Regulatory barriers associated with prefabricated and modular construction

Final Report

October 2022

Preface and acknowledgement

Swinburne University of Technology (SUT) has undertaken this research and development work investigating regulatory barriers for off-site construction focusing on prefabricated and modular buildings.

The project is commissioned by the Housing Industry Association (HIA) on behalf of the Advanced Manufacturing Growth Centre's Prefab Innovation Hub. HIA is the project sponsor. This work forms part of a series of projects being supported by the Advanced Manufacturing Growth Centre (AMGC) Prefab Innovation Hub.

The project aims to develop a report that identifies and analyses the regulatory barriers for off-site construction. The project is conducted in two phases.

The first phase involved developing a Briefing Paper to provide background information and key issues identified by the project team. This was shared with stakeholders which were consulted to provide their opinions and experience.

The second phase of the project involved reviewing and examining the findings from the consultation, including an industry survey, and literature on overseas arrangements to identify regulatory barriers across the spectrum of the construction process. From these recommendations for further work and/or responses to the identified regulatory barriers have been developed.

An interim report was prepared and circulated to stakeholders outlining themes and suggested responses with further work and consultation done to complete this Final Report.

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Executive summary

This project focused on the regulatory barriers that prevent greater take-up of prefabricated (prefab) and modular construction. It sought to identify those barriers in the Australian context and made recommendations to overcome them.

The project has been initiated by Housing Industry Association (HIA) and carried out by Swinburne University of Technology (SUT). It is part of a series of projects supported by the Advanced Manufacturing Growth Centre (AMGC) Prefab Innovation Hub which commenced in 2019 to support Australia's manufacturing and building and construction industry harness the potential benefits of prefabrication.

The investigation included review of overseas practice, including countries where prefabricated and modular construction has gained greater momentum such as Japan and Sweden and countries where this form of construction is developing, including Canada, Singapore, United Kingdom, United States of America and New Zealand.

Consultation with various stakeholders were undertaken in the form of online surveys and written submissions, one-on-one/group interviews and meetings to gain a better understanding of the Australian practice and the challenges that are faced by the industry.

The general finding was that regulatory ambiguities for prefab and modular construction cause uncertainties for all involved parties that in turn prevent greater take-up of this form of construction.

The quality of the off-site construction products needs to be assured since on-site inspection can be challenging or unable to be fully verified in-situ for complex prefab and modular units. Certification of the factory outputs can be a means to increase the confidence of all practitioners.

But even before a project can start, there are barriers in the design rules, approvals processes and financing arrangements, particularly for housing, that can make the use of prefabrication more difficult, if not impossible.

These barriers are clearly impeding the productivity benefits that industry and governments understand and expect to flow from the prefabricated building sector.

This project finds that there are several initiatives governments can take to assist the industry and these are listed in the Recommendations.

Some of the technical recommendations can be addressed via a new section in the National Construction Code (NCC), or a separate protocol or standards published that could be recognised by the NCC, to clarify many ambiguities in the technical construction requirements, when compared to on-site construction methods.

The Recommendations outline the regulatory steps that could be taken to address these barriers and support the prefabricated building and construction sector meeting the expectations of the industry, governments and consumers.

Recommendations for planning system reform

Recommendation 1: That planning requirements for prefabrication and modular housing be:

(a) amended to use standardised terms for off-site constructed buildings (e.g., manufactured home, movable home, relocatable home, kit homes, manufactured home estate) and align with associated terms to be incorporated into the NCC and state and territory building regulations;

(b) amended to explicitly recognise prefabrication, modular and tiny homes as acceptable forms of housing;

(c) planning or housing codes apply excessive design requirements for modular and prefabricated homes and changes be identified that can better align these codes with lightweight construction and smaller housing designs; and

(d) that a definition of a 'tiny house on wheels parking space' be established and that local governments amend local planning scheme requirements to permit such parking spaces on any land where residential buildings are permitted.

Recommendations for building and construction

Recommendation 2: That prefabrication and modular construction be explicitly recognised as regulatory acceptable construction practice and a standardisation of relevant terms and definitions be established for use in Australian building codes, standards or technical requirements.

Recommendation 3: That the Australian Building Codes Board (ABCB) establish a project to identify ways to provide prescriptive and performance requirements into the National Construction Code (NCC) to support the orderly use and approval of prefabrication and modular construction, especially for Class 1 buildings.

Recommendation 4: That Standards Australia develop a work program to:

(a) review and modify the relevant construction standards, particularly NCC referenced standards, for their adequacy to address prefabricated and modular construction; and

(b) develop a new suite of Australian Standards specifically for prefabricated and modular construction to provide industry with a set of deemed to satisfy (DTS) construction solutions.

Recommendation 5: That the current Australian product conformity infrastructure be reviewed for its ability to cope with new prefab and modular products that need testing, individually and as a whole, as the basis for their acceptance in building approvals.

Recommendation 6: That a manufacturer certification scheme be developed to suit the specific needs of the prefab and modular building industry.

Chain of responsibility, financial and contractual requirements

Recommendation 7: That the supply chain roles and responsibilities are made clear with prefab and modular construction in mind and implemented in practice.

Recommendation 8: That a building industry taskforce is set up to further investigate and address barriers associated with contracts, progress payments, licencing, mandatory stage inspections and insurance.

Education and government support

Recommendation 9: That the industry is upskilled by setting up specialist courses for prefab and modular construction.

Recommendation 10: That the Australian government provide incentives and support by encouraging increased use of prefab and modular construction in their procurement specifications.

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1. Introduction

1.1 Background

Australia's building codes and standards, along with the regulatory systems that apply to zoning land and approving the construction of buildings, are founded on the traditional (conventionally) methods of constructing buildings and the building products, practices and systems that have existed for many decades.

As a result, they introduce challenges with regulatory acceptance and approvals with respect to off-site construction methods, including prefabricated (prefab) and modular construction, that are creating impediments to the cost effective and timely delivery of buildings.

This can result in inconsistent outcomes for industry and consumers, with the potential for non-approval. This can also result in manufacturers and suppliers being hesitant to bring new products and systems to market given the inconsistency and uncertainty.

The regulatory system for building practitioners is already very complex to navigate for conventional construction and it is even more of a complex web for prefab and modular construction.

In addition, the regulatory requirements for small scale residential construction and financing by home buyers also fail to recognise alternative construction methods (such as prefab and modular construction) and contract arrangements making finance for new homes difficult.

Given the likelihood of a steady increase in demand for fast-tracked building construction, a vast number of construction projects including housing, will move to off-site and modular or systems-based construction methods over the next 5, 10 and 20 years.

It is critical that there is a clear understanding of the regulatory barriers that exist today for prefab and modular construction and potential solutions are identified now to allow Australia to create a regulatory framework that support and promotes the effective use of these building technologies.

'Australia's regulatory systems need to be updated and revised to remove the unnecessary barriers and enable greater uptake and recognition of the suitability and effectiveness of prefabricated and modular construction and facilitate an appropriate and streamlined process for the necessary approvals.'

1.2 Australian research

Multiple initiatives have taken place to assist with the progress of the use of prefabricated and modular construction in Australia which has seen increasing demand over the last decade.

In June 2019, Karen Andrews, the then Minister for Industry, Science and Technology, announced the Advanced Manufacturing Growth Centre (AMGC) Prefab Innovation Hub to support Australia's manufacturing and building and construction industry harness the opportunity this sector offers.

The AMGC first undertook a feasibility study for a manufactured building hub for the prefabricated building industry. Arising from that study, the Hub was established as a structured set of research projects aimed at the development and implementation of the following outcomes:

- support links between the construction and manufacturing sectors to enable businesses to benefit from advanced manufacturing processes;
- support new technologies and innovations enabling the transformation of the industry to provide smarter, more affordable and more sustainable construction solutions for Australians; and
- grow the manufactured buildings eco-system to improve business capability to incorporate advanced technologies and processes within industry.

HIA's project forms part of a series of projects being supported by the Prefab Innovation Hub.

The Prefab Innovation Hub is supported by a Steering Committee comprised of a broad range of experts with representatives from industry, academia and research organisations, including HIA and Prefab Australia (prefabAUS).

Some of the other initiatives which have taken place to assist with the development of off-site construction, include:

- prefabAUS: the peak body for Australia's prefabricated building industry, formed in 2012 (prefabAUS, 2021).
- The Australian Research Council (ARC) Training Centre for Advanced Manufacturing of Prefabricated Housing (CAMP.H): administered by the University of Melbourne(The University of Melbourne).
- Sustainable Built Environment National Research Centre (SBEnrc): formed in 2010 acts as a research broker between industry, government and research organisations to provide support to the built environment industry(Sustainable Built Environment National Research Centre (SBEnrc)).
- Modular Construction Codes Board (MCCB): published the first handbook for the design of modular structures in Australia in 2017 (Modular Construction Codes Board (MCCB), 2017).

Much of the research from the above initiatives and other researchers have focused on general barriers or constraints for the uptake of off-site manufacturing.

While it has been identified that regulatory systems for buildings in Australia require attention to address prefab and modular construction, a consolidated and specific research approach has not occurred to date.

1.3 Project description

1.3.1 Objective and scope

The objective of this project is to identify regulatory issues that need to be addressed and potential opportunities to facilitate the use of prefab and modular construction in Australia.

The project examines regulatory barriers for residential buildings (single dwellings) and low to mid-rise buildings (multiple dwellings).

The aspects of the regulatory requirements which are explored include:

- planning and building approvals;
- building codes and standards;
- testing and certification; and
- practitioner licencing, stage inspections and contractual requirements;

Temporary structures or other temporary or short-term accommodation buildings are not within the scope of this project.

1.3.2 Methodology

The project has been completed in two phases.

Phase 1

The first phase of the project included literature review of overseas practice and consultation with stakeholders in the form of a survey, interviews and meetings. In preparation for the consultation, a Briefing Paper was prepared for the stakeholders to provide background information and key issues that had been identified by the project team.

Phase 2

The second phase of the project has involved reviewing and examining the findings from the consultation and literature review to clearly identify the regulatory barriers and to provide recommendations and implementation considerations for further work. The findings of the project are presented this Final Report.

2. What is prefabricated and modular construction?

Prefab and modular construction is the common term that has been adopted in Australia to refer to off-site construction, generally meaning a method of construction of buildings with components that have been fabricated off-site or away from the building location.

It is different to the conventional on-site construction method, sometimes referred to as stick-built, where all or most of the building work is conducted sequentially on-site.

Photograph from Modscape (2020)

Off-site construction of a house

Photograph from BUILD (n.d.)

On-site construction of a house

Figure 1: Examples of off-site and on-site construction of houses during construction

Many other terms are used to describe off-site construction method, including off-site manufacturing (OSM) and design for manufacture and assembly (DfMA). Similarly, different terms have been adopted to refer to buildings with prefabricated or modular construction methods, including prefab or modular buildings and pre-manufactured homes.

For the purpose of this report the terms prefab and modular construction will be predominantly used. The regulatory barriers examined are applicable to construction types such as *tiny homes*, 3D printed homes, bathroom and kitchen pods and multiple purpose/function building elements. However, it is likely that different and more nuanced solutions would be needed to different types of modular and prefabricated construction.

It is noted that this report predominantly aims to address the regulatory challenges associated with 2D and 3D prefabricated products which have enclosed structures with one or more elements associated with fire, thermal, acoustic, and weatherproofing, and/or with one or more mechanical, electrical, plumbing, or other systems.

Open 2D and 3D prefabricated products such as timber or steel trusses and frames which contain elements that can be visually inspected on site and precast concrete components are generally well managed by the industry and are supported by current Australian standards.

It should be noted that while prefab and modular construction may seem like a new construction method, there are records suggesting that it has been around for more than two centuries. The process of off-site construction has significantly transformed since then into an innovative form of construction today.

Figure 2: A house being moved by using horses in San Francisco, 1908 (Desroches, 2018)

2.1 Type and levels of prefabrication

Classification can be used to determine the type and level of prefabrication (i.e., the extent of off-site construction work) as shown in Figure 3.

There are three basic types of prefabricated components:

- Simple linear components (1D prefab): most components in construction involve some form of prefabrication for ease of on-site erection, for example steel beams and columns manufactured to be easily bolted on site.
- Panelised components (2D prefab): assemblies of components designed for ease of transport and erection. Panelised systems vary from basic system design to serve a specific purpose such as structural panels for roofs, walls and floors, internal/external cladding system to complete panel systems to serve multi-purpose.
- Modular components (3D prefab): this term is often reserved for pre-assembled three-dimensional products varying from single utility units such as bathroom pods or prefab classrooms to a full residential unit (an apartment or a house).

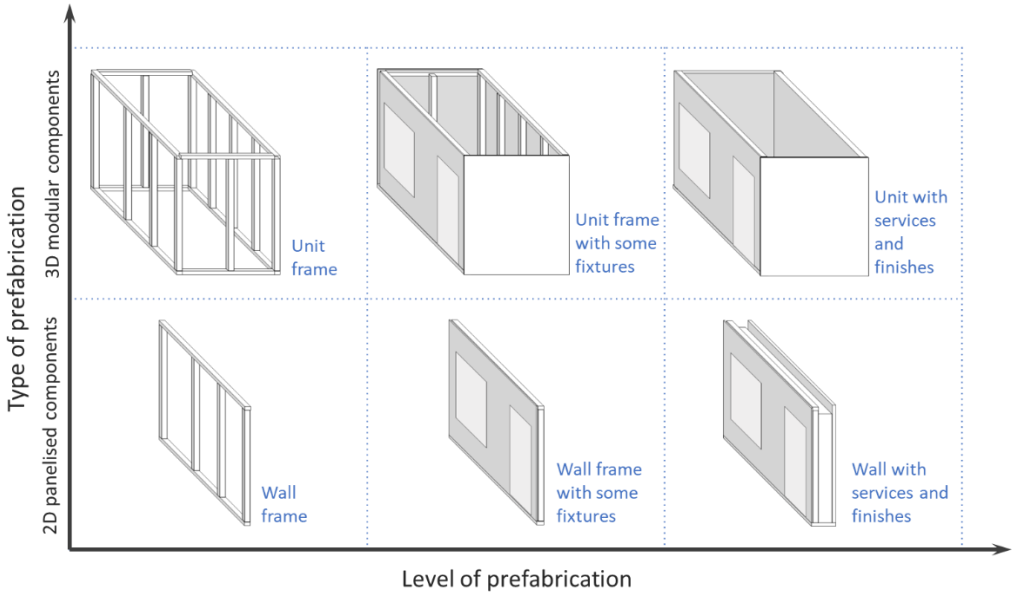

Figure 3: Type and level of prefabrication

From regulatory perspective, a definition or classification enables appropriate and effective measures necessary for each class of products to achieve compliance and quality assurance.

This report will predominantly focus on prefabricated components which are enclosed and service multiple functions. Therefore, this report does not directly address open frames, trusses or precast concrete panels, which are generally well established and supported by current Australian standards. Further discussion is provided in Section 5.2.1.

Furthermore, the classification in terms of the source of fabrication may also be important. Products that are manufactured overseas face another layer of regulatory barriers associated with imports, in addition to the building control measures for locally product building products which is already difficult to navigate.

'Therefore, the need for clear set of agreed definitions is critical in developing specific regulatory triggers or tailored building or planning systems and standards requirements.'

2.2 Construction process

The critical stages for the construction of a building with modular and prefab components and the corresponding approval requirement is shown in Figure 4.

The different stages of construction may include regulatory and non-regulatory requirements. While this study aims to focus on regulatory barriers, some issues which are not considered directly as regulatory will also be discussed.

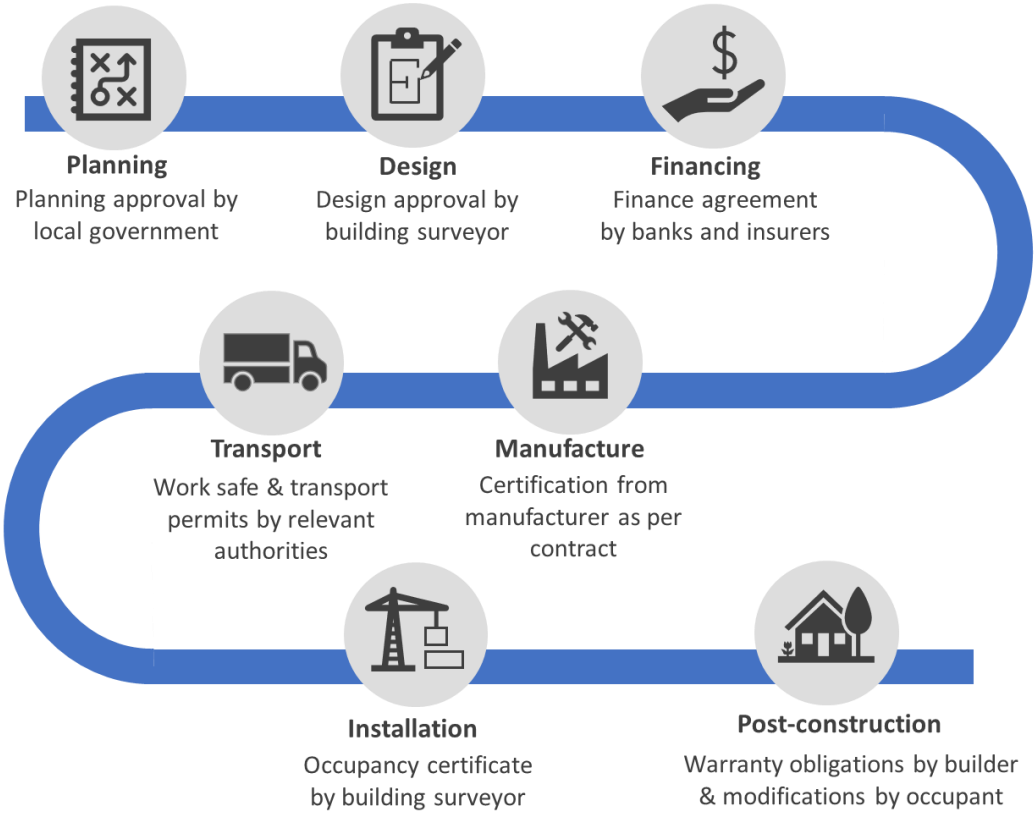

Figure 4: Overview of the construction process for prefab and modular buildings

2.3 Benefits and advantages

The are many benefits and advantages that prefab and modular construction can provide, some of the key benefits are shown below.

Figure 5: The benefits of prefab and modular construction

3. Overview of overseas practice

Prefabricated housing has gained great momentum in some countries such as Japan and Scandinavian and Northern European countries, with fluctuating popularity in other countries such as the United States and United Kingdom since post war period (Bertram et al., 2019).

For most countries the modular industry is still largely regulated by the same codes as conventional construction. However, significant work has been conducted to improve the compliance and quality assurance (QA) of prefabricated and modular products and construction process. Some of these measures includes:

- Third-party certification of factories, products and processes which often involves surveillance and inspections;
- Manufacture/supplier declaration (also referred to as self-certification) and quality control procedures;
- Development of standards and guidelines for prefabricated buildings;
- Product identification and traceability systems; and
- Schemes to provide assurance to consumers and lenders.

The following sections provides an overview of off-site construction in countries which have a varying level of off-site manufactured buildings, namely: Japan, Sweden, Canada, Singapore, United Kingdom, United States of America, and New Zealand, and what learnings from the practices in these countries can be adopted in Australia.

3.1 Japan

Japan is considered as one of the world-leaders in prefabricated and modular housing. Approximately 15% of new construction is modular and it has the largest volumetric modular company in the world, Sekisui Heim.

The development of manufactured homes started in the 1960s and 1970s due to high demand for housing for which conventional construction was unable to meet (Friedman, 2021). Initially, prefabrication and modular construction was developed to speed up construction and increase affordability of houses.

However, since the 1970s Japan changed its focus to superior quality and now volumetric houses are approximately 8% more expensive than conventionally built houses (Modular Building Institute, 2019).

Quality assurance and guarantee is typically provided by large companies with strong reputations. Japanese companies take great care to develop houses with high level of durability, advanced features, warranties and post-occupation care (Manley & Widén, 2019).

It is common for manufacturers to demonstrate the reliability of their products through earthquake, fire and water resistance tests at publicly-available laboratories (Manley & Widén, 2019).

In addition, advanced features in relation to air quality, sound insulation, thermal insulation and envelope seal are provided as a standard. Manufacturers typically fix defects without additional costs to consumers and follow the “Home Guarantee System” and “After Sales and Maintenance Service System” strategies introduced in the 1960s, to provide services such as upgrades, renovations, and re-customization (Linner & Bock, 2012).

In addition to manufacture quality control systems, third-party certification is also necessary. The Minister of Land, Infrastructure, Transport and Tourism (MLITT) established the housing performance labelling system and certifies private companies to conduct assessments to issue performance evaluation of houses (Chang-Richards et al., 2019). Prefabricated buildings come with a standard 20-year warranty which includes after sales service provisions (SBEnrc, 2017).

Many Japanese companies have sought to replicate their construction methods in Australia but ultimately have elected to follow ‘the Australian way’ due to the inability to navigate our complex regulatory environment.

3.2 Sweden

Sweden, similar to Japan, is also considered to be a leader in prefabricated and modular buildings due to its high rate of adoption compared with other countries. However, success is related to a highly-skilled workforce that has valued research, training and understanding of new systems instead of technological advances and automation (Manley & Widén, 2019).

Leading firms initially started with providing single-family homes and now predominantly focus on affordable multi-unit housing (Modular Building Institute, 2019).

Sweden's volumetric modular construction is governed by conventional building codes (Modular Building Institute, 2019). It has a national type approval system for assessment and verification of construction products with requirements in the Swedish building regulations.

Type approvals are provided for products which are not covered by harmonised standards and European Technical Assessments (ETAs) (Boverket, 2021). As part of the validity of the approval, the manufacturing process is inspected regularly by a third-party (Research Institute of Sweden (RISE)).

The study conducted by Chang-Richards et al. (2019) demonstrated that self-certification (supplier declaration) is the primary mechanism used for quality assurance.

This is then followed by third-party inspection and certification of factory production process and factory facilities/capacity. The high-quality focus seems to be a norm due to the high uptake of prefabrication in the housing sector and hence requires less regulatory interventions.

3.3 Canada

Modular construction has gained popularity in Canada since end of World War II with the booming of Canada's population and economy. It is approximated that in the last decade, factory built residential houses compose of 8-16% of the total single family housing market (Norman & Bray, 2020).

The Canadian Standards Association (CSA) has developed three standards which are directly related to prefabricated and modular buildings:

- CSA A277-16 (R2021): Procedure for Certification of Prefabricated Buildings, Modules, and panels
  This standard provides the procedure for certifying buildings, and partially or fully enclosed modules and panels for buildings of any occupancy. It provides requirements for certification of the factory quality program and the prefabricated product, auditing of the factory quality program; and in-factory inspection of the prefabricated product.
- CSA Z240 MH Series-16 (R2021): Manufactured Homes
  This standard provides general requirements for manufactured homes, including technical requirements, and requirements on quality control, markings, and provision of printed instructions.
- CSA Z240.10.1:19: Site preparation, foundation, and installation of buildings
  This standard provides requirements related to building installation, including: site preparation, permanent foundations, anchorages to resist overturning and pier toppling due to wind, connection of modules, and skirting.

In addition, prefab and modular buildings must comply with province and territory building code requirements and additional certifications are used to quantify other aspects of the modular buildings including energy efficiency and sustainability (BC Housing, 2014).

The manufacturer is responsible for implementing quality control procedures to ensure compliance with necessary performance requirements. Furthermore, factory surveillance inspections are conducted by a third-party to assess manufacturer quality control procedures and to ensure the building complies with all necessary performance requirements (Chang-Richards et al., 2019). A summary of the quality assurance and compliance procedure in accordance with CSA A277 is shown in Figure 6.

Figure 6: Approval process in accordance with CSA A277, adapted from Chown (2015).

3.4 Singapore

The government in Singapore is encouraging construction companies to use construction methods which require reduced labour such as modular construction through implementing various schemes and incentives (Shang et al., 2020).

The Singaporean Building and Construction Authority (BCA) has developed an acceptance framework for modular construction, referred to as prefabricated prefinished volumetric construction (PPVC), on mandated development sites (BCA, 2022). It consists of two parts:

(i) Acceptance by the Building Innovation Panel (BIP); and
(ii) Accreditation by PPVC Manufacturer Accreditation Scheme (MAS).

An overview of the process involved for acceptance by BIP is shown in Figure 7. The suppliers and manufacturers need to ensure that their PPVC systems meet the building code performance requirements and submit an application to BIP. BIP seeks suitable regulatory authorities to provide feedback about the application.

If accepted, In Principle Acceptance letters are issued to the supplier/manufacturer and are listed on the BCA's website. Additional accreditations are also required via the Precaster's Accreditation Scheme for PPV shell production and PPVC Manufacturer Accreditation Scheme for fitting out works.

The PPCV MAS is managed by the Singapore Concrete Institute and the Structural Steel Society of Singapore. The scheme ensures quality assurance and control in the production of PPVC and sets the process for manufactures to produce high quality PPVC systems.

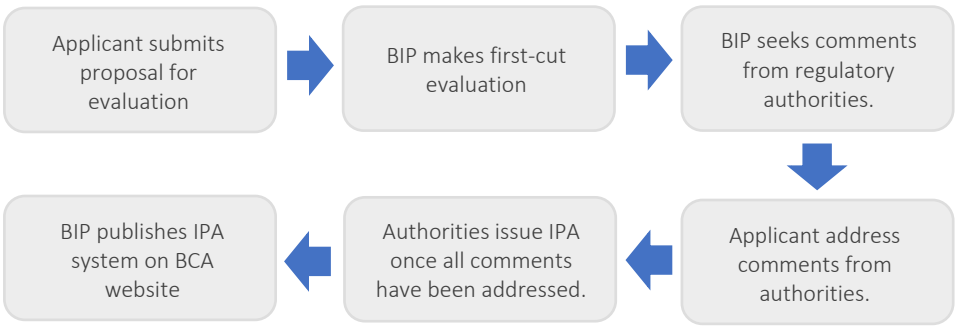

Figure 7: Building Innovation Panel PPVC acceptance process (adapted from BCA (2022))

3.5 United Kingdom

Modular construction became popular in the UK during post-war period in the 60s due to high demand for housing, however its popularity reduced with decrease in demand and collapse of the Ronan Point apartment tower in London in 1968 raising concerns about the safety of prefabricated housing (Bertram et al., 2019).

Currently, the UK is again seeing more prefab and modular projects. In 2013 the Build Offsite Property Assurance Scheme (BOPAS) was launched to encourage off-site construction.

BOPAS is a risk-based evaluation which provides assurance to funders, lenders and purchasers that buildings constructed using non-traditional methods and materials will last for at least 60 years (BOPAS, 2021)

The relationship between UK regulations and standards is shown in Figure 8. The British Board of Agrément (BBA) is the UK body which issues certificates for construction products against various schemes (e.g., BBA Agrément, European Technical Assessment, CE marking) to demonstrate fitness of purpose of the product and compliance with various building regulations. During the validity of the certifications manufacturers may be audited to ensure adequate quality management systems and repeated testing may be required (Chang-Richards et al., 2019).

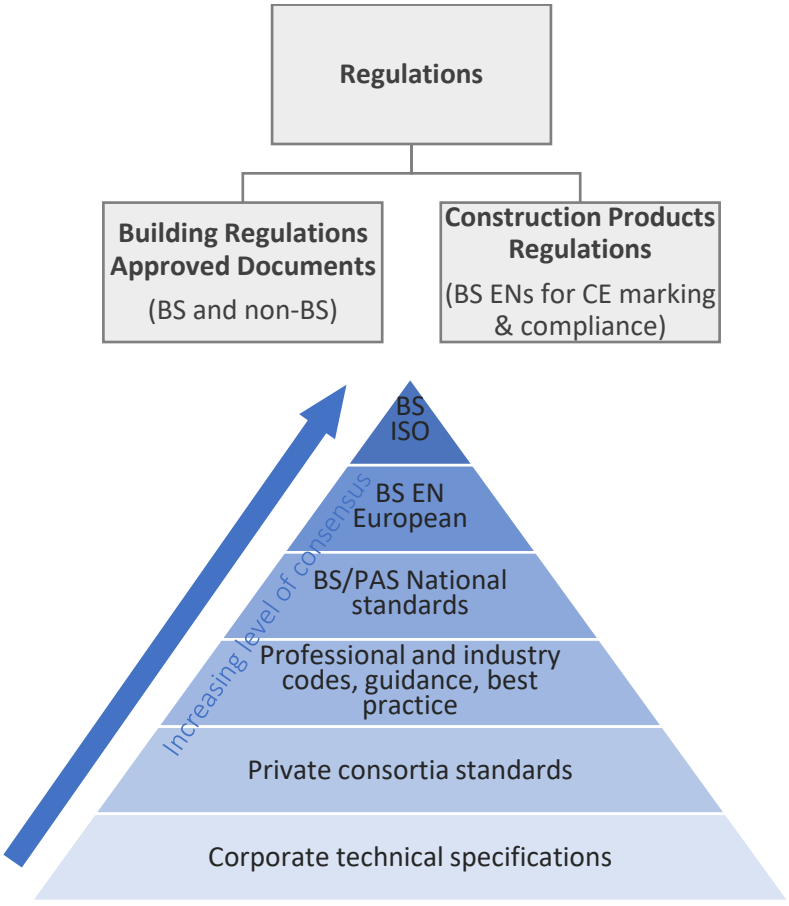

Figure 8: Relationship between standards and regulations and level of consensus for different standards and specifications, adapted from BSI (n.d.)

In general, the UK modular industry is regulated by the same codes as conventional construction (Modular Building Institute, 2019). A recent study was undertaken by the British Standards Institution (BSI) to examine how existing standards need to be updated and the development of new standards to meet industry requirements for off-site construction (BSI, n.d.).

It was identified that while there are some standards (international, European, British and industry) that are used for the design and construction of off-site buildings, they tend to be out of date or limited in scope. The study identified four broad aspects that need to be addressed:

- Design: A standardised procedure is necessary to assist with this phase and to take into consideration aspects which are unique to off-site construction, including: types of off-site systems, transportation and installation, the extent of disclosure of intellectual property (IP), demonstration of compliance at different stages, and considerations about maintenance and repair.
- Accuracy and tolerances: Updating standards addressing tolerances as currently they do not consider improvements in manufacturing accuracy, increased measurements and surveying equipment capabilities.
- Integration and connections: A method to deal with the difficulty in integrating different materials, systems, and/or modules from different suppliers into a common building.
- Technology and knowledge sharing: Developing consistent set of standards and use of terminologies.

3.6 United States of America

Currently, the United States of America has a relatively low uptake of modular construction, however, it is expected to grow within the next decade (Bertram et al., 2019).

In the U.S., there is a clear separation between the *manufactured housing industry* and *modular industry*.

The *manufactured housing industry* includes manufactured homes which are built at a manufacturing factory and transported in one or more sections on a permanent chassis to ensure transportability.

Manufactured homes are regulated federally and are constructed in accordance with the code which is administered by the U.S. Department of Housing and Urban Development, referred to as the HUD code (United States Department of Housing and Urban Development, n.d).

The *modular industry* is primarily regulated at a state or provincial level. Typically, most states have an administrative agency/office which oversees the industry and sets out the requirements.

While the requirements vary between states, they generally included requirements about the inspection process in the factory, quality control issues, the process for submitting, reviewing and approving building plans (Modular Building Institute, 2022).

The U.S. does not have a modular code, although, there are a series of administrative rules and regulations, and for some cases there are guidelines and standards. Overall, the construction of the building is regulated by the same codes as conventional construction. Typically, there is a state-adopted version of the International Building Code (IBC).

The IBC does not directly deal with modular buildings. The Modular Building Institute (MBI) is working with the International Code Council (ICC) to develop guidelines and standards, including recently published standards (Modular Building Institute, 2022):

- ICC/MBI 1200-2021 Standard for Off-site Construction: Planning, Design, Fabrication and Assembly: it includes provisions about planning and preparation requirements such as: the role of the architect/modular manufacturer/construction manager/general contractor, location of plant versus construction site, and material procurement and lead times.
- ICC/MBI 1205-2021 Standard for Off-site Construction: Inspection and Regulatory Compliance: it includes provisions about the inspection, approval and regulatory compliance of off-site residential and commercial construction components as well as their assembly and completion at the final building site.

3.7 New Zealand

New Zealand, similar to Australia, is also looking to expand its prefabricated housing market and is facing similar challenges. BRANZ has initiated research to investigate how to improve the NZ compliance and assurance frameworks for manufactured buildings (Chang-Richards et al., 2019).

The study highlighted the importance of establishing a chain of custody across the supply chain where all stakeholders (e.g., designers, manufacturers, suppliers, builders, and building consent authorities) take their due diligence. Clear regulation is required to define the responsibilities of importers and manufacturers/suppliers to assure the performance of imported products.

It is the responsibility of the manufacturers and suppliers to provide evidence that the product is fit for purpose. Like Australia, third-party certification (e.g., CodeMark, BRANZ and ISO) is voluntary in New Zealand and therefore there is lack of incentive for manufacturers to get costly certifications.

In 2010, the Ministry of Business, Innovation and Employment (MBIE) introduced a national multi-purpose approval, known as Multiproof, to streamline the consent process for standardised designs and enhance the compliance process for prefabricated buildings with the Building Code.

However, the research undertaken by Chang-Richards et al. (2019) showed that industry professionals suggested that the approach required more flexibility and efficiency.

Recently, the New Zealand Government has introduced the *Building (Building Products and Methods, Modular Components, and Other Matters) Amendment Act 2021*, which will be effective from 7 September 2022 (New Zealand Government, 2022a).

The change to the Act includes a voluntary manufacturer certification scheme for modular component manufacturers (MCM) (New Zealand Government, 2021, 2022b).

The new scheme (shown in Figure 9), involves assessment and certification of the entire prefabricated construction process from design, manufacture, assembly, transportation and installation on-site.

Third party inspection, audits and post-certification surveillance will be undertaken to ensure certified manufacturers are producing modular components that meet the requirements of the New Zealand Building Code.

The certified and registered manufacturers will be allowed to issue a manufacturer certificate for a component detailing its compliance with the building code and other relevant specifications. Building consent authorities must accept a certified modular component by a certified and registered modular component manufacturer.

The scheme is intended to benefit manufacturers by providing streamline consenting process and less inspection requirements.

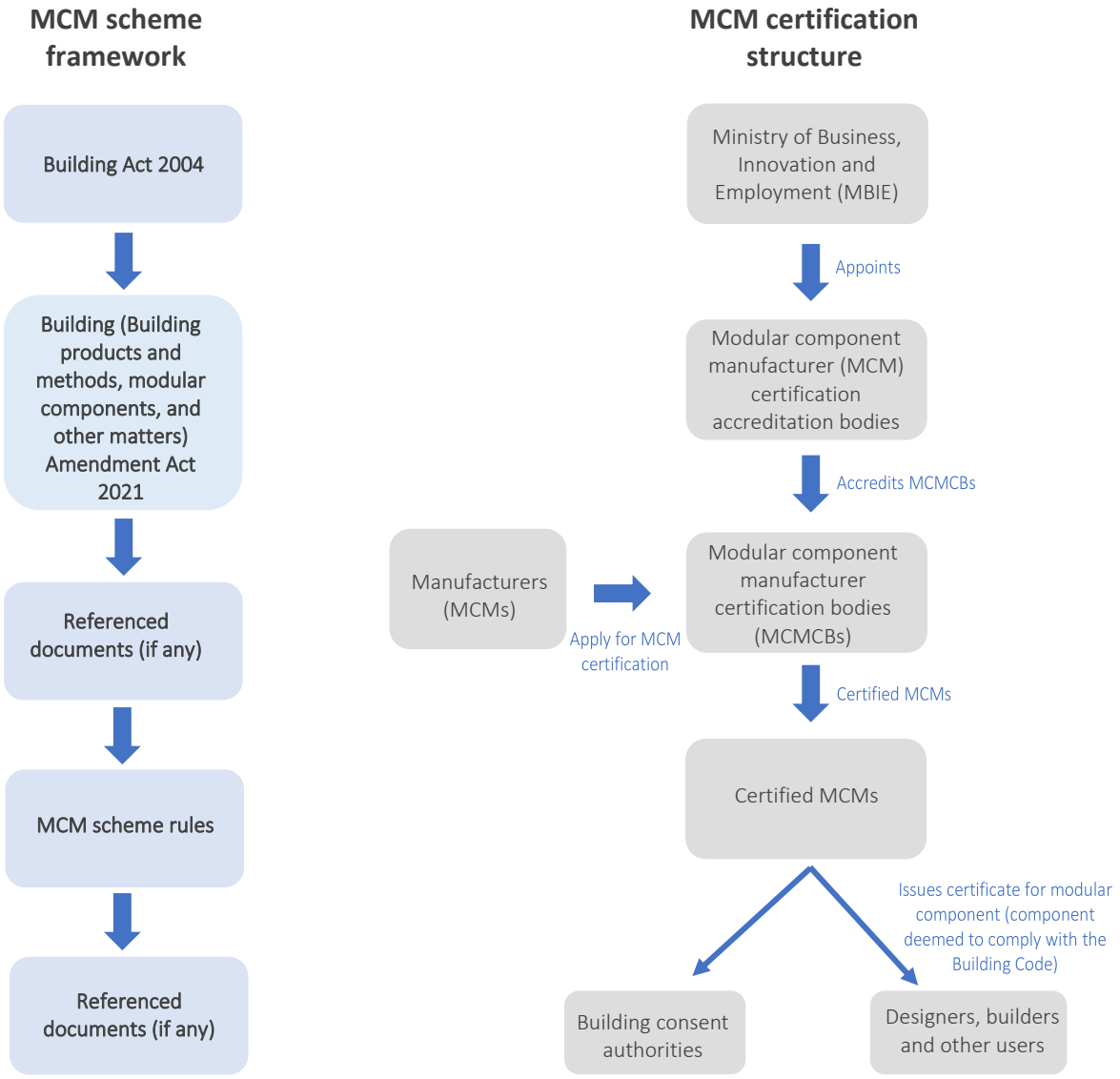

Figure 9: New Zealand system for managing modular component manufacturer certification, adapted from New Zealand Government (2022b, 2022c)

3.8 Learnings for Australia

The review of overseas practice has demonstrated that each country has their own methodology to assist with the development of prefabricated and modular construction. Some countries seem to have better established regulatory system and building codes and standards while others rely on general industry practice for conventional construction.

Some of the key learnings from international practice which are relevant for Australia and may assist in the uptake of prefabricated and modular construction are discussed below.

Third-party certification for manufacturers

The recent scheme which has been introduced in New Zealand to certify manufacturers to produce modular components by assessing the overall process is an effective method of streamlining the consent process while not compromising the compliance process may be relevant to the Australian experience.

Similar processes are also adopted in countries which are leaders in prefab and modular construction, such as Japan, Sweden and Canada.

While these countries tend to rely on supplier declaration to ensure high quality and compliant products, they are reinforced with third-party inspections and certifications of factory processes and facilities. A similar process in Australia can be adopted for manufacturers in Australia and oversees.

Third-party certification for products

A comprehensive system for third-party certification of construction products is critical for the progress of prefab and modular construction. This is particularly the case for innovative products for which the demonstration of compliance with performance requirements is not straightforward as current standards and guidelines are not applicable.

A type of approval process is often necessary in these circumstance prior to the process becoming standardised. A national system is necessary to provide this support to avoid the use of non-compliant products and delays during approvals process.

Japan deals with innovative solutions by having multiple publicly available laboratories which can demonstrate compliance for various performance requirements via undertaking tests.

Sweden has addressed this issue through the Research Institute of Sweden (RISE) and organisation which performs industry research and testing and evaluation.

A similar solution as to that of RISE in Sweden is likely to be suitable for Australia.

Development of codes and standards

Development of codes and standards are important in setting out the minimum requirements to meet performance requirements and ensure a level playing field for all. In most countries, the construction of prefab and modular buildings is regulated by the same codes as conventional.

Some countries, such as the UK, have identified that while there are some standards that are used for the design and construction of off-site construction, further specific and up-to-date standards are required which take into account specific aspects that make off-site construction different to conventional construction.

Some countries have also recently published standards specifically for off-site construction such as Canada and the United States. Codes and standards specific for prefabricated and modular construction will also be beneficial for the Australian construction industry.

To help with the development of these standards, existing international standards should be reviewed in detail.

Schemes to provide assurance to consumers and lenders

The reliability of construction products is critical, and there is naturally more hesitancy to use innovative products as it is associated with increased risk.

Therefore, schemes which provide guarantee systems and maintenance services are particularly useful in gaining the trust of consumers as demonstrated in Japan.

Furthermore, schemes are necessary to provide assurance to lenders, such as the risk-based evaluation Build Offsite Property Assurance Scheme (BOPAS) introduced in the UK.

Similar types of schemes can be introduced in Australia to encourage the greater uptake of off-site construction.

4.Stakeholder consultation

Consultation with various stakeholders has been undertaken in the form of online surveys and written submissions, one-on-one/group interviews and meetings.

A total of 286 participants completed the online survey and individual discussions with more than 20 participants have been undertaken.

The meetings have included discussions with various government bodies and code/standard representatives, including:

- The Australian Buildings Code Board (ABCB);
- The National Association of Testing Authorities (NATA);
- Standards Australia; and
- The NSW Office of the Building Commissioner.

All invited participants were provided a Briefing Paper which provided background information and identified key issues and questions related to prefab and modular construction which had been identified by the project team.

The stakeholders that have been consulted to provide their opinions and experiences include:

- Builders (main contractors) involved in installing/assembling prefab/modular buildings;
- Design engineers and architects;
- Prefab/modular manufacturers and suppliers;
- Sub-contractors (e.g., mechanical, electrical, or plumbing service works);
- Building surveyors, inspectors and local authorities;
- Government bodies and code/standard representatives
- Industry associations; and
- Researchers.

4.1 Surveys

Participants were invited to provide feedback via completing an online survey or providing written submission in response to the Briefing Paper. In total, 286 participants completed the survey. All written answers to questions were optional.

The survey had 28 questions in total. The survey questions and a summary of the responses are provided in Appendix A. A summary of the type of organisation or work that the participants associated themselves with is shown in Figure 10.

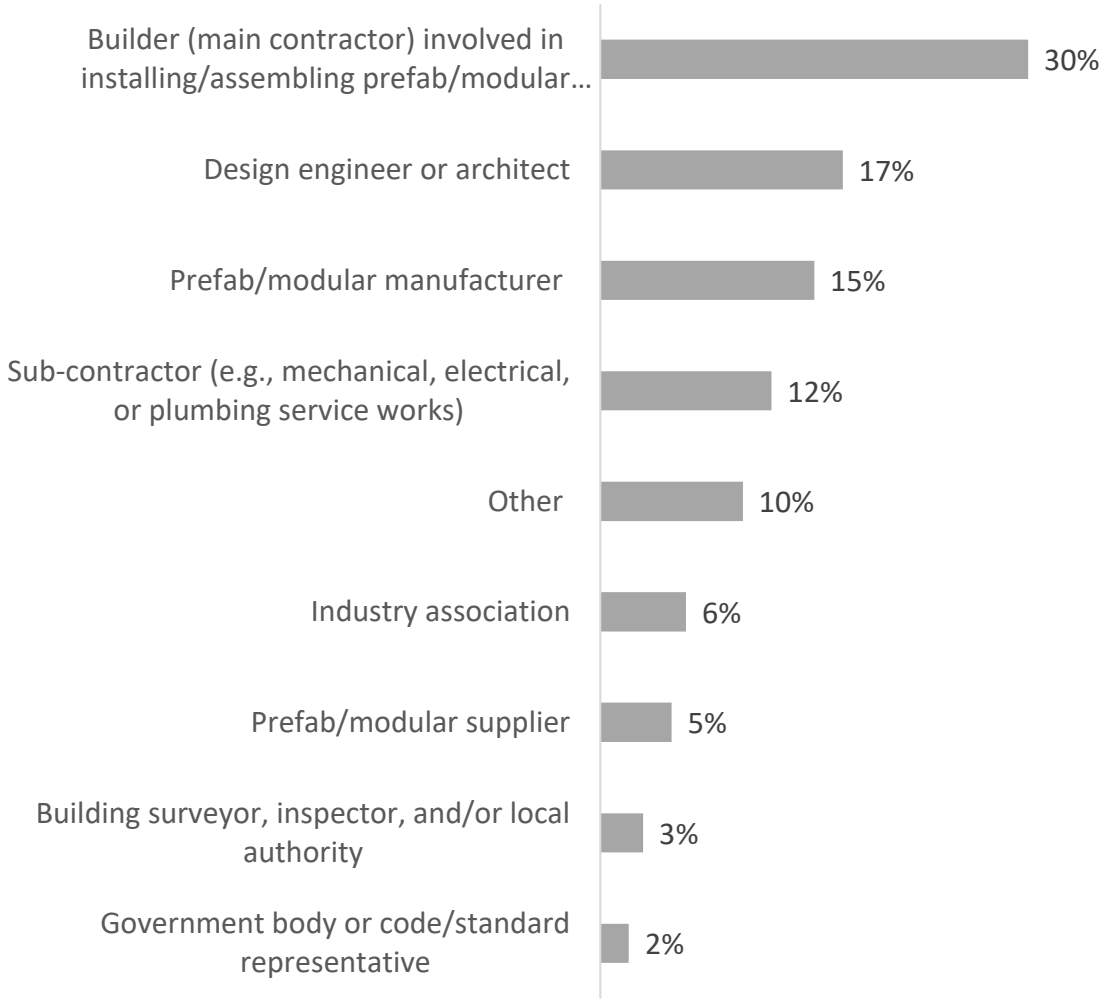

Figure 10: Participants involved in the survey

4.2 Interviews and meetings

Semi-structured interviews and meetings have been undertaken with discussion related to:

- The scopes and limitations of planning and building regulations on off-site construction particularly in residential construction;
- The differences in planning and building approval processes for on-site and off-site construction; and
- Suggestions on what changes are needed in this space (if any).

In total 17 interviews and meetings have been conducted with 23 participants. A summary of the participants is shown in Figure 11. The selection of the participants was based on their type of expertise and familiarity with off-site construction. The aim was to include various stakeholders involved in the supply chain.

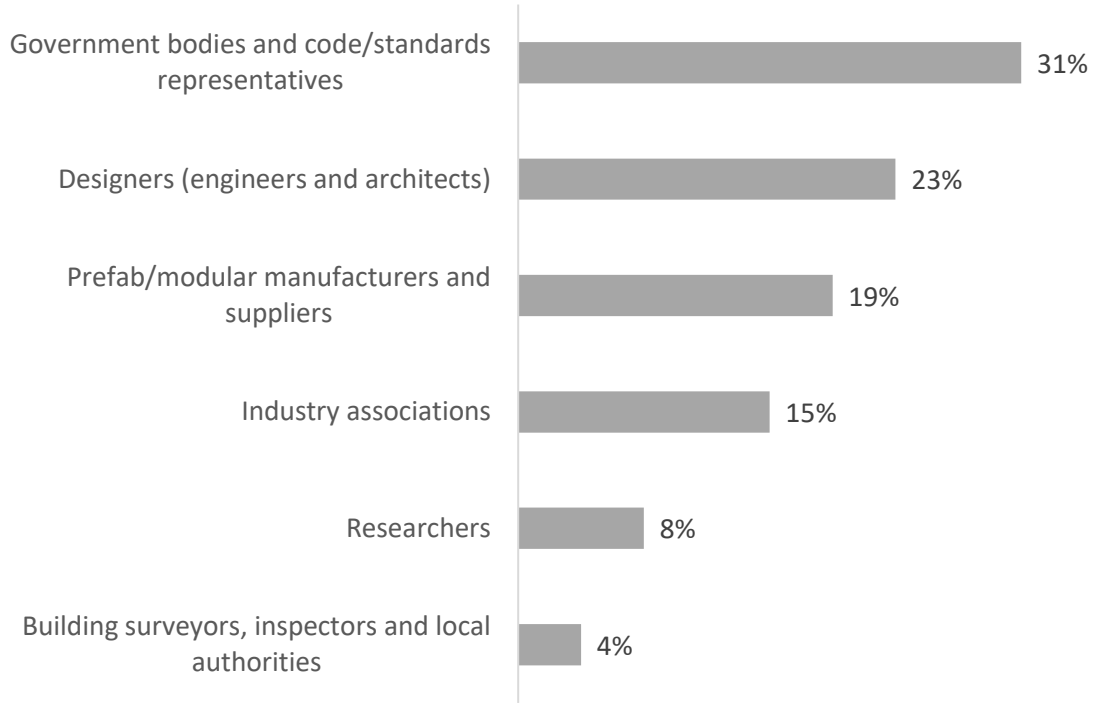

Figure 11: Participants involved in the interview and meetings

4.3 Overview of responses

In general, it was observed from the online surveys, interviews/meetings, and written submissions, that there is a need to improve existing planning and building regulations to help with the uptake of prefab and modular construction. This was clearly evident in the survey response shown in Figure 12, with 68% of participants agreeing that some form of change or improvement is necessary for planning and building codes and Australian Standards.

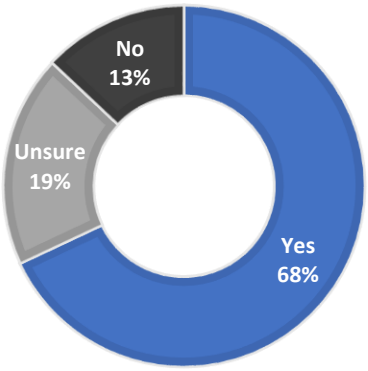

Figure 12: Survey response to "Do you think any improvements/changes need to be made to existing planning and building codes and Australian Standards to assist with the uptake of prefab and modular buildings?"

Different regulatory barriers and related issues were identified by the participants as hinderances for the uptake of prefab and modular construction. These have been summarised under seven key issues which are provided below:

(i) Definitions
(ii) Town planning
(iii) Design guidelines
(iv) Compliance and quality control
(v) Chain of responsibility
(vi) Finance
(vii) Incentive, familiarity and experience

Each of the above are discussed in detail in the following subsections. It is noted that more detailed responses to all the survey questions are provided in Appendix A.

4.3.1 Definitions and recognition

The general feedback from all participants was that there is a need for proper recognition of off-site construction as a method of construction and clarification of definitions and consistent use of terms.

Clarification of terms are required for both the type of prefab, that is for example if dealing with 2D panels or 3D volumetric modules, and the level of prefab, which describes the extent of prefabrication including if structural elements are open or enclosed (i.e., hidden) and what other components are included such as mechanical, electrical, plumbing, and finishes.

The importance of definitions especially for the level of prefabrication was observed in response to the survey question asking if we should promote the use of a fixed set of definitions based on the level of prefabrication for technical and regulatory use, with 67% of participants agreeing that this is necessary, see Figure 13.

It is noted that in prefabricated components for which the structural members are not enclosed (such as trusses and frames), there are no regulatory barriers, especially if a deemed-to-satisfy (DTS) solution applies.

The regulatory environment starts to struggle with enclosed components (e.g., wall panel or floor cassette) where it is not possible to see and examine all the necessary components. This is also when certification becomes difficult as it is unclear how the component has been manufactured.

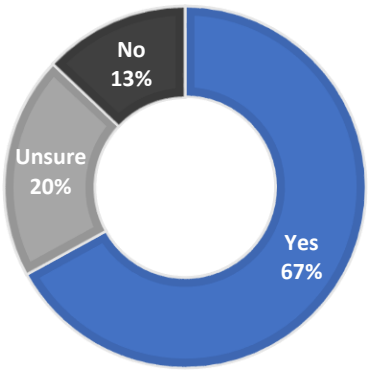

Figure 13: Survey response to "Do you think we should promote the use of a fixed set of definitions based on level of prefabrication for technical and regulatory use?"

4.3.2 Town planning

Generally, a mixed response was observed about town planning issues. Some participants noted that there were no additional barriers or challenges in relation to prefabricated and modular buildings whereas others raised concerns. Some participants stated that the state and council are hesitant to provide approvals for new concepts which can cause very long delays.

It was also noted that both off-site and on-site construction face similar challenges when the final resolution to achieve sign-off is prolonged.

However, for on-site construction, this issue can usually be resolved through the building approval documentation stage while the site preparation works are in progress.

Whereas, for off-site construction, the delays become a significant issue as site preparation and construction of building/building components take place simultaneously.

The other issue that was raised was around the numerous terms used for off-site constructed buildings (e.g., manufactured home, movable home, relocatable home, temporary structures, kit homes, manufactured home estate) and confusion about when the NCC applies and lack of consistencies between states and territories.

4.3.3 Design guidelines and standards

Many participants noted that the NCC and most design standards have been written with on-site construction in mind and therefore it is difficult to apply all of the current requirements for off-site construction.

Some participants noted that there is a need for a comprehensive and user-friendly document to provide guidance for prefab and modular construction and to ensure that it is acknowledged by NCC as a reference document.

The following are examples for which a prescriptive form of guidance is needed:

- Loads to be considered for transportation (temporary loads);
- How to maintain rigidity of components during lifting and transportation;
- Precision and tolerance requirements; and
- Connection and integration requirements, describing how the prefab/modular component connects to each other and to the rest of the building.

It was discussed that guidance may be necessary for each construction material (e.g., concrete, timber, and steel) and composite materials. It was also noted that some materials are covered better than others, e.g., precast concrete.

Overall, guidance may be provided based on the building class (low rise versus mid- and high-rise buildings), the type of prefabrication (2D and 3D), and the level of prefabrication (i.e., component with exposed structural elements such as a truss or wall frame versus a component with structural elements and services and finishes).

Furthermore, in general, it was noted that the Handbook by the Modular Construction Codes Board (MCCB) provides good general information about modular buildings, however, more specific and detailed guidance is necessary.

This was also reflected in the response to the Survey Question concerning the level of support provided by the Handbook, shown in Figure 14. 71% of participants responded either as neutral or not enough support is provided by the handbook. Many participants also noted that they were not familiar with the Handbook.

Another issue that was raised was about repairs and maintenance post-construction. Repair work for a prefab/modular constructed building may be different from on-site, for example, a critical wall component or connection may not be easily replaced or modified.

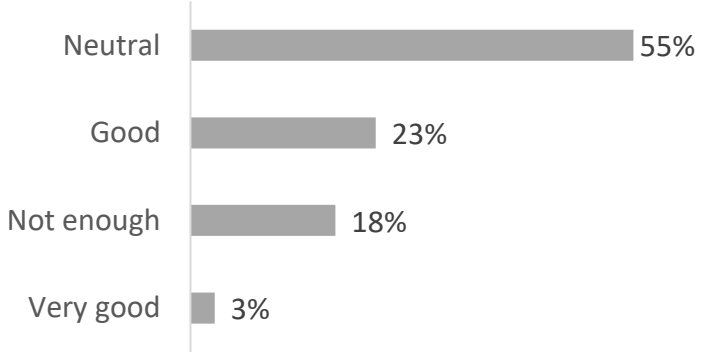

Figure 14: Survey response to 'What level of support does the Handbook for modular structures by the Modular Construction Codes Board provide?'

4.3.4 Compliance and quality control

Compliance and quality control were one of the key themes that were discussed in the interviews and questioned in the survey. To some extent, a mixed response was observed about compliance challenges for prefab/modular construction.

This was also apparent in the survey question which asked about the effectiveness of the current method to demonstrate conformity and quality control, shown in Figure 15. Around 61% of the participants responded as neutral, 20% as good/very good, and 18% as bad/very bad.

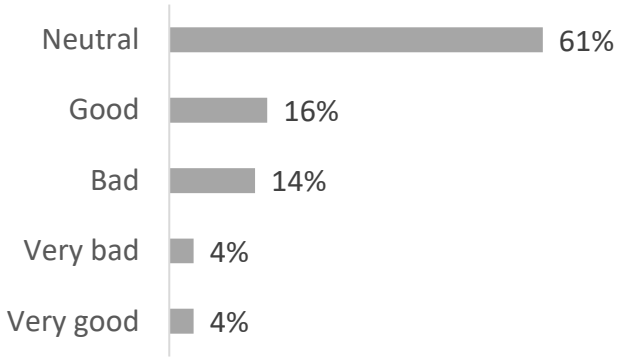

Figure 15: Survey response to "How effective do you think the current method to demonstrate conformity and quality is?"

The mixed response highlights the need for guidance and a standardised process as some seem to be facing limited challenges while others are facing great barriers. Furthermore, in general, it was noted by the majority that the regulations have been written for on-site construction.

In particular, the approval process and the role of the inspector are based on on-site activities, e.g., for on-site construction inspection is required on completion of framing work. There is a need to clearly define the approval process for off-site construction based on different levels of prefabrication.

It was noted that currently, the approval of a complex building product is done at the end after the product has been manufactured and installed on-site. Hence, after the building has been constructed, it is possible to have issues with compliance approval. Therefore, manufacturers and builders are reluctant to uptake modular construction due to the increased risk.

In addition, the challenges related to performance solutions were also highlighted, and currently, the process applies to a specific job. It was suggested that two forms of performance solutions are necessary:

(i) One-off approval for a specific job, this should be relatively simple since the risk is lower,

(ii) Generic approval which is not limited to a specific job/site, has a higher risk, and hence the process is likely to be more stringent than 'one-off' approvals.

Furthermore, it was noted that currently there is no guidance on quality control, this is a general problem for all construction products and is not yet addressed in the NCC. Quality control systems must cover compliance with all the necessary performance requirements for each component of a system.

It was discussed by some that it is preferable and practical to have a process such that the source of the product does not matter (i.e., overseas products can follow the same procedure).

Currently, there are also different rules in different states and territories which also mean that a product that is accepted in one state (e.g., Victoria) may not be accepted in another (e.g., Western Australia).

Nevertheless, it was noted that it is important that the process for compliance is not too complex or expensive. Some participants expressed concerns that currently, the cost of compliance is too high.

It was also highlighted that good documentation of products used in buildings, including prefab/modular components is critical. It is necessary to know exactly what has been included in a building, especially for future changes and demolition.

4.3.5 Chain of responsibility

In the interviews and meetings, it was highlighted that there is a need to clearly define the responsibilities of the supply chain with prefab/modular construction in mind, which in turn will assist with understanding the regulatory requirements.

This was also observed in the survey, with 48% stating the role and responsibilities of stakeholders are not clear for prefab and 30% stating that they were unsure (see Figure 16).

It was suggested that the supply chain responsibilities need to be spread across all those involved including the manufacturer and builder.

Some participants stated that currently if something goes wrong with a building most of the responsibility lies with the engineer, building surveyor, and certified electrician/plumber.

For example, under the licensing regime, the electrician/plumber who is undertaking the installation/connection is responsible to approve the final product and is, therefore, reluctant to do so with prefabricated products. It is noted that while the product can have a Watermark, these are typically componentry and it does not mean the system is okay or fit-for-purpose.

In contrast, some participants noted that there are not facing any issues, particularly for residential construction where the plumbing and electrical systems are all 'plug and play' and certification is provided by the plumber/electrician by checking on-site after installation.

Issues were also raised about post-construction such as problems associated with repairs and maintenance and warranty conditions. It is unclear how these issues are to be handled.

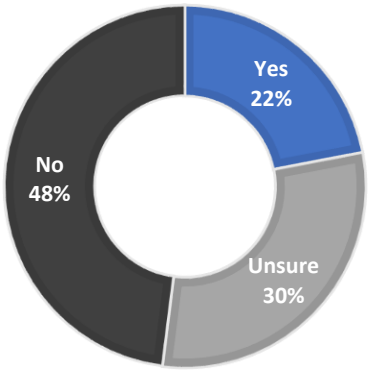

Figure 16: Survey response to "Do you think the responsibilities and roles of stakeholders in the supply chain for prefab are clear?"

4.3.6 Finance, deposits and stage payments

The issue of finance for the manufacturer (builder) consistently came up during the consultation even though it is not directly related to regulations. It has been highlighted to be one of the main barriers to prefab/modular construction. It includes challenges associated with obtaining bank guarantees and high premiums for insurance.

Furthermore, for high-level prefabricated products, most of the work is done off-site, and therefore the current method for finance loans for houses is based on a series of progress payments after inspection of key stages (e.g., excavation for foundations, foundation construction, frame, and truss installation, and completion) which are not suitable for this method of construction.

A new approach is necessary for when inspections of work done need to take place and how payments need to be managed.

Currently, only large companies can handle the financial risk associated, including short-term risk related to cash flow and long-term risk of something going wrong and needing insurance cover. For customers, they require the majority of their finance upfront rather than through progress payments.

4.3.7 Incentive, familiarity and experience

The consultation revealed that, in general, there seems to be very little incentive for the uptake of off-site construction. This is both due to insufficient awareness of the potential benefits as well as lack of demand in Australia.

In addition, since most large builders have not taken up prefab and modular construction, this form of construction is not very accessible, and consumers are not well informed.

It was also highlighted that the industry at this stage is not necessarily capable of dealing with modular construction due to insufficient technical knowledge and support, and a clear understanding of how to achieve compliance and quality assurance.

Participants noted that government support and incentives are required to encourage the development of prefab/modular construction. Also, educational campaigns are necessary to inform people of the potential advantages of off-site construction.

A consistent view emerged that a key area where prefab and modular housing, and construction more generally, can provide great support, is post disasters such as bushfires and floods. This is primarily due to the speed of construction and the reduced demand for on-site labour at a time when labour is stretched to its limits.

Furthermore, it is necessary to upskill and educate the industry so that there is greater familiarity with prefab and modular construction. It is noted that this is subject to a separate project through the Prefab Innovation Hub.

4.4 Learnings from the stakeholder consultation

The consultation with stakeholders has helped to identify the regulatory barriers and related issues that are faced by the various stakeholders in the supply chain for prefab and modular construction. The key learnings are summarised below.

Clarification of the planning regulations for prefab and modular construction

There is a need to review and clarify the planning requirements for prefab and modular construction of buildings, particularly housing. There currently seems to be inconsistencies between states and territories an ambiguity about when the NCC applies for an off-site constructed building.

Improvements to building and construction regulations for prefab and modular construction

The key areas related to building and construction regulation which require development are provided below:

(i) Recognition and definitions of terms: Currently, there is no formal recognition of off-site construction as a construction method and there are no uniform set of terms that are used for regulatory purposes. In particular, there is a need to define the type and level of prefabrication as it effects the type of approval process that needs to be implemented.

In general, there no real challenges faced by open prefabricated components, where all elements can be inspected on-site. The challenges arise with enclosed prefabricated components which are typically serving more than two functions, for example structural, fire, acoustic, and/or weatherproofing, and when the component incorporates mechanical, electrical or plumbing systems.

(ii) Expansion of the NCC and design standards: The NCC and most design standards have been written with on-site construction in mind and therefore they are not always suitable or adequate for prefabricated construction. There are design and construction aspects of off-site construction that are different to on-site construction and these need to be dealt with through comprehensive and user-friendly design provisions.

(iii) Development and clarification of compliance and quality assurance pathways: There is currently inconsistencies between the challenges faced by the industry for demonstrating compliance and quality control measures. There is confusion around what is necessary to demonstrate compliance, especially for enclosed prefabricated components.

Performance solution methods are currently inadequate or inefficient to deal with prefabricated products as they are typically applicable for specific jobs. Also, there are challenges since there are different regulatory requirements between state and territories. There is a clear need for a standardised process for the approval process and ensuring that the process is not too expensive or time consuming.

Clarification of the roles and responsibilities for the supply chain involved in prefab and modular construction

The role and responsibilities of the supply chain is not clear, especially as the prefabricated component transitions from being a product developed off-site to on-site building work and a consumer good, being a home.

It was highlighted that it is necessary that the supply chain responsibilities are spread across all those that are involved, and that the final responsibility should not just lie with the building specialist who conducts the on-site installation or inspection.

Modifications to existing finance systems suitable for prefab and modular construction

A key challenge for prefab and modular construction is the challenges associated with finance, in particular obtaining bank guarantees and high premiums for insurance.

The stage payment method adopted for on-site construction are not suitable for off-site construction as a significant amount of work and cost required is for off-site work. A new system for finance is necessary which is suitable for off-site construction.

Upskilling the industry and providing incentives for prefab and modular construction

Overall, the industry does not have adequate familiarity or experience with off-site construction and the benefits that it can provide to some projects. There is a need for government incentives and support in terms of financial and educational aspects to assist the industry with the uptake of prefab and modular construction.

5. Australian practice and examination of findings

Residential construction, and all other forms of building construction, is subject to a raft of regulations and controls based on the planning and building administrative frameworks. The Australian Constitution gives the states and territories the responsibility for regulating the planning and building activities as shown in Figure 17.

Hence, Australia has eight different systems, however they share many similarities including the adoption of the National Construction Code (NCC) as the primary technical standard for building and plumbing work.

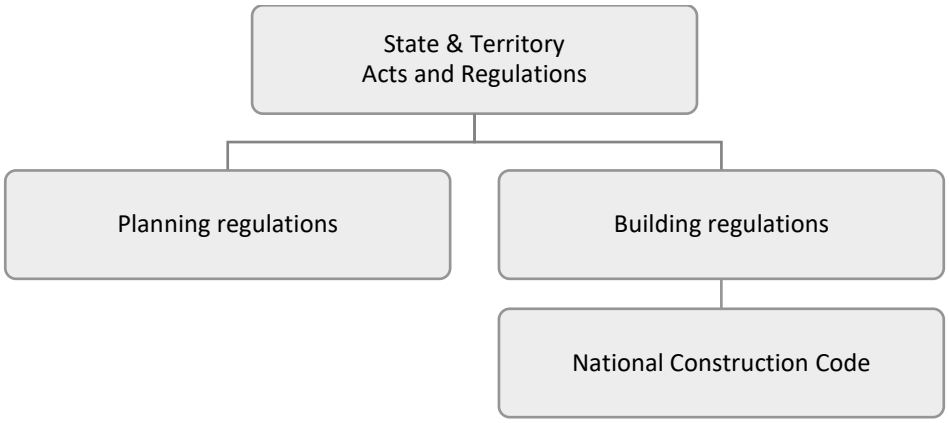

Figure 17: The Australian planning and building regulatory framework

This section provides an overview of the critical aspects of the Australian planning and building regulatory framework and related systems (including financial and contractual liabilities), highlighting the barriers related to prefab and modular construction and recommendations to overcome the barriers. The following aspects are examined:

- Planning requirements;
- Building and construction requirements;
- Chain of responsibility, financial and contractual requirements; and
- Education and government support.

5.1 Planning requirements

5.1.1 Introduction

The use of prefabrication in building, particularly in housing, has been occurring for several decades. In general terms, prefabrication related to components, or construction modules, is not a matter than planning systems will generally take regard of.

Commercial and industrial building use a significant amount of prefabrication and modular components based on modern engineering and design construction techniques. Where this occurs, the building system, rather than the planning system, is the key barrier to further productivity benefits.

However, prefabrication and modular construction in relation to housing, faces a very different circumstance.

The planning system operates primarily to manage the use of land. In simple terms, the planning system dictates where and what type of buildings can be constructed, while the building system dictates how buildings are construction to ensure their health, safety and amenity.

In Australia, the planning system is regulated by state governments and planning approvals are generally the remit of local governments. Local governments are authorised to develop planning schemes and codes that direct the type of buildings permitted and the design of those buildings.

With respect to housing, this means that local governments are the primary regulatory authority in most states and territories. Of note for this project, there are currently no consistent planning approval requirements for prefabricated and modular residential buildings, especially single homes.

Planning authorities effectively 'hedge their bets' based on the location of the home. Often in regional or rural settings, recognition of a prefabricated home is straightforward, while metropolitan councils are conflicted as to whether a home should be defined under legislation for manufactured homes and caravan parks, or whether it can and should be defined as a home, in the traditional sense of the term.

The planning system has remained in the past. Legislation that was traditionally created to manage genuine manufactured home estates and caravan parks is now part of the problem, rather than the solution for prefabricated homes used in traditional housing settings.

Legislation that was traditionally created for housing, has become overloaded and crafted on the basis of home being built on-site, using a range of building materials and having a scale that suits a 'streetscape' or a 'design code'.

While there are many forms of prefabricated homes that need to be considered, this report finds that all forms are being pigeon holed into an outdated regulatory framework.

Substantial reform and increased productivity in housing delivery will only come when genuine attention is paid to rebalancing the planning system.

5.1.2 When is a house not a house?

For many decades, prefabrication or modular forms of housing, were the domain of caravan parks. But time have moved on and modular forms of housing are now a much more common choice by home buyers seeking to choose an affordable option or seeking to harness the benefits of faster construction of a home.

As outlined the use of prefabricated elements in the construction of a home is less often impeded by the planning system, where those elements are used to deliver a home that looks like a modern single family home.

However, when a home is constructed as a modular home, issues can arise. The first of these is simply whether the building is, or can, meet the definition of a home.

Our research found that there tends to be a hesitancy in local government when faced with the choice of defining a modular home as a home, simply due to the alternative construction methods use. It is also likely that this response is in part due to a preference for modern homes to be a particular shape and style of construction.

Industry feedback found that a consistent response from local government to the construction of a modular home on a parcel of land zoned for residential use was that the home would need to meet a raft of design codes requirements, along with the later construction requirements for a building approval, and that the home would not be suitable.

Others experienced the view that a modular home is only permitted to be constructed in a manufactured home estate of some type, or in a more rural setting, and not within a suburban setting.

'There is clearly a need for guidance and standardisation in the approach taken by local governments when considering the use of modular or prefabricated homes in traditional residential locations.'

5.1.3 Design codes

Perhaps the reason in part for the hesitancy of local governments to accept modular homes as an acceptable option in traditional locations is the extent of control now sought through planning design codes or housing codes.

Lead in part by land developers seeking to create a bespoke and unique streetscape in new suburbs and estates, local governments over the last two decades have moved to a position that standard design rules should be established which set out extensive architectural design requirements for new housing in all forms.

Traditionally, these housing codes were limited to building envelope controls to appropriately manage the scale of new housing and offer a reasonable level of protection from neighbouring homes in respect to overlooking and overshadowing.

Covenants were also used by land developers to set a standard with respect to minimum home size, external building materials and fencing.

Today, these codes and covenants go far beyond the building envelope. Housing codes now set minimum standards that can dictate the external building materials have a mix of at least three different products, that there must be a combination of lightweight and masonry, dictate the colour

palette to be used, mandate particular types of fixtures such as solar hot water or solar panels, dictate requirements for undercover parking, driveways and landscaping.

Whilst these requirements may be seen as delivering a modern, attractive new home product, they compete against the ideals of affordability and compact living. Outcomes that modular construction can excel at.

While reducing the many design obligations in these codes would assist in improving the affordability of all new homes, the recommendation of this report is that space be made to guide and support the construction of a modular home, or a tiny home, in our existing and future suburbs.

This could be achieved through the recognition of these housing forms in housing codes and aligning a set of practical requirements to these homes.

5.1.4 The tiny home

The 'tiny home' is the modern day equivalent of the manufactured home.

The issues outlined above in relation to definitions and design codes apply to the approach taken by local governments where a person may seek to use a tiny home as their primary residence.

However, a more common experience is the concept of using a tiny home as a secondary dwelling on an existing residential property.

As occurs for a primary residence, utilising a 'tiny home' as a second home on one parcel of land is generally defined in the planning system as a secondary dwelling. Other terms such as granny flat, ancillary dwelling, dual occupancy and the like, may also be the relevant planning term, depending on the state and the local government.

The planning system has traditionally set out controls for secondary dwellings, whatever form they take. There is no contention that a tiny home being used as a secondary dwelling should not require some form of consent.

However, the issue arising from this research focuses on the approach currently taken by the planning system to a 'tiny house on wheels'.

In the absence of a tiny house definition, a tiny house (where it is moveable) is commonly deemed as a caravan by most local councils throughout Australia, which has placed them outside the local planning system.

A tiny house on wheels has emerged as a housing choice to address affordability across the spectrum of home seekers. Singles, first home buyers, and increasingly single women aged over 50 are seeing this option as an affordable and practical housing solution.

The regulatory barriers for a 'tiny home on wheels' arise from questions around permanency of the home. Commonly these homes are designed to be self-sufficient, off-grid for power, requiring a water connection for potable supply, and often using composting toilets. and are able to be moved off site. This is particularly relevant where the tiny house occupier parks their tiny house on land owned by another person.

Given the connection to a trailer and the mobility of 'tiny homes on wheels', they are commonly viewed as caravans. This means that the local government rules for caravans in residential properties generally apply. These limit the number of days a caravan can be occupied.

The barriers that need to be addressed are traditional land use matters. Where can a 'tiny home on wheels' be placed? How long can a 'tiny home on wheels' remain in-situ and if permitted, what rules should apply?

A tiny house by its very nature will be limited in size – meaning there is little purpose in creating traditional planning controls about the house itself. The regulatory question is where can someone place a 'tiny house on wheels' and for how long?

A tiny house by its very nature will be limited in size and the permanence of the structure would suggest that planning controls for a tiny house are outside the intent of a land use system. The regulatory question is where can someone place a 'tiny house on wheels' and what conditions the occupation of the tiny house should abide by?

Secondary questions exist around the arrangements a land owner can legally make to allow a 'tiny house on wheels' to be located on their property.

The findings of this research bring forward the views of the Australian Tiny House Association (ATHA). ATHA are promoting the need for the planning system to establish a defined land use as a 'tiny house parking space'. ATHA are promoting the need for a regulatory pathway to gain approval for a 'tiny house parking space'.

This approach offers a planning solution whereby a home owner that has sufficient vacant area on their property and suitable access to allow a tiny home to park, can gain a approval from a local government for a 'tiny home parking space'.

The rules for such a space would consider the impact of the location on the adjoining properties and streetscape along with the manner in which the tiny home would connect to the services and utilities on the property.

Once an approval is granted, a property owner can then proceed to make private arrangements with tiny home owners to park their home in the designated and approved space. No further approvals should be required by the owner of the tiny home.

There should be no limits on the time a tiny home can remain in-situ so long as it remains compliant with the parking space approval.

This approach also offers a practical solution for additional short term housing in areas where itinerant workforces operate, such as agricultural or tourist towns.

Recommendations for planning system reform

Recommendation 1: That planning requirements for prefabrication and modular housing be:

(a) amended to use standardised terms for off-site constructed buildings (e.g., manufactured home, movable home, relocatable home, kit homes, manufactured home estate) and align with terms for inclusion in the NCC;

(b) amended to explicitly recognised prefabrication, modular and tiny homes as acceptable forms of housing; and

(c) reviewed to identify where planning or housing codes apply excessive design requirements for modular and prefabricated homes and changes be identified that can better align these codes with lightweight construction and smaller housing designs

(d) That a definition of a 'tiny house on wheels parking space' be established and that local governments amend local planning scheme requirements to permit such parking spaces on any land where residential buildings are permitted.

5.2 Building and construction requirements

5.2.1 Building and construction approval process

Critically, prefab and modular building design is no different to conventionally built houses. However, the design and construction stages are managed very differently when prefabrication and modular construction is used, which can lead to variations in the approval process.

Comparison of the key stages between the conventional construction of a house and a house with high level of prefabricated modular components is shown in Table 1.

Table 1 is based on generalised best practice in Australia (standardised across the type of construction and materials as well as across the state and territories), however, it is not always easily achieved or followed.

In general, the regulations for building and construction have been written for on-site construction. There is no clear recognition of prefab and modular construction as a form of construction (i.e., off-site construction) which causes approval authorities concerns about the safety and suitability of these buildings constructed using this method.

The building approval process is not clear, especially in terms of the role of the inspector, i.e. building surveyor, if aspects of the building product or building cannot be examined on-site.

In particular, there are confusions about what and when components are considered as a *product* and as building work and the necessary approval process to ensure that once all the components are installed on-site, the building complies with the NCC requirements and it is fit-for-purpose.

This is particularly the case for prefabricated products, where components associated with the structure, fire, thermal, acoustic and weatherproofing, can be hidden or not easily assessed on-site.

There are also challenges when the prefabricated components consist of mechanical, electrical, and plumbing (MEP) systems.

Under the licensing regimes, the specialist tradesperson installing MEP systems, such as the electrician or plumber is responsible for approving the final installed product.

These specialists can be reluctant to install and approve prefabricated components which cannot be visually inspected on-site to examine their suitability.

While there is some support to assist with the approval of these prefabricated products (such as WaterMark), they are typically componentry and therefore do not ensure that the installed product within a system is fit for purpose.

Overall, there appears to be inconsistencies in the industry and the level of challenges and barriers experienced during the approval process. This is partially due to the extent of prefabrication, the building type (e.g. residential and commercial) and the experience and familiarity of the stakeholders involved, especially building consent authorities such as building surveyors and local councils.

'There is clearly a need for guidance for a standardised process for the approval process of prefab and modular buildings to ensure a level playing field for all.'

Table 1: Critical stages and approval requirements for off-site and on-site construction of a house

	Prefab and modular construction	On-site construction
Pre-construction phase	**Planning and conceptual design** Development/planning approval – approval to develop the land in a particular way. Submitted by builder/developer on behalf of the owner and typically granted by local council. Early engagement of the modular manufacturer.	**Planning and conceptual design** Development/planning approval – approval to develop the land in a particular way. Submitted by builder/developer on behalf of the owner and typically granted by local council.
	Finance Finance approval or bank guarantee obtained by the owner/builder. Staged payments based on on-site construction not suitable and need to enter contractual agreement.	**Finance** Finance approval or bank guarantee from the lender applied by the owner/developer. Typically, staged payments are provided for key stages of on-site construction.
	Detailed design Building approval – approval that the proposed building complies with relevant building regulations, including compliance with the NCC performance requirements. Completed by builder/designer and approved by relevant authority (e.g., building surveyor).	**Detailed design** Building approval – approval that the proposed building complies with relevant building regulations, including compliance with the NCC performance requirements. Completed by builder/designer and approved by relevant authority (e.g., building surveyor).
Construction phase	**Site prep and foundation** Includes underground connections made such as plumbing, electrical and stormwater systems.	**Site prep and foundation** Includes underground connections made such as plumbing, electrical and stormwater systems.
	Manufacture of modules (off-site) Modules includes framing and other components such as internal services (e.g., MEP work), weatherproofing, insulation, cladding, fixtures and finishes. Manufacturer responsible for implementing quality assurance procedures and obtaining necessary product certifications. Inspection of completed modules by an authorised inspector/supervisor reporting to the building surveyor.	**Transportation of materials and elements to site** Materials and elements transported and stored on-site with necessary measures to protect against the weather.
	Transportation and storage of modules on-site Temporary works engineer employed by the builder, responsible for obtaining approval for transportation, including heavy vehicle requirements. Project engineer representing the builder, responsible for obtaining approval for storage of modules on site.	**Frame construction (on-site)** Construction of walls and roof trusses. Builder is responsible for ensuring this stage is inspected by authorised inspector/building surveyor before progressing to next stage.
	Lifting and installation of modules Project engineer representing the builder, to inspect modules prior to installation and during installation. Temporary works engineer representing the builder, responsible for temporary works, lifting, and work safe requirements. Installation or connection of modules with MEP components by licensed tradesperson.	**Locking-up/enclosing the house** Installation of external cladding, including roof, floor and walls, and installation of weatherproofing, insulation, and MEP work by licenced tradesperson.
	Exterior and interior finishes Installation of exterior and interior finishes with product certification as necessary.	**Fixing and fit-off** Installation of internal fixings and finishes, including waterproofing of wet areas, wall plasters, internal doors, cabinetry, benchtops, and final fit-off for MEP work. This stage requires inspection from authorised inspector/building surveyor for approval.
	Completion of building works Occupancy permit or certificate of final inspection. Approved by the authorised inspector/building surveyor.	**Completion of building works** Occupancy permit or certificate of final inspection. Approved by the authorised inspector/building surveyor.
Post-construction	**Occupancy period** Maintenance period and building warranty/guarantee provided by the builder.	**Occupancy period** Maintenance period and building warranty/guarantee provided by the builder.

A clear first step of developing a standardised process for approval is clarification of terms that are used in prefab and modular construction. The regulatory definitions need to be logically constructed to be effective and the terms need to fit in with current regulatory terminology without creating complications.

Some proposed key terms for preliminary consideration are provided below which are based on international practice and the feedback received during the stakeholder consultation. Furthermore, the complexity of the approval process is often related to the type and level of prefabrication.

Therefore, as an example a more detailed breakdown of the type and level of prefabrication is provided in Table 2 which can be utilised from a regulatory perspective to differentiate the approval process necessary and the level of risk associated with prefabricated products. Examples of prefabricated products are shown in Figure 18.

It is noted that this report predominantly aims to address the regulatory challenges associated with 2D and 3D prefabricated products which have enclosed structures with one or more elements associated with fire, thermal, acoustic, and weatherproofing, and/or with one or more mechanical, electrical, plumbing, or other systems.

Open 2D and 3D prefabricated products such as timber or steel trusses and frames which contain elements that can be visually inspected on site and precast concrete components are generally well established and supported by current Australian standards.

Preliminary proposal of definition of terms

Buildings: results from construction operation that has the provision of shelter for its occupants or contents as one of its main purposes (adapted from ISO 6707-1). The term can also be used in singular form as an adjective to distinguish from other kinds of civil engineering construction.

Building works: on-site construction works performed by **builders** to create **buildings.**

Builders: entities responsible for **building works.**

Prefabricated and modular manufacturers: entities responsible for manufacturing prefabricated products, including modular components.

Prefabricated product: a product that is manufactured (in whole or in parts) at a site/s where the product is not intended to be installed and is intended to be transported to another site for installation. It is not relevant if the site for installation is unknown at the time of manufacture and if some assembly work is required on-site (adapted from New Zealand Government (2022a)).

1D (linear) prefabricated product: is a prefabricated linear open or enclosed structural component. It is intended to be used as, or contribute to the structural performance of beams or columns in a building.

2D (planar) prefabricated product: is a prefabricated open frame or a truss, or an enclosed fame or panel, with or without elements associated with fire, thermal, acoustic, and weatherproofing, and mechanical, electrical, plumbing or other systems. It is intended to be used as, or contribute to the structural performance of the roof, floor, or wall of a building (adapted from New Zealand Government (2022a)).

3D (volumetric) prefabricated product: is a prefabricated volumetric structure that consists of one or more 2D prefabricated products, and is intended to be used as, or contribute to the structural performance of two or more of any of the roof, floors, or walls of a building (adapted from New Zealand Government (2022a)).

Whole building prefabricated product: is a whole building that is a prefabricated product, where the term *whole building* excludes site work, such as foundations and connections to services (adapted from New Zealand Government (2022a)).

Modular component: is a prefabricated product, and can include 1D, 2D, 3D, and whole building prefabricated products. This term is typically used for 3D and whole building prefabricated products.

Table 2: Preliminary proposal for defining the type and level of prefabrication for regulatory purposes.

Type of prefabrication	Level of prefabrication
Type 1: 1D (linear) prefabricated product	Level 1: Open simple linear components.
	Level 2: Enclosed simple linear components.
Type 2: 2D (planar) prefabricated product	Level 1: Open frame or truss
	Level 2: Enclosed frame or panel with or without one or more elements associated with the fire, thermal, acoustic, and weatherproofing.
	Level 3: Enclosed frame or panel as described in Level 2 and with one or more mechanical, electrical, or other systems.
Type 3: 3D (volumetric) prefabricated product	Level 1: Open frame or truss.
	Level 2: Enclosed structure with or without one or more elements associated with the fire, thermal, acoustic, and weatherproofing.
	Level 3: Enclosed frame or panel as described in Level 2 and with one or more mechanical, electrical, plumbing, or other systems.
Type 4: Prefabricated whole buildings	Level 1: The whole building is prefabricated and consists of Type 2 and/or 3 prefabricated products.

Notes:
1. *Open* means that all elements of the prefabricated component can be visually inspected on site.
2. *Whole building* excludes site work such as foundations and connections to services.

1D prefabricated open beams

Photograph from HEB Construction

1D prefabricated enclosed beams

Photograph from Wright Quarry Products

2D prefabricated open frame

Photograph from Trusses Plus

2D prefabricated enclosed wall

Photograph from KNAPP Connectors

3D prefabricated open frame

Photograph from FRAMECAD

3D prefabricated enclosed frame

Photograph from SurePods

Prefabricated whole buildings

Photograph from Clayton

Figure 18: Examples of different type and levels of prefabricated products

The second key step for developing a standardised process for approval process is developing guidelines or a protocol which addresses the demonstration of compliance at various stages of construction, including third-party assessment and certification requirements and the necessary audits, inspection and surveillance for prefab and modular construction.

These need to consider various activities, including design, site preparation, manufacture, transport, installation, maintenance and repair.

The requirements for prefab and modular construction could be written into a protocol or standard that is referenced in the NCC. This would be an effective regulatory tool to manage technical issues that are difficult to include under the current format of the NCC.

A similar approach was used to describe the process for evaluation of building energy consumption when the process was under development and is still being used to describe requirements for software for the design of roof trusses.

An NCC referenced document would particularly assist the use of prefab and modular construction for Class 1 buildings (low-rise residential buildings) since they predominantly rely on deemed-to-satisfy provisions for regulatory acceptance.

The approval process is highly reliant on the building codes and standards and an effective system for the evaluation and certification of building products for intended use, which are discussed in more detail in Section 5.2.2 and Section 5.2.3, respectively.

Recommendations for building and construction requirements: approval process

Recommendation 2: That prefabrication and modular construction be explicitly recognised as regulatory acceptable construction practice and a standardisation of relevant terms and definitions be established for use in Australian building codes, standards or technical requirements.

Recommendation 3: That the Australian Building Codes Board (ABCB) establish a project to identify ways to provide prescriptive and performance requirements into the National Construction Code (NCC) to support the orderly use and approval of prefabrication and modular construction, especially for Class 1 buildings.

5.2.2 Building codes and standards

The planning and building administrative framework in each state and territory calls up the NCC to set the technical standards for the design and construction of buildings in Australia.

The NCC is developed and maintained by the Australian Building Codes Board (ABCB) on behalf of the Australian Government and each state and territory. Each state and territory may have variations to the NCC provisions.

The NCC provides the minimum required level for the safety, health, amenity, accessibility and sustainability for buildings. It mainly applies to the design and construction of new buildings, plumbing and drainage systems in new and existing buildings, and for some cases it can apply to structures associated with buildings and new building work or new plumbing and drainage work in existing buildings.

The NCC is a performance-based building and plumbing code, meaning the mandatory requirements of the NCC are the Performance Requirements and compliance can be achieved in following the prescriptive Deemed-to-Satisfy Provisions (DTS) or in developing a Performance Solution that can allow for innovative solutions.

Under the DTS pathway the NCC calls up a range of relevant standards (Australian Standards and others) which set benchmarks for the material, design and construction requirements, for example:

- AS 1684 for timber residential construction and AS 1720 for timber structures;
- AS 2870 for residential slabs and footings and AS 3600 for concrete structures design;
- AS 3740 waterproofing of wet areas and AS 4671.1 and 4671.2 for water proofing membrane above ground area;
- AS 4100 for steel design and AS 4600 for cold-form steel design; and
- AS 4773 for masonry for small buildings and AS 3700 for masonry design.

Whilst a builder and designer could adapt or apply these Australian Standards, or the principles contained within them to a particular construction type, they have generally not taken into account or specifically been drafted with off-site and modular and prefab construction in mind.

Similarly, the DTS Provisions of the NCC are written with conventional construction in mind and for products to be generally serving a specific purpose to satisfy the NCC rather than a full wall or roof system for example encompassing numerous parts required for NCC compliance.

This leaves builders, designers and manufacturers either trying to make the product fit into the NCC DTS Provisions, developing a Performance Solution specific for the building or some form of a hybrid solution.

This results in inconsistent approaches, uncertainty in approvals and hesitancy to stick with the tried and tested as opposed to bringing new and innovative solutions to market.

The issues are particularly more challenging for high-level prefab components (complete panel or modular unit). A high-level prefab product will require multiple aspects of performance to be evaluated, for example a complete wall panel will have to satisfy structural requirements, fire requirements, acoustic requirements, water proofing requirements (if external).

There is a need for comprehensive standards which address aspects of design which are unique for prefabricated and modular buildings. Currently, some specific standards have or are in the process of being developed overseas. In Australia, the only specific handbook for modular construction is the one developed by the Modular Construction Codes Board (MCCB).

While this handbook provides useful general information, more specific and detailed standards are necessary. For example, detailed information is necessary for the following:

- Consideration of temporary loads especially during transportation and lifting and how to maintain the rigidity of components;
- Precision and tolerance requirements, these are typically higher than those for conventional construction;
- Transportation of prefab components to site including lifting without any damage to the component and the surrounding environment.
- Installation, connection and integration of components with the rest of the building;
- Demonstration of compliance during the different stages of construction;
- Quality management system to consistently produce prefab components in accordance with specifications;
- The extent of disclosure of intellectual property (IP), this is critical for compliance process during construction and repairs/changes need to be made to the building post-construction; and
- Considerations related to repair and maintenance.

Recommendations for building and construction requirements – building codes and standards

Recommendation 4: That Standards Australia develop a work program to –

(a) review and modify the relevant construction standards, particularly NCC referenced standards, for their adequacy to address prefabricated and modular construction; and

(b) develop a new suite of Australian Standards specifically for prefabricated and modular construction to provide industry with a set of deemed to satisfy (DTS) construction solutions.

5.2.3 Building product conformity infrastructure

In conjunction with the detailed design and construction requirements of the NCC and Australian Standards, a core component is requirements for building product conformity, which includes product testing, certification, approval, and surveillance.

The NCC contains building product conformity requirements under the 'evidence of suitability provisions' which lists product evidentiary requirements and ways for which a material, product, design or form a construction to demonstrate compliance with the NCC (Australian Building Codes Board (ABCB), 2019a, 2019b). Under these provisions the NCC provides a number of ways to demonstrate compliance, these are:

(i) A CodeMark certificate of conformity,

(ii) A certificate of accreditation under a state government certification scheme (where one exists),

(iii) A test report by an accredited testing laboratory, for example accreditation from the National Association of Testing Authorities (NATA),

(iv) A certificate or report by a professional engineer or other appropriately qualified body, including a certificate issued by a certification body accredited by the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) – this includes industry schemes such as ACRS and EWPAA schemes,

(v) Another form of documentary evidence such a Product Technical Statement or Technical Appraisal.

Many of the Australian standards referenced in the NCC contain testing requirements for products to show compliance with that standard.

Whilst this framework exists and could apply to singular modular elements or full systems there are shortcomings.

The CodeMark Australia Scheme is a building product certification scheme owned by the Commonwealth of Australia and administered by the ABCB. It is a non-mandatory scheme where conformity assessment bodies (CABs) accredited by JAS-ANZ are responsible for assessing the product conformity against the performance requirements in the NCC.

The capability of the CodeMark system to cope with growing demands of innovative building products is a concern due to insufficient technical expertise and testing facilities.

The evaluation of the performance of prefabricated products is challenging in terms of determining what performance requirements need to be assessed and how to demonstrate conformance when the requirements are qualitative.

Currently, the applicant seeking a CodeMark certification selects the provisions of the NCC which are assessed for conformance and therefore all requirements are not necessarily assessed to ensure that the product is fit for purpose. (Note – it is recognised that the building approval authority is responsible for confirming whether such a certification meets all of the relevant requirements under the NCC.)

Also, NATA and JAS-ANZ will generally accredit a testing laboratories or certification bodies to issue certificates or reports against a scope of accreditation to specific Australian Standards. Some requirements and accreditation systems are state specific and hence a product approved in one state or territory is not necessarily accepted in the other.

Furthermore, the way the NCC and Australian Standards have been designed generally requiring testing or approval against specific tests, say for fire or acoustics, of individual components rather than a complete assembly.

Meaning a product requires multiple tests to show the full suite of NCC compliance rather than holistic performance of the completed element test across all the relevant standards.

Similarly, given the NCC and Australian Standards are written generically, many of the modular and prefab construction products and systems differ greatly from manufacturer to manufacturer, so a single standard or specification may need to be developed specifically to that product which is not an approach used elsewhere.

The issues that are faced by the current Australian conformity system often result in very slow, challenging, and expensive approval process for innovative products including high level prefab products, thus resulting in a determent from going down this path.

There is a clear need to improve and develop the building product conformity system in Australia. It is important to note that some of the critical issues that have been discussed are not just unique to prefab and modular components but are issues that generally apply to construction products.

Some of the following suggestions may help to improve the current product conformity issues:

- Developing the building product conformity system such that it is capable of efficiently dealing with products within Australia (acceptance by all states and territories) and overseas. And consider having separate approval system for products which are specific for a single job/site and for products that are not specific for a job/site. The latter typically have higher risk associated with them and are likely to require more stringent approval process.
- Introducing manufacturer certification, similar to the modular component manufacturers (MCM) certification scheme introduced in New Zealand, where the manufacturer is certified to produce prefab and modular components based on assessment of the overall process that the manufacturer is responsible for including, design of the product to ensure compliance with building code requirements, transportation and installation.

Recommendations for building and construction requirements – building product conformity

Recommendation 5: That the current Australian product conformity infrastructure be reviewed for its ability to cope with new prefab and modular products that need testing, individually and as a whole, as the basis for their acceptance in building approvals.

Recommendation 6: That a manufacturer certification scheme be developed to suit the specific needs of the prefab and modular building industry.

5.3 Chain of responsibility, financial and contractual requirements

5.3.1 Chain of responsibility

Clarity about the responsibilities of the stakeholders in the supply chain is critical for all construction work, including off-site construction, as there is a transition from building product to building work.

Currently, the supply chain responsibility is predominantly handled within contracts as states and territories have limited regulations for buildings products. Generally, building products are not covered by consumer product laws and are therefore not controlled under the Australian Consumer Law.

A new home fully constructed off-site is generally not recognised by state and territory home building laws as a building, but as a building product until it comes to site and installed on site and then becomes building work.

In 2017, Queensland introduced the Building Construction (Non-conforming Building Products – Chain of Responsibility and Other Matters) Amendment Act 2017, which provides legislation about the duties of the stakeholders in the chain of responsibility, including those who design, manufacture, import, supply and install building products.

A key aspect of introducing the duties has been to ensure building products are suitable and safe for their intended use and the required information about the product is made available along the supply chain.

The Australian Building Codes Board also provides a description of the role and responsibility of the stakeholders in the supply chain on their website (ABCB, n.d.). A brief summary of the key stakeholders is provided below:

- Manufacturers (includes prefab and modular manufacturers)

  Are responsible for knowing the requirements of the compliance and conformance of their product and the evidence required to demonstrate compliance (such as testing, assurance, and certification) and to know how potential customers should and should not use their products.
- Suppliers (importers, wholesalers, distributors and retailers)

  Are responsible for ensuring that the building products supplied do not breach trade or consumer laws or industry-specific requirements for safety or performance. Building products, when necessary, must have the requirements to demonstrate safety and suitability before they can be lawfully sold.
- Architects, designers, engineers and other specialists

  Are responsible for ensuring that they understand and specify the performance requirements of buildings, including building products. Designers must design buildings in accordance with the NCC and other appropriate state requirements.
- Approval authorities (e.g., building surveyor)

  Are responsible for ensuring that plans, specifications, and critical aspects of construction comply with Codes, standards and laws. Approval authorities are state and territory registered practitioners. They can also be involved in inspecting buildings and construction work and need to be able to identify when protects are not fit for purpose or used incorrectly.

- **Developers, builders, and other specialist tradespersons**

  Are responsible for on-site construction and installation work. Developers and state and territory registered builders (main contractor) are responsible for ensuring the building and building product performance meets relevant regulatory requirements alongside contractual requirements with the client they are building the house for.

  They need to ensure that all building work and building products have the necessary certificates for demonstrating compliance and approval and provide this documentation to the building owner at completion of the building work.

  Other specialist tradespersons (or subcontractors) are responsible for on-site construction and installation work which is outside of the expertise of the builder (e.g., mechanical service workers, electricians and plumbers). Specialist tradesperson are also state and territory registered practitioners.

The roles and responsibilities of key stakeholders is applicable to conventional forms of construction and off-site construction. However, the above responsibilities are not necessarily practiced fully, especially when prefabricated and modular construction is involved. This is due to numerous reasons, including:

- Minimal surveillance and policing system in Australia to ensure stakeholders follow expected industry practice.
- Inadequate product conformity system which is not capable of providing a complete evaluation of products to identify when the products should and should not be used.
- Insufficient familiarity and experience of industry professionals to deal with innovative products, including high level prefabricated products

In addition, as discussed earlier, a challenge with prefabricated and modular buildings is the clarification of what is considered a *product* and *building work* and the necessary approval process to ensure that once all the components are installed on-site, the building complies with the NCC requirements and it is fit-for-purpose is not as clear cut as it is for conventional construction.

It is important that the supply chain responsibilities are clearly defined with prefab and modular construction mind. This is critical for understanding the requirements for the approval process and to address issues that may arise during or post-construction.

It's been identified that there are in general three options for the approval process of prefab and modular construction which in-turn effects the roles and responsibilities of the stakeholders in the supply chain (see Figure 19):

(i) Regulating the final product which has been completed off-site

This will involve certifying the product after it has been manufactured off-site for its intended use in a building on-site.

This process involves alternative requirements to have qualified and registered professionals during manufacturing process, however the product in the end must be certified by an independent third-party.

This is similar to the current approach that is followed under the *NCC evidence of suitability provisions* when for example a CodeMark certificate of conformity is obtained for a product to demonstrate compliance with the NCC.

(ii) Regulating the construction work that is done off-site

This can involve certifying the manufacturer of prefab and modular construction products, where there are requirements for the manufacturer to have staff with required competency training, and where necessary, qualified and registered professionals.

Furthermore, necessary surveillance can be undertaken by the approval authorities post certification. This option is similar to the process that is followed for on-site construction work. It will be necessary to ensure that the building product produced off-site is suitable for its intended use once installed on-site.

(iii) Hybrid approach

This will involve a hybrid approach between regulating the construction work that is done off-site (i) and where necessary to have certification of products (ii) for the final product that is produced by the manufacturer.

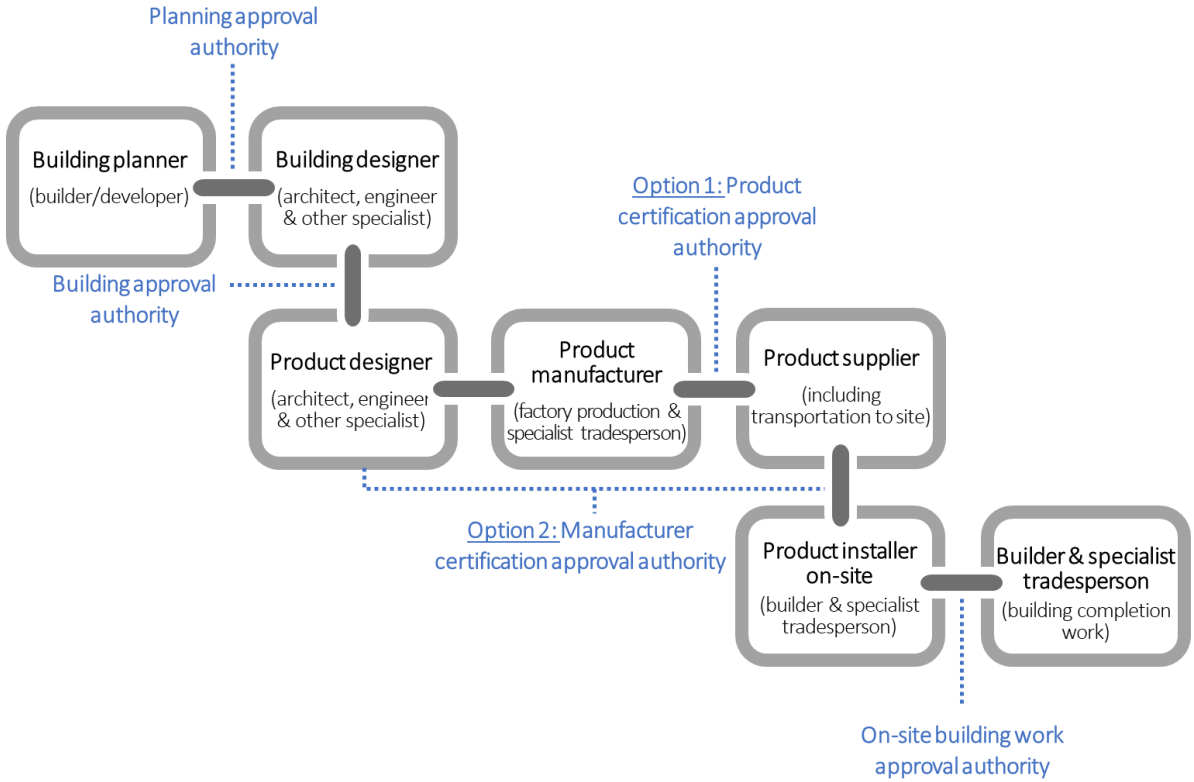

Figure 19: Chain of responsibility showing two options for approval of prefab products

Recommendations for supply chain responsibilities

Recommendation 7: That the supply chain roles and responsibilities are made clear with prefab and modular construction in mind and implemented in practice.

5.3.2 Financial and contractual issues

Building a home is subject to a raft of consumer laws that impact the contractual arrangement between a builder and a home buyer. These laws broadly assume a home is built on-site and that stages of progress are reached to allow partial payment to a builder.

A prefab or modular home built wholly off-site is treated as a manufactured product with different payment regimes in place, either deposit at the start and full payment at end or full payment before work starts.

Neither of these arrangements suit home lending arrangements in the traditional sense. In most jurisdictions, these same consumer laws will only apply once the work is captured by domestic or residential building law, i.e., most off-site work is not captured and therefore not regulated by these arrangements.

This offers both challenges and flexibility depending on the circumstances of the parties involved.

For example, limits on deposits that apply when carrying out home building work on site will not apply to the manufacture of prefabricated building components allowing the manufacturer more flexibility to charge for the works being carried out.

Recommendations for financial and contractual issues

Recommendation 8: That a building industry taskforce is set up to further investigate and address barriers associated with contracts, progress payments, licencing, mandatory stage inspections and insurance.

5.4 Education and government support

The uptake of prefab and modular construction in Australia is relatively low compared to some overseas countries and key reason for this appears to be that there is very little incentive and the system remains complex to navigate, making many steer back towards traditional construction methods for housing.

This appears to be related to insufficient familiarity of building professionals with this form of construction and a lack of awareness of the benefits it can provide for certain projects.

There is clearly a need for educational programs in Australia to upskill the building certification industry with technical knowledge required for prefab and modular construction and when and it can effectively be implemented for building construction including housing.

It is also noted that there is currently very little demand in Australia, that is, not many clients are seeking prefab or modular construction. This is partially due to lack of familiarity with this form of construction and the perceived increased risk.

Prefab and modular construction has the potential to support the society in various forms such as providing affordable housing and quick construction of houses which can be used to support communities for post-disasters such as floods and bushfires.

Government supports and incentives, including certain percentage of government tenders requiring prefab and modular construction where suitable, can be an excellent way to help increase the demand for off-site construction. This will in-turn increase the level of familiarity as more building professionals will be exposed to this form of construction.

In addition, schemes which provide guarantee and assurance to lenders, such as Build Offsite Property Assurance Scheme (BOPAS) introduced in the UK, can assist with the perceived risk of off-site construction

Recommendations for education and government support

Recommendation 9: That the industry is upskilled by setting up specialist courses for prefab and modular construction.

Recommendation 10: That the Australian governments provide incentives and support by encouraging increased use of prefab and modular construction in their procurement specifications.

6. Summary of recommendations and implementation considerations

This section provides a summary of recommendations that have resulted from this study. Implementation considerations have also been provided for regulatory matters which is within the scope of this project.

The goal is to facilitate the passage of any prefab and modular housing proposal through the necessary regulatory requirements and to remove any regulatory barriers.

The implementation activities should be on a national basis as building products are free to travel interstate. The only national regulatory vehicle is the National Construction Code and its referenced documents, such as Australian Standards.

The ABCB also produces mandatory protocols and non-mandatory handbooks and guides. These are also national documents and all can play a role in effectively reducing the regulatory barriers for prefab and modular construction in Australia.

Recommendations for planning system reform

Recommendation 1: That planning requirements for prefabrication and modular housing be:

(a) amended to use standardised terms for off-site constructed buildings (e.g., manufactured home, movable home, relocatable home, kit homes, manufactured home estate) and align with terms for inclusion in the NCC;

(b) amended to explicitly recognised prefabrication, modular and tiny homes as acceptable forms of housing; and

(c) reviewed to identify where planning or housing codes apply excessive design requirements for modular and prefabricated homes and changes be identified that can better align these codes with lightweight construction and smaller housing designs

(d) That a definition of a 'tiny house on wheels parking space' be established and that local governments amend local planning scheme requirements to permit such parking spaces on any land where residential buildings are permitted.

Planning schemes need to be reviewed and amended to have consistent definitions for different types off-site constructed buildings, and to acknowledge prefabricated, modular and tiny homes as the lack of formal regulatory recognition has been identified as a major barrier to the acceptance and approval of this form of construction.

This is the major cause for the perception of increased risks for all parties in this form of construction.

Recommendations for building and construction

Recommendation 2: That prefabrication and modular construction be explicitly recognised as regulatory acceptable construction practice and a standardisation of relevant terms and definitions be established for use in Australian building codes, standards or technical requirements.

The lack of formal regulatory recognition has been identified as a major barrier to the development of this form of construction. On-site construction was a traditionally defining characteristic of the building industry as distinct from the manufacturing industry.

The building regulatory system was largely constructed on this basis. This is the major cause for the perception of increased risks for all parties in this form of construction.

Furthermore, clarification of terms and definitions is necessary for regulatory process for different prefab and modular products.

In particular, definitions are necessary to describe the level of prefabrication (e.g., if structural elements are open or enclosed (i.e., hidden) and what other components are included such as mechanical, electrical, plumbing, and finishes) and the type of prefab (2D panels or 3D volumetric units).

This will assist with clarification of regulatory process for different prefab and modular products.

To implement this recommendation, prefab and modular construction should be explicitly referred to in the NCC. This could be in the form of:

(i) a new Section G of the NCC for prefab and modular construction,
(ii) a separate protocol on prefab and modular construction published by ABCB and referred to in the NCC, or
(iii) an ABCB handbook or guide on prefab and modular construction.

These measures are not mutually exclusive, and all could be used to address different aspects of the problem.

Recommendation 3: That the Australian Building Codes Board (ABCB) establish a project to identify ways to provide prescriptive and performance requirements into the National Construction Code (NCC) to support the orderly use and approval of prefabrication and modular construction, especially for Class 1 buildings.

The National Construction Code (NCC) is Australia's primary set of technical design and construction requirements for buildings. The NCC has traditionally been drafted for convention construction and construction methods.

Whilst the NCC is a performance-based code, meaning the NCC presently can enable the use of innovative forms of construction via development of Performance Solutions to meet the code. However, this pathway is variable in potential acceptance and presents challenges for manufacturers in bringing new products and systems to market and can be costly and time consuming.

Furthermore, the NCC's Performance Requirements are generally drafted in qualitative language meaning it is very difficult and can result in significant inconsistency in what a product or system may need to meet to satisfy the approval body for the project.

This recommendation seeks for the ABCB who produces and maintains the NCC, to establish a project on their work program to review the NCC provisions in how they would apply to modular

and prefabricated construction and to develop new DTS Provisions and Performance Requirements specifically for modular and prefabricated construction to support their orderly use and approval of prefabrication and modular construction for Class 1 buildings.

This recommendation is of particular importance to low-rise residential construction that rely on DTS provisions for its regulatory acceptance.

This recommendation should be referred to ABCB for further consideration. It could also be considered as follow-up action from Recommendation 2.

Recommendation 4: That Standards Australia develop a work program to:

(a) review and modify the relevant construction standards particularly NCC referenced standards for their adequacy to cope with Prefabricated and Modular construction; and

(b) develop a new suite of Australian Standards specifically for Prefabricated and Modular construction to provide industry with DTS construction solutions.

It is necessary to undertake a review and modify the relevant construction standards particularly the NCC referenced standards for their adequacy to cope with prefabricated and modular construction.

This may include work that is required to be performed, supervised, and/or signed off by licensed practitioners. This recommendation is of importance to low-rise residential construction that rely on DTS provisions for its regulatory acceptance.

This recommendation is for Standards Australia to consider as it is a key component of Australia conformance infrastructure.

Recommendation 5: That the current Australian product conformity infrastructure be reviewed for its ability to cope with new prefab and modular products that need testing, individually and as a whole, as the basis for their acceptance in building approvals.

This includes review of CodeMark and the National Association of Testing Authorities (NATA) for conducting tests and providing certifications for innovative products, including prefab and modular components.

The specific need of prefab and modular is to have a compliance and quality assurance system to ensure the products from off-site fabrication can be installed on-site with appropriate safeguards. A similar solution as to the Research Institute of Sweden (RISE) is likely to be suitable for Australia when dealing with products that cannot be assessed according to existing standards.

Recommendation 6: That a manufacturer certification scheme be developed to suit the specific needs of the prefab and modular building industry.

There is a need to ensure that products from off-site manufacturing are consistently used in accordance with their design specifications. A specified voluntary scheme (like the Bill that is to be implemented in New Zealand to allow a new voluntary manufacturer certification scheme for modular component manufacturers) has been suggested as an effective way forward. The building surveyor/certifier still has the final check of the product on-site.

This is the specific need of the prefab and modular industry that the current Australian conformity system cannot cope. Other industries have set up specific certification schemes to suit their needs and the prefab and modular industry could do the same.

Supply chain, financial and contractual requirements

Recommendation 7: That the supply chain roles and responsibilities are made clear with prefab and modular construction in mind and implemented in practice.

Recommendation 8: That a building industry taskforce is set up to further investigate and address barriers associated with contracts, progress payments, licencing, mandatory stage inspections and insurance.

While this is not within the brief of this project, a range of related regulatory and quasi regulatory barriers have also been identified that this taskforce could be tasked with:

(i) Reviewing state & territory building laws and develop a new tailored progress payment arrangement for building contracts for modular and prefab construction to act alongside the progress payment arrangement for conventional construction

(ii) Reviewing and state & territory building laws and develop a new tailored arrangement for staged building inspections throughout the construction process, for those states with mandatory construction stage inspections in place, for modular and prefab construction taking account of differences and to act alongside on arrangements for conventional construction.

(iii) State and territory licencing requirements particularly those states with trade contractor licencing have been developed to reflect works carried out for conventional construction. State & territory licencing laws should be reviewed and expand the existing classes of licences for those parties working on modular and prefab construction.

Other related non-regulatory but barriers to use and acceptance of modular and prefab construction nonetheless includes difficulties to obtain a bank guarantee if it is prefab & modular construction higher insurance premium for prefab and modular design and construction.

The taskforce should look at what other improvements could be made to address these matters.

Education and government support

Recommendation 9: That the industry is upskilled by setting up specialist courses for prefab and modular construction.

This will serve the dual purpose of:

(i) Improving national capability; and

(ii) Increasing awareness among building surveyors/certifiers, engineers, architects, and builders for this form of construction.

Recommendation 10: That the Australian governments provide incentives and support by encouraging increased use of prefab and modular construction in their procurement specifications.

Government incentives and schemes with provide schemes which provide guarantee and assurance to lenders, such as Build Offsite Property Assurance Scheme (BOPAS) introduced in the UK, can assist with the uptake of off-site constructions.

The benefits of such policy include:

(i) Providing manufacturers with more projects to recover their initial setup cost;

(ii) More builders will transform their practice to be able to participate, and

(iii) More research and development activities in innovation and smart technologies.

Concluding remarks

It is critical that the Australian government, along with state and territory governments, move quickly to recognise prefab and modular construction as an appropriate form of construction in Australia and as a viable solution for solving the affordability of residential buildings.

It is clear that definitions lead outcomes, and in the case of prefab and modular construction, conflicting definitions are leading to much of the confusion for industry and governments. Making change here is possibly the 'quick win' that could be achieved, with the subsequent benefits potentially very long lived.

Apart from reference to other organisations such as Standards Australia for further consideration, the most feasible immediate follow-up action is to produce a guideline or a protocol for prefab and modular construction to be referenced in the National Construction Code.

The protocol will clarify factors to be considered to satisfy regulatory requirements for prefabrication and modular construction. This would be an appropriate response to Recommendations 2 and 3, and would provide the necessary regulatory basis for Recommendations 4, 5 and 6.

This protocol should be drafted by an industry committee headed by an appropriate industry body such as HIA and submitted to ABCB for reference in the National Construction Code.

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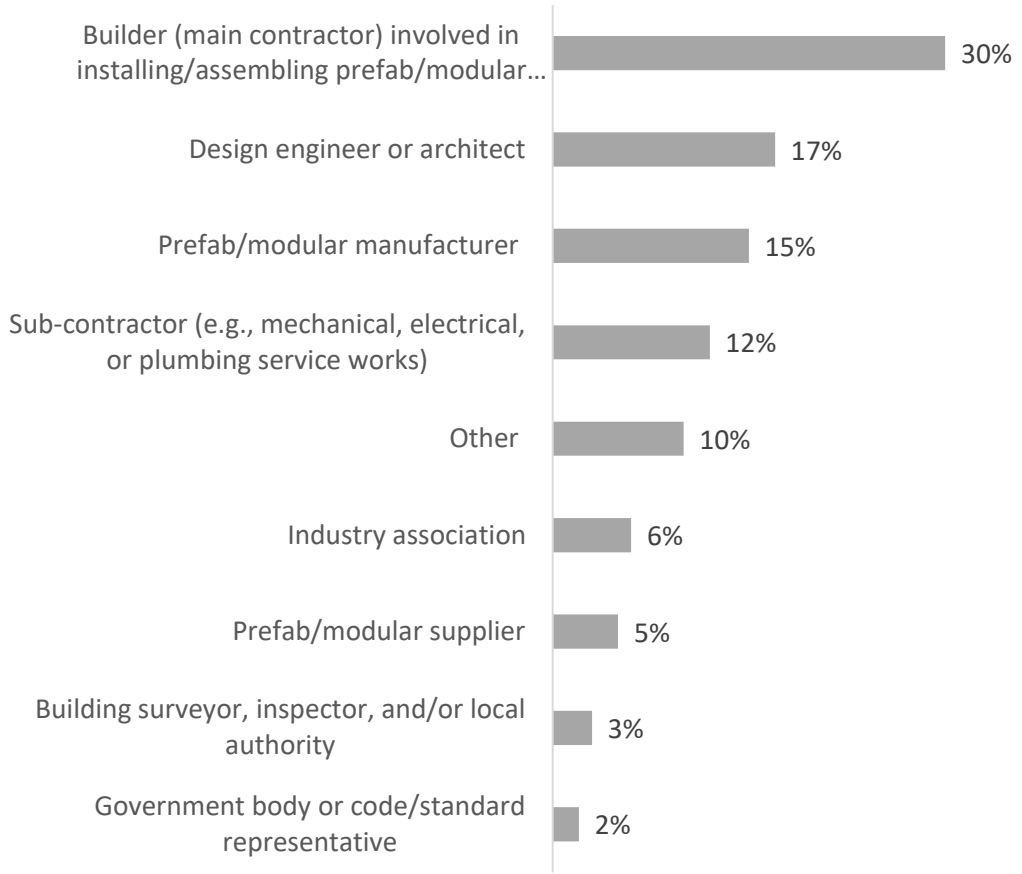
Appendix A: Summary of responses to survey questions

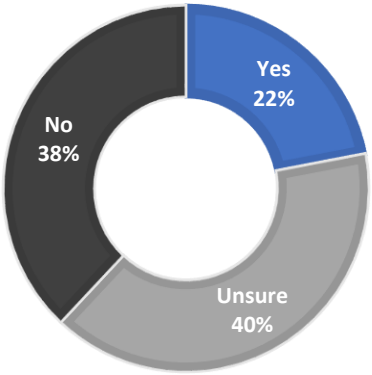
1. **Which type of organisation/work do you associate yourself with?** (You can select one or more options)



'Other' included:

- Academic
- Builder of non-prefab
- Carpenter
- Construction manager
- Contract administrator
- Customer
- Developer
- Draft person
- Energy efficiency consultant
- Estimator
- Precast concrete manufacture and erection industry
- Town planner

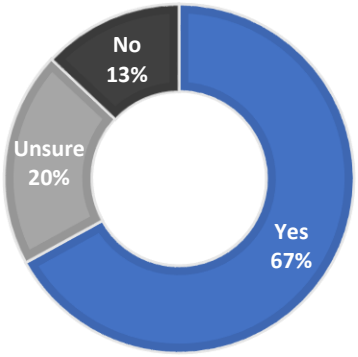
2. In relation to prefab and modular construction, do you have preferred terms to be used for regulatory purposes? (Yes, No, Neutral) If yes, please explain.



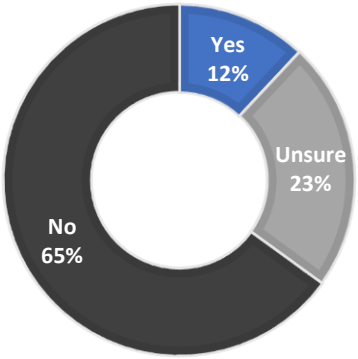
Participants responded that it would be good to use terms with clear and accurate definitions that are applied to all Government regulations. The terms should take into account the level of prefabrication, for example, prefabricated concrete wall panels versus prefabricated homes that are delivered to the site ready to plumb, with electrical connection, and ready to go. Some participants also highlighted that the terms should also consider the delivery, quality assurance process, and efficiency. It was also highlighted that the terminology used distinguishes between 2D and 3D volumetric components. It was noted that prefab is used in reference to off-site manufactured panels, systems, and components whereas modular is the term used for volumetric construction. Some respondents also noted the difference between prefab, panelise, and modular, where prefab is commonly used for wall frames & roof trusses, panelised is used for wall panels (open/closed) or floor/roof cassettes, and modular is used as volumetric modular.

The terms in relation to the type of off-site constructed buildings were also discussed. Namely, the different terms available in Queensland and New South Wales. It was noted that in QLD, the term "Modular Building" is used which is deemed as a Class 1a Single Dwelling house for the Planning Act and does not affect the use of the building for compliance purposes. However, in NSW from the NSW Home Building Act 1989, the available terms are "Kit-home" or "Manufactured home" which do not accurately define the product that some manufacturers are producing. For example, a manufacturer can provide a dwelling house constructed in a factory, separated into modules, shipped, and re-assembled on the chosen site. These manufacturers believe that NSW does not obtain a current definition for this type of building work and hence creates difficulty in obtaining compliance for what should be considered as a dwelling house.

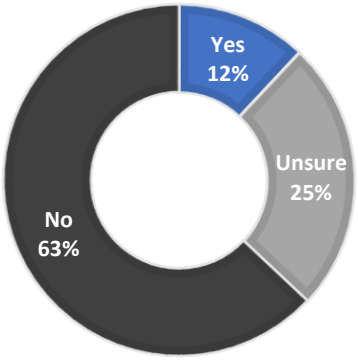
3. Do you think we should promote the use of a fixed set of definitions based on the level of prefabrication for technical and regulatory use? (Yes, No, Neutral)



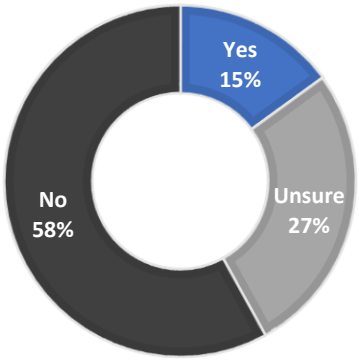
4. Are you aware of any research on regulatory issues in Australia as a barrier to the development of the prefab industry? (Yes, No, Neutral) If yes, please explain.



5. Are you aware of any regulations from any country specifically designed for the prefab industry that could be introduced in Australia? (Yes, No, Neutral) If yes, please explain.



6. **Are you aware of any schemes from any country that facilitate the prefab industry and could be introduced in Australia?** (Yes, No, Neutral) If yes, please explain.

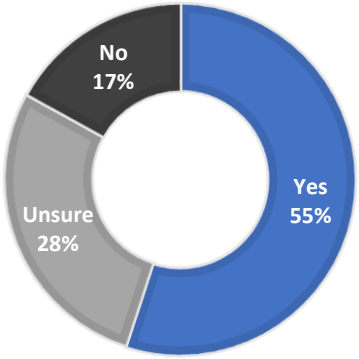


Participants highlighted a few countries/regions with schemes that may be suitable for Australia, including the UK, Europe (specifically some noted Germany, Northern Europe, all of Europe), the USA, Canada, and Vietnam. In particular, the schemes available in the UK were discussed, including the Modern Methods Construction (MMC) bill. It was highlighted that the UK Government has introduced new specifications/criteria which prefer builders of government construction projects that adopt modular/prefab design in their buildings. The Australian Government should consider increasing incentives/funding to promote extensive investment in technology in this area but needs to tackle the building code changes that are necessary to improve the efficiency and practicality of modular construction.

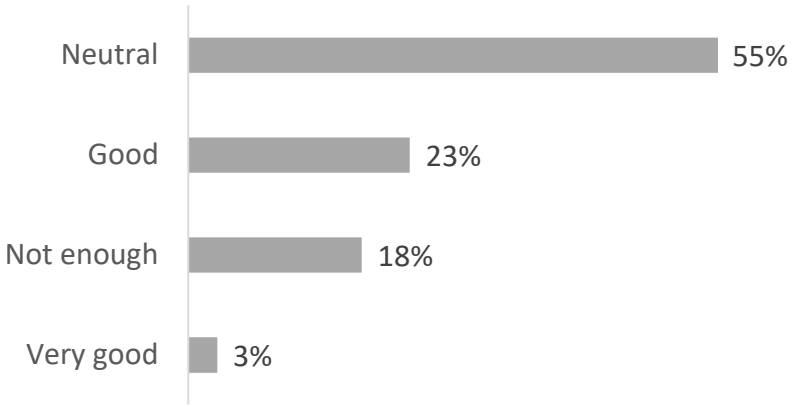
Furthermore, for finance, it was suggested that the work that Offsite New Zealand has done for negotiation with Westpac is a good example for Australia.

It was also noted that some South American countries have seen modular design and construction methods used in conjunction with economic schemes. The housing infrastructure is partially resolved with technical details that allow the buildings to be easily developed in the future.

7. **In lieu of changing or making new regulations – is better use of current regulations and more guidance and supporting tools the answer?** (Yes, No, Neutral)

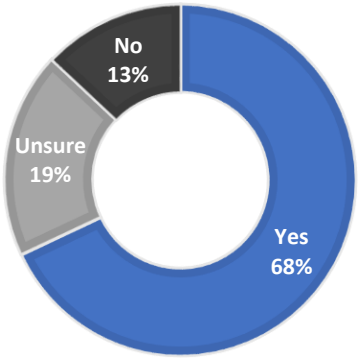


8. **What level of support does the Handbook for modular structures by the Modular Construction Codes Board provide?** (Very Good, Good, Neutral, Not enough) Please explain your rating.



In general, it was noted that the Handbook by the MCCB provides good general information about modular buildings, however, it was noted that it could be expanded. It was highlighted that details are required to address planning barriers and risk-averse culture in Australian urban growth. Furthermore, the Handbook could be improved by cross-referencing to or correlating with the NCC, as well as providing case studies with respect to the application of the NCC to modular construction. Furthermore, many respondents noted that they were not familiar with the code.

9. **Do you think any improvements/changes need to be made to existing planning and building codes and Australian Standards to assist with the uptake of prefab and modular buildings?** (Yes, No, Neutral)



The following questions are in relation to the regulatory acceptance process:

10. In your opinion, what are the key differences in regulatory compliance between on-site and off-site construction and do you think there are 'grey' areas that require clarification?

    The following key points were raised about the key differences in regulatory compliance between on-site and off-site construction:

    - Planning issues. Participants highlighted their challenges with local town planning, especially as every state and council is not willing to approve any new concepts promptly whereupon delays exhaust enthusiasm to giving up.
    - Inspection and approval process. For a closed panel system, it is not possible to complete a framing inspection on site. It is also difficult to complete in the factory because generally, only one panel will be under construction at any point in time. Similarly, an inspection of services is difficult when they are hidden in walls, etc, and becomes more challenging when the product is built in a different local authority to the site where it's going to be installed. It was noted that if the mandatory stage inspections can be satisfactorily undertaken both within the pre-fabrication process and on-site, the regulatory framework can remain similar and compliance with the same building codes for prefab and on-site construction can be achieved.

      Some also note that modular projects currently appear to get around traditional legislation and that specific legislation is required to rectify this issue. It was suggested that a new type of inspector is required during construction that can certify each as-built building (engineers and certifiers) in the factory and then re-certify once on site.
    - Demonstration of compliance. This is especially a concern for higher-level prefabricated products. It was noted that there is insufficient detail and testing of products coming to the market. Some modular home manufacturers highlighted that they do not seek any exemptions to the current codes and that there should be little, if any difference, in the final product performance. Regulatory compliance for off-site construction is challenging when it comes to innovation as some stakeholders do not know how to deal with the different construction methods. Other participants suggested that the difference between off-site and on-site is minimal, especially if the off-site construction works are certified in line with engineer detailing or Australian Standards.
    - Benefits of energy efficiency not completely realised. Nature of energy efficiency compliance, smaller homes have smaller energy usage and the potential to be fully off-grid. The standard JV3 and DTS methods of assessment may not fully appreciate the nature of these homes being more energy-efficient.

    Furthermore, the challenges associated with finance were raised. Current progress payments are suitable for on-site construction work. It is difficult to get funding when there is no physical asset on-site.

    The following specific points were raised in terms of design:

    - Fire compartments are difficult to achieve.
    - All buildings should be built to the highest wind loading to allow relocation without constraint.

- Challenges with clearance heights, the natural ground level (NGL) to the first structural member is difficult to achieve NCC compliance.

The following recommendations/suggestions were also provided:

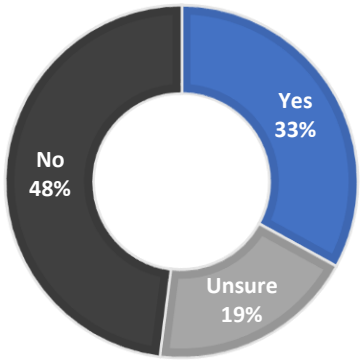
- Better use of BIM CAD tools for virtual inspections and compliance photos/processes in the factory are options to improve quality assurance.
- A separate section needs to be introduced with Safety in Design requirements since most of the construction work is done in a factory environment.
- Essential to maintain 3rd party certification including for on-site work.
- Certification of the end product will need to be more comprehensive as compliance and checking off-site prior to transportation is not an option.
- Suggestion to have a NCC volume 4 for modular construction, and that one code not numerous standards would be easier to deal with.
- Off-site construction needs to follow a manufactured product approach. Typically, the quality of the product is higher because built in a factory-type environment. For on-site construction, the quality is highly variable depending on the day and personnel involved. The level of supervision also seems to be lower for on-site.

11. How long does the regulatory acceptance process take for prefab/modular buildings and how does this compare with conventional buildings?

A mixed response was observed for this question. Some participants stated that there was little or no difference between on-site and off-site homes in terms of compliance time and the number of hurdles. Whereas, other participants noted that the process is significantly longer for off-site construction. A participant noted that it can be nearly three times as long due to town planning issues caused by inexperience and fear to approve this kind of work, and that it is not unusual to wait two years and go to arbitration. Some also noted that both off-site and on-site face similar challenges when the final resolution to achieve sign off is protracted. However, in on-site construction this issue can usually be resolved through the building approval documentation stage whiles the site preparation works are in progress. Whereas, for off-site construction, since these construction activities are concurrent rather than in a linear sequence, the delays become an issue.

Specifically, it was noted that in NSW, the regulatory compliance framework does not support modular buildings under the provisions of the State Environment Planning Policies (SEPP). Therefore, the Local Government local environmental plans (LEP)/development control plans (DCP) provisions are sought for compliance where most Local Government (LG) provisions do not include the term 'Modular Building' and therefore fall into a 'Miscellaneous' category of a 'Section 68' assessment. This can cause a myriad of issues that relate to the permissible use of Modular Buildings within the LG area and the inability for a specific framework to be assessed against. It was noted that without these mechanisms, builders/designers are finding it hard to properly plan and design a complaint dwelling for both clients and contracts. It was suggested that a specific SEPP statute is passed for modular/prefab homes to assist with regulatory compliance of modular houses.

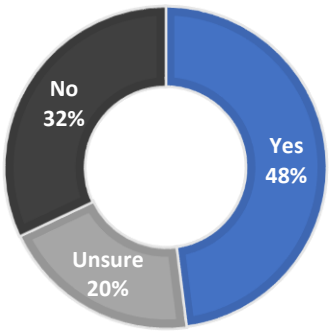
12. **Have you had experiences with projects using modular or prefab construction that have been unnecessarily hindered by planning or building regulation**? (Yes, No, Neutral). If yes, please explain your answer.



The participants that answered 'yes' to this question noted the following issues with planning and building regulations:

- Development of a suitable fire resistance level (FRL) performance solution for Type A construction.
- Concerns with having the installation determined as temporary and not needing fire hydrants installed throughout the development as it was argued that the buildings were hard-wired, connected to sewer/water, and welded to the foundation, thus making it permanent.
- Concerns with different types of external finishing systems. For Victoria, it was noted that there is a lot of focus on external facades which increases the project cost.
- Approval panel not familiar with the modular process. Some participants noted that they build in a lot of remote areas and some councils need more information to gain an understanding that it is not a caravan, however, this is usually easily navigated through to approval.
- Due to the speed of construction, the local government was too slow in approvals.
- Specific issue in NSW was raised again that the regulatory compliance framework does not support modular buildings under the provisions of the SEPP. Therefore, the Local Government LEP/ DCP provisions are sought for compliance where most LG provisions do not include the term Modular Building and therefore fall into a Miscellaneous category of a "Section 68" assessment.

13. **Do you think factory sign-off could be used as a solution, including factories not located in Australia?** (Yes, No, Neutral)



14. **How do you think the regulatory acceptance process can be improved for prefab/modular buildings?**

    The following improvements were suggested by the participants:

    - **Planning.** To change planning provisions that allow developers to put 'no prefab' caveats on estates.
    - **Building code and standards.** Some participants noted that they would like the development of new codes and standards that are specifically for prefab and modular constructions. Many of the standards are developed internally at significant cost, it would be great to see the industry cover off-site considerations in terms of areas outside of on-site construction. An example is transport, whilst there are standards for transport it is not readily known how to apply these to off-site construction, many transport operators are not aware of how to determine the best practice for moving large custom elements.

      It was also highlighted that whilst a regulatory environment such as the NCC is performance-based, it still does not sufficiently recognise the project delivery methodology and provide for acceptable alternative pathways to achieve a performance outcome. This results in frequent site-specific custom solutions and the inherent cost of development. In contrast, some participants stated that modular dwelling houses can still comply with all deem-to-satisfy provisions of the NCC and that there are no issues to address.
    - **Certification and approvals.** Some suggested that the factor should provide a certificate of compliance while others stated that certifiers should attend the factory to provide approval prior to transportation. It was also noted that an introduction of a regulatory mechanism where the manufacturers can attain accreditation of standardised prefab/modular systems as meeting a range of NCC requirements could be useful.

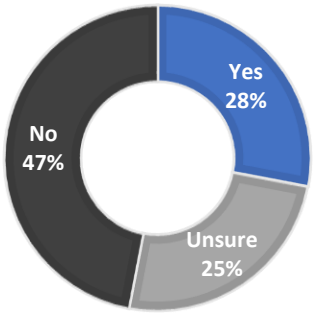
      Furthermore, bulk compliance based on audits and 'product testing' post-construction was also suggested. It was noted that predominantly these are production line manufactured buildings and they should have an updated regulatory process to better suit this type of manufacturing.

      Concerning imported products, it was highlighted that a greater level of scrutiny is required for inferior prefabricated buildings.

- **Finance**. It was noted that the government needs to amend the contracts Act to support builders financially so that they do not have to fund projects upfront.
- **Education.** Regulators to become more familiar with off-site construction. Furthermore, changing the generally negative perceptions of off-site construction and educating people about the advantages.

The following questions are in relation to building codes and standards:

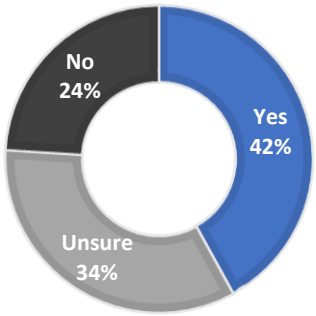
15. **Do you think that current planning and building codes are difficult to apply for prefab and modular buildings?** (Yes, No, Neutral). If yes, please explain your answer.



The following responses were provided for the participants who agreed that current planning and building codes are difficult to apply for prefab/modular buildings:

- Difficult with planning, especially the NSW problem as stated previously.
- Difficult to show compliance even though the system performs better than the traditional method.
- Harder to achieve energy star rating due to floor disconnected from the ground.
- They have become too difficult to apply to building in general, the regulatory system needs to be reviewed for efficiency and suitability for purpose.
- They are hard because the BCA is hard. It keeps people safe and should not be watered down.

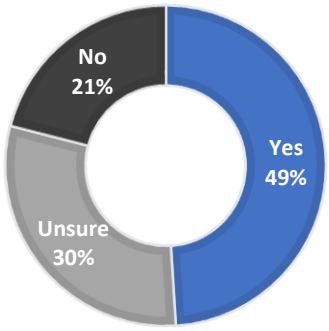
16. **Do any improvements or changes need to be made to existing Australian Standards or should there be specific Australian Standards developed for modular and prefab construction?** (Yes, No, Neutral). If yes, please explain your answer.



The following responses were provided for the participants who agreed that changes need to be made to existing Australian Standards for modular and prefab construction:

- A code for modular construction would make approvals easier.
- A specific Australian Standard would help to show the industry has a national acceptance level. It was also noted that the standards need to be updated to keep up with technology.
- Consideration of renovations.
- Allow for international suppliers.
- There need to be real compliance verifications throughout the building process, using independent personnel.

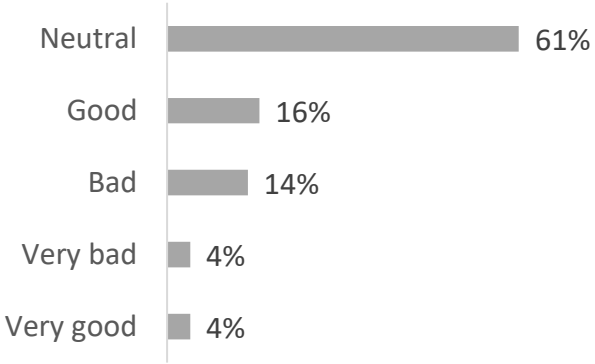
17. **Should the NCC have a dedicated Section dealing with prefab and modular buildings or should this be left to Performance Solutions?** (Yes, No, Neutral).



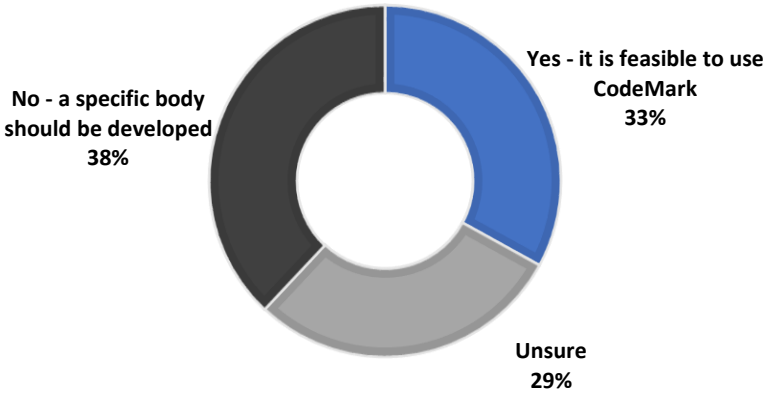
18. **What method do you use, or do you think is used, to demonstrate conformity and quality assurance? (e.g., self-certification, third-party independent product certification, factory and production certifications, traceability measures such as product identification methods).**

    A mixed response was observed for this question. Some participants noted that all forms of demonstration of conformity and quality assurance (the examples provided in the question) are necessary, while others note specific ones, including a combination of self and third-party certification, factory and production certifications, independent audits, internal factory quality assurance processes and certifications by qualified engineers.

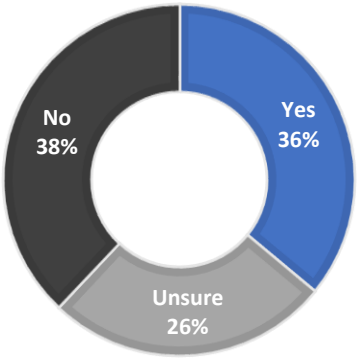
19. **How effective do you think the current method to demonstrate conformity and quality is**? (Very good, good, neutral, bad, very bad)



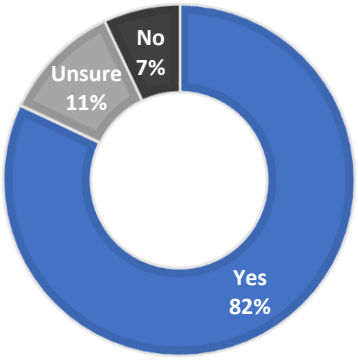
20. Do you think it is feasible to use CodeMark for evaluating prefab/modular products or should a specific body be setup to perform the task for better efficiency? (Yes – it is feasible to use CodeMark. No – a specific body should be developed, Neutral)



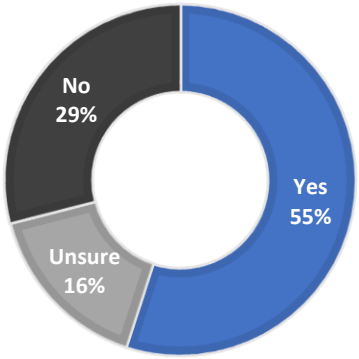
21. Do you think compliance should be left to developing performance-based solutions? (Yes, No, Neutral)



22. Do you think we need on-site validation as a means of certification as a fully assembled structure? (Yes, No, Neutral)

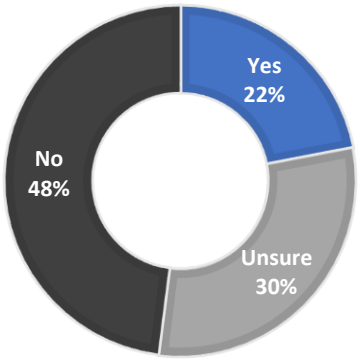


23. **Would development of prototypes for testing and certification be a means to overcome certification and testing issues?** (Yes, No, Neutral)



The following questions are in relation to chain of custody:

24. **Do you think the responsibilities and roles of stakeholders in the supply chain for prefab is clear?** (Yes, No, Neutral)

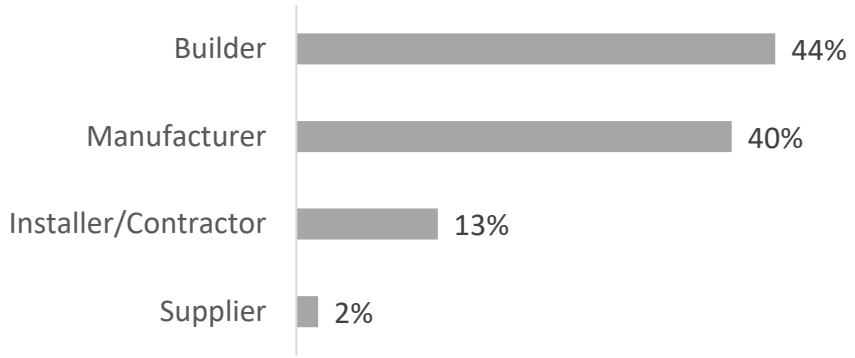


25. **Who do you think is responsible for ensuring the quality of the final product?**

    A mixed response was provided for this question. Notably, many stated that they expected the builder/head contractor or the manufacturer to be responsible for the final product, while others noted that the responsible party is dependent on the type of damage observed. Other responses were also provided, including:

    - All parties involved in the delivery from the manufacturer to the end-user.
    - All stakeholders associated with the building industry including government bodies.
    - Both the builder/installer and the factory.
    - Builder if same as manufacturer, otherwise manufacturer. The manufacturer needs to identify ways to sign off or certify components.
    - Whoever caused the defect must take responsibility.
    - Manufacturer, transporter, and installer.
    - Building surveyors and engineers

26. Who do you think is responsible for defects (Builder, Manufacturer, Supplier, Installer/Contractor)



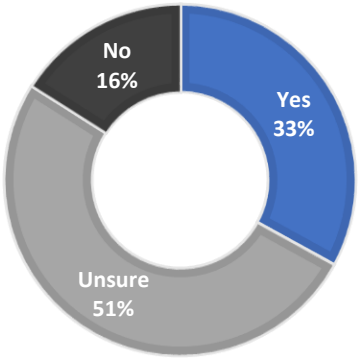
Final general questions:

27. In terms of motivation, opportunity and capability, in your opinion what is the main factor that is holding us back?

The following responses were provided:

- Government town planning rules (e.g., planning rules that limit multi tiny houses estates).
- Finance and payment schedules.
- Very expensive insurance.
- High initial start-up or set-up cost for manufacturing facilities.
- Costs associated with transportation.
- Unclear regulation and compliance pathways.
- Attitudes and understanding of the off-site industry, it is a method of building houses.
- Builders not supporting innovation.
- Architects not supporting of off-site construction because feel that they are not as involved or required for the design of buildings, as well as fewer variations allowed once the design is finalised.
- Education within the industry. Fundamentally the requirements for buildings exist in existing legislation and regulation, and the onus is on the industry to comply. There seems to be motivation to bypass building requirements purely because it is hard to accommodate within the manufacturing process.
- Difficulty in obtaining approvals due to non-experienced building surveyors/certifiers.
- Road transport restrictions limit design options and make it harder to comply.
- Builders' acknowledgment that they need to be accountable for the product that they deliver. It needs to be backed up by real insurance policies, that cover the consumer should the builder not deliver upon the quality. Each builder needs to have a star rating applied based on valid claims made by the consumer.
- Scale, not necessarily enough demand for off-site constructed buildings.
- Vested too heavily on Australian manufacturers.

28. **Do you think there are any other regulatory barriers that should be investigated?** (Yes, No, Neutral) If yes, please explain.



The following responses were provided:

- Approvers aren't up to speed with new technology.
- Contracts Act needs to be changed.
- Nobody regulates the builders now.
- Non-compliant products such as imported modular buildings that do not comply with our current Australian Standards.
- Progress payments.
- Government support.
- Transportation and logistics.
- Finance (security of payments), title & ownership.
- Sustainably including life cycle costing. Ability to achieve zero emissions buildings.
- Long term testing (at least 10 years) before a product is brought to market.
- Standard forms of construction contracts might be able to be modified to create a modular-specific contract, with emphasis on the design hold points.