR SOCIAL HOUSING.

Rationale:

Cost and time efficiency are two primary benefits often key terms used to represent modular construction. However, there is still very little evidence of this method concerning rural Wales, where the logistics of the region, workforce availability, and regulations may challenge the feasibility of a modular housing project.

How This Objective Will Be Achieved:

➤ **Cost Analysis:**

- Obtain cost breakdowns for modular and traditional housing case studies in Pembrokeshire and other rural regions of Wales (if possible).
- Include expenses related to design, manufacture, transportation, onsite assembly, infrastructural connections, and long-term maintenance work.
- Calculate costs on a unit basis and total project budgets to establish areas of projected savings or overspending.

➤ **Time Efficiency:**

- Measure the amount of time required to complete modular and traditional houses from initial planning to completion.
- Determine which tasks (e.g. design, manufacture, site work, assembly) are the most time conservative.
- Determine all the site-specific problems such as the movement of goods and personnel, adverse weather, and regulatory challenges that caused delays.

➤ **Benchmarking:**

- Measure against industry standards and past modular housing studies to find the level of efficiency achieved in rural Wales.

Expected Outcome:

- A clear comparison of the cost and time savings (or overruns) of modular versus traditional construction.
- Identification of specific cost drivers and areas where modular construction could be optimized to improve efficiency.

OBJECTIVE 2: TO IDENTIFY KEY CHALLENGES, INCLUDING LOGISTICAL, REGULATORY, AND QUALITY CONTROL ISSUES

Rationale:

Even though modular construction shows great promise, its use in rural areas presents its own set of challenges. The need to deliver prefabricated modules to remote locations, lack of skilled labour, unfavourable local weather conditions, and uncertainty regarding quality and durability in the longer term can all pose issues. Knowing these issues is important for the advancement of modular construction in rural Wales.

How This Objective Will Be Achieved:

➤ **Logistical Challenges:**

- Identify the transportation issues and infrastructural bottlenecks such as services to rural areas in Pembrokeshire.
- Analyse narrow roads, weight restrictions, and site accessibility in relation to module delivery to the site.
- Conduct interviews with construction managers and logistics companies to find out easy and common transport problems and methods of dealing with them (if possible).

➤ **Regulatory Challenges:**

- Analyse Welsh building regulations and policies on social housing to determine barriers of modular construction (e.g. planning permissions, design constraints, policies on land use).
- Interact with relevant local political organs to explain the approval procedure and if the organ has some bias against modular methods.
- Establish differences between requirements for the modular and conventional methods of construction in terms of fire safety, energy efficiency, and structural standards.

➤ **Quality Control:**

- Examine completed modular home projects to assess energy efficiency, material quality, and structural soundness.
- Ask housing managers and residents about any persistent maintenance problems or flaws. (if possible).

Expected Outcome:

- Examine the differences in quality standards between modular and conventional housing.
- Determination of the main logistical, legal, and quality assurance obstacles to modular building in rural Wales.
- Suggestions for raising quality standards, streamlining regulatory compliance, and optimising transportation logistics.

Objective 3: To gather perceptions of local authorities, contractors, and potential residents regarding modular housing

Rationale:

The success of modular housing projects depends on stakeholder approval. Even if modular construction is technically and economically feasible, local authorities, developers, and potential tenants must perceive it as a practical, appealing housing solution. Understanding stakeholder attitudes will help address any misconceptions and resistance that may be apparent with this modern method of construction.

How This Objective Will Be Achieved:

➤ **Stakeholder Interviews:**

- Conduct semi-structured interviews with key stakeholders, including:
 - Local authority officials are responsible for housing and planning.
 - Construction firms involved in modular and traditional housing projects.
 - Housing association managers.
- Explore their opinions on the benefits and drawbacks of modular construction.
- Determine issues with long-term value, tenant satisfaction, and project viability.

➤ **Resident Surveys:**

- Design and distribute structured questionnaires to existing tenants of both, modular housing and traditional housing, and potential social housing applicants.
- Measure opinions of:
 - Build quality and durability.
 - Comfort, noise insulation, and energy efficiency.
 - Design appeal and customization options.
 - Overall satisfaction compared to traditional housing.

➤ **Potential Use of Focus Groups:**

- Potentially organize focus group discussions with residents, housing association staff, and local policymakers.
- Explore common misconceptions, design preferences, and social attitudes toward modular housing.
- Investigate whether modular housing is viewed as a permanent or temporary solution.

Expected Outcome:

- A detailed understanding of how modular housing is perceived by different stakeholder groups.
- Identifying factors influencing stakeholder resistance or acceptance of modular housing.
- Recommendations for improving stakeholder engagement and increasing acceptance of modular housing.

5. LITERATURE REVIEW

REVIEW OF RELEVANT LITERATURE

The demand for social housing in Pembrokeshire has been rising due to demographic shifts, increasing housing costs, and economic challenges. According to the Welsh Government, there are approximately “**67,000 people** on social housing waiting lists in Wales” (Cymorth Cymru & Community Housing Cymru, n.d.), with a severe shortage of one-bedroom properties across Wales (*Exploring the Allocation of Social Housing in Wales: March 2024 to July 2024* | GOV.WALES, 2024). Traditional construction methods are struggling to meet this demand due to higher costs, longer build time, and planning constraints in conservation or areas of natural beauty.

1. Welsh Government Initiatives and Reports

Innovative Housing Programme, Year Two: Lessons Learnt (Summary)

This report outlines the Welsh Government's efforts to support innovation in housing development, focusing on construction techniques and delivery pathways. It provides insights into the challenges and successes of implementing modern methods of construction (MMC) in Wales (*Innovative Housing Programme, Year Two: Lessons Learnt* | GOV.WALES, 2025).

Social Housing Supply – Senedd Cymru | Welsh Parliament

This document discusses the need for a long-term plan to increase the proportion of social homes in Wales, highlighting opportunities and challenges within the current housing supply framework (Welsh Parliament et al., 2024).

Re-imagining Social House Building in Wales: A Modern Methods of Construction Strategy for Social Housing

This strategy outlines the Welsh Government's expectations for integrating Modern Methods of Construction (MMC) in social housing projects. It expresses the need for an innovative approach to meet housing demands efficiently (Welsh Government, 2020).

Modern Methods of Construction (MMC) of New Homes Framework (NH3)

This framework supports social housing providers in adopting MMC to address challenges related to sustainability and housing supply. It highlights the importance of environmentally fit construction methods (Consortium Procurement Construction, n.d.).

2. Modular Construction in Rural Contexts

How Modular Construction Improves Accessibility in Remote Areas

This article explores how modular structures address issues of remote accessibility and limited infrastructure in rural projects, emphasizing the benefits of off-site manufacturing (*How Modular Construction Improves Accessibility in Remote Areas - Pressmach*, n.d.)

Benefits of Modular Construction in Remote Areas – Mechfab

This piece highlights the advantages of modular construction in remote locations, including faster project completion and cost-effectiveness, which are pertinent to rural Wales (Mechfab, 2024)

3. Challenges and Opportunities in Modular Construction

Volumetric Modular Construction Research – GOV.UK

This research investigates potential risks to safety and performance posed by volumetric construction and identifies options for mitigating those risks, offering lessons applicable to the Welsh context (*Volumetric Modular Construction Research*, 2024).

4. Case Studies and Practical Implementations

- **Ty Unnos – Feasibility Report**

This report examines the feasibility of producing low-cost social housing using homegrown softwood in Wales (Coed Cymru et al., 2015).

- **Welsh Minister Calls for Modular Homes to Boost Social Housing**

This article discusses the advocacy for factory-made modular housing to expedite the construction of high-quality social and affordable homes across Wales, reflecting governmental support for such initiatives (The Planner, 2022).

5. International Perspectives

- **Increasing Affordable Housing Stock Through Modular Building**

This article outlines the benefits of modular building, including cost savings and environmental advantages, offering perspectives that can be adapted to the Welsh context (Bonitatibus, 2024).

6. Collaborative Initiatives

- **Standardised Modular Housing Pattern Book by Welsh Social Landlords**

A collaboration among 23 Welsh social landlords resulted in a modular housing pattern book featuring layouts for various house types, including accessible designs. This initiative aims to streamline design processes and ensure quality standards (Built Offsite, 2025).

7. Case Studies and Practical Implementations

- **Crofts Street Modular Housing Project, Cardiff**

This project comprises nine two-bedroom council houses designed to be carbon-positive. It serves as an example of sustainable modular construction on brownfield land (Rshp, n.d.).

- **Ffordd-y-Rhaffau Development**

Located on a former gasworks site, this innovative development provides temporary modular accommodation to 154 families, showcasing the potential of modular solutions in addressing urgent housing needs (Construction, 2024).

8. Industry Perspectives

- **Challenges and Recommendations for MMC in Wales**

This report discusses the evolving narrative around MMC in Wales, highlighting challenges and providing recommendations to unlock productivity and achieve better outcomes in the construction sector (CEWales, n.d.).

9. Policy Developments

- **Affordable Homes Taskforce**

The Welsh Government's forthcoming Affordable Homes Taskforce aims to boost modular

housing delivery, reflecting a strategic commitment to modern construction methods in addressing housing shortages (*Welsh Government Aims to Boost Modular With Affordable Homes Taskforce*, n.d.).

6. IDENTIFICATION OF GAPS IN CURRENT RESEARCH

1. Environmental and Sustainability Performance in Rural Contexts

The sustainability benefits of modular construction such as less waste and better energy efficiency have been studied in urban environments, but there is little research on whether this holds up at all for rural Wales. Since we have not done any comprehensive life-cycle assessments for modular housing in a rural environment; For example, the impact on the environment of transporting pre-fabricated units is considered over long distances, no figures are available.

2. Long-Term Performance and Maintenance of Modular Housing

As yet, there is no comprehensive research concerning long-term structural integrity or maintenance requirements of modular homes in rural areas such as those around Wales that are constantly wet and cold, and where houses are exposed to breezes coming off land or sea. However, there is lack of study on thermal efficiency during long-term occupancy for modular homes in rural areas compared with conventional houses.

3. Social and Cultural Acceptance

As already mentioned, there has been virtually no research into how rural people in Wales see prefabricated housing. The perceived view of modular housing may be viewed as a "temporary" or "second class" solution as against traditionally built homes in rural areas. There is a need for more testimony on how modular housing affects community identity and social cohesion in rural Wales.

4. Economic and Financial Viability

The evidence on the economic viability of modular construction in rural Wales is minimal, and savings from standardisation and factory production may be substantially reduced by transportation costs and installation. There is hard data on the correlation between the cost reductions in the construction phase, and the cost on the end user(client).

5. Supply Chain and Skills Shortage

In reference to the supply chain for building materials and components in modular construction, the lack of manufacturing of modular structures in Wales may cause logistical and cost implications and would need to be further analysed. Also unknown is what proportion of the workforce in rural areas can acquire the necessary skills and training for off-site construction and whether this offers an opportunity to develop the local workforce's skill set.

6. Tenant Satisfaction and Lived Experience

So far little study has been done on the conditions that residents in modular social dwellings actually live under in terms of comfort, noise insulation, privacy, and flexibility. There is no feedback from tenants regarding modular construction itself, the impact on their life quality and whether it affords them a sense of security, this would be solved by contacting schemes of modular construction to request data from surveys on their residents.

7. Resilience to Climate Change and Extreme Weather

Again, there has been relatively little research yet, into how modular housing in rural Wales withstands heavy rainstorms or strong winds. As well as if materials need to be changed to suit the local climate. Nor is it known whether and how flexible forms of modular construction can be adapted in flood-prone, high-risk areas.

8. Policy and Regulatory Barriers

The planning policy and building structures in Pembrokeshire require a detailed investigation into how this is related to modular projects. There are no studies on the land acquisition procedures in rural Wales and whether the current land-use policies facilitate or obstruct the adoption of modular housing.

7. HOW YOUR RESEARCH WILL ADDRESS THESE GAPS

1. Environmental and Sustainability Performance in Rural Contexts

How the Research Will Address It:

- Conduct life-cycle assessments (LCAs) (Department for International Development, 2015) of modular construction projects in rural Wales to measure environmental impact, including transportation, installation, and operational performance.
- Compare the energy efficiency and carbon footprint of modular homes versus traditional homes in similar rural environments (Admin, 2023)
- Include qualitative data from tenants and construction professionals on perceived and actual sustainability benefits.

2. Long-Term Performance and Maintenance of Modular Housing

How the Research Will Address It:

- Collect performance data from existing modular housing developments in rural Wales (e.g., heating costs, structural issues, maintenance frequency) (Cole & Make UK, n.d.).
- Interview residents and housing association managers to assess the maintenance challenges and long-term durability of modular housing.
- Compare maintenance costs and lifespan expectations between modular and traditional housing.

3. Social and Cultural Acceptance

How the Research Will Address It:

- Conduct stakeholder interviews with local residents, community leaders, and policymakers to explore perceptions and cultural acceptance of modular housing.

- Use surveys to measure levels of acceptance and identify specific concerns or misconceptions about modular construction.
- Analyse how the design, layout, and aesthetic of modular housing could be adapted to align with local architectural traditions and cultural preferences.

4. Economic and Financial Viability

How the Research Will Address It:

- Perform a cost-benefit analysis comparing modular and traditional construction methods for rural social housing projects.
- Assess how transportation costs and installation challenges affect the overall financial practicality of modular housing in rural Wales.
- Explore potential funding and government incentives that could improve the economic viability of these modular projects.

5. Supply Chain and Skills Shortage

How the Research Will Address It:

- Identify the main gaps in the modular supply chain in Wales through interviews with suppliers and construction firms.
- Assess the availability of skilled labour and training programs specific to modular construction.
- Look to develop recommended strategies to develop local supply chains and upskill the workforce to support these projects.

6. Tenant Satisfaction and Lived Experience

How the Research Will Address It:

- Conduct nonbiased structured surveys and interviews with tenants of social housing to evaluate satisfaction with comfort, privacy, and overall living experience.
- Compare tenant feedback from modular and traditional housing to identify strengths and weaknesses in modular designs.
- Look to recommend improvements in modular housing design to better meet tenant needs and enhance long-term satisfaction.

7. Resilience to Climate Change and Extreme Weather

How the Research Will Address It:

- Evaluate the structural resilience of existing modular housing in Wales through engineering reports and existing data (if available). (Hayles & Royal Commission on the Ancient and Historical Monuments of Wales, 2022)
- Analyse the impact of local weather conditions on modular housing performance and maintenance needs.
- Look to recommend design improvements to improve resilience, such as enhanced insulation, flood-proof foundations, and storm-resistant materials.

8. Policy and Regulatory Barriers

How the Research Will Address It:

- Analyse current planning regulations and building codes affecting modular construction in Wales as a whole (Thurairajah et al., 2023).
- Interview local authorities and policymakers to identify specific regulatory barriers.
- Develop policy recommendations to streamline the approval process for modular housing projects and encourage investment and the continuation of development.

8. RESEARCH DESIGN AND METHODOLOGY

Research Design and Methodology

A mixed-methods approach will be used to collect both qualitative and quantitative data. Relying solely on qualitative data would be too time-consuming to analyse within the time constraints of the study. A survey-based approach is the most appropriate method, as it allows the collection of opinions from a broad range of stakeholders while ensuring the data can be processed and analysed effectively within the given timeframe. A questionnaire will be used as the primary data collection tool to gather sufficient data for this research (Naoum, 1998).

Research Approach

A survey is considered the most efficient method for this study due to the need to gather data from multiple stakeholder groups, including local authorities, construction professionals, housing associations, and existing and potential tenants. Conducting one-on-one interviews with enough participants would not be feasible given the time limitations. Therefore, a structured questionnaire will be distributed to collect both qualitative and quantitative data.

Data Collection Methods

- **Questionnaire Design:**
The questionnaire will consist primarily of closed-ended questions to streamline data analysis and ensure consistency in the responses. Respondents will be asked to rate their answers using a scale to quantify their perceptions of modular housing's cost, quality, and feasibility.
 - Both positive and negative statements will be included to reduce the likelihood of response bias.

- The questionnaire will not disclose the full research title to avoid influencing the responses, and only the general topic area will be mentioned.
- **Testing and Refinement:**
The questionnaire will be tested on a small sample of participants to ensure clarity and relevance. Feedback from the test phase will be used to revise and improve the final version before distributing all the questionnaires.
- **Distribution and Collection:**
The questionnaires will be distributed via email or post, depending on the preference of the participants. To increase the response rate, a follow-up plan will be implemented, including email reminders and direct collection of responses where possible.

Sampling Methods

A combination of **purposive** and **random sampling** will be used:

- **Purposive Sampling:** Key stakeholders such as housing association managers, local policymakers, and construction professionals will be targeted to gather insights into regulatory and logistical challenges.
- **Random Sampling:** Residents and potential social housing applicants will be selected to ensure a diverse range of perspectives regarding the quality and acceptability of modular housing. Approximately 30–40 questionnaires will be distributed to ensure a robust dataset for analysis.

Data Analysis Plan

- **Quantitative Analysis:**
Data from the closed-ended questions will be statistically analysed using SPSS to identify patterns and correlations, using tests such as the T-test, Anova, and Chi-Squared, in stakeholder perceptions, cost efficiency, and time savings.
- **Qualitative Analysis:**
Open-ended responses and interview data will be subjected to thematic analysis using NVivo to identify key themes and stakeholder attitudes toward modular construction (Philip Adu, Ph.D, 2023).

9. ETHICAL CONSIDERATIONS

All participants will be informed about the purpose of the research and their right to withdraw at any time without consequence. The questionnaires will be coded, to protect the identity of respondents. A cover letter will assure participants of their anonymity and how their data will be used so to not breach GDPR. Finally, the findings and conclusions will be shared with participants and relevant stakeholders to promote accountability and trust if requested.

10. TIMELINE

Task	Duration
Literature Review	1 Month
Designing Surveys and Interview Guides	2 Weeks
Data Collection	2 Months
Data Analysis	1 Month
Drafting the Report	1 Month
Review and Revisions	2 Weeks
Total Duration	6 Months

11. EXPECTED OUTCOMES

- **Cost Analysis:** Modular construction is expected to show a reduction in costs by 15–20%.
- **Time Savings:** Potential reduction of project timelines by up to 40%.
- **Housing Shortage:** A reduction in housing waiting times will be reduced by 20% (within Pembrokeshire)
- **Challenges:** Logistical challenges in transporting modules in rural areas and resistance from residents and stakeholders.
- **Recommendations:** Policy suggestions for improving the feasibility of modular housing in rural contexts.

12. REFERENCES

- Admin, 2023. *How volumetric modular can cut carbon emissions in 2023* | Tide [online]. Tide. Available from: <https://tideconstruction.co.uk/latest-news/volumetric-construction-is-fast-safe-and-precise/>.
- Anon., 2024a. *Priority 1 - Increase the Supply of Affordable Housing to Meet Local Needs* [online]. Available from: <https://www.pembrokeshire.gov.uk/housing-strategy/priority-1-increase-the-supply-of-affordable-housing-to-meet-local-needs>.
- Anon. 2024b. *Exploring the allocation of social housing in Wales: March 2024 to July 2024* | GOV.WALES [online]. GOV.WALES. Available from: <https://www.gov.wales/exploring-allocation-social-housing-wales-march-2024-july-2024>.
- Anon. 2024d. *Volumetric Modular Construction research* [online]. GOV.UK. Available from: <https://www.gov.uk/government/publications/volumetric-modular-construction-research/volumetric-modular-construction-research>.
- Anon. 2025a. *Innovative Housing Programme, year two: lessons learnt* | GOV.WALES [online]. GOV.WALES. Available from: <https://www.gov.wales/innovative-housing-programme-year-two-lessons-learnt>.
- Anon. 2025b. *Innovative Housing Programme, year two: lessons learnt* | GOV.WALES [online]. GOV.WALES. Available from: <https://www.gov.wales/innovative-housing-programme-year-two-lessons-learnt>.
- Anon. n.d. *How Modular Construction Improves Accessibility in Remote Areas - Pressmach* [online]. Available from: <https://www.pressmach.com/blog/how-modular-construction-improves-accessibility-in-remote-areas>.
- Anon. n.d. *Welsh government aims to boost modular with Affordable Homes Taskforce* [online]. Social Housing. Available from: https://www.socialhousing.co.uk/news/welsh-government-aims-to-boost-modular-with-affordable-homes-taskforce-88857?utm_source=chatgpt.com.
- Bonitatibus, S., 2024. Increasing Affordable Housing Stock Through Modular Building. *Center for American Progress* [online], February 15, 2024. Available from: <https://www.americanprogress.org/article/increasing-affordable-housing-stock-through-modular-building/>.
- Built Offsite, 2025. *23 Welsh social landlords collaborate on standardised modular housing pattern book* | Built Offsite [online]. Built Offsite. Available from: https://builtoffsite.com.au/news/23-welsh-social-landlords-collaborate-on-standardised-modular-housing-pattern-book/?utm_source=chatgpt.com.
- CEWales, n.d. *Modern Methods of Construction Challenges and Recommendations from Sector Insight* [online]. Available from: https://www.cewales.org.uk/files/5517/2622/7370/MMC_Final.pdf.
- Coed Cymru, Davies Sutton Architects, Penhevad Studios, and Mann Williams, 2015. *Extending the Adaptability of Ty Unnos Technical Feasibility Study* [online]. Available from: <https://www.tyunnos.co.uk/wp-content/uploads/2016/03/160125-Feasibility-Report-Final-Low-Res.pdf>.
- Cole, S. and Make UK, n.d. *Greener, Better, faster* [online]. Make UK. Available from: https://chcymru.org.uk/cms-assets/documents/Spotlight-Session_Benefits-and-challenges-of-modular-housing_21-March-2022.pdf.

- Consortium Procurement Construction, n.d. *NH3 Modern Methods of Construction (MMC) of New Homes* [online]. NH3 Framework Guide. Available from: https://www.cpconstruction.org.uk/media/oqzhfxur/cpc_nh3_frameworkguide_v3.pdf.
- Cymorth Cymru and Community Housing Cymru, n.d. *Housing Matters* [online]. Housing Matters. Available from: <https://chcymru.org.uk/cms-assets/documents/Housing-Matters-Budget-2022-23-ENG.pdf>.
- Department for International Development, 2015. *A Newcomer's Guide to Life Cycle Assessment - Baselines and Boundaries* [online]. GOV.UK. Available from: <https://www.gov.uk/research-for-development-outputs/a-newcomer-s-guide-to-life-cycle-assessment-baselines-and-boundaries#citation>.
- Edmonds, W. A. and Kennedy, T. D., 2017. *An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods* [online]. Available from: <https://methods.sagepub.com/book/mono/an-applied-guide-to-research-designs-2e/chpt/convergentparallel-approach>.
- Hayles, C. and Royal Commission on the Ancient and Historical Monuments of Wales, 2022. *How resilient are buildings in the UK and Wales to the challenges associated with a changing climate? Practical recommendations for risk-based adaptation* [online]. Welsh Government. Available from: <https://www.gov.wales/sites/default/files/publications/2023-10/resilience-of-buildings-to-challenges-associated-with-climate-change.pdf>.
- Mechfab, 2024. Benefits of Modular Construction in Remote Areas. *Mechfab* [online]. Available from: <https://mechfab.org/benefits-of-using-modular-construction-in-remote-areas/>.
- Philip Adu, Ph. D, 2023. From Survey to Insight: A NVivo Tutorial on Analyzing Open-Ended Responses. *YouTube* [online]. Available from: <https://www.youtube.com/watch?v=ttiimES8-10>.
- The Planner, 2022. *Welsh minister calls for modular homes to boost social housing* [online]. The Planner. Available from: <https://www.theplanner.co.uk/2020/02/27/welsh-minister-calls-modular-homes-boost-social-housing>.
- Thurairajah, N., Rathnasinghe, A., Ali, M., and Shashwat, 2023. *Unexpected Challenges in the Modular Construction Implementation: Are UK Contractors Ready?* [online]. Sustainability. Available from: https://researchportal.northumbria.ac.uk/ws/portalfiles/portal/99298536/sustainability_15_08105_v2.pdf.
- Welsh Government, 2020. *Re-imagining social house building in Wales: A Modern Methods of Construction Strategy for Social Housing* [online]. Available from: https://www.gov.wales/sites/default/files/publications/2020-02/social-house-building-strategy_0.pdf.
- Welsh Parliament, Griffiths, J., Waters, L., Gwenllian, S., Evans, J., Hussain, A., Griffiths, L., Murphy, S., Fletcher, L., Gwynfor, M. A., Thomas, C. and Blythyn, H., 2024. *Social Housing Supply* [online]. Local Government and Housing Committee. report. Available from: <https://senedd.wales/media/xxndldwa/cr-ld16800-e.pdf>.

